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# HANDBOOK OF CAST IRON PIPE

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OF

# CAST IRON PIPE

FOR

## Water, Gas, Sewerage and Industrial Service

**Second Edition**

*Service Mark Reg.*

CAST IRON PIPE RESEARCH ASSOCIATION
Chicago 3, Illinois

Price $5.00

Printed in the United States of America

## Preface to Second Edition

THE first edition of the "Handbook of Cast Iron Pipe," published in 1927, has had a distribution of nearly 50,000 copies among water and gas utilities, municipal and consulting engineers, and all principal engineering schools.

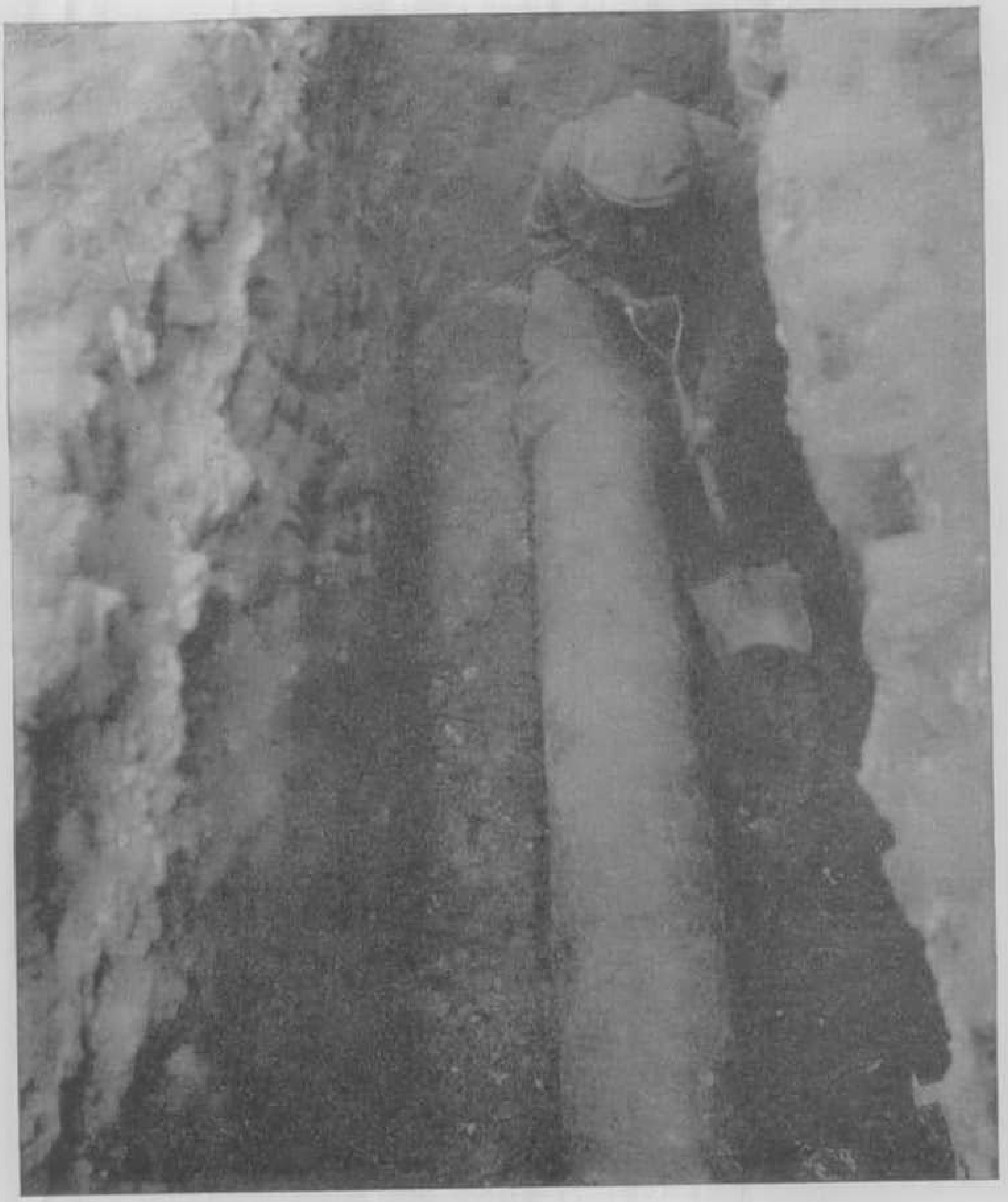
The present second edition includes much new material due to important changes that have occurred in the Cast Iron Pipe industry in the past two decades; among these are new specifications for pipe; increased knowledge of stresses in underground piping; advances in foundry practice and foundry control; the development of new joints; new data on coefficient of flow in pipe; and improvements in pipe laying practice. Because of these changes new sections have been added to the Handbook and other sections rewritten in the light of present day knowledge.

Among the new sections are those dealing with new processes of manufacture; specifications for centrifugally cast pipe; submarine joints; short bodied fittings, and mechanical joint pipe. The section dealing with carrying capacity has been changed in its entirety and includes a number of flow tests on cement lined pipe. The section on pipe laying has been revised to conform with practices known to be desirable on the basis of tests at the University of Illinois and Iowa State College in connection with the preparation of the American Standards Association Specification for Cast Iron Pipe.

In general this second edition of our Handbook aims to give complete information regarding the use of cast iron pipe for service underground, above ground and underwater.

CAST IRON PIPE RESEARCH ASSOCIATION

December, 1952



*America's oldest cast iron water main, laid in Philadelphia in 1821*

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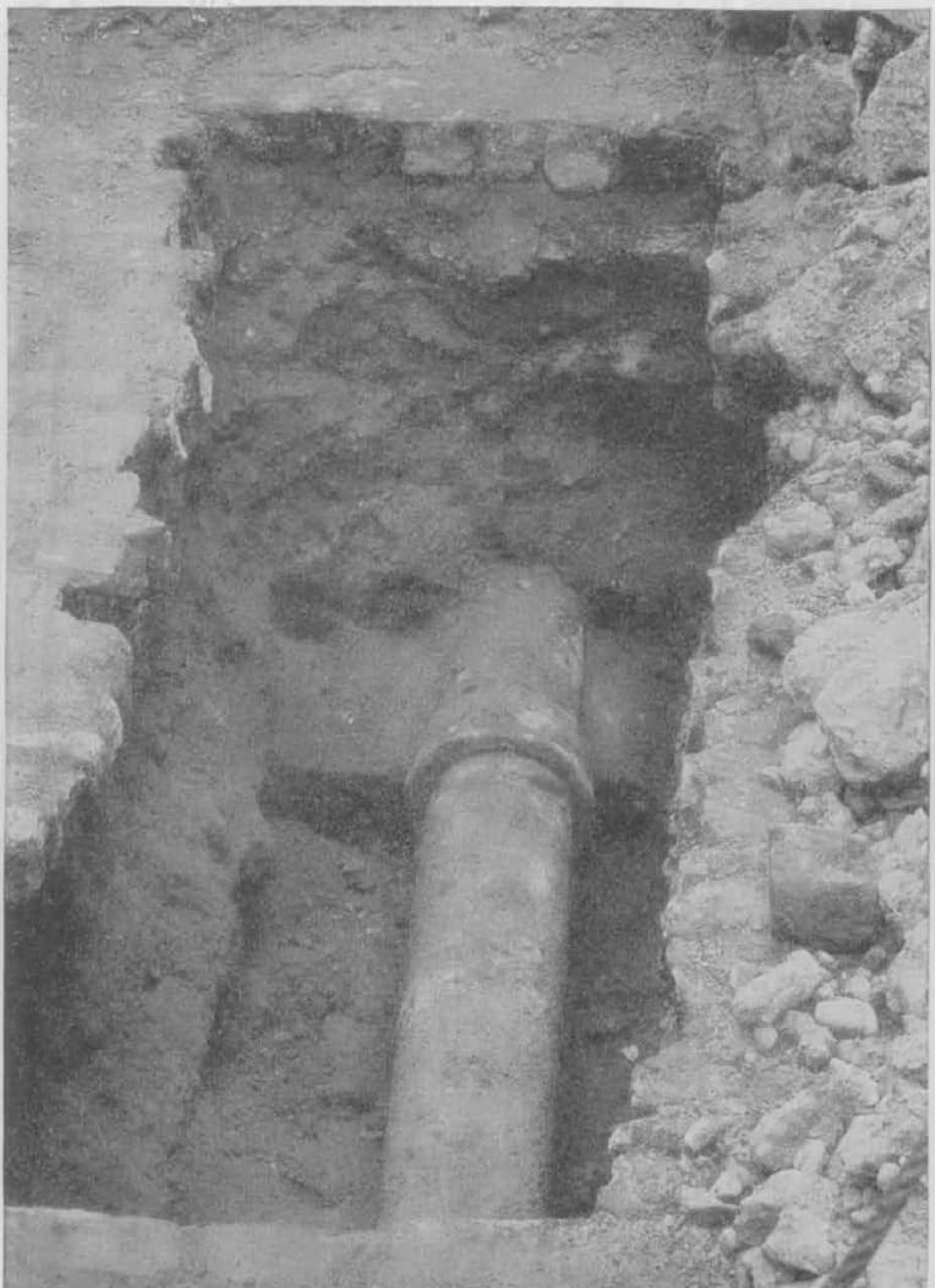
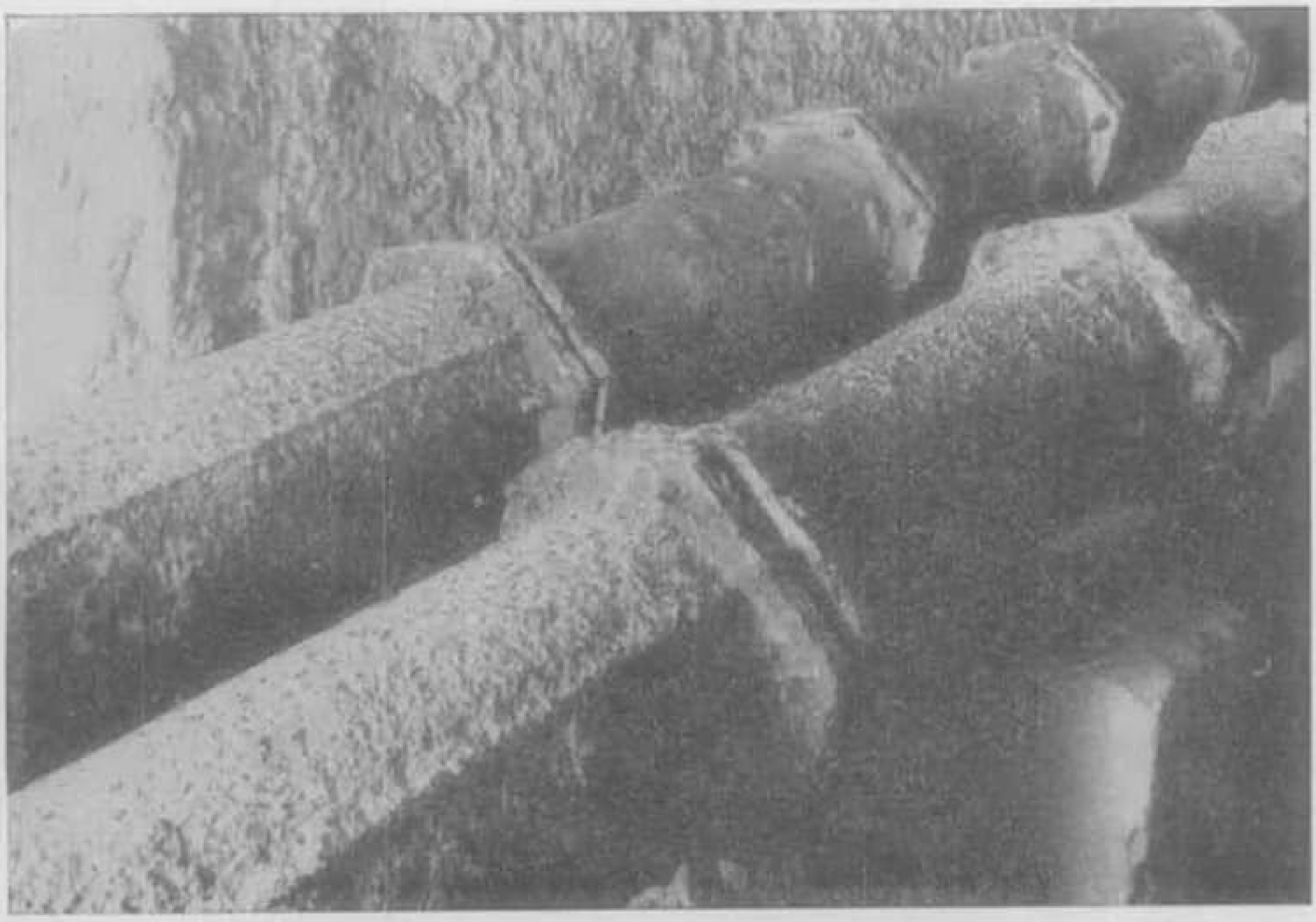


*America's oldest cast iron gas main, laid in Baltimore in 1834*

# SECTION I

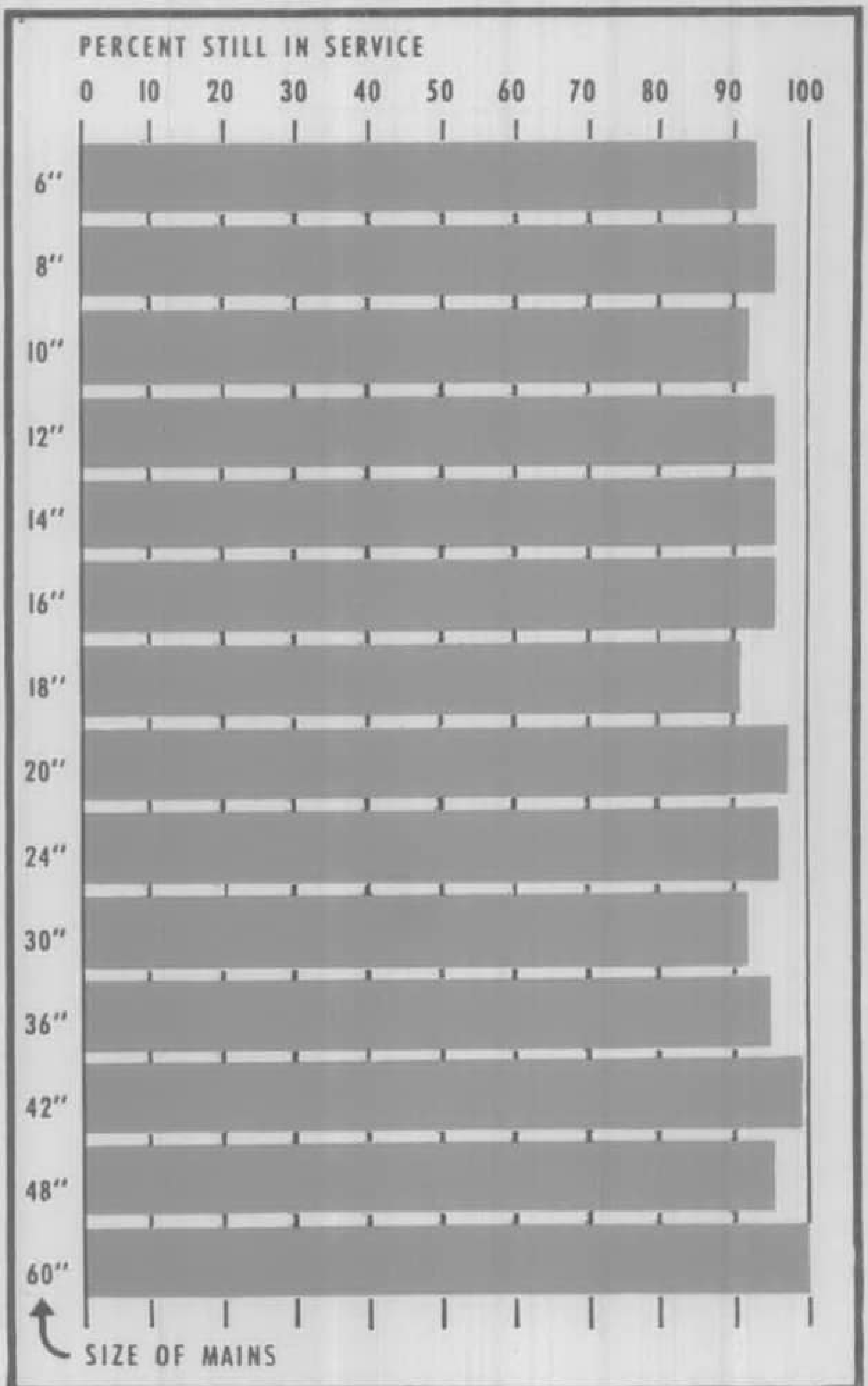
## Evolution and History of Piping



*This cast iron water main installed at Versailles, France, in 1664 is still in service*

## SERVICE RECORDS OF CAST IRON WATER MAINS IN 25 CITIES

**96% of all 6-inch and larger mains are still in service.**




*Based on reports of the study directed by a Joint Committee representing the American Water Works Association, New England Water Works Association, and the Institute of Water Supply Utilities.* *(See pages 10-11.)*

# SECTION 1
## Evolution and History of Piping

THE first pipe used as a conduit for water was probably made of baked clay. Archeologists have unearthed in ancient Mesopotamia twin lines of baked clay tubes and a number of tees and bends, which served as part of the plumbing system of Nippur. A later and more elaborate use of clay pipe was in the drainage system of the House of Minos at Cnossus on the island of Crete, *circa* 2000 B.C.

Other forms of early conduits were pipes made of wood and lead, masonry channels, pierced stones cemented together, tunnels and aqueducts. Greatest achievements of the ancient water works engineers were the vented tunnels and the aqueducts bringing water into Grecian and Roman cities, there to be distributed to neighborhood fountains, and residences of the wealthy, by clay, wood and lead pipe. Despite the short life of wood pipe, breaks in clay lines, and imperfectly refined lead, these old Roman materials continued to be used down through the middle ages in European cities and, in fact, until 1738 when the substitution of coke for costly charcoal in the reduction of ore made cast iron pipe available to water works at a price they could afford.

#### FIRST LARGE-SCALE WATER DISTRIBUTION SYSTEM

The cities that sprang up in Europe during the middle ages, taking advantage of growing knowledge of the principles of mechanics and hydraulics, were ultimately able to expand distribution systems. London, typical of such cities at the beginning of the 17th Century, was in dire need of an adequate system.

Sir Hugh Myddelton, generally referred to as the "father of modern water distribution systems," built in 1609-1613 his New River Aqueduct and laid more than 400 miles of wooden mains, in addition to pipe previously installed. A water power pumping plant had been built at London Bridge in 1582, and the city no doubt considered itself equipped with an adequate water system. Yet defective piping was giving constant trouble. The wooden pipe leading from the pumps could not withstand the pressure required to force water into the upper stories of many houses and its rapid deterioration gave it an average life of only ten to fifteen years. In addition, the great fire of 1666 destroyed quantities of both lead and wood pipe at the time when it was most needed.

### A REVOLUTIONARY EXPERIMENT

After the London fire, English engineers must have followed with keen interest an experiment with cast iron pipe then being made in France. King Louis XIV had ordered the construction of a cast iron main extending for 15 miles from a pumping station at Marly-on-Seine to Versailles to supply water for the fountains and town. The first authenticated installation of cast iron pipe for the purpose, it is still functioning after more than 280 years. When the line was begun (1664) the production of iron in England and Europe required the use of expensive charcoal for the reduction of the iron ore. Attempts to produce a lower-cost iron by the use of coke instead of charcoal were unsuccessful until 1738. Immediately thereafter, cast iron mains began to be installed by the more progressive cities.

### INVENTION OF BELL AND SPIGOT JOINT

The joints of these early cast iron lines were of the flanged type, with lead gaskets. These joints, although unsatisfactory, were used until Sir Thomas Simpson, engineer of the Chelsea Water Company, London, invented the bell and spigot joint in 1785. It was adopted soon afterwards when that Company relaid a forty-five-year-old line whose bolted joints had "perished." Thus was developed bell and spigot cast iron pipe which has been used extensively ever since. Many of the original bell and spigot lines are still in use, apparently good for more centuries of service.

Most of the cities of this country are young enough to have built their distribution systems with pipe that is the standard material today. Some of the older cities, however, went through disagreeable experimental stages with other kinds of pipe before building cast iron systems.

### CAST IRON THE STANDARD MATERIAL

Since the introduction of cast iron pipe in the United States, shortly after 1816, substitutes of various materials have been offered as suitable for water distribution mains. That none of these has proved able, throughout 130 years, to supplant cast iron pipe in the confidence and preference of water works engineers, is demonstrated by the fact that *more than 95% of all the distribution mains in our principal cities are cast iron mains*. Many of these mains have been in service from 100 to

125 years. In filtration plants also, more than 95% of all pipe installed is cast iron pipe.

A survey of survival and retirement experience with water works facilities in 25 representative cities, from Canada to Florida, disclosed that 96% *of all cast iron distribution mains, sizes 6-inch and over, ever laid in those cities, were still in service.* (See Chart on page 8.) The survey, recently completed, was directed by a committee representing three water works associations and the findings published by the American Water Works Association.

Because of such expert evidence and the cumulative experience of generations of water works engineers, cast iron pipe remains more strongly intrenched than ever in its acknowledged position as the standard material for water distribution mains.

### CAST IRON PIPE FOR GAS

An Englishman, William Murdock, is usually called the "father" of the gas industry. In 1792 he succeeded in distilling coal in an iron retort and piping the gas seventy feet through tinned tubes to his residence to be used for lighting purposes. Later he lighted the foundry of Boulton, Watt & Co. with gas and introduced the "gas tip" which later came into general use.

In 1812 the London and Westminster Gas Light and Coke Company was granted a charter. The following year the Westminster Bridge was lighted and the citizens of London were dumfounded by the spectacle. The system was extended rapidly thereafter. In 1816 the gas meter and gas holder were developed.

Following its success in London, gas lighting spread quickly to other countries. In the United States, Baltimore in 1816 was the first city to light its streets with gas.

In designing early distribution systems in this country and abroad, gas engineers benefitted by the experience of water works engineers before them and constructed their mains with cast iron pipe. The Baltimore company imported cast iron pipe from England until 1834 when a pipe foundry was built at Millville, New Jersey, the forerunner of an industry destined to play an important part in the development of the gas industry in America. Indeed, from its beginning in London in 1812, the gas industry may be said to have had its roots in cast iron pipe.

### GROWTH OF GAS INDUSTRY

For half a century our use of gas was confined largely to street-lighting, due to high cost of production. The great growth in gas consumption for home-lighting began at the close of the Civil War. The gas stove was introduced at the Centennial Exposition in Philadelphia in 1876. Today, the gas industry serves more than twenty million customers, and a population of ninety million people, with manufactured, natural or mixed gas for cooking, heating and industrial purposes.

### DEVELOPMENT OF MECHANICAL JOINT

Until a quarter-century ago, the bell and spigot joint was used, as it is today, for mains distributing manufactured gas. It gave good service because manufactured gas contains sufficient moisture to keep the jute packing in a damp, expanded condition resulting in a tight joint.

With the advent of dry natural gas, and higher working pressures, the cast iron pipe industry developed and perfected a new type of joint to meet the changed requirements. This is called the Mechanical Joint and consists of four elements: (1) A special socket cast integral with the pipe; (2) a rubber gasket; (3) a cast iron gland or follower ring; (4) necessary cast iron bolts. It is fully described in another section (see page 237). In early tests by the American Gas Association laboratory, and subsequent performance in thousands of installations, it has been proved bottle-tight at all working pressures.

### CAST IRON PIPE IN SEWERAGE SYSTEMS

Since the development of water supply systems, by the Greeks and Romans, sewage has been transported by water carriage to rivers and large bodies of water. It remains true today that without a water supply there can be no sewerage system.

The early conduits for sewage disposal and for water distribution were, as previously stated, clay, stone, lead and wood pipes. Centuries later, large cities in Europe and this country built sewers of brick, vitrified clay and concrete. Unfortunately, in the light of later developments, these were combined sewers carrying both storm water and domestic sewage.

### DEVELOPMENT OF SEWAGE TREATMENT

The importance of cast iron pipe as a factor in sewage works construction began with the development of sewage treatment at about the turn of the century. Public health officials promoted sewage treatment as the only answer to the problem of sewage disposal without pollution of the air or of streams, lakes and coastal waters.

The primary purpose of a municipal treatment plant is to treat domestic sewage which is a dilute liquid rarely containing more than 1/10th of 1% of total solid matter. The volume of domestic sewage to be treated should govern the size of the plant and its investment and operating costs. To insure an influent that would be confined to domestic sewage required separate sanitary sewers that would be leak-proof and infiltration-proof. From generations of experience in the water works field, cast iron mains were known to have tight joints that would not permit leakage or infiltration. Thus was created a wide demand for cast iron pipe for influent mains and, because of its effective resistance to corrosion, in the construction of plants as well. More than 90% of the pipe in all treatment plants is cast iron pipe.

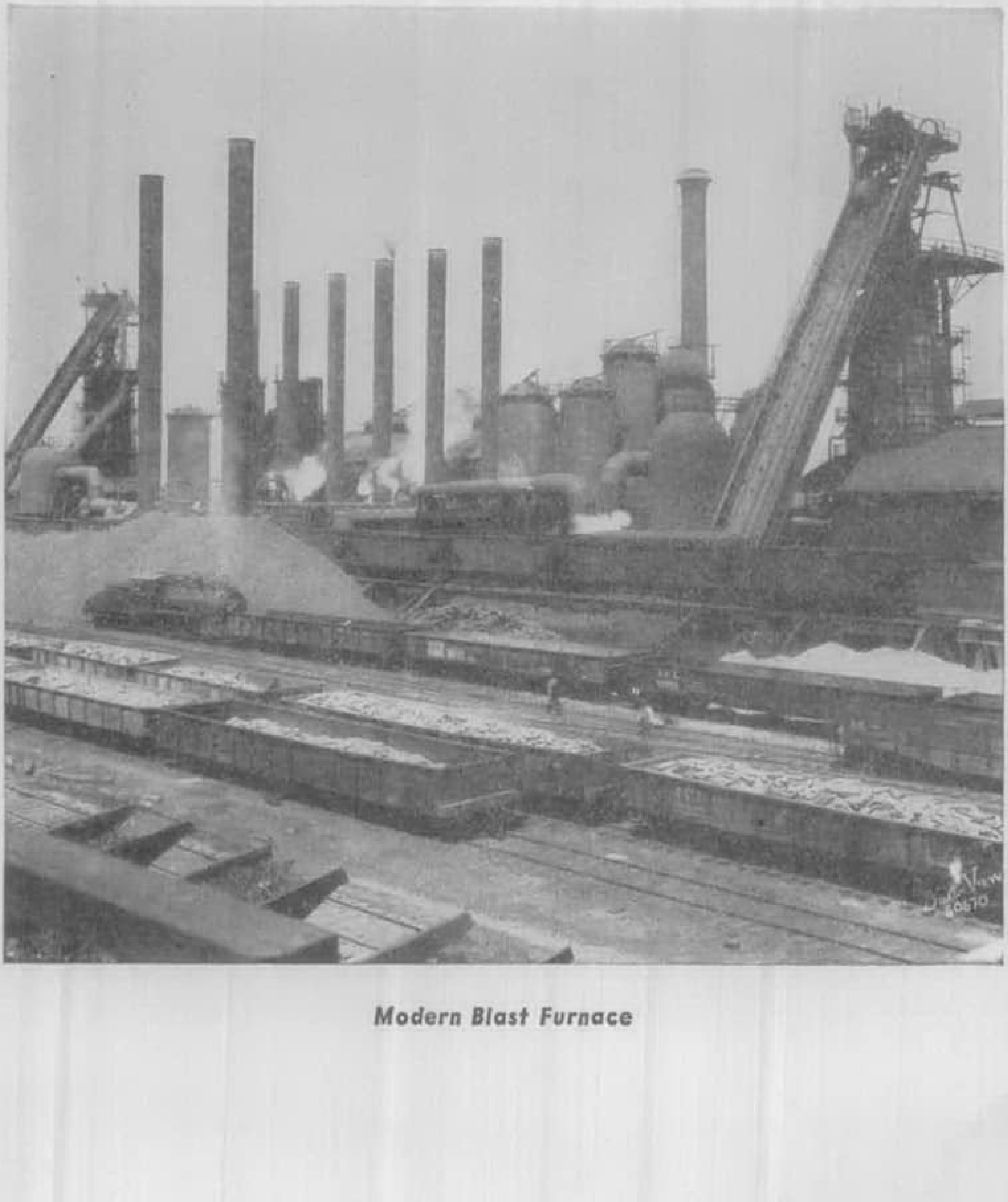
#### PRESSURE AND OUTFALL SEWERS

With the installation of treatment plants it usually became necessary to transport the sewage from the old point of discharge to the treatment plant. This required, in most instances, a pressure sewer. An important advantage of a pressure sewer is that it can follow the contour of the ground. Thus the initial cost of the sewer is reduced, due to the size factor as well as to the fact that a trench shallower than generally required for gravity sewers is possible. Flow tests on pressure sewers and waste sludge lines, in service for long periods, indicate that ordinary hydraulic tables can be used for calculating the capacity of cast iron pipe for such service.

Outfall sewers, discharging untreated or partially treated sewage into a body of water or stream, should be leak-proof. Since they extend for considerable distances into the water to avoid pollution of water supply, bathing beaches or fishing grounds, construction should be such as to permit no leakage. The land section of outfall sewers also may be exposed to wet and dry conditions, both internally and externally, and, therefore, must effectively resist corrosion, especially when laid in muck or when submerged in salt water at high tide. Cast iron pipe has successfully met these requirements in a large number of installations during the past fifty years.

## SECTION 2

# The Production of Iron



*Modern Blast Furnace*

# SECTION 2
## The Production of Iron

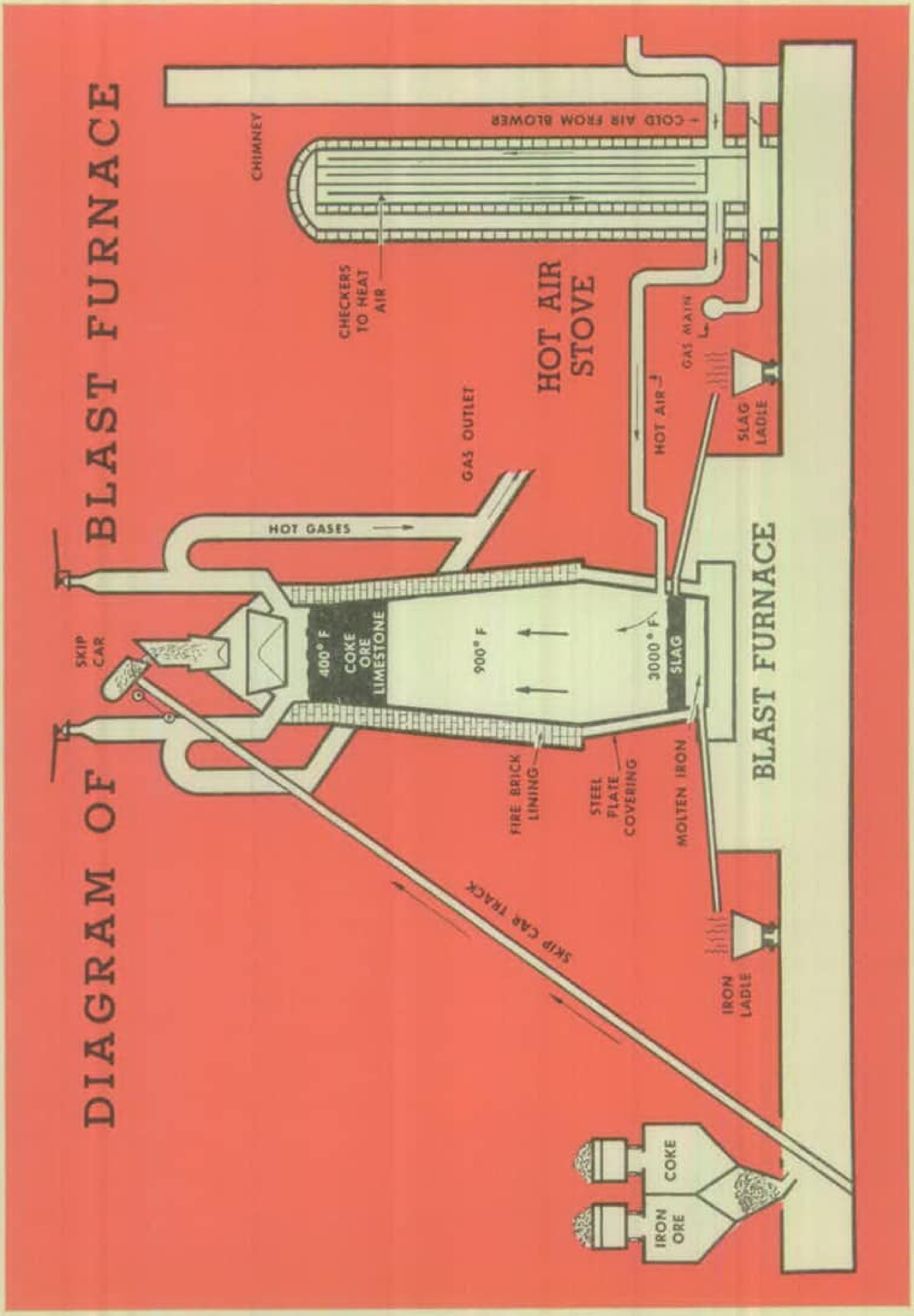
THE production of iron is one of the oldest of the arts, dating back to some unknown iron master five or six thousand years ago. Metallurgical methods in those ancient times were so wasteful of both material and labor, that the metal was not of great economic importance. Ores were reduced to a pasty metallic mass at a temperature below the melting point of the iron itself, and the clay and sand embedded in the ore were laboriously kneaded out by hammering. The science of metallurgy had its origin in about the thirteenth century A.D. when furnaces were developed in Western Europe to produce iron in a molten condition.

The modern blast furnace is a barrel-shaped shaft about a hundred feet in height and twenty-five feet at its largest diameter, with thick fire-brick walls jacketed and supported with steel plates. The bottom section, seven to ten feet high, is cylindrical. It is topped by a ring of openings for nozzles or tuyeres, as they are called, through which the blast of air is forced. Immediately above is a divergent conical section called the "Bosh." The "Bosh" is surmounted by another cylindrical section, then another cone, and finally another cylinder at the top. A bell, drawn up tight against a ring, seals the top and can be lowered at intervals to drop in fresh supplies of ore and coke. A "skip" or charging car periodically brings up fresh supplies of raw materials from the nearby stock house, which are dumped into the annular hopper around the bell.

In blast furnace practice, the raw materials are divided into three classes—ores, fuels and fluxes. The ores are the mineral sources of the metal, occurring in Nature as deposits of the oxides of iron. They are mined by open cutting or tunnelling, depending on local conditions, and are usually shipped to the furnace without other treatment than sizing.

The fuels are used to produce the temperatures and also the gases that deoxidize the ores. At present coke is the only one of commercial importance, though in the past much charcoal was used.

The fluxes are minerals which combine with the coke ash and the impurities in the ore, to form an easily fusible slag. Generally these are




*Courtesy of Inland Steel Company*

**Diagrammatic Drawing of Blast Furnace**

the carbonates of calcium or magnesium, which are charged in the furnace as raw limestone (dolomite).

The reduction of the ore is accomplished by the removal of oxygen, through the agency of two chemical reactions, accompanied by heat. When air passes through a thick bed of incandescent coke or charcoal, incomplete combustion takes place and a gas called carbon monoxide or C O is formed. This gas has very active reducing properties so that at temperatures above 600 degrees Fahrenheit, it will take up the oxygen in the ore, leaving metallic iron. There are several intermediate reactions, but the whole reducing process may be generalized as follows:

$$6\,C + 3\,O_2 = 6\,C\,O$$

$$2\,Fe_2O_3 + 6\,C\,O = 2\,Fe_2 + 6\,C\,O_2$$

The gases that pass off are high enough in heat value to be used under boilers and for heating the regenerative stoves for the blast. These stoves are steel shells about twenty feet in diameter by a hundred feet high, filled with brick checkerwork. They are alternately heated with the gas and then thrown in on the blast line. The cold air from the blowing engine for a time is heated to about 1300 degrees F. while passing through the checkerwork, but when the stove has cooled so that the blast is no longer as hot as desired, the air is passed through another stove and the cool one is again heated with the gas from the furnace. The heated blast is led through brick-lined pipe to the tuyeres where it enters the furnace. The blast pressure in the more modern plants is from 20 to 25 pounds per square inch and is developed in large blowing engines or turbo blowers.

The furnace is kept nearly full of carefully proportioned charges of coke, ore and limestones. This column travels slowly downward as the coke below is consumed, being heated as it approaches the "Bosh" by the ascending gases. The ore is also acted on by the carbon monoxide so that most of it has been reduced by the time the combustion zone in the "Bosh" is reached. Here the heat is intense and the iron and slag melt and trickle down to collect in the hearth below the tuyeres.

Their great difference in specific gravity separates the iron and slag into layers, permitting the withdrawal of iron through a hole, or notch, at the bottom, and the slag through another notch higher up. Both notches are usually plugged but as often as the slag level rises to approach the tuyeres, the cinder notch is opened and the accumulation of slag flows out into a receiving vessel. At less frequent intervals, five or six times a day, the iron notch is opened and the furnace drained of iron.

The molten iron is received in large ladles to be carried to the pig casting machine. In this country the most commonly used casting machine has a slow-moving endless chain which carries a series of parallel molds with overlapping edges. The molten iron from the ladle is carefully poured into a trough provided with a skimming device that carries it to the slowly moving metal molds which have been coated to keep the iron from sticking to the mold surface. The pigs are cooled and removed from the molds, after which the molds are again coated and poured. Previous to the use of casting machines, pig iron was cast in molds made in a sand bed and it was from this process that the name "Pig Iron" originated. The arrangement of these molds (a long channel with shorter and narrower channels opening into it on one side) suggested a litter of pigs to an Englishman who gave the terms "sow" to the main channel and "pigs" to the shorter ones. On solidifying, the pigs and sow were broken into convenient sizes for handling.

Iron has never been produced in an absolutely pure state except under the most precise laboratory conditions. At high temperatures, it has a strong tendency to alloy with many of the non-ferrous substances which are present in the fuel or ore and these naturally are retained in the cast iron. They are not to be regarded as injurious substances because each has its peculiar modifying influence on the metal. By scientific control of these constituents the foundryman produces the desired qualities in his castings.

Steel and wrought iron, the two other commercial forms of iron, are both made by reducing the non-ferrous constituents of pig iron to a desired minimum. This reduction is accomplished through treatments that cause these elements to separate from the iron and form gas or slag. In steel-making these new substances are formed in a molten bath of metal and are either burned out or, being lighter than iron, they float to the surface to be skimmed off. For wrought iron, the slag is formed while the metal is at a pasty heat, and is removed from the resulting mass by kneading. Each of these metals exhibits distinct physical characteristics which are modified greatly by the presence of such non-ferrous elements as remain.

As compared with cast iron, the most marked changes caused by these conversions are the increase in strength, ductility, and forging properties, and the loss of the original granular structure.

Cast iron, because it readily lends itself to formation into intricate shapes, has always been a metal of wide usefulness to the foundryman. The outstanding merit of the metal, however, is its effective resistance to corrosion when used for conduits in the form of cast iron pipe and fittings.

## METALLURGY OF CAST IRON PIPE

Cast iron is essentially an alloy of iron and carbon containing appropriate amounts of silicon and manganese. Most cast iron is made by melting pig iron with selected scrap. In gray cast iron, which is the type used for pipe and fittings, a major part of the carbon content occurs as free carbon or graphite in the form of flakes interspersed throughout the mass of metal. The engineering properties specific to gray cast iron are principally due to the presence of these free carbon graphite flakes.

The excellent corrosion resistance of cast iron pipe in underground service is well known. Cast iron is not rust-proof, but when rust forms on cast iron it is tightly adherent and helps to protect the metal beneath. Graphite is non-corrodible and the appreciable volume of this component, together with relatively inert iron phosphides, causes gray cast iron to be more resistant to corrosion than the purer forms of iron.

In severely corrosive conditions where the metallic content of a cast iron pipe is severely reduced by corrosion, the corrosion products of cast iron form an interlocking mat of graphite, phosphides and iron oxides which is strong and dense enough to enable the pipe to continue to serve indefinitely as an effective conduit under ordinary pressures.

Machinability of any metal structure is important, particularly where it must be drilled, tapped, or cut with ordinary tools. At a given hardness level cast iron is more easily machined than most other metals because the graphite flakes break up the chips and lubricate the cutting tool.

## CHEMICAL COMPOSITION OF CAST IRON PIPE

*Carbon:* Carbon in cast iron pipe may vary from about 3.00% to 3.75%. In gray cast iron high carbon means soft iron and low carbon means hard iron. In general the carbon content is adjusted to suit the particular method of manufacture and the cooling rate of a given size of casting.

*Silicon:* Silicon in cast iron normally ranges from about 1% to 2.75%. Silicon promotes graphitization, and, therefore, higher silicon will make the iron softer where other conditions are equal. Silicon is a very useful element to control the properties of iron in thick and thin sections. If the silicon is raised for casting thin sections which normally tend to be harder, and lowered for casting heavy sections which normally tend to be soft, a wide range of different castings may be made with uniform strength and hardness properties.

*Manganese:* The usual range of manganese content in gray iron is from about 0.20% to 1.00%. Manganese is useful in minimizing the detrimental effects of sulfur and is adjusted to suit the particular method and cooling rate used in producing cast iron pipe and fittings.

*Phosphorus:* Phosphorus in cast iron is usually between 0.10% and 1.00%. Phosphorus increases the fluidity of the molten iron, making it easier to pour at low temperatures and better for casting thin sections. When phosphorus is above about 0.15% it forms iron phosphides in the iron. These phosphides are hard, wear-resistant, and corrosion-resistant. Therefore a high phosphorus content is useful for certain wear services and adds corrosion-resistance. For cast iron pipe a medium-to-high phosphorus content is often preferred because the increased fluidity gives sounder casting and the phosphides add corrosion-resistance.

*Sulfur:* It was formerly thought that a sulfur content above about 0.10% was dangerous, but since the laws of balancing sulfur with manganese have been understood, sulfur contents up to 0.15% are found in high quality irons.

*Alloys:* In the normal run of cast iron pipe and fittings, special alloys are not necessary, but they may be used to advantage where special properties are required. Of the alloying elements, Chromium and Molybdenum tend to prevent graphitization while aluminum, titanium, and zirconium are graphitizers. Copper and nickel are nearly neutral but slightly graphitizing.

Molybdenum is the most effective alloy for increasing strength. Chromium is the best for increasing heat resistance. Nickel has the unusual properties of making iron very hard in the 4 to 6% range when combined with Chromium (Ni Hard), but in the 12 to 30% range making gray iron austenitic-soft, non-magnetic, corrosion-resistant (Ni Resist). Copper, up to about 2%, is alloyed with iron to add resistance to acid corrosion.

*Inoculation:* In addition to the effect of the specific elements mentioned above it is common practice to inoculate cast iron immediately before pouring. This is done by adding small amounts of such materials as graphite or ferrosilicon whose effect is to alter the structure by an amount out of proportion to the normal chemical action of these elements. Such a practice is very beneficial and is widely used to promote uniformity of product in the manufacture of pipe and fittings.

### METALLURGICAL CONTROL

The methods of casting and the types of molds used have a profound effect on the structure and properties of cast iron.

In general, the desirable structure of cast iron for pipe and fittings shows a sound gray fracture with uniformly dispersed graphite flakes in a dense uniform matrix. Hardness should be not over 95 Rockwell B in order to allow cutting and tapping in the field. The iron should have good strength yet retain enough resilience and toughness to confer adequate impact resistance.

ASTM specification A–48 lists seven classes of gray cast iron ranging in tensile strength from 20,000 psi. to 60,000 psi. Cast iron for pipe and fittings, which must be soft and freely machinable, is usually in the 30,000 to 40,000 tensile strength range, as measured by the ASTM arbitration test bar.

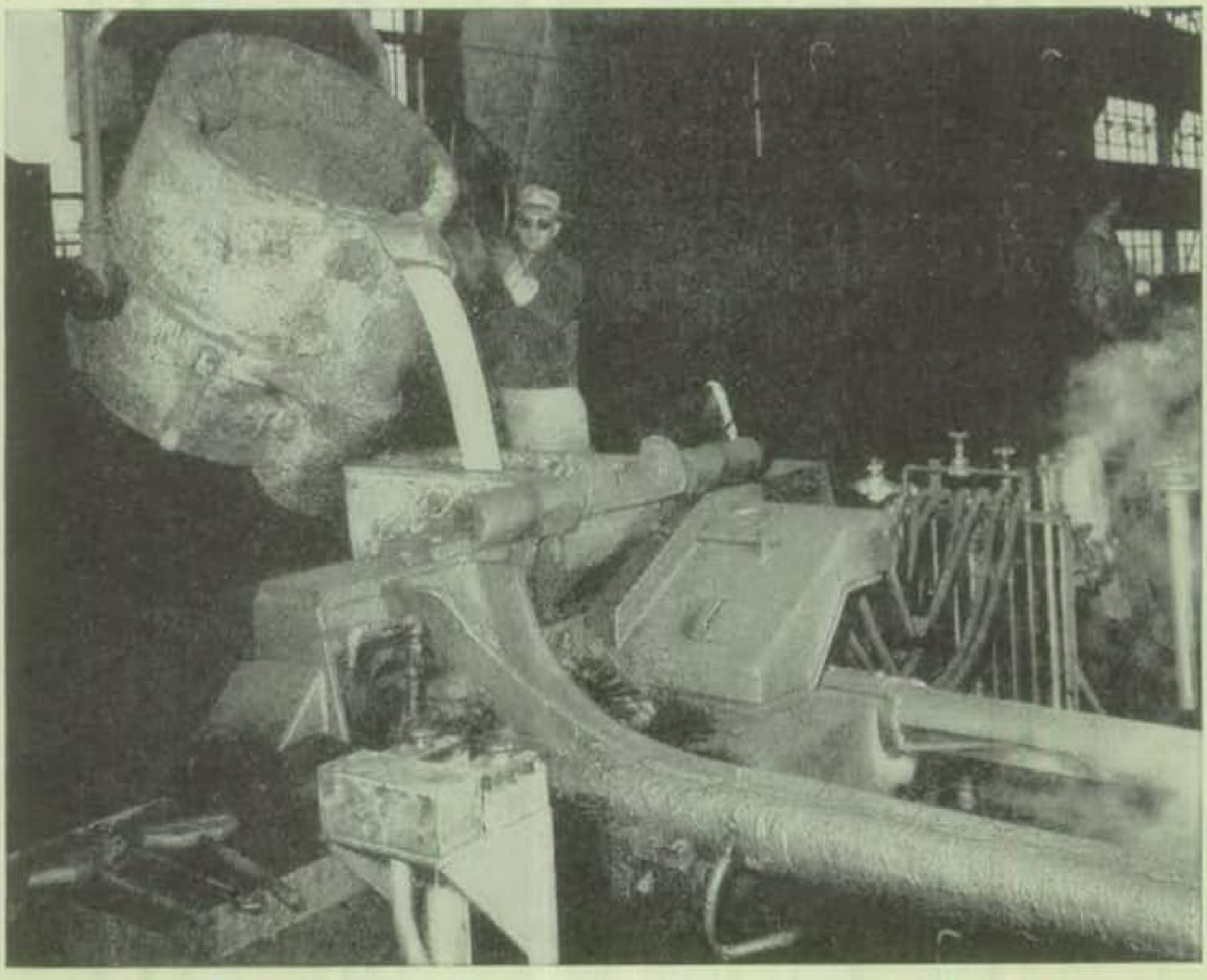
The compressive strength of gray cast iron is much higher—about three times greater—than its tensile strength. Therefore, cast iron can be used at high stresses in compression.

Since bending is a combination of tension and compression, the bending strength of cast iron—modulus of rupture—falls between the tensile and compressive strengths, usually about twice the tensile strength.

Modern metallurgical control enables the foundry to produce quality castings with the best combination of properties. The routine tests carried out as a guide to metallurgical control include: Frequent chemical analyses for each mix used in the cupola, chill tests for graphitizing tendency, test bars, Talbot strips from the pipe wall, ring tests on rings cut from the pipe, full length bursting tests of pipe, impact tests, direct tensile tests, and others. One of the routine tests of the finished product is the hydrostatic test to which every length is subjected. Correlation of the values obtained from all these tests with service performance of the castings have enabled the cast iron pressure pipe industry to produce progressively better and more reliable cast iron pipe and fittings.

# SECTION 3

## Manufacture of Cast Iron Pipe



*Pouring ladle tilts to introduce molten iron through the trough into the spinning mold—metal mold process.*

# SECTION 3
## Manufacture of Cast Iron Pipe

CAST iron pipe is known to have been produced as early as the 15th Century. There is an official record of its manufacture in a foundry at Siegerland, Germany in 1455 for installation at the Dillenburg Castle.

The underlying principle of the process is the same today as it was then. The molten iron was introduced into casting molds where it solidified into the desired shape. Hand labor, of course, was used exclusively and technical controls were unknown. Nowadays, the process is largely mechanized; the most efficient machines electrical and mechanical engineers can devise are utilized and production is guided by the science of metallurgy.

### THE FOUR CASTING METHODS

Cast iron pipe was originally cast in horizontal molds in lengths of from four to five feet. The mold into which the molten iron was poured was formed in two boxes of damp sand. Each box contained an impression, in the sand, of half the outer circumference of the pipe. The two half-molds were then closed around a core whose diameter was that of the pipe bore. As the core was a cylinder of baked sand reinforced with iron rods, the limit of the length of molds, and therefore of pipe length, was the extreme length at which the core would support itself without bending.

The problem of increasing the length of pipe, so as to reduce the number of joints, was only partially solved until about 1850 when the method of vertical pouring, or pit casting, came into use. The length of cast iron pipe was thereby increased to twelve feet and later, to as much as 16 feet. The vertical method of casting, as well as an improved horizontal method, are both in use today; the former, chiefly for large diameter pipe; the latter, for small diameter pipe only.

The centrifugal method of machine casting, by which the majority of pipe is produced today, was developed in the early twenties. Some foundries cast pipe centrifugally in sand-lined molds; others use metal molds.

The application of the principle of centrifugal force is fundamentally the same in both processes.

Thus, there are four methods by which cast iron pipe is manufactured:
(1) improved horizontal casting;
(2) vertical, or pit casting;
(3) centrifugal casting in sand-lined molds; and
(4) centrifugal casting in metal molds.

The latter three methods, by far the most widely used, are described farther on in this section.

All these methods involve various operations common to all pipe foundries. These operations are, in order: The analysis of raw materials; the melting of the iron; analysis of the molten iron; the casting, or pouring of the pipe; and finally, the cleaning, testing, and inspection of the finished product.

### THE MODERN PIPE FOUNDRY

The modern pipe foundry is so laid out that raw materials are received and stored at one side of the plant and the finished product delivered from the other side. First come the storage piles of pig iron, scrap, coke and limestone; then the nearby cupolas in which the pig iron is melted. The casting floor is next. Here the molten metal is poured into horizontal molds, the vertical molds or the centrifugal casting machines. Where the process requires the preparation of molds, a large area is provided for this purpose, adjacent to the casting floor. After the pipe is cast, it goes to the cleaning floor where it is cleaned, tested, coated and given final inspection.

The cupola is a steel shell, from 5 to 10 feet in diameter according to capacity, and forty feet high, lined with a twelve inch fire-brick wall. The bottom is sealed and a hole through the wall just above it opens into the trough for the escape of the iron as it melts. A short distance higher another hole is pierced for the removal of the slag, and still higher, about three feet above the bottom, a full circle of openings are arranged through which the blast of air is forced. At about half its height, a door in the cupola opens on the second story of the building for the charges of raw materials. Above this point, the cupola serves as a draft stack to prevent the hot gases blowing out through the door.

After a bed of coke several feet thick has been thrown in and ignited, the cupola is filled to the door with alternate charges of coke, pig iron and limestone. The blast of air is led from a low-pressure blower through the openings near the bottom, and in a short time the molten iron begins to flow out. As the coke is consumed and the iron at the bottom is removed, the column of iron and fuel is replenished through the door until a sufficient quantity has been charged. The charges are made up from weight fractions from the various piles of pig iron and are usually brought to the cupola platform one at a time, as needed. A proportion of scrap iron is mixed with the pig, originating either from "home" scrap or from outside sources. When used with a proper analysis of the metal, scrap iron improves the quality of the castings. Limestone is charged with the pig iron to render more fluid the pasty mass of slag formed from the ash in the coke and the foreign matter adhering to the iron, and to permit its easier removal at the slag hole. All pipe foundries use practically the same method of melting iron and, by metallurgical controls have precise knowledge of the physical characteristics of the iron before it is poured into the mold.

### MANUFACTURE OF PIT CAST PIPE

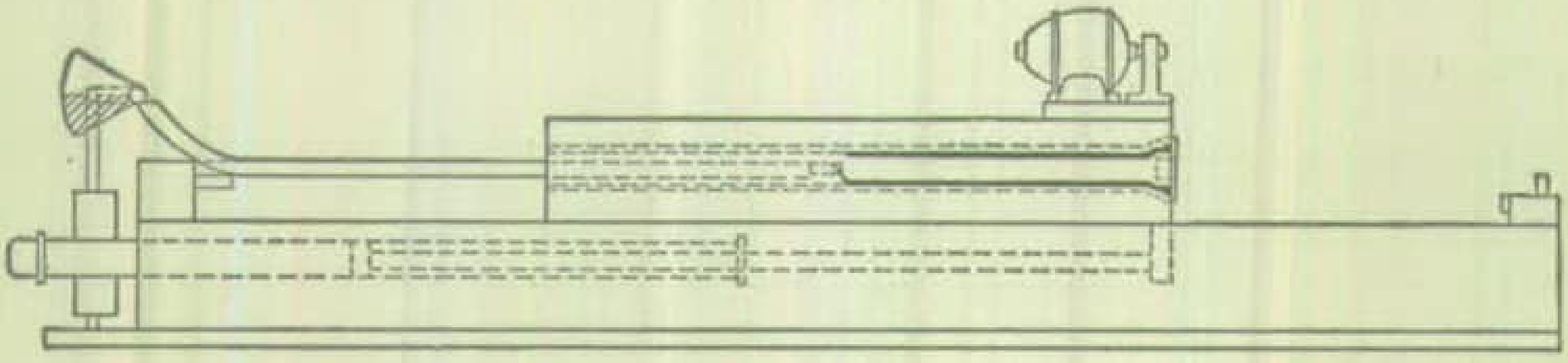
The casting floor of the pit cast department of a pipe foundry is a series of pits in which the molds are rammed and poured. The molds are made in cylindrical containers, called flasks. The barrel pattern is a metal cylinder with handling rings at one end.

Empty flasks and molding sand are brought to the pits to be rammed. Damp sand is thrown in at the top between the pattern and the flask and rammed, or compacted, to form a separating wall. For pipe to be made with bell up, a bell pattern is then placed over the barrel pattern and more sand rammed around it until the mold is full. The barrel pattern is withdrawn by the crane and the complete mold is carried to a drying oven. Hot gases bake the mold until it is thoroughly dry.

Cores are meanwhile being prepared in another department. Both barrel and head cores are made of a mixture of sand and clay and after being formed are baked. When mold and cores are dry they are ready for assembly. The barrel core is lowered through the mold and seated, and the bell core is placed over it. When a group of molds and cores are assembled, molten iron is brought from the cupola in a ladle and poured into the molds. The iron solidifies; the core bar is withdrawn; the flask lifted out of the pit and suspended horizontally over a rail runway leading to the cleaning floor; clamps are knocked off, and the pipes roll out. After cleaning, inspection, and coating, each pipe is subjected to the final hydrostatic test. In the testing press, the pipe is filled with water and must withstand a pressure considerably in excess of what it will encounter in actual service.

#### CENTRIFUGAL CASTING IN METAL MOLDS

By this process, the pipe is cast centrifugally in water cooled metal molds, a method that has been used commercially in this country since 1922. The machine in which the pipe is cast consists essentially of a cylindrical metal mold mounted on rollers in a water jacket so that it can be rotated at comparatively high speeds. The water jacket is mounted on wheels so that the entire assembly can be moved by means of a hydraulic cylinder in the direction of the longitudinal axis of the mold on a fixed bed inclined slightly to the horizontal. The molten iron is fed into the mold through a trough similarly inclined. The trough has a spout on its lower end which is curved toward the sidewall of the mold. Pre-analyzed molten iron is supplied to the trough by a small casting ladle of sufficient capacity to make one pipe. In casting, the ladle is tilted at a uniform rate by an electrically operated tilting mechanism thus maintaining a constant uniform pouring rate (see diagram). In making bell and spigot or me-



chanical joint pipe, it is necessary to insert a sand core into the bell end of the mold to form the inside contour of the pipe bell. This is done when the mold is at the lower end of the fixed bed. Following that operation the mold and assembly are moved to the upper portion of the fixed bed.

When the mold is at the extreme upper end of the fixed bed, it is ready for casting at which time the trough extends down the barrel of the mold for nearly its full length. After the casting ladle has been filled by a transfer ladle from the cupola, the machine operator, stationed at the upper end of the machine brings the mold up to speed and actuates the mechanism controlling the tilting of the ladle. In a few seconds the iron has filled the bell space at which time the core setter, stationed at the lower end of the machine, gives the operator a signal to start moving the revolving water jacketed mold longitudinally down the bed. The stream of iron discharged from the spout flows tangentially onto the surface of the mold, where it is held in place by centrifugal force and forms a homogeneous pipe with a perfectly cylindrical bore. The hydraulic cylinder is supplied with a regulated amount of water at a constant pressure which results in uniform longitudinal movement of the mold. Since the pouring rate of the casting ladle and the amount of water supplied to the hydraulic cylinder can be regulated easily and accurately, the wall thickness of the pipe produced is held within desired tolerances without difficulty.

After the pipe is completely cast, the mold is kept rotating at its original speed until the pipe has cooled to approximately 1500° F. The pipe is then taken from the machine, transferred to and travels through a closely regulated heat treating furnace where it reaches a maximum temperature of 1700° F. and is slowly cooled below 1200° F. before leaving the furnace.

After removal of each pipe from the casting machine, the mold is cleaned and is then ready for coating and the casting of another pipe. The entire casting operation requires from 1½ to 8 minutes depending upon the diameter and the length of the pipe.

### CENTRIFUGAL CASTING IN SAND-LINED MOLDS

By this process, the pipe is also cast centrifugally but in sand-lined molds.

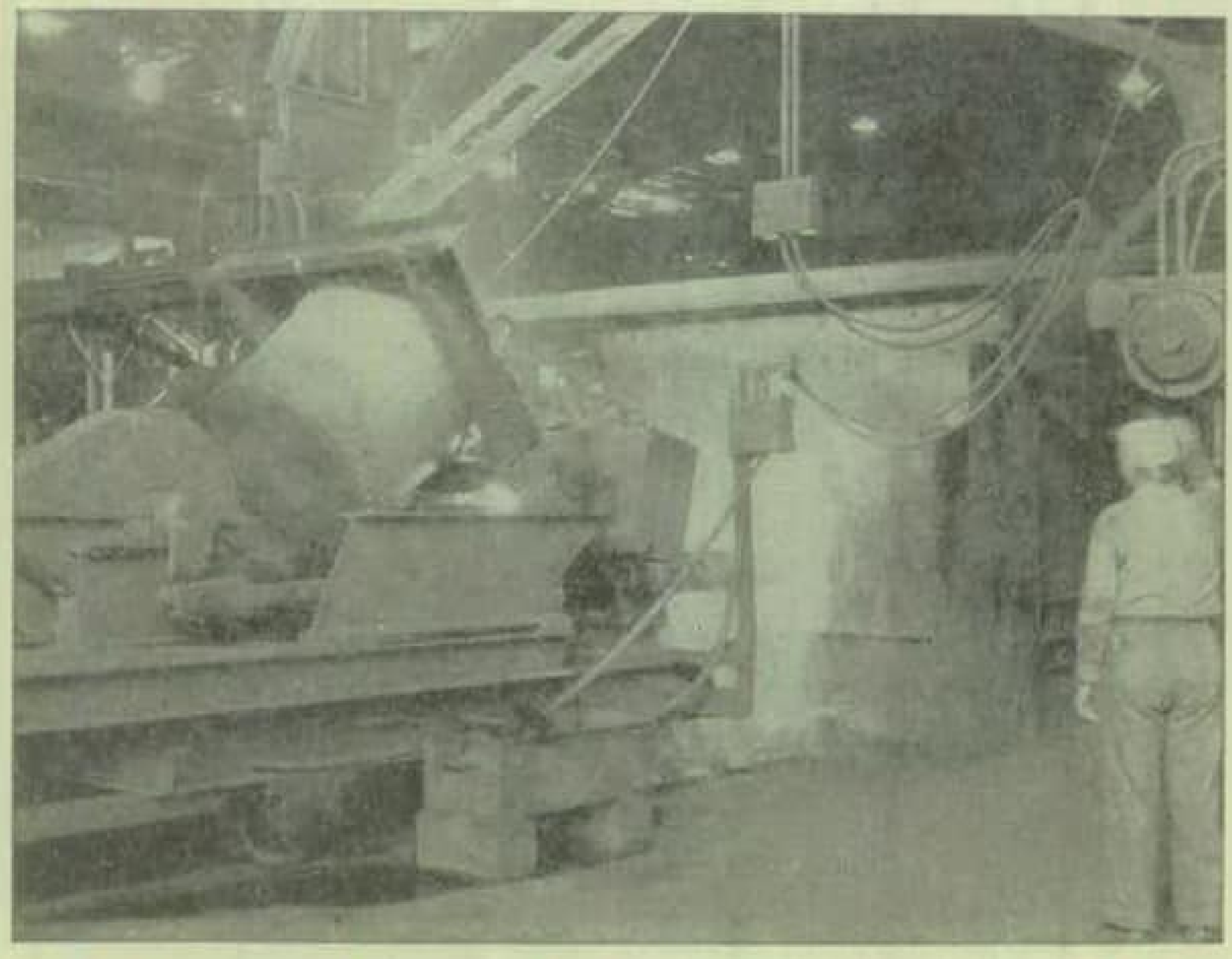
In preparing a mold, the metal flask is placed in a vertical position on a metal stool which closes the lower end of the flask and centers the metal pattern concentrically within the flask. Tempered and bonded synthetic foundry sand is fed at a uniform rate into the open upper end of the revolving flask as rammers pack the sand firmly between the pattern and the flask. When the ramming of the entire length is completed, the pattern is then withdrawn.

The bell or flange end of the mold is closed with a baked oil sand core which extends into the mold to shape the socket of the pipe. The spigot end of the mold is similarly closed with a flat ring-shaped core. In the center of either the bell or spigot end core there is a suitable opening for admission of the molten metal.

The completed and dried mold assembly is placed horizontally in the centrifugal casting machine in which the flask is spun about the horizontal axis by two sets of powered rollers. Since the process is one of continuous production, molten iron of the correct analysis and temperature is being made ready at the same time that the mold is being prepared. Continuous melting cupolas feed molten metal into large receiving and mixing ladles whence the ladles serving the casting machines obtain iron as required. The pouring ladle attached to the casting machine is filled with a carefully weighed amount of pre-analyzed iron. When the flask-mold combination is brought to the proper spinning speed the pouring ladle empties itself into the mold through a trough extending into one end of the mold. Centrifugal force holds the liquid metal on the wall of the sand mold, forming a perfectly cylindrical bore, and spinning is continued until the metal has solidified.

The proper spinning speed to quickly throw the molten metal on the mold wall is determined largely by the inside diameter, and to a lesser degree by the wall thickness, iron temperature, and method of pouring.

When the spinning metal has completely solidified the pipe is cooled in the mold to about 1200° F., then stripped from the flask by breaking loose the sand mold. Each pipe is then cleaned by chipping and grinding all roughnesses at the ends and grinding and washing the inside to remove all adhering slag. After hydrostatic testing, gaging, weighing, and coating or lining, the pipe is ready for shipment.



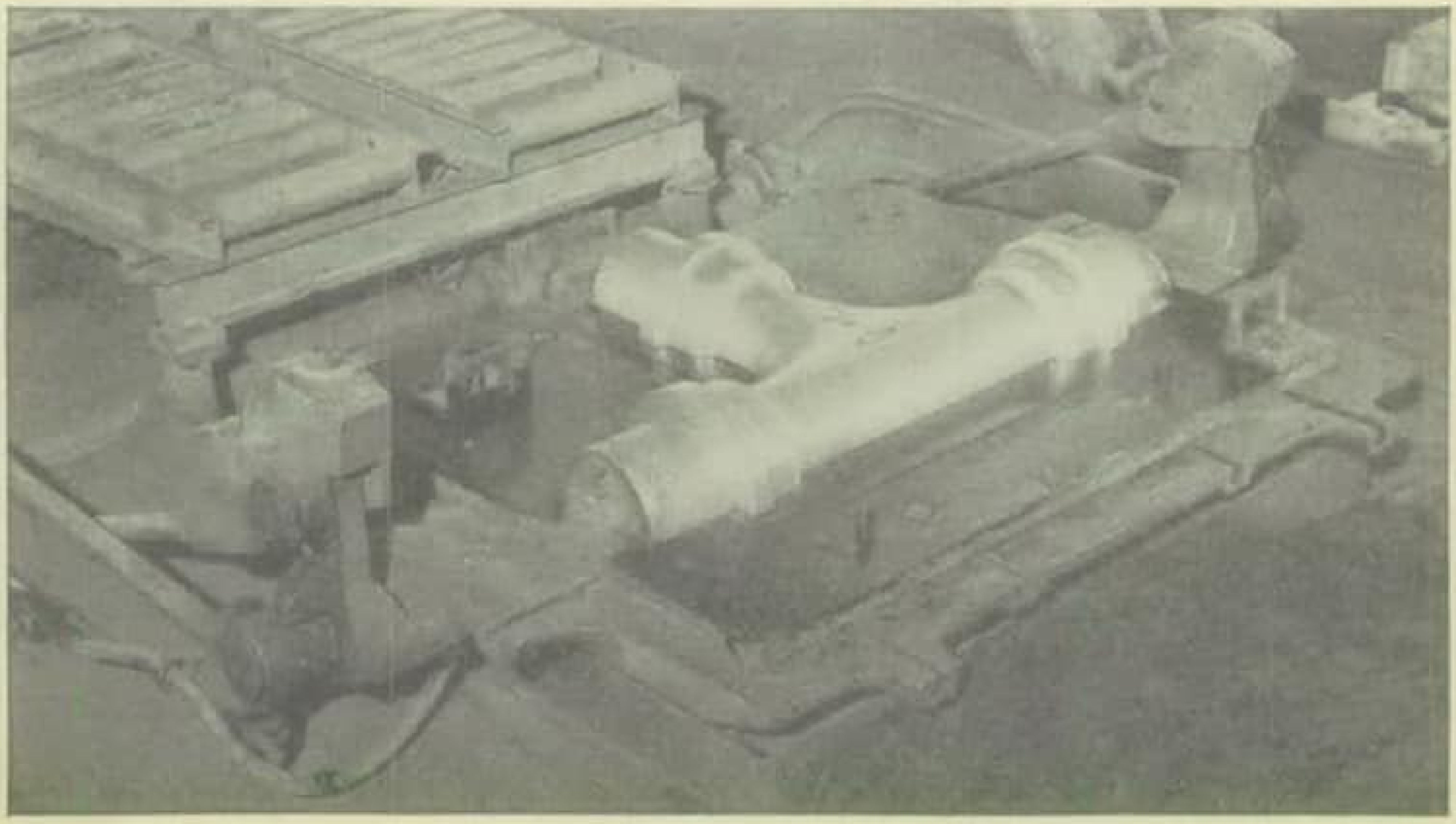
*Pouring ladle tilts to introduce molten iron through the trough into the spinning mold—sand-lined mold process*

**MANUFACTURE OF FITTINGS**

Fittings for cast iron pipe are not made in the pipe shop but in a separate department, or building, or even a separate plant devoted exclusively to the manufacture of fittings and special castings.

Most small fittings are made with solid patterns and core boxes in damp or "green" sand molds. The manner of molding is determined by the shape of the casting, as the mold must be parted so that the pattern can be removed without disturbing the sand surfaces. The flasks are conveniently shaped frames with cross bars to support the sand. Hand ramming is still practiced though molding machines and sandslingers of various kinds are used extensively. The accompanying illustration shows one type of these machines, mounted with a six-inch tee pattern. One of the flasks piled in the background is placed over the pattern shown on the left-hand side of the machine, and is filled with sand. An air cylinder underneath the pattern plate raises and drops the pattern and flask with sharp blows until the sand has packed tightly in place. Another cylinder, through arms underneath the pattern plate, swings the flask and pattern vertically to the right side of the machine, where the mold is shown in the illustration. The pattern is then withdrawn from the mold and swung back to its former position, leaving the mold ready to be carried to the pouring floor.

Just back of the machine is shown the core box. A special reinforcing rod or arbor is placed in one half of the box, and both halves are packed



with sand. The box is then closed and one half is lifted off, leaving a firm sand core shaped like the inside of the tee. It is lifted out by the exposed tips of the arbor and placed on the supporting shoulders or "prints" formed at each bell or spigot opening in the mold. The prints fit the core snugly so that when the upper half of the mold is placed over it, the core is held firmly in position and no joints are left between it and the mold through which the iron may run out. Two openings are made into the mold from the upper surface of the flask: One serves as the gate into which the iron is poured; the other serves to indicate when the mold is full and also to permit the air in the mold cavity to escape as it is replaced by the iron. Before closing the mold, both the mold and the core are covered with graphite, or some other refractory material, so that the sand will not fuse to the iron.

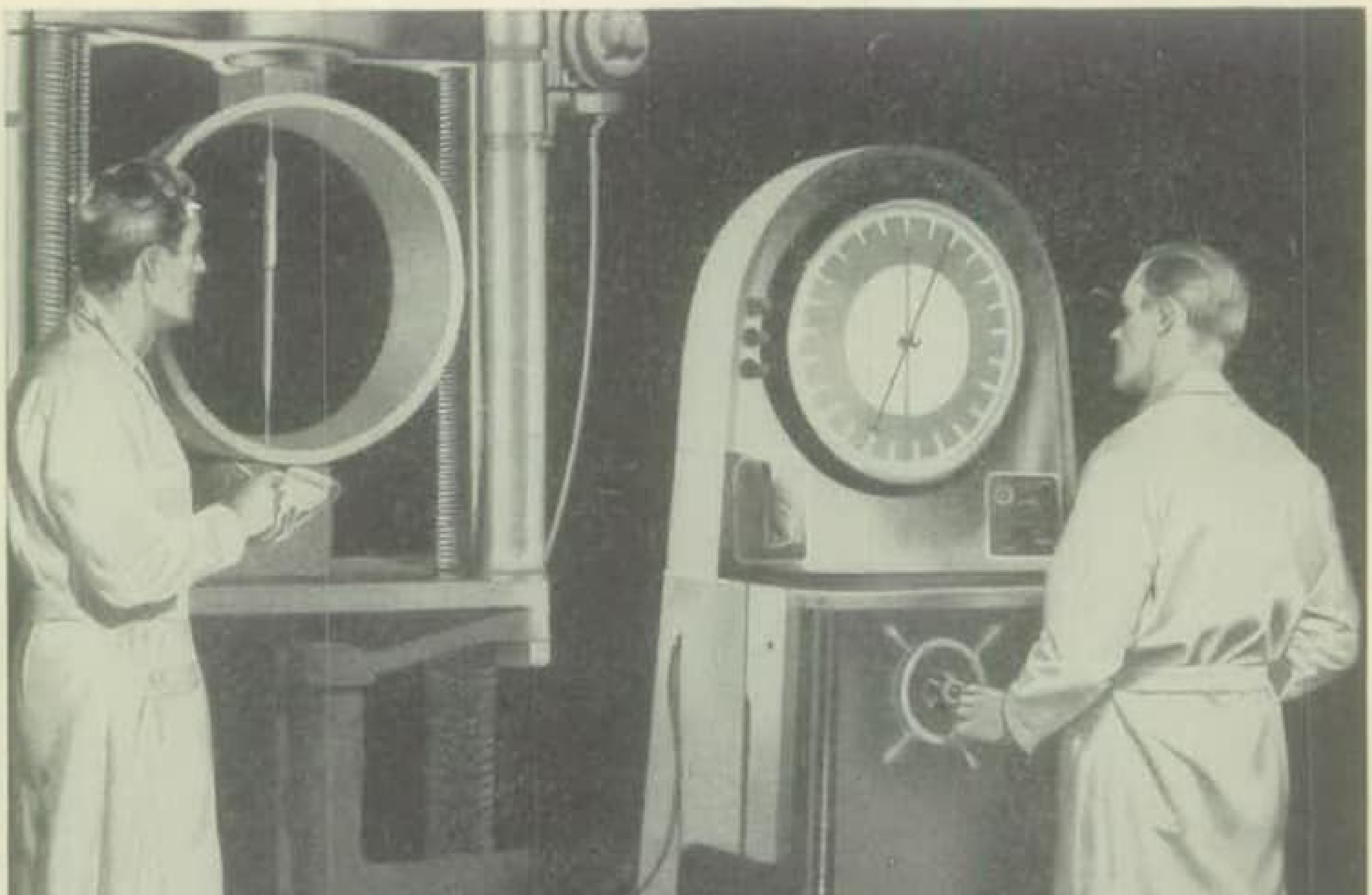
Tees, crosses, and bends up to the twelve-inch sizes are all made very much in the same manner as just described. Above these sizes it is usually more economical to use less expensive pattern equipment even though the molding cost is greater. Then, too, as the sections increase with the size of the fittings, dry sand molds must be used, and numerous variations of molding practice may be employed.

After the fittings have been poured and allowed to cool in the mold, the sand is shaken out in the foundry, and the casting is carried out to be cleaned. Most of the smaller castings are placed in a steel drum where, with slow revolving, they tumble against each other until all adhering sand has been rubbed off. Those castings not suitable for cleaning in this manner are brushed or sand-blasted. All fins and gates are chipped and ground off and the fittings are heated and given the same coating used for pipe.

When the fittings are coated and weighed, they are given a final inspection, occasionally with a representative of the purchaser collaborating with the plant inspector. They are then loaded on cars for shipment, and it is worthy of note that the precautions against rough handling in the field, which are suggested elsewhere in this book, are scrupulously observed by the manufacturer. The fittings are carefully loaded in a manner that reduces to a minimum the possibility of shifting and damage in transit.

## SECTION 4

# A.S.A. Method of Design



*The Ring Test*

# SECTION 4

## A.S.A. Method of Design*

THE method described here for the design of Cast Iron Pipe was developed by the American Standards Association Committee A-21, whose sponsors were the American Water Works Association, the New England Water Works Association, the American Gas Association, and the American Society for Testing Materials. The committee was composed of representatives from these sponsor bodies, pipe manufacturers, consulting engineers, and representatives of other pipe using organizations. This method of design corrects the faults of previous methods by the adoption of the following factors not previously considered in pipe design.

1. The effect of crushing load due to backfill on the strength of pipe subjected to internal pressure.
2. Variations of the crushing load transmitted to the pipe with different trench conditions.
3. Factors of safety based on the overall stresses due to internal pressure and external load.
4. Allowances for corrosion and foundry tolerance.

An extensive series of tests were carried out including bursting, crushing, beam action, impact and pull out strength of joints—separately and in some cases in combination with one another. These tests were carried out at the University of Illinois, Iowa State College, and Ohio State University. A complete report covering these tests and the method of design was presented before a meeting of the American Water Works Association in May of 1938, and published in the American Water Works Association Journal in May, 1939. The title of this paper was, "A Proposed New Method of Determining Barrel Thickness of Cast Iron Pipe," by Thomas H. Wiggin, M. L. Enger, and W. J. Schlick. Comprehensive tests determined: (1) The actual strength of the pipe by bursting full length specimens; (2) the strength of pipe in crushing by three-edge bearing tests; (3) the relation of actual crushing stresses to the three-edge

*For complete details see A.S.A. Bulletin A-21.1.

crushing tests, and (4) the magnitude of surface loads transmitted to the pipe.

**COMBINED LOADS**

The relationship between the internal pressure and the external load caused by the weight of the backfill and surface loads is expressed by the following equation:

$$w = \frac{W}{\sqrt{P}} \sqrt{(P-p)}$$

in which "W" is the external crushing load in pounds per lineal foot of pipe in 3-edge bearing that would cause failure independent of internal pressure; "w" and "p" will be any combination of external load and internal pressure respectively sufficient to cause pipe failure when acting together.

**INTERNAL PRESSURE**

The internal pressure is made up of two components. First, nominal working pressure, and second, water hammer that may be caused by rapid closing of valves, the stopping of centrifugal pumps, or other causes. The normal water pressures depend on local conditions and requirements and are known. The pressures caused by water hammer are those commonly used in the water works industry. They are as follows:

WATER HAMMER ALLOWANCE

3″ to 10″—120 lbs. per sq. in.
12″ to 14″—110 lbs. per sq. in.
16″ to 18″—100 lbs. per sq. in.
20″........90 lbs. per sq. in.
24″........85 lbs. per sq. in.
30″........80 lbs. per sq. in.
36″........75 lbs. per sq. in.
42″ to 60″— 70 lbs. per sq. in.

The bursting strength of pipe, "P" is determined from the formula:

$$P = \frac{2tS}{D}$$

in which "t" is the thickness of pipe in inches, "D" is the internal diameter in inches, and "S" is the tensile strength of the metal found by bursting full lengths of pipe. The value of "S" has been determined by full-length bursting tests to be not less than 11,000 pounds per square inch for Pit Cast Pipe, and 18,000 pounds per square inch for Centrifugal Pipe. (Using certain foundry practice and controls, this latter figure may be as high as 25,000 pounds per square inch.) The stresses of 11,000 and 18,000 pounds per square inch referred to correspond to metal that when tested in a straight tension test would have values of from 18,000 to 30,000 pounds per square inch.

### EXTERNAL LOAD

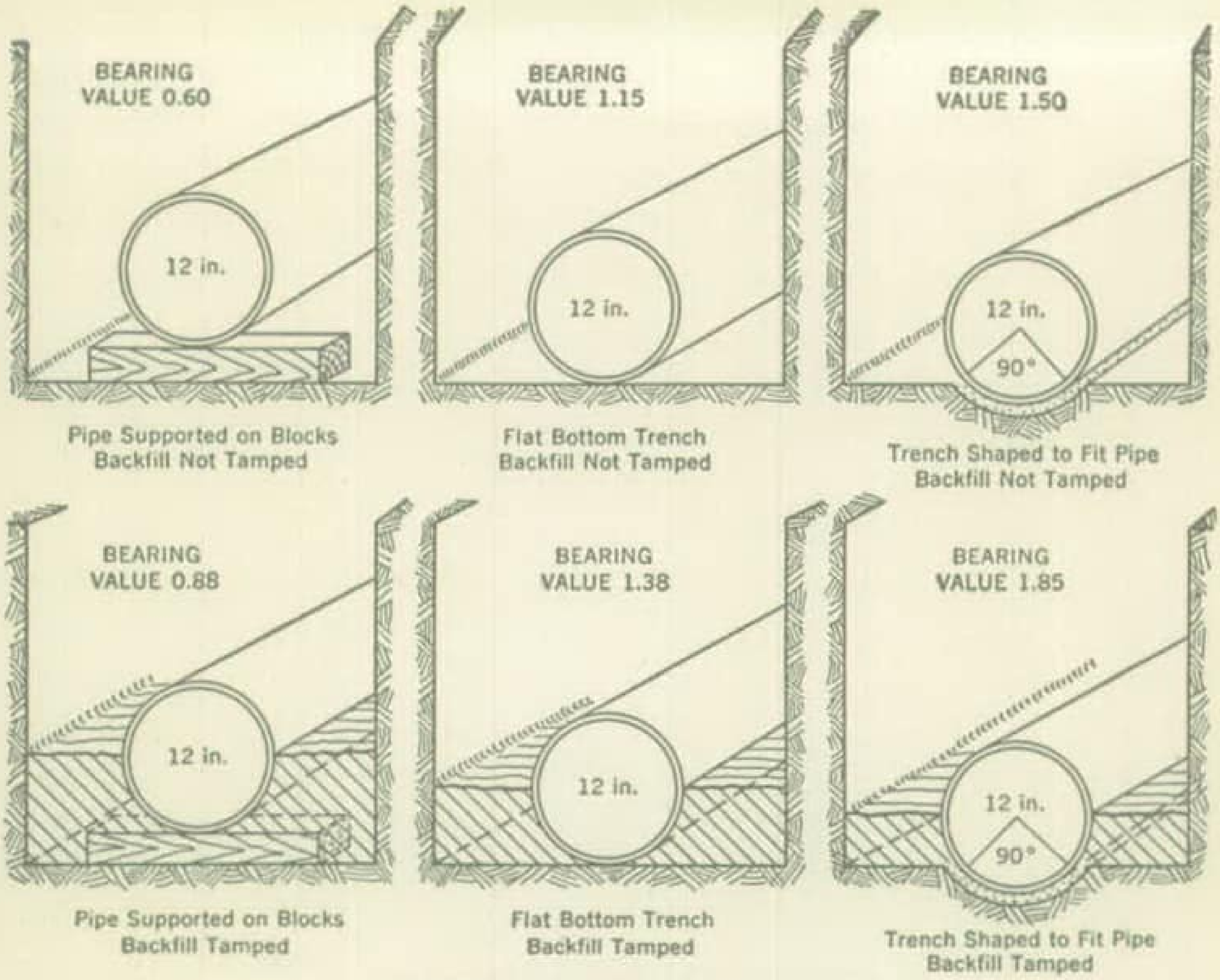
The external load on a pipe is made up of: (1) Weight of backfill; and, (2) weight of the traffic plus impact, and is influenced by the trench condition. These factors must be considered when calculating the crushing load on the pipe.

The fill loads on pipe for various depths of cover and for six methods of installing the pipe on the bottom of the trench are covered by several graphs, curves and tables in the American Standards Association Manual of Design (A.S.A. A. 21.1). The magnitude of the loads can be readily determined by use of the manual. In computing the surface traffic load, it was assumed that two 5-ton trucks are passing over the pipe at the same time. A curve shows the amount of load that is transmitted through the earth to the pipe for various depths of cover. A pipe laid with only a shallow cover will be called upon to carry a large per cent of the surface load caused by the trucks, while pipes laid deep are only slightly affected. However, they are in turn called upon to carry a heavy load caused by the earth backfill.

### TRENCH CONDITIONS

The effect of these external forces and loads can be reduced by proper installation. Tests at the University of Iowa for American Standards Association Committee A-21 were made to evaluate the various methods of laying pipe and these methods and values are shown in the following diagram. The six views show the common methods of laying pipe at the bottom of the trench and the bearing values of each 12-inch pipe. These bearing coefficients change for various sizes of pipe.

The first view shows a pipe laid on blocks. This is the poorest way to lay underground pipe, since for sizes under 12 inches it produces a direct beam action, and for larger sizes concentrates crushing loads at the block. Utility operators for years have used this method of laying pipe. If it is




***TYPES OF TRENCH BOTTOMS***

used, the inspector should insist on the tamping of the backfill under and around the pipe. The two center views show the common method of laying water pipe—a flat bottom trench with the backfill either tamped or untamped. Tamping backfill up to the center line of the pipe is worth the added expense. The two righthand views show the sewer type of construction. This is not often used for water mains, but could be employed to advantage in special cases, such as under deep fills and locations where there is a heavy load on the pipe.

#### RING CRUSHING TESTS

The ability of cast iron pipe to withstand external loads is determined by crushing rings cut from the pipe and tested in the three-edge crushing test. These rings may vary in width from 1 inch to 12 inches. They are placed in a compression testing machine and loaded until failure occurs. Hundreds of specimens were tested in arriving at the values to be used for design purposes. These values are 31,000 p.s.i. for pit cast pipe, and 40,000 p.s.i. for centrifugal pipe. Since the stresses caused under actual trench conditions vary from those that occur in the three-edge bursting test, conversion factors were arrived at as a result of tests made under actual trench conditions. These conversion factors are shown in the American Standards Association Manual (A.S.A. 21.1–1939).

#### CORROSION ALLOWANCE AND FOUNDRY TOLERANCES

A corrosion allowance of 0.08 inches of additional metal has been agreed upon for all sizes of cast iron pipe, and foundry tolerances in accord with the following tables were adopted:

FOUNDRY TOLERANCE

| *Diameter* | *Pit Cast Pipe* | *Centrifugal Pipe* |
|---|---|---|
| 3″ to 8″ | .07″ | .05″ |
| 10″ to 12″ | .08″ | .06″ |
| 14″ to 24″ | .08″ | .08″ |
| 30″ to 60″ | .10″ | .10″ |

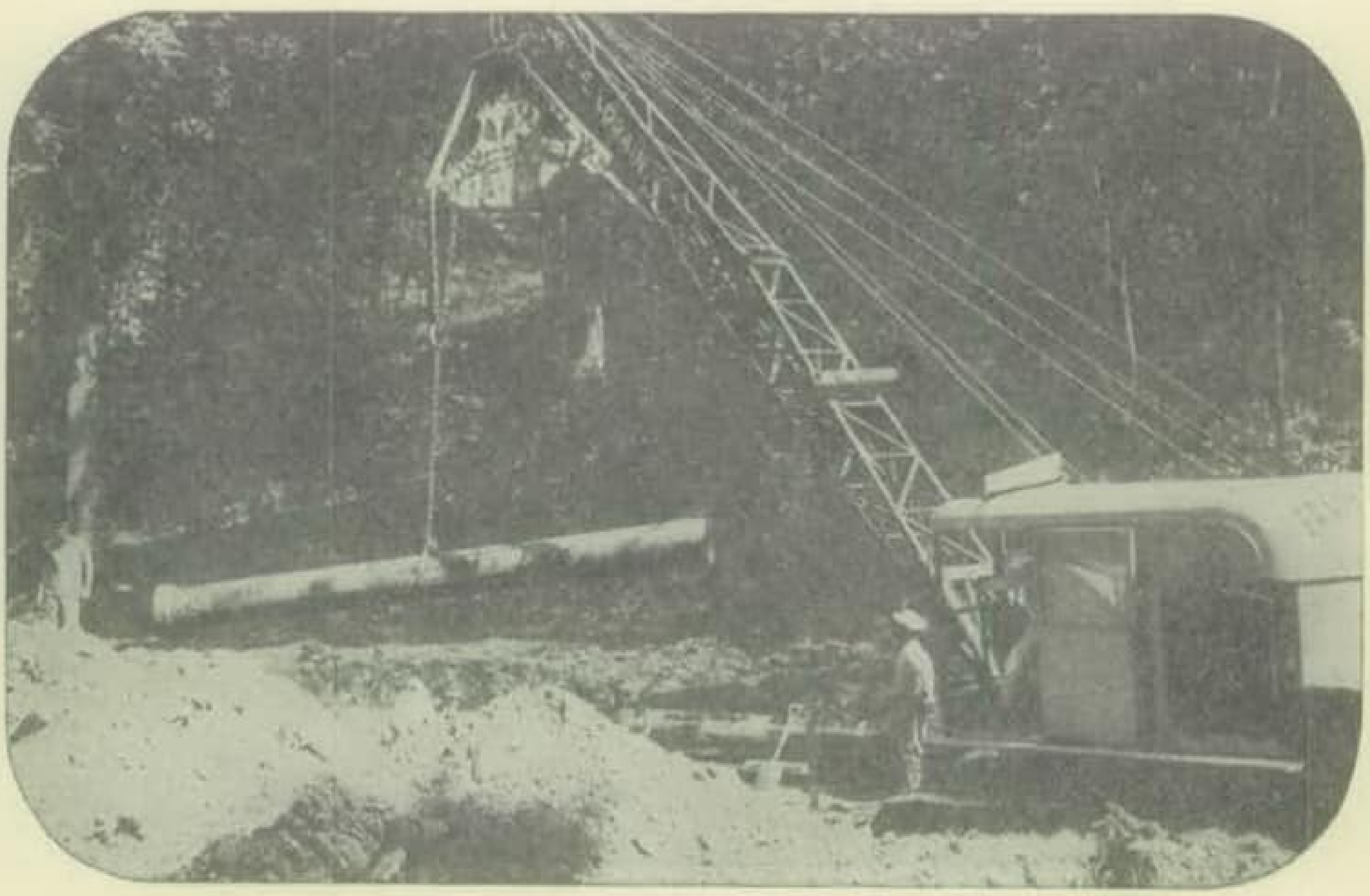
#### WALL THICKNESSES TO BE USED

Tables in the A.S.A. Manual A21.1 show the recommended wall thickness for cast iron pipe under various trench conditions and depths, and for various internal working pressures. The engineer can readily select from this table the proper metal thickness for pipe for conditions under which it will be called upon to serve.

THE STANDARD LAYING CONDITION ADOPTED BY COMMITTEE A-21 WAS THE FLAT BOTTOM TRENCH WITH TAMPED BACKFILL WITHOUT BLOCKS AND WITH 5 FT. OF COVER. TABLES OF WALL THICKNESSES FOR THIS STANDARD CONDITION ARE SHOWN IN AMERICAN STANDARDS ASSOCIATION SPECIFICATIONS.

# SECTION 5

## Laying Cast Iron Pipe



# SECTION 5
## Laying Cast Iron Pipe

THE installation of cast iron underground mains is often regarded as a simple task capable of being performed by almost any kind of labor. This concept has arisen for several reasons: (1) The inherent strength and corrosion-resistance of cast iron; (2) the fact that thousands of miles of cast iron mains, laid by unskilled labor, without proper engineering planning and supervision, have given excellent service, many for more than 100 years. This assumption is almost true. Laying cast iron pipe is a relatively simple job. However, experience and research show that certain elementary requirements should be observed to insure trouble-free service for generations. If a construction engineer were to build a distribution system with his own money, as a lifetime investment for himself and his descendants, he would undoubtedly observe these few simple requirements.

Good judgment suggests that it is more economical to use conscientious care in handling and installing pipe than it is to have to spend money later on for unnecessary maintenance. This is but consistent with the care taken by the manufacturer in producing the pipe and in handling it for shipment. There have been innumerable instances where the blame for a repair job was charged to the pipe only to find, by later investigation, that the fault was properly chargeable to the method of laying the pipe, or lack of reasonable care in handling or installing it.

The following review of the principal points of good practise in the handling and laying of cast iron pipe may be helpful in the promotion of better pipeline construction.

### UNLOADING PIPE

From the time the pipe is taken from the molds or the centrifugal casting machine, until it is loaded by special cranes on freight cars or trucks, the manufacturers exercise utmost care to avoid damage to their product. Each length of pipe is examined, hydraulically tested, and inspected before it is loaded for shipment. Every precaution is taken to insure that the pipe will arrive at destination, as it left the foundry, in first class condition.

Damage from rough handling in transit will occasionally occur; consequently, the purchaser or contractor should inspect the pipe as it is being unloaded. A simple precaution is to "ring" each length with a hammer. Damaged pipe should be noted on the freight bill and immediately brought to the attention of the agent for his signature to insure proper adjustment with the transportation company.

In unloading, dropping pipe to the ground from trucks or cars is apt to cause damage which may not show up until after the pipe is installed in the line. Pipe being unloaded on skids should not be rolled against other pipe. Observance of these simple precautions takes little time or trouble and can save money.

### DELIVERY AT TRENCH SITE

In the delivery of small diameter pipe to be laid by hand, efficiency requires that the pipe be strung along the route with the bells facing in the direction in which the work is to proceed. To avoid unnecessary handling, the pipe, as well as fittings, should also be placed as close as possible to the locations it will occupy in the finished line.

Usual procedure is to place the pipe close to the trench on the opposite side from the earth pile. Traffic conditions and type of excavation and installation equipment will effect this procedure. A desirable safety measure is to keep the pile of excavated earth between the trench and the road traffic. When travelling cranes are used for handling, the pipe should be strung so as to cause the least interference with traffic.

In the northern states, valves, fittings and hydrants should be placed, or stored, where they will not collect rain water and be damaged in freezing weather. Pipe for future use should be carefully stacked in the storage yard in even layers with 4″ x 4″ stringers between each layer and with heavy blocks at the end of each row to prevent rolling. Bottom layers should be raised on heavy timbers to prevent dirt and rubbish from entering the pipe. For convenience as well as safety, each size should be separately stacked.

### EXCAVATION

The width of trench for various sizes of pipe is determined by the type of soil, the depth of laying, type of excavating equipment and the space required to allow workmen to backfill thoroughly around and under the pipe. It is conceivable to install a 36″ pipe, for instance, in a trench 48″

wide, but it would be a physical impossibility to tamp the backfill material properly around and under the pipe with such small clearance. Generally speaking, the wider the trench the greater the earth load on the pipe. However, the trench must be of sufficient width to enable the workmen to tamp the backfill around the bottom half of the pipe. Most specifications allow the trench to be from one to two feet wider than the outside diameter of the pipe.

### TRENCH WIDTHS FOR VARIOUS PIPE SIZES

The following table will serve as a guide for width of trench:

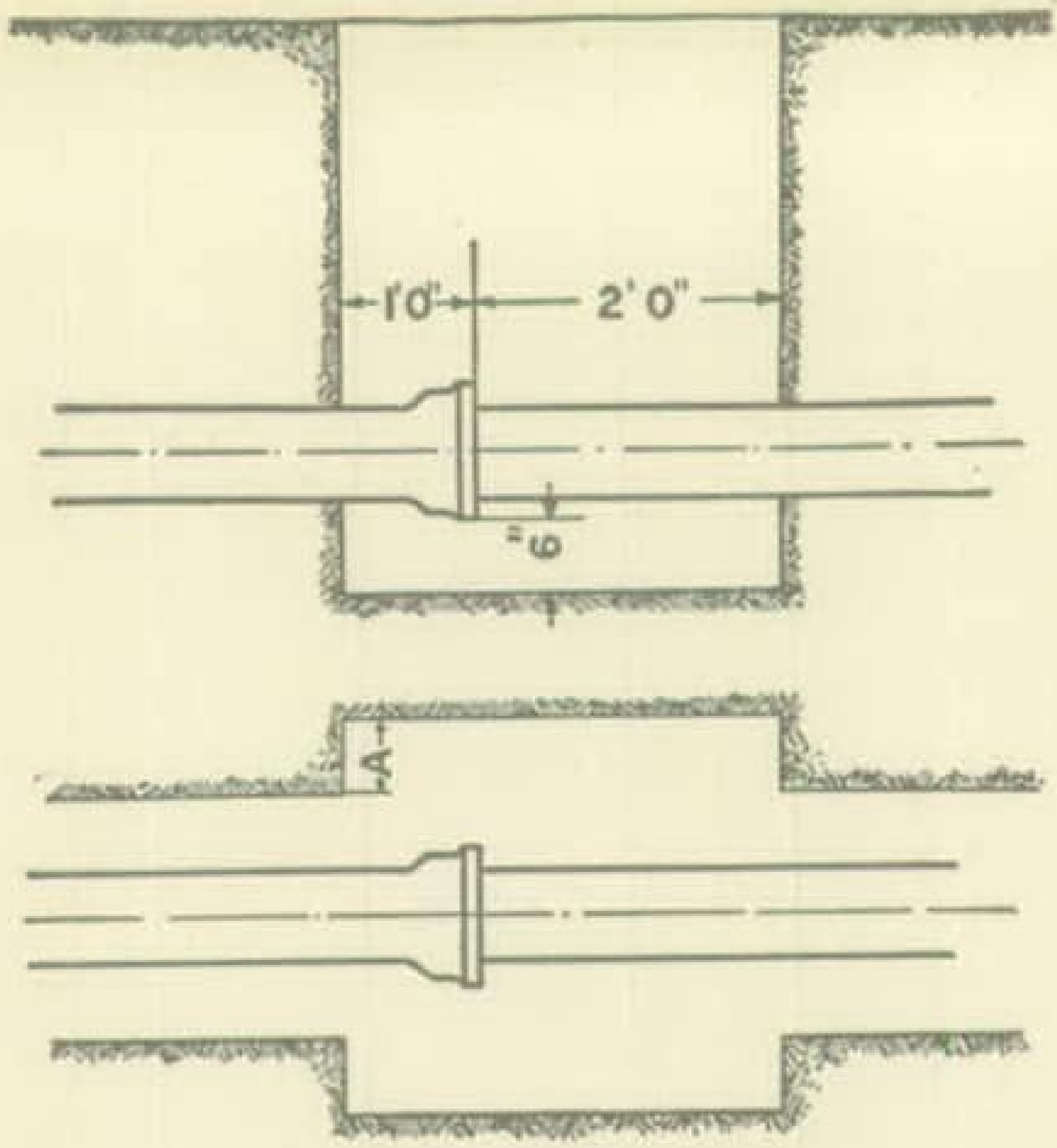
| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Diameter of Pipe, Inches | *2* | *3* | *4* | *6* | *8* | *10* | *12* | *14* | *16* | *18* | *20* | *24* | *30* | *36* | *42* | *48* |
| Minimum Width of Trench, Inches | *18* | *18* | *18* | *21* | *24* | *26* | *28* | *30* | *31* | *32* | *33* | *36* | *47* | *54* | *61* | *68* |

The bottom of the trench should be cut true and even, so that the barrel of the pipe will have a bearing for its full length. When trenches are dug with a power-shovel or back-hoe, special care should be taken to make sure that the trench bottom is levelled off to provide a bed for the pipe.

The depth of the trench for water pipe must be at least sufficient to bring the pipe below maximum depth of frost. Large mains laid in heavy traffic streets, under railroad crossings, or in any location where shock might be transmitted to the pipe, should be laid deeper than the minimum requirements mentioned above. In some cases, a minimum covering of 4 to 5 feet is required for mains of even large diameters to provide a cushion to absorb shocks due to traffic. In the southern states, where there is no danger of freezing, a covering of from 2½ to 4 feet is usually sufficient.

### BELL HOLES

At each joint a bell hole is dug of sufficient size to insure proper joint making. Digging bell holes so small that the calker cannot easily swing his calking hammer, or operate an air-driven hammer, is false economy. On the other hand, too large bell holes are a detriment to the pipe. Experience has shown that large bell holes dug with a ditching machine place undue stress on small diameter pipe, resulting in breaks due to extra and unnecessary beam action. The diagram following shows the general dimensions of bell holes for small diameter pipe.




Dimension "A" varies from 6 inches to 10 inches, depending on kind of soil, type of joint, calking material used and method of calking (hand or air). In smaller sizes of pipe bell holes may not extend to the surface of the ground in stiff material but may be dished out for about a foot and a half above the top of the pipe.

## ROCK EXCAVATION

In rock excavations, it is necessary that the rock be removed to such an extent that at no place will it come closer than 6 inches to the finished pipe line. After the excavation is completed, a bed of sand, or earth free from stones or clods, 6 inches deep, should be made on the bottom of the trench and the pipe placed on this "cushion." Failure to do this may result in the pipe resting on a sharp point of rock, a condition which has caused many breaks in small diameter mains.

Underground mains should be carried around underground obstructions, such as sewers, conduits, piers, vaults and other construction, using special fittings where necessary. Pipe should not be allowed to rest on any unyielding structure, nor should it be called on to support another structure. Pipe should not be laid in a manner that will cause it to act as a beam. It should not be poured solid in concrete walls, footings, piers, abutments or other immovable objects, as the weight of the backfill and settlement of the trench often cause the pipe to act as a cantilever beam, with resulting failure. Sleeves or special wall castings should be used at the junction with these heavy subsurface structures.

## CORROSIVE CONDITIONS

Experience has shown that in certain types of soil—some natural and some man-made, corrosion of cast iron pipe may occur. The Cast Iron Pipe Research Association has cooperated with the National Bureau of Standards in their soil corrosion test work ever since its inception, and more recently have undertaken a test program of their own. This work is being carried on in spite of the fact that places where severe corrosion of cast iron pipe occurs are comparatively rare. We know, however, that from time to time pipe must be laid through cinder fills, through garbage dumps, through salt marshes, through muck soils and places of high alkali or acid concentration. Our tests are intended to develop methods of protection for these isolated cases. These tests include trench improvement, cathodic protection, and coatings, including cement armor coating, and as other methods suggest themselves, they too will be investigated. The results of tests up to date indicate that as a general rule, trench improvement, that is, the use of sand or limestone screenings, or similar inert materials, from a point 10 in., below the pipe to 10 in. above, is usually effective and much cheaper than other methods. In the rare cases where extremely corrosive conditions exist, it may be advisable to make a complete study of the conditions surrounding the pipe and to determine a method of protection most suitable for each individual case.

## BREAKS IN PIPE

The durability of cast iron pipe, as proved by service records, occasionally persuades construction superintendents and contractors to disregard some of the aforementioned elementary principles of pipe-laying practice. It is true that thousands of miles of cast iron mains, laid before the maze of underground construction beneath the streets of metropolitan cities could have been foreseen, are still in service. Moreover, many of those old mains were installed without benefit of engineering planning or supervision. It is, therefore, remarkable that the percentage of breaks per year in cast iron pipe compared to lengths in service, is negligible.

Surveys made by staff members of the Cast Iron Pipe Research Association and studies of annual reports of water supply systems, show that "breaks per mile per year" amount to less than one one-thousandth of one per cent of the lengths of cast iron pipe in service.

Breaks in water distribution mains are "front page news" for the very reason that they occur infrequently. Newspaper reporters are seldom informed before press-time that the broken length of pipe was resting on a sewer line, supporting a conduit, or was serving under conditions unforeseen at the time it was installed.

Cast iron pipe is designed and produced to have wide margins of safety in beam strength, bursting strength and compressive strength. With reasonable care in handling and installation, and due regard to the hazards of other underground installations, breaks in cast iron pipe will continue to be, as they have in the past, a rare occurrence.

### METHODS OF INSTALLING PIPE

There are several types of trench bottom used in laying pipe. These include laying pipe on blocks placed on the bottom of the trench; laying pipe on a flat bottom trench; or on a trench bottom rounded out to fit the shape of the pipe. Some foremen have tamped the backfill around and under the pipe; others have thought it a waste of time, and many have their own particular methods of construction. The American Standards Association has carried on research studies through its Committee, A-21, at Iowa State College and the University of Illinois. These studies of pipe-laying conditions have developed actual relative strength values for various methods of installing pipe in the bottom of the trench. Diagram on page 35 gives relative bearing values for 12″ pipe for different trench conditions.

Six methods of installing pipe were studied by this committee:

A. Flat bottom trench, backfill not tamped.
B. Flat bottom trench, backfill tamped.
C. Pipe supported on blocks, backfill not tamped.
D. Pipe supported on blocks, backfill tamped.
E. Bottom of trench shaped to fit the bottom of the pipe for about 90 degrees, unevenness filled in with sand as required, backfill not tamped.
F. Same as E, except that the backfill is tamped.

Method "C" produces the greatest loads that tend to crush the pipe, and method "F" produces the smallest crushing loads. Type "B" method is the one adopted as standard by Committee A-21 of the American Standards Association.

When blocks are used for aligning and supporting the pipe, they should be placed at two points in the length of the pipe. Especially is this important for sizes under 16″ in diameter. The blocks should be laid on undisturbed earth and set in slots in the bottom of the trench so that they project about 1″ above the trench bottom. They should be so set as to have a bearing over the entire surface. The primary purpose of blocking is to support and level the pipe during construction. The backfill material should be carefully tamped around and under the pipe so that the blocks will carry only a small per cent of the finished load. The use of blocks for installing water mains is becoming less common and the practice may soon be discarded altogether.

### HANDLING PIPE

Pipe should be handled by mechanical equipment if possible and not just rolled or pushed into the trench from the bank. Pipe up to 12″ in diameter may be lowered into the trench by taking a turn of rope around each end of the pipe, while standing on the other end of the rope, and then playing it out until the pipe rests on the bottom of the trench. Large sizes are best handled by means of power equipment.

Before the pipe is lowered into the trench, it should be swabbed or brushed out to insure that no dirt or foreign material gets into the finished line. Where pipe has been allowed to remain along the right-of-way for a considerable time, it may become fouled with surface pollution and should be swabbed out or otherwise disinfected with a chlorine solution. Trench waters should be kept out of the pipe and the pipe kept closed by means of test plugs whenever work is not in progress.

### YARNING

Before entering the spigot of the pipe into the bell of the preceding length, strands of yarn are held in place around the spigot so that both enter the bell at the same time. The yarn serves to center the spigot in the bell and to keep it at the proper distance from the bottom. This is important, and if by chance, after the crane slacks off on the pipe, it is found that the joint space on the bottom is smaller than on top, the pipe should be raised by the crane, ropes or wedges, and additional yarn driven into the lower part of the bell.

Strands of yarn, or braided hemp if used, are cut somewhat longer than the circumference of the pipe so that the ends will overlap, and the overlapping ends of successive strands should be staggered. The separate strands should be driven home with a yarning tool and hammered, and when the last one is in place all strands should be thoroughly compacted. This is essential to the making of a good joint as the yarn forms a compressible gasket that helps assure water tightness. Sufficient yarn should be used to fill the bell up to within 2 to 2½ inches of the face. There are several grades of yarn for various types of work. The yarns that are used by plumbers or boat makers are not suitable for water works construction, as they are impregnated with tar or oil and will impart a definite phenol taste and odor to the water. If sterilized yarn is used it should be kept in substantial containers with tight-fitting covers so that it will not be contaminated during construction. Sanitary aspects of water works construction are receiving more care and thought than in the past.

Yarn has been used as a calking material for over 100 years, but recently several alternative products have been developed: A specially prepared paper calking material, a braided cotton material and various types of rubber products. The rubber gasket material is prepared in a round form which can be cut off in suitable lengths for the various sizes of pipe, and also ready-formed in diameters for various sizes of pipe. These materials were developed because of contamination entering water mains due to the use of yarn as calking material. Yarn has been the source of considerable criticism due to its ability to support gas forming bacteria.

### JOINT MATERIALS

The most common type of joint is made with cast lead. For water lines cement and sulfur jointing compounds are also used. Recently, mechanical gland-type joints having heavy rubber gaskets have gained much favor in both the water and gas industries.

### LEAD JOINTS

After the joint is yarned, the lead runner is put in place on the joint so that it fits tightly against the face of the bell and the outside of the pipe. Clay should be used whenever necessary to make a tight joint between runner and pipe. The pouring gate is built up with clay to a point at least one inch above the top of the joint space. If possible, joints should be poured from one ladleful of lead. If more than one ladleful is required, no considerable time should elapse between pouring successive ladles. In the case of joints on pipe above 48 inches in diameter, in extremely cold weather, it is sometimes necessary to pour the joints in halves. The runner is placed around the bottom halfway up on the pipe. Lead is then poured into both gates until it has reached a point just below the midpoint on the pipe. The bottom of the runner remains in place and the upper ends are then placed over the top half of the pipe and a pouring gate built up at the extreme top as in pouring ordinary joints. The remainder of the joint is then poured in the usual manner. As soon as the joint has cooled, the runner is removed and the joint is ready for calking.

In extreme cold weather it occasionally becomes necessary to heat the joints of large size pipe to avoid "misses."

Good calking practise requires that each calking tool be used, from the smallest to the largest, that will fit in the joint space and that the joint be calked completely around with each tool. This method calls for more work than would be necessary if only the larger tools were used but the joint that results is worth the additional effort. Pneumatic calking hammers are recommended even for small diameter pipe. Their use produces a much better job of calking, with less effort by the workmen and at a lower cost. Excessive calking should be avoided to prevent splitting bells. The depth to which calking is effective has been found to be about ¾ of an inch when calking is properly done. Lead wool may be used for repairing joints. It comes in a loosely shredded rope form and is calked into the defective joint one strand at a time.

### LEAD ALLOYS

Where extremely high pressures are to be used, alloys are added to the commercial lead, the object being to produce a material that is harder and consequently less apt to "flow" or flatten out when pressure tends to push the lead out of the joint. The City of Boston after experimenting with different alloys for use in its high pressure fire-fighting system, adopted one consisting of 96% lead, 2% tin and 2% antimony; a mixture of 95% lead and 5% tin was also used with good results.

### LEAD SUBSTITUTES

Several kinds of self-calking substitutes for lead have been developed. These materials are usually a mixture of iron, sulfur, slag and other ingredients which, when melted and cooled, forms a hard slag-like mass. They are furnished in either a powdered form or in small pigs. Less heat is required for melting than in the case of lead. The best results are obtained with a gasoline-fired furnace as temperatures can be accurately controlled. Overheating of the material is a common fault and results in a poor joint.

In yarning the joint, it is important that a dry yarn be used and that the inside of the bell and outside of the spigot be thoroughly cleaned. Braided hemp is better than ordinary yarn for this type of joint. The jointing operation is usually kept four lengths back of the pipe-laying crew.

The runner is placed in the usual manner and the pouring gate built up 6 or 8 inches above the top of the bell. The manufacturers furnish cone-shaped metallic runner-heads that are used in place of clay for a high pouring gate. The joint is now ready for pouring. The compound is at the proper temperature when it flows freely, reflects one's image as in a mirror, and is free from foam or bubbles. If too hot or too cold it will be somewhat thicker than the required consistency, and it should be either reheated or cooled before pouring. The joint should be poured with one ladleful until the joint and pouring gate are full. When the jointing material has cooled, the runner should be removed, the joint inspected, and the runner-head cut off. In case of a defective joint the material should be cut out for several inches, all loose material removed, and the defective joint repoured. This joint requires no calking and is ready for use as soon as it has cooled. As it is a characteristic of this joint to sweat or seep a little at first, the final leakage test is not run until 30 days after the pouring. Since this type of material may not be adaptable under certain conditions, prudence suggests investigating installations operating under similar conditions before its use.

### CEMENT JOINTS

Water systems throughout the Southwest and along the Pacific Coast have used cement joints for pressures up to 150 pounds. A number of different methods of making the joint have been developed. The method described below seems to be the most common.

First, the pipe should be properly supported before the joint is started, so as to eliminate any possibility of movement before the cement has set. The next step is to yarn the joint, just as for any other type of material, being sure to see that the yarn is driven home with hammers in the usual manner. The yarn should be free from all oil and grease. Cement for the joint itself should be about one quart of cement to ¼ pint of water, and thoroughly mixed by workmen, usually in wheelbarrow so that mixing can keep pace with joint making. Experience shows that neat cement mixed with a sufficient quantity of water, and thoroughly kneaded by hand to such a consistency that no moisture will show when squeezed tightly in the hand, will give proper results. The cement should be dry enough to give a metallic sound while being calked. Cement mortar should be made up in small batches so that no mortar shall stand longer than 30 minutes before using. A wooden or iron tool with a broad face is used for ramming the mortar into the joint. The joint should be calked when half-filled with cement, and again when filled, using lighter blows than for a lead joint.

## MECHANICAL JOINTS

The mechanical joint, developed about 25 years ago, is based upon the well-known engineering principle of the stuffing box. It has four parts: A flange cast integral with the socket, or bell, of the pipe; a rubber gasket fitting a recess in the socket; a gland, or follower ring, to compress the gasket, and the bolts and nuts for tightening the gland. A complete description of this joint with instructions for assembling will be found in Section 12.

The assembly of this joint is simplicity itself, requiring but one tool, an ordinary ratchet wrench. It is quick and easy for even untrained men. A wet trench presents little or no difficulty because the pipe can be jointed above the trench and lowered.

One of the problems in the operation of gas systems distributing dry or mixed gas has been "unaccounted-for leakage." The mechanical joint proved to be the answer. It is bottle-tight at high pressure for both gas and water lines. It permits a high degree of deflection as well as longitudinal expansion and contraction.

Mechanical joint cast iron pipe can be laid faster with less equipment and smaller crews, more than offsetting the higher cost per foot compared with bell and spigot pipe. Moreover, it is now completely standardized so that fittings and accessories made by one manufacturer will fit the pipe produced by any other manufacturer.

## COUPLED JOINTS

For connecting plain end pipe several types of couplings are available, the best known being the Dresser Coupling. This coupling consists of two flanges, two gaskets, a middle ring and the necessary bolts. The gaskets are usually of rubber, but various types are available for the specific duty of the pipe line. To insure uniform compression of the gasket, bolts opposite each other are drawn up a little at a time until all are drawn up to the limit. The best joint is obtained when two men work on opposite bolts, each drawing his up an equal amount. On small size pipe several lengths may be joined together on the bank before lowering into the trench. For large size pipe, the joint must be made in the ditch.

*Victaulic Coupling:* This type of coupling for cast iron pipe has two malleable iron half housings, an endless rubber ring and malleable iron bolts. The couplings for large pipe are made up of several segmental housings bolted together. Cast iron pipe for use with victaulic couplings is furnished with shouldered ends for high pressure and with grooved ends for medium or low pressure.

### SUBMARINE PIPE LAYING

There are several methods of installing cast iron pipe across rivers or other bodies of water. The most common practise is to use mechanical gland type pipe, either the standardized mechanical joint that deflects up to 8 degrees, or the ball and socket joint that deflects up to 15 degrees. Large pipe, 24 inches or over, is usually made up in sections of three or four lengths either on shore or on the deck of a barge, and then attached to a "strongback" and the assembly lowered to the bed of the stream where the sections are progressively connected by divers. Submarine lines under 24 inches in diameter are usually laid with joints provided with positive locking devices so that the pipes cannot be pulled apart. This type of pipe can be assembled on a barge and lowered from the rear of the barge as the line progresses across the river or lake. These joints have a wide angle of deflection and readily follow the contour of the bottom of the river.

In shallow water it is often economy to construct cofferdams and after pumping them out, to lay the pipe as on dry land. If the body of water is navigable the cofferdam should be constructed in sections, to provide a channel for boats. In still water the line may be joined together on shore along the bank and floated by means of barrels or rafts attached to the pipe. When the entire length of line has been assembled, one end is towed out until the pipe occupies the desired position. It is then lowered by releasing the barrels, care being taken during the sinking process so that the joints do not become distorted. If lead joints are used, the entire line should be lowered as one unit. Cofferdams are then constructed at the shore ends and pipe connected up in the usual manner.

A somewhat similar method is to lay the pipe on the shore and as each length is connected up to push it down skids into the water where barrels are attached to it. As each successive length is laid, the line extends further into the water. The finished line is sunk in the manner described above.

Another method is to drive piling in pairs along the proposed line and to rest the pipe on timbers supported between piles. When the entire line is connected up, sills are laid across the top of the piles and pipe supported from the sills by means of rope, blocks, or chain hoists. The pipe is then raised enough to release the timbers upon which it was resting, and after their removal the line is lowered gradually to the bottom of the water. It is not necessary that the entire line be lowered as a whole. It should be lowered beginning at one end and proceeding to the other so that the total deflection of the joints is not excessive.

Submarine lines laid in navigable streams should be placed in trenches and covered over so that the pipe will not be injured or pulled up by boats dragging their anchors.

### TESTING WATER MAINS

Good engineering practice requires that all pipe lines be tested before placing in service, and usually before backfilling. In city streets with heavy traffic, backfilling is done as soon as two or three lengths of pipe have been laid. This applies to both water and gas mains. In the case of water mains the test pressure should equal the pressure under which the line will operate plus 50 per cent over the working pressure. Care should be taken to see that air is expelled and all caps and plugs are properly braced before the test pressure is applied and that all piers and masonry supports at bends and tees are in place.

Air is expelled by opening a fire hydrant near the high point of the line, or by opening a corporation cock that has previously been inserted. When the air has been expelled, the valve or valves between the old part of the system and the line under test are closed. Pressure is then applied to the portion under test either by means of a hand pump for small lines, or small sections of large lines, or by use of a gasoline pump or fire engine for large lines. After the main has been brought up to the test pressure it should be held at this pressure for at least 30 minutes and the make up water carefully measured by the use of a displacement meter or by pumping the water from a vessel of known volume. The American Water Works Association Specification for Installation of Cast Iron Water Mains (C600-49T) requires that the leakage shall not exceed 70 gallons per 24 hours per inch of diameter per mile for 12-foot lengths and correspondingly varied for other lengths of pipe when the test pressure is 150 lbs. A table in the specification shows allowable leakage per 100 joints for other test pressures. While the pipe is under test it should be thoroughly inspected from one end to the other, especially the joints, to be sure that they have been properly calked. Any leaking or sweating joints should be redriven and the line made tight.

In the case of sulfur compound joints the line should be left full of water for 30 to 40 days before making the final measured leakage test.

However, initial hydrostatic tests may be run at any time after the joints have been poured and before backfilling. Pipe joints made with cement should not be subjected to the hydrostatic test until after 36 hours from the making of the last joint in the line. The measured leakage test should not be made until 14 days have elapsed. After any leaks or other defects have been repaired the ditch should be backfilled.

### TESTING GAS MAINS

In testing gas pipe, air pressure is used and leaks are detected either by applying soapsuds to each joint, or by placing a water-filled canvas bag around the joint. In the case of leaks, bubbles will appear and the joints can be recalked, if of lead, or the bolts tightened if of the mechanical joint type. As a rule the actual leakage in gas lines is not measured by a displacement meter, but the tightness of the line is determined by the fact that the pressure, when built up to the test point remains stationary for a 24-hour period. Recording pressure charts and recording thermometers are used for making the check. Temperature is a very important factor in the test and must be given due consideration.

### SUPPORTS FOR FITTINGS

Supports should be constructed behind all bends, tees, caps, and plugs. They should be designed to carry the load that will be imposed upon them with the pipe working under its maximum head, and with a reasonable allowance for water hammer. They should bear against undisturbed earth and in case this is not possible, they should be made correspondingly larger due to poor bearing capacity of newly filled ground. The use of supports behind fittings refers to fittings in the vertical plane as well as those used in the horizontal plane. These should be so designed that they will not interfere with recalking joints should such work become necessary.

### BACKFILLING

One phase of pipe line construction that is apt to receive casual attention is backfilling. The old fashioned idea of shovelling the dirt into the trench and letting nature take its course is a prolific source of trouble. The proper method is to replace the excavated earth in such a way that future settlement will be reduced to a minimum. When a trench is carelessly backfilled the pipe may be called upon to act as a beam in supporting material directly over it. In the case of excavation in sand, backfilling can be done efficiently by the proper use of flooding, although even in this case some care is necessary to see that no open spaces are left under the pipe.

### CUTTING PIPE

There are two general methods used for cutting cast iron pipe: A cutting machine, or by the use of diamond points, chisels, hammers, etc. The ordinary wheel type of cutter is used for pipe up to about 16 inches in diameter. The operation of this type of cutter requires no particular explanation, nor is a great amount of skill required.

A certain degree of skill and care is necessary when cutting pipe with cold chisels, diamond points, and hardys. When cutting pipe in the trench, or when cutting larger pipe on the bank, it is advisable to use a chisel with a diamond-shape point. This tool actually removes the iron in small chips instead of merely deforming it. After a groove has been cut completely around the pipe with the diamond point, a cold cut or hardy is used for finishing the cut. It is possible, by striking hard blows with heavy hammers, to cause small cracks in pipe that is being cut, which may not show for some time. Care is needed if pipe is not to be damaged in the cutting process.

### CHLORINATION OF MAINS

All new water distribution systems, or extensions to existing systems should be thoroughly flushed and sterilized before being placed in service. The contractor or construction superintendent should see that the pipe is clean when installed, and should give the new mains a complete flushing before turning them over for operation.

Chlorination or sterilization of mains should be done by men who have had experience with chlorine or other sterilizing agents. Prior to chlorination all dirt and foreign matter should be removed by a high velocity flushing through fire hydrants or other approved blow-offs. A good flushing is a very important factor in sterilization. Chlorine can be used in several forms, as a gas with direct feed as the water is let into the new main, as a dry powder such as Hypochlorite placed in each length of pipe as the line is laid, and as a mixture of chlorinated lime and water. The dry powder is the easiest to use, especially when the work is being done by the contractor, although, some sanitary engineers rate it as the least effective method. The important point in the chlorination of a main is to have it entirely filled with a chlorine solution of at least 40 to 50 parts per million of chlorine and to retain it in the pipe for at least three hours.

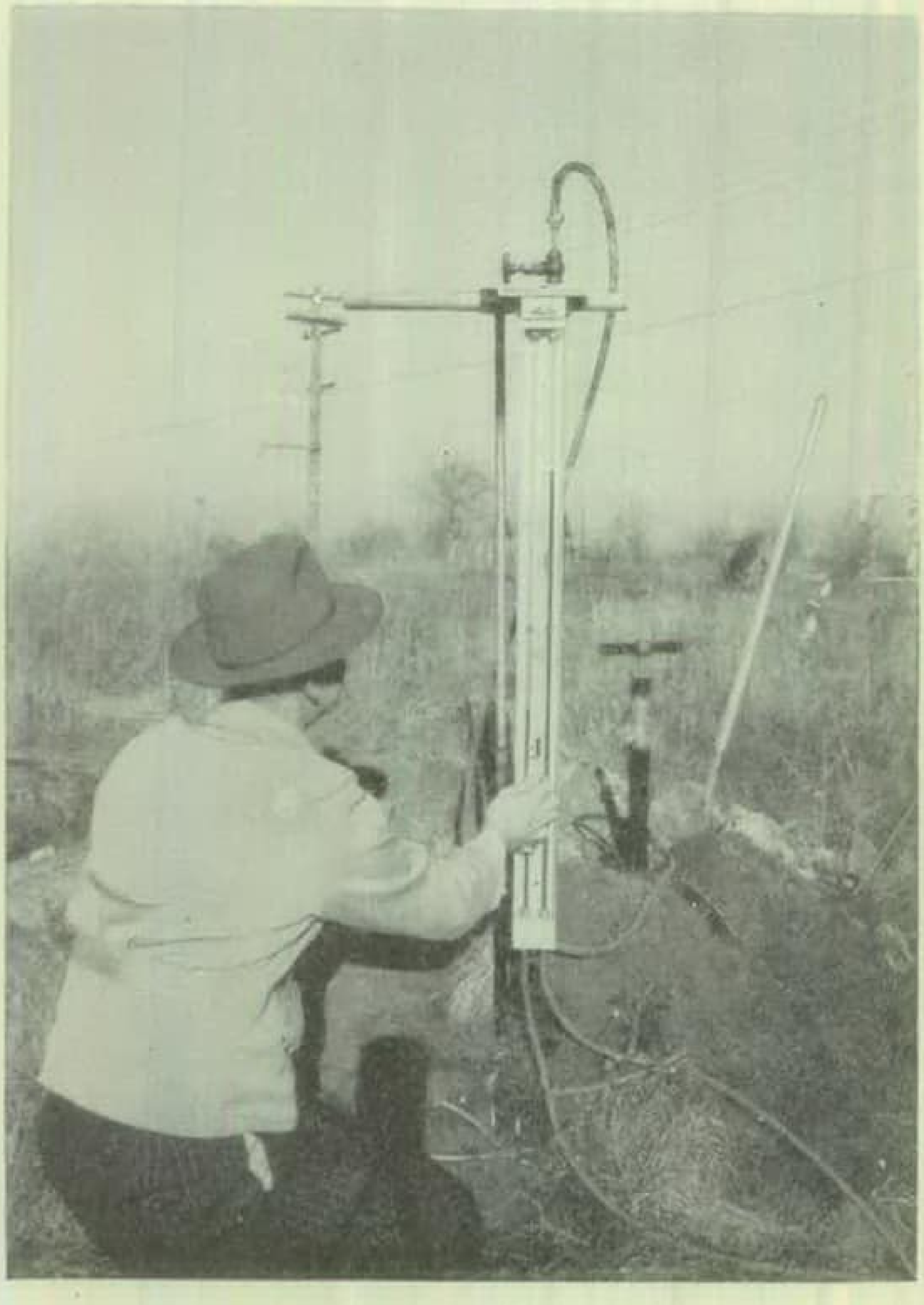
After this period the chlorine residual at the pipe extremities should be at least 5 parts per million.

The dosage for sterilizing new mains when using Calcium Hypochloride (comparable to commercial products known as H.T.H. Perchloron, and Maxochlar which contains about 70 per cent available Chlorine Maxochlar), shall be one pound for each 1,680 gallons of water pipe capacity treated. This dosage is equivalent to a treatment of 50 p.p. million available chlorine. In like manner, one pound of Calcium Hypochlorite powder will treat 2,100 gallons of water to 40 p.p. million chlorine. Following chlorination, all treated water should be thoroughly flushed from the newly laid pipe line at its extremities until the replacement water throughout its length shall equal in quality, both chemically and bacteriologically, the water served to the public by the water supply system. (See A.W.W.A. specification for disinfecting water mains.)

For detailed information on chlorination of water mains see A.W.W.A. Document C601–48 (or the most recent revision), "The Procedure for Disinfecting Water Mains." Reprints of this publication can be secured from the American Water Works Association, 521 Fifth Avenue, New York 17, New York—Price 15c.

# SECTION 6

## Flow of Water in Cast Iron Pipe with Flow Tables



# SECTION 6

## Flow of Water in Cast Iron Pipe

IN SOME areas of the United States, water mains have lost an appreciable part of their original carrying capacity after years of service, and for this reason consideration of the causes of this trouble and the remedies should be of interest. This loss in carrying capacity results in increased costs either because of extra pumping expense or additional capital charges if larger mains are required. There are many reasons for a reduction in the flow capacity of a pipe line—reduced flow does not necessarily indicate that the trouble is caused by tuberculation. Increased friction may be due to any of the following:

1. Sedimentation; mud, silt or sand.
2. Obstruction of the pipe due to debris; sticks, boards, stones, tools and other things that may have gotten into the pipe during construction.
3. Partly closed valves.
4. Accumulation of air at summits.
5. Mineral deposits.
6. Slime growths on walls of pipe.
7. Tuberculation.

All of these difficulties can be taken care of by proper design and operation.

#### SEDIMENTATION

Transmission mains that carry raw water from rivers or lakes are subject to heavy deposits of silt and sand whenever the rivers are at flood stage, or the lakes turbulent. Many of the older distribution systems were supplied with raw water for years before the construction of treatment plants. During the low consumption periods at night, these waters settled out a layer of mud along the bottom of the pipe. Sand may enter the raw water lines at most any time and it may enter the distribution lines whenever the filters become defective or when the beds are abused by inexpert operation. If sedimentation has occurred, the remedy is either to flush the mains or when this is not effective, to carry on a pipe cleaning operation.

### OBSTRUCTIONS IN PIPE

Modern pipe laying specifications require that each length of pipe be cleaned out before installation in the line. They also require that the end of the pipe be closed with a plug after each day's work. In spite of these provisions it is a fact that at times stones thrown into the pipe by children, or pieces of wood, tools, boots, and other things placed in the last pipe by workmen, who expect to remove them before the work continues, are sometimes left in the pipe. Good laying practice should eliminate this difficulty.

### PARTLY CLOSED VALVES

In the ordinary operation of a water works system, it becomes necessary from time to time to close valves to carry on maintenance and extension work and in many of the systems, valves are throttled for pressure control purposes. Care should be taken to the end that closed valves be opened after the construction work is completed and the location of throttle valves properly recorded so that in the event that future operation requires a full opening, these valves may be opened. The opening and closing of valves is an important part of distribution system operation and records should be kept in such a fashion that no valves are accidentally left closed or partly closed.

### ACCUMULATION OF AIR AT SUMMITS

In supply lines in hilly country, there is occasionally an opportunity for air to accumulate at a summit to the point where the water occupies only a portion of the total area of the pipe. In extreme cases, water may even be shut off completely by the accumulation of air. The remedy for this difficulty is to provide air valves at summits in installations of this nature.

### MINERAL DEPOSITS

In rare cases, waters are highly mineralized. These minerals are picked up from the rock formations through which the water seeps in its underground passage. Some waters are super-saturated and the minerals only loosely held in solution. A small amount of air mixed with water in the pumping operation may cause the mineral to deposit out, or the water may change temperature and in this manner cause precipitation. Natural lime waters usually form a hard, smooth deposit on the entire wall of the pipe and do not increase the friction loss to an appreciable extent until the diameter of the pipe is materially reduced. Mineral deposits in mains are difficult to remove, usually requiring special cleaning tools. Lime deposits that result from softening and filtration processes are sometimes carried out into the mains. As a rule, these deposits are relatively soft and may be removed by ordinary pipe cleaning operations.

### SLIME GROWTHS

Some water supplies are troubled with organic growths in the mains. Many of the growths may be due to the use of surface water containing microscopic organisms. Some of these may cause tastes and odors, and others, while having little effect on the quality of the water, cling to the walls of the pipe reducing the rate of flow in the line. These growths may be removed by the use of chlorine, a combination of chlorine and ammonia, or copper sulfate. The nature of the treatment depends on each individual case and the application of chemicals should usually be started by the use of small dosages with gradual increase until the required effect results. A sudden change in chemical dosage is liable to cause complaints of tastes or odors.

### TUBERCULATION

In certain parts of the United States, uncoated or unlined cast iron water mains may develop a nodular growth on the interior of the pipe. These growths are called tubercules and their accumulation will materially affect the capacity of the pipe line. These growths can only occur where the water comes in contact with the metal of the pipe and the remedy for the difficulty is the use of cement linings wherever "active" waters are to be transported. The details on cement lining processes and advantages can be found on page 59 of this book.

***Williams-Hazen Flow Tables and typical examples of flow computations will be found in the section following.***

## Williams-Hazen Flow Tables

THE following friction flow tables (pages 63 through 71) are based on the Williams and Hazen formula, $V=Cr^{0.63}\ s^{0.54}\ 0.001^{-0.04}$. The formula makes use of a coefficient "C" which varies with the condition of the interior surface of the pipe—the smoother the surface of the pipe wall the larger the value of "C" and, consequently, the greater the carrying capacity; the rougher the surface, the smaller will be the value of "C". Field tests of modern cast iron pipe shows the value of "C" to range from 140 to 150 for new pipe. Many tests conducted in the field on long working lines suggests the following values of "C" for design purposes.

Use C = 140 for transmission mains and supply lines. If the water is tuberculating and forms nodules on the inside surface of the pipe, cement lined cast iron pipe should be used in order to maintain the original carrying capacity of the line.

Use C = 130 for secondary mains of shorter length and smaller diameter.

Use C = 100 for city distribution work involving a large number of fittings, hydrants, services, short runs of pipe and for old unlined pipe lines. The tables that follow have been prepared to show capacities and friction losses for these three conditions. The following are examples of how the flow tables may be used:

*EXAMPLE NO. 1*—Find the friction loss in five miles of 24-inch cement lined cast iron pipe supply line, delivering 6,000,000 gallons per 24 hours. A coefficient of C = 140 should be used for a pipe line of this character, and by referring to the table for 24-inch pipe we find that the friction loss per 1,000 ft. of main is 1.06 ft. (reading across the table from the 6,000,000 gallon rate of flow and in the column under C = 140). Then the friction loss in the pipe line will be $5 \times \frac{5280}{1000} \times 1.06 = 28$ ft., which is equivalent to 12.1 pounds.

*EXAMPLE NO. 2*—Find the friction loss in 500 ft. of unlined 8-inch cast iron distribution main laid twenty years ago, delivering 400,000 gallons per 24 hours. A coefficient of C = 100 should be used for a condition of this kind. By referring to the table for 8-inch pipe and by reading across from the 400,000 gallon per day rate of flow and in the column under C=100, we find a loss of 2.76 ft. per thousand feet of pipe. Then the friction loss will be $\frac{500}{1000} \times 2.76 = 1.38$ ft., which is less than one pound loss.

*EXAMPLE NO. 3*—How much water will a 16-inch lined cast iron pipe, 6,000 ft. long, deliver when the head (or pressure) at the supply end is 120 feet and a residual head of 100 feet is desired at the delivery end of the line. By subtracting the desired residual pressure from the initial pressure we find that 20 feet is available for overcoming the friction loss. As the water main is 6,000 feet long, the head that can be expended for each 1,000 feet of pipe is 20 divided by 6, or 3.33 ft. By referring to the table on 16-inch pipe in the column head C=140, we find that with a friction loss of 3.33 feet per thousand feet of pipe, the pipe in question will deliver 3,825,000 gallons per 24 hours.

### CEMENT LININGS FOR CAST IRON PIPE

Cement linings for cast iron pipe have been in use for approximately 30 years, and cement linings in other metal pipe have been in use for over 80 years. For the majority of water supply systems, tuberculation presents no problem; however, in certain parts of the United States, uncoated or unlined cast iron water mains had lost an appreciable part of their original carrying capacity after many years of service. In these relatively limited areas, reduced carrying capacity was generally caused by tuberculation, a nodulose growth on the inside of the pipe caused by tuberculating water. It is now known, and has been conclusively demonstrated, that the use of cement linings prevents tuberculation by keeping the "active" water from coming into contact with the iron.

### DEVELOPMENT OF CEMENT-LINED CAST IRON PIPE

The first attempt to solve the problem of tuberculation was the application of a tar coating to the inside of the pipe. The tar-coated pipe resisted tuberculation to a greater degree than the uncoated pipe. However, it became apparent, with time, that "active" water penetrated pinholes in the tar coating and tuberculation ensued. The need of an effective pipe lining to combat tuberculation led to experiments with cement mortar.

In 1921, the first cement-lined cast iron pipe was installed in the water distribution system of Charleston, South Carolina. Tests made over a period of 23 years showed virtually no loss in carrying capacity in spite of the fact that highly tuberculative water was carried. Subsequent experience in many installations, during more than a quarter-century, has demonstrated that cement-lined cast iron pipe is tuberculation-proof, insuring high carrying capacity for the life of the pipe.

### ECONOMICS OF CEMENT LININGS

The advantages of cement-lined cast iron pipe go beyond the prevention of tuberculation and are clearly applicable to installations in territories where tuberculating waters do not exist. In order fully to understand the financial advantages of using cement linings it is necessary to have some knowledge of certain hydraulic phenomena.

When water moves through pipe, friction is developed between the water and the inside of the pipe. The result is that, as the water travels through the pipe, some of the energy imparted to it by the pump is consumed by the friction, resulting in a loss of pressure. The amount of friction so developed is the criterion by which the size of pipe, and the amount of power required for pumping, are determined. When a given amount of water is to be transported, the total amount of friction developed depends on the diameter and length of the pipe and the condition of its interior.

### THE WILLIAMS-HAZEN FORMULA

For nearly a half century, engineers have been guided in determining pipe capacity by the Williams-Hazen formula.

$$V = Cr^{0.63} s^{0.54} 0.001^{-0.04}$$

This formula was developed empirically from results of tests on a number of water lines throughout the United States. The coefficient "C" in this formula is intended to reflect the condition of the pipe interior. The other values in the formula have to do with length, loss of head and size of pipe.

The tests on which this formula was based indicated that new tar-coated cast iron pipe had a coefficient of 130, and that, as time went on, with certain waters, it fell off to less than 100. For design purposes it became the custom to use a coefficient of 100 as the value of "C" in the formula.

Since most waters do not cause serious tuberculation, the practice of using a value of 100 produced results definitely on the safe side. Pipe lines designed according to that value performed above par; that is, either pumping costs were lower than contemplated, or capacities exceeded those assumed in the original design. The reverse was true where growths developed in the pipe restricting the flow to the point where higher pressures were needed at the pumping station, pipe cleaning was resorted to, or even new lines required.

#### FINANCIAL ADVANTAGES

The principal advantage of cement linings is increased carrying capacity when the pipe is new and maintained carrying capacity as the pipe grows older. The economy resulting from the prevention of tuberculation is obvious, but experience has shown that less friction results when cement linings are used even where non-tuberculating waters are transported.

For example, a test made on a new 36-inch *tar-coated* cast iron supply line showed a coefficient of approximately 135. A test on a new 36-inch *cement lined* cast iron line showed a coefficient of 145. Since new pipe was tested in both cases, the difference in values was due to the different conditions of the pipe interiors.

As a demonstration of the financial advantages accruing from the use of cement linings, consider a typical instance based on flow conditions that prevailed at the time flow tests were made on the 36-inch cement lined pipe referred to above, and project them into the future.

A 36-inch (nominal diameter) cement-lined pipe under test was carrying 8,290,000 gpd. in a line 74,400 feet long. The Williams-Hazen coefficient determined by the tests was 145 and the loss of head was 16.8 feet.

Also tested was a 20-inch tar-coated line that had been in service 29 years which was found to have a coefficient of 102. (It is safe to assume that at the end of another year this coefficient would have been 100.) Assuming no increase in demand and a pumping cost of 5¢ per mil. gal., 1 ft. high, the annual cost of pumping against friction head only, if tar-coated pipe were used (actual inside diameter 36.8 in.), would have ranged from $3,140.00 per year when new (C=130) to $5,160.00 per year when the pipe had reached an age of 30 years (C=100).

In the case of cement-lined pipe, the pumping cost of the first year (C=140) would have been $2,540.00 and would remain at that figure throughout the 30-year period. The actual saving for this period resulting from the use of a cement lining would, therefore, be $48,300.00,

### SMALL DISTRIBUTION PIPING

In the case of smaller diameter pipe used in distribution systems, sizes are usually determined by fire protection requirements. The additional pressure available when cement linings are used may stop a fire in its early stages that would otherwise become a conflagration.

Where tuberculating waters are carried, the falling-off in capacity of smaller tar-coated mains occurs at a faster rate than is the case with larger mains. This can mean that in a relatively short time the capacity of tar-coated pipe is so reduced that replacement becomes advisable. The cost of cement lining, which insures high carrying capacity for the life of the pipe, is much less than the cost of replacement, even though it be delayed for as long as 45 years.

### THE CEMENT LINING PROCESS

The extrusion method of applying cement-mortar lining through a hollow shaft is modern practice. In this process the pipe is mounted horizontally on rollers. A hollow shaft is inserted to the far end of the pipe and the mortar extruded as the shaft is withdrawn. By this method, sufficient mortar for lining a predetermined number of lengths of pipe can be prepared and placed in the hopper of the machine, and linings applied at a rate permitting mass production. After the mortar is applied, the pipe is spun at a high speed to compact the mortar and remove excess water.

After the pipes are lined, they are either stored in a moist atmosphere during the curing period, or given a bituminous seal-coating to prevent too rapid loss of moisture. Applied in this manner, the cement lining adheres to the wall of the pipe so closely that pipe may be cut and tapped without damage to the lining.

To summarize: (1) Cement lined cast iron pipe prevents tuberculation. (2) In supply lines, the high Williams-Hazen "C" values result in economy due to lower pumping cost. (3) Cement linings make it possible to use smaller diameter pipe since the flow coefficient remains constant as compared to reduced capacity where tar-coated pipe is used. (4) With certain types of water, cement lining mitigates tastes, odors and red water troubles. (5) Modern cement linings adhere to the wall of the pipe and are not damaged by cutting or tapping.

## Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 2-Inch Pipe | | | | 3-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=120 | C=100 | C=80 | | C=120 | C=100 | C=80 |
| 8,640 | 0.61 | 1.4 | 2.0 | 2.9 | | | | |
| 14,400 | 1.02 | 3.6 | 5.0 | 7.6 | 0.45 | 0.50 | 0.7 | 1.0 |
| 28,800 | 2.04 | 12.9 | 18.2 | 27.5 | 0.91 | 1.80 | 2.5 | 3.8 |
| 36,000 | 2.55 | 19.6 | 27.3 | 41.6 | 1.13 | 2.71 | 3.8 | 5.8 |
| 43,200 | 3.06 | 27.3 | 38.4 | 58.0 | 1.36 | 3.81 | 5.4 | 8.1 |
| 50,400 | 3.57 | 36.6 | 51.0 | 78.0 | 1.59 | 5.10 | 7.1 | 10.7 |
| 57,600 | 4.08 | 46.8 | 66.0 | 99.0 | 1.82 | 6.50 | 9.1 | 13.8 |
| 72,000 | 5.11 | 71.0 | 99.0 | 150.0 | 2.27 | 9.80 | 13.8 | 20.8 |
| 86,400 | 6.13 | 99.0 | 139.0 | 210.0 | 2.72 | 13.70 | 19.2 | 29.1 |
| 100,800 | 7.15 | 132.0 | 184.0 | 280.0 | 3.18 | 18.30 | 25.7 | 38.8 |
| 108,000 | 7.66 | 149.0 | 209.0 | 318.0 | 3.41 | 20.70 | 29.0 | 43.8 |
| 115,200 | 8.17 | 169.0 | 237.0 | 358.0 | 3.63 | 23.40 | 32.8 | 49.6 |
| 129,600 | 9.19 | 210.0 | 294.0 | 447.0 | 4.09 | 29.10 | 40.8 | 62.0 |
| 144,000 | 10.21 | 256.0 | 358.0 | 540.0 | 4.54 | 35.20 | 49.6 | 75.0 |
| 172,800 | 12.25 | 360.0 | 500.0 | 760.0 | 5.45 | 49.70 | 70.0 | 106.0 |
| 201,600 | 14.30 | 479.0 | 670.0 | | 6.35 | 66.00 | 92.0 | 139.0 |
| 230,400 | 16.34 | 610.0 | 860.0 | | 7.26 | 84.00 | 118.0 | 179.0 |
| 259,200 | | | | | 8.17 | 106.00 | 148.0 | 223.0 |
| 288,000 | | | | | 9.08 | 128.00 | 178.0 | 271.0 |
| 316,800 | | | | | 9.99 | 153.00 | 213.0 | 323.0 |
| 345,600 | | | | | 10.89 | 179.00 | 251.0 | 380.0 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 4-Inch Pipe | | | | 6-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 20,000 | 0.36 | 0.17 | 0.19 | 0.32 | | | | |
| 30,000 | 0.53 | 0.36 | 0.41 | 0.67 | | | | |
| 40,000 | 0.71 | 0.61 | 0.70 | 1.13 | | | | |
| 50,000 | 0.89 | 0.92 | 1.05 | 1.71 | 0.39 | 0.13 | 0.15 | 0.24 |
| 60,000 | 1.07 | 1.29 | 1.47 | 2.40 | 0.47 | 0.18 | 0.20 | 0.33 |
| 70,000 | 1.24 | 1.72 | 1.96 | 3.20 | 0.55 | 0.24 | 0.27 | 0.44 |
| 80,000 | 1.42 | 2.20 | 2.52 | 4.10 | 0.63 | 0.30 | 0.35 | 0.57 |
| 90,000 | 1.60 | 2.72 | 3.12 | 5.04 | 0.71 | 0.38 | 0.43 | 0.71 |
| 100,000 | 1.78 | 3.30 | 3.81 | 6.19 | 0.79 | 0.46 | 0.53 | 0.86 |
| 110,000 | 1.95 | 3.95 | 4.55 | 7.40 | 0.87 | 0.55 | 0.63 | 1.03 |
| 120,000 | 2.13 | 4.63 | 5.17 | 8.65 | 0.95 | 0.65 | 0.74 | 1.21 |
| 140,000 | 2.49 | 6.20 | 7.10 | 11.60 | 1.10 | 0.87 | 0.99 | 1.62 |
| 160,000 | 2.84 | 7.90 | 9.10 | 14.70 | 1.26 | 1.10 | 1.26 | 2.06 |
| 180,000 | 3.19 | 9.80 | 11.30 | 18.30 | 1.42 | 1.37 | 1.57 | [illegible] |
| 200,000 | 3.56 | 12.00 | 13.80 | 22.20 | 1.58 | 1.67 | 1.91 | [illegible] |
| 220,000 | 3.91 | 14.20 | 16.40 | 26.70 | 1.73 | 1.99 | 2.29 | 3.71 |
| 240,000 | 4.27 | 16.70 | 19.30 | 31.20 | 1.89 | 2.33 | 2.69 | 4.35 |
| 260,000 | 4.63 | 19.40 | 22.40 | 36.10 | 2.05 | 2.71 | 3.10 | 5.00 |
| 280,000 | 4.99 | 22.30 | 25.50 | 41.60 | 2.21 | 3.11 | 3.58 | 5.80 |
| 300,000 | 5.34 | 25.30 | 29.10 | 47.10 | 2.36 | 3.54 | 4.06 | 6.60 |
| 400,000 | 7.12 | 43.20 | 49.50 | | 3.15 | 6.00 | 6.90 | 11.30 |
| 500,000 | | | | | 3.94 | 9.10 | 10.40 | 16.90 |
| 600,000 | | | | | 4.73 | 12.80 | 14.60 | 23.80 |
| 700,000 | | | | | 5.52 | 17.00 | 19.50 | 31.60 |
| 800,000 | | | | | 6.30 | 21.60 | 24.90 | 40.40 |
| 900,000 | | | | | 7.09 | 26.90 | 30.90 | 50.00 |
| 1,000,000 | | | | | 7.88 | 32.90 | 37.80 | 61.00 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 8-Inch Pipe Velocity in Feet Per Second | 8-Inch Loss of Head in Feet C=140 | C=130 | C=100 | 10-Inch Pipe Velocity in Feet Per Second | 10-Inch Loss of Head in Feet C=140 | C=130 | C=100 |
|---|---|---|---|---|---|---|---|---|
| 200,000 | 0.89 | 0.41 | 0.47 | 0.77 | | | | |
| 220,000 | 0.98 | 0.49 | 0.56 | 0.92 | | | | |
| 240,000 | 1.06 | 0.58 | 0.66 | 1.07 | | | | |
| 260,000 | 1.15 | 0.67 | 0.77 | 1.25 | | | | |
| 280,000 | 1.24 | 0.77 | 0.88 | 1.43 | | | | |
| 300,000 | 1.33 | 0.87 | 1.00 | 1.62 | 0.85 | 0.29 | 0.34 | 0.55 |
| 320,000 | 1.42 | 0.98 | 1.13 | 1.84 | 0.91 | 0.33 | 0.38 | 0.62 |
| 340,000 | 1.51 | 1.10 | 1.26 | 2.05 | 0.96 | 0.37 | 0.42 | 0.69 |
| 360,000 | 1.60 | 1.22 | 1.40 | 2.28 | 1.02 | 0.41 | 0.47 | 0.77 |
| 380,000 | 1.68 | 1.35 | 1.55 | 2.51 | 1.08 | 0.45 | 0.52 | 0.85 |
| 400,000 | 1.77 | 1.48 | 1.70 | 2.76 | 1.13 | 0.50 | 0.57 | 0.93 |
| 450,000 | 1.99 | 1.85 | 2.11 | 3.43 | 1.28 | 0.62 | 0.71 | 1.16 |
| 500,000 | 2.22 | 2.25 | 2.58 | 4.18 | 1.42 | 0.76 | 0.87 | 1.41 |
| 550,000 | 2.44 | 2.68 | 3.07 | 5.00 | 1.56 | 0.90 | 1.03 | 1.68 |
| 600,000 | 2.66 | 3.14 | 3.61 | 5.90 | 1.70 | 1.06 | 1.21 | 1.97 |
| 650,000 | 2.88 | 3.64 | 4.18 | 6.80 | 1.84 | 1.23 | 1.41 | 2.29 |
| 700,000 | 3.10 | 4.19 | 4.80 | 7.80 | 1.99 | 1.41 | 1.62 | 2.64 |
| 750,000 | 3.32 | 4.73 | 5.40 | 8.80 | 2.13 | 1.60 | 1.84 | 3.00 |
| 800,000 | 3.55 | 5.30 | 6.10 | 9.90 | 2.27 | 1.81 | 2.08 | 3.38 |
| 900,000 | 3.99 | 6.70 | 7.60 | 12.40 | 2.55 | 2.24 | 2.58 | 4.18 |
| 1,000,000 | 4.43 | 8.10 | 9.30 | 15.10 | 2.84 | 2.73 | 3.13 | 5.10 |
| 1,100,000 | 4.88 | 9.60 | 11.10 | 18.00 | 3.12 | 3.25 | 3.72 | 6.10 |
| 1,200,000 | 5.37 | 11.30 | 13.00 | 21.10 | 3.40 | 3.82 | 4.40 | 7.10 |
| 1,300,000 | 5.76 | 13.10 | 15.10 | 24.50 | 3.69 | 4.44 | 5.10 | 8.30 |
| 1,400,000 | 6.20 | 15.10 | 17.30 | 28.10 | 3.97 | 5.10 | 5.80 | 9.50 |
| 1,500,000 | 6.65 | 17.00 | 19.50 | 31.80 | 4.26 | 5.80 | 6.70 | 10.80 |
| 1,600,000 | 7.09 | 19.20 | 22.00 | 35.80 | 4.54 | 6.50 | 7.50 | 12.20 |
| 1,800,000 | 7.98 | 23.80 | 27.20 | 44.20 | 5.11 | 8.10 | 9.30 | 15.10 |
| 2,000,000 | 8.86 | 29.00 | 33.30 | 54.00 | 5.67 | 9.90 | 11.30 | 18.40 |
| 2,400,000 | 10.64 | 41.00 | 47.00 | 77.00 | 6.81 | 13.70 | 15.70 | 25.50 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 12-Inch Pipe | | | | 14-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 300,000 | 0.59 | 0.12 | 0.14 | 0.22 | 0.43 | 0.057 | 0.066 | 0.107 |
| 400,000 | 0.79 | 0.20 | 0.24 | 0.38 | 0.58 | 0.098 | 0.112 | 0.182 |
| 500,000 | 0.99 | 0.31 | 0.36 | 0.58 | 0.72 | 0.147 | 0.169 | 0.275 |
| 600,000 | 1.18 | 0.44 | 0.50 | 0.81 | 0.87 | 0.207 | 0.238 | 0.388 |
| 700,000 | 1.38 | 0.58 | 0.66 | 1.08 | 1.01 | 0.277 | 0.317 | 0.52 |
| 800,000 | 1.58 | 0.74 | 0.85 | 1.38 | 1.16 | 0.351 | 0.406 | 0.66 |
| 900,000 | 1.77 | 0.92 | 1.06 | 1.72 | 1.30 | 0.44 | 0.50 | 0.82 |
| 1,000,000 | 1.97 | 1.12 | 1.29 | 2.10 | 1.45 | 0.53 | 0.61 | 1.00 |
| 1,100,000 | 2.17 | 1.34 | 1.54 | 2.50 | 1.59 | 0.63 | 0.73 | 1.18 |
| 1,200,000 | 2.36 | 1.58 | 1.81 | 2.94 | 1.73 | 0.74 | 0.86 | 1.38 |
| 1,300,000 | 2.56 | 1.83 | 2.10 | 3.40 | 1.88 | 0.86 | 0.99 | 1.62 |
| 1,400,000 | 2.76 | 2.10 | 2.40 | 3.90 | 2.02 | 0.99 | 1.14 | 1.85 |
| 1,500,000 | 2.96 | 2.39 | 2.73 | 4.43 | 2.17 | 1.13 | 1.28 | 2.10 |
| 1,600,000 | 3.15 | 2.69 | 3.09 | 5.00 | 2.31 | 1.27 | 1.46 | 2.37 |
| 1,700,000 | 3.35 | 3.00 | 3.45 | 5.60 | 2.46 | 1.42 | 1.63 | 2.65 |
| 1,800,000 | 3.55 | 3.33 | 3.82 | 6.20 | 2.60 | 1.58 | 1.82 | 2.93 |
| 1,900,000 | 3.74 | 3.70 | 4.24 | 6.90 | 2.75 | 1.74 | 1.99 | 3.24 |
| 2,000,000 | 3.94 | 4.06 | 4.65 | 7.60 | 2.90 | 1.92 | 2.20 | 3.57 |
| 2,200,000 | 4.33 | 4.85 | 5.60 | 9.00 | 3.18 | 2.33 | 2.64 | 4.28 |
| 2,400,000 | 4.73 | 5.70 | 6.50 | 10.50 | 3.48 | 2.69 | 3.08 | 5.00 |
| 2,600,000 | 5.12 | 6.60 | 7.60 | 12.30 | 3.76 | 3.12 | 3.58 | 5.80 |
| 2,800,000 | 5.52 | 7.60 | 8.70 | 14.10 | 4.05 | 3.58 | 4.12 | 6.70 |
| 3,000,000 | 5.91 | 8.60 | 9.90 | 16.00 | 4.35 | 4.07 | 4.65 | 7.60 |
| 3,500,000 | 6.89 | 11.40 | 13.20 | 21.30 | 5.07 | 5.40 | 6.20 | 10.10 |
| 4,000,000 | 7.88 | 14.50 | 16.60 | 27.00 | 5.79 | 6.90 | 8.00 | 12.90 |
| 4,500,000 | 8.87 | 18.00 | 20.60 | 33.60 | 6.51 | 8.60 | 9.90 | 16.10 |
| 5,000,000 | 9.85 | 22.00 | 25.10 | 41.00 | 7.24 | 10.40 | 12.00 | 19.50 |
| 5,500,000 | 10.84 | 26.50 | 30.30 | 49.40 | 7.96 | 12.50 | 14.30 | 23.20 |
| 6,000,000 | 11.82 | 31.10 | 35.70 | 58.00 | 8.68 | 14.70 | 16.80 | 27.30 |
| 7,000,000 | 13.79 | 41.20 | 47.20 | 77.00 | 10.12 | 19.50 | 22.30 | 36.50 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 16-Inch Pipe | | | | 18-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 400,000 | 0.44 | 0.051 | 0.058 | 0.095 | 0.35 | 0.029 | 0.033 | 0.053 |
| 600,000 | 0.66 | 0.108 | 0.124 | 0.201 | 0.52 | 0.061 | 0.069 | 0.113 |
| 800,000 | 0.89 | 0.183 | 0.210 | 0.34 | 0.70 | 0.103 | 0.118 | 0.193 |
| 1,000,000 | 1.11 | 0.278 | 0.319 | 0.52 | 0.88 | 0.156 | 0.179 | 0.291 |
| 1,200,000 | 1.33 | 0.389 | 0.446 | 0.72 | 1.05 | 0.218 | 0.251 | 0.409 |
| 1,400,000 | 1.55 | 0.52 | 0.60 | 0.96 | 1.22 | 0.290 | 0.333 | 0.54 |
| 1,600,000 | 1.77 | 0.66 | 0.76 | 1.23 | 1.40 | 0.374 | 0.43 | 0.69 |
| 1,800,000 | 1.99 | 0.82 | 0.95 | 1.53 | 1.57 | 0.461 | 0.53 | 0.86 |
| 2,000,000 | 2.22 | 1.00 | 1.15 | 1.87 | 1.75 | 0.56 | 0.65 | 1.05 |
| 2,200,000 | 2.44 | 1.19 | 1.37 | 2.22 | 1.93 | 0.67 | 0.77 | 1.25 |
| 2,400,000 | 2.66 | 1.41 | 1.62 | 2.62 | 2.10 | 0.79 | 0.90 | 1.47 |
| 2,600,000 | 2.88 | 1.63 | 1.87 | 3.03 | 2.28 | 0.92 | 1.06 | 1.71 |
| 2,800,000 | 3.10 | 1.87 | 2.15 | 3.49 | 2.45 | 1.05 | 1.21 | 1.96 |
| 3,000,000 | 3.32 | 2.12 | 2.43 | 3.98 | 2.63 | 1.19 | 1.37 | 2.23 |
| 3,500,000 | 3.87 | 2.81 | 3.21 | 5.10 | 3.07 | 1.58 | 1.83 | 2.96 |
| 4,000,000 | 4.43 | 3.61 | 4.15 | 6.80 | 3.50 | 2.02 | 2.34 | 3.79 |
| 4,500,000 | 4.99 | 4.50 | 5.20 | 8.40 | 3.94 | 2.53 | 2.92 | 4.71 |
| 5,000,000 | 5.54 | 5.50 | 6.30 | 10.20 | 4.38 | 3.07 | 3.53 | 5.70 |
| 5,500,000 | 6.09 | 6.60 | 7.50 | 12.20 | 4.83 | 3.68 | 4.20 | 6.80 |
| 6,000,000 | 6.65 | 7.70 | 8.80 | 14.30 | 5.25 | 4.31 | 4.95 | 8.00 |
| 6,500,000 | 7.20 | 8.90 | 10.20 | 16.60 | 5.70 | 4.98 | 5.70 | 9.30 |
| 7,000,000 | 7.76 | 10.20 | 11.70 | 19.00 | 6.13 | 5.80 | 6.60 | 10.70 |
| 7,500,000 | 8.31 | 11.60 | 13.30 | 21.70 | 6.57 | 6.50 | 7.50 | 12.20 |
| 8,000,000 | 8.86 | 13.10 | 14.90 | 24.20 | 7.01 | 7.40 | 8.40 | 13.60 |
| 8,500,000 | 9.42 | 14.50 | 16.60 | 27.00 | 7.45 | 8.20 | 9.40 | 15.30 |
| 9,000,000 | 9.97 | 16.30 | 18.60 | 30.20 | 7.90 | 9.10 | 10.50 | 17.00 |
| 9,500,000 | 10.53 | 17.80 | 20.50 | 33.20 | 8.33 | 10.10 | 11.60 | 18.80 |
| 10,000,000 | 11.08 | 19.80 | 22.60 | 36.80 | 8.76 | 11.10 | 12.70 | 20.80 |
| 11,000,000 | 12.19 | 23.60 | 27.00 | 44.00 | 9.65 | 13.30 | 15.20 | 24.60 |
| 12,000,000 | 13.30 | 27.80 | 31.80 | 52.00 | 10.50 | 15.60 | 17.80 | 29.00 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 20-Inch Pipe | | | | 24-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 600,000 | 0.43 | 0.037 | 0.049 | 0.068 | | | | |
| 800,000 | 0.57 | 0.062 | 0.071 | 0.115 | | | | |
| 1,000,000 | 0.71 | 0.094 | 0.107 | 0.174 | 0.49 | 0.038 | 0.044 | 0.072 |
| 1,200,000 | 0.85 | 0.131 | 0.150 | 0.243 | 0.59 | 0.054 | 0.062 | 0.100 |
| 1,400,000 | 0.99 | 0.174 | 0.200 | 0.326 | 0.69 | 0.071 | 0.082 | 0.133 |
| 1,600,000 | 1.13 | 0.223 | 0.257 | 0.416 | 0.79 | 0.092 | 0.105 | 0.170 |
| 1,800,000 | 1.28 | 0.278 | 0.319 | 0.52 | 0.89 | 0.113 | 0.130 | 0.212 |
| 2,000,000 | 1.42 | 0.339 | 0.389 | 0.63 | 0.98 | 0.138 | 0.159 | 0.259 |
| 2,500,000 | 1.77 | 0.51 | 0.58 | 0.95 | 1.23 | 0.210 | 0.240 | 0.39 |
| 3,000,000 | 2.13 | 0.72 | 0.82 | 1.33 | 1.48 | 0.293 | 0.338 | 0.55 |
| 3,500,000 | 2.48 | 0.95 | 1.09 | 1.78 | 1.72 | 0.391 | 0.449 | 0.73 |
| 4,000,000 | 2.84 | 1.22 | 1.39 | 2.28 | 1.97 | 0.50 | 0.58 | 0.93 |
| 4,500,000 | 3.19 | 1.52 | 1.74 | 2.83 | 2.22 | 0.62 | 0.72 | 1.16 |
| 5,000,000 | 3.55 | 1.84 | 2.11 | 3.43 | 2.46 | 0.76 | 0.87 | 1.41 |
| 5,500,000 | 3.90 | 2.20 | 2.52 | 4.09 | 2.71 | 0.90 | 1.03 | 1.68 |
| 6,000,000 | 4.26 | 2.59 | 2.97 | 4.81 | 2.96 | 1.06 | 1.22 | 1.97 |
| 6,500,000 | 4.61 | 3.00 | 3.43 | 5.60 | 3.20 | 1.23 | 1.41 | 2.29 |
| 7,000,000 | 4.96 | 3.43 | 3.95 | 6.40 | 3.45 | 1.41 | 1.62 | 2.63 |
| 7,500,000 | 5.32 | 3.90 | 4.48 | 7.30 | 3.69 | 1.61 | 1.84 | 2.98 |
| 8,000,000 | 5.67 | 4.39 | 5.10 | 8.20 | 3.94 | 1.81 | 2.07 | 3.38 |
| 8,500,000 | 6.03 | 4.91 | 5.60 | 9.20 | 4.19 | 2.02 | 2.32 | 3.77 |
| 9,000,000 | 6.38 | 5.50 | 6.30 | 10.20 | 4.43 | 2.26 | 2.58 | 4.20 |
| 9,500,000 | 6.74 | 6.00 | 6.90 | 11.30 | 4.68 | 2.48 | 2.85 | 4.62 |
| 10,000,000 | 7.09 | 6.60 | 7.60 | 12.40 | 4.92 | 2.73 | 3.12 | 5.10 |
| 11,000,000 | 7.80 | 7.90 | 9.10 | 14.80 | 5.42 | 3.26 | 3.74 | 6.10 |
| 12,000,000 | 8.51 | 9.40 | 10.70 | 17.40 | 5.91 | 3.82 | 4.39 | 7.10 |
| 13,000,000 | 9.22 | 10.80 | 12.40 | 20.10 | 6.40 | 4.45 | 5.10 | 8.30 |
| 14,000,000 | 9.93 | 12.40 | 14.20 | 23.10 | 6.89 | 5.10 | 5.80 | 9.50 |
| 15,000,000 | 10.64 | 14.10 | 16.20 | 26.20 | 7.39 | 5.80 | 6.60 | 10.80 |
| 16,000,000 | 11.35 | 15.80 | 18.20 | 29.60 | 7.88 | 6.60 | 7.50 | 12.20 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 30-Inch Pipe | | | | 36-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 1,500,000 | 0.47 | 0.028 | 0.032 | 0.052 | 0.33 | 0.011 | 0.013 | 0.021 |
| 2,000,000 | 0.63 | 0.047 | 0.054 | 0.087 | 0.44 | 0.019 | 0.022 | 0.036 |
| 2,500,000 | 0.79 | 0.071 | 0.081 | 0.132 | 0.55 | 0.029 | 0.033 | 0.054 |
| 3,000,000 | 0.95 | 0.099 | 0.113 | 0.184 | 0.66 | 0.041 | 0.047 | 0.076 |
| 3,500,000 | 1.10 | 0.132 | 0.151 | 0.247 | 0.77 | 0.054 | 0.062 | 0.102 |
| 4,000,000 | 1.26 | 0.168 | 0.194 | 0.315 | 0.88 | 0.070 | 0.080 | 0.129 |
| 4,500,000 | 1.42 | 0.210 | 0.241 | 0.391 | 0.98 | 0.086 | 0.099 | 0.160 |
| 5,000,000 | 1.58 | 0.256 | 0.292 | 0.476 | 1.09 | 0.105 | 0.121 | 0.196 |
| 5,500,000 | 1.73 | 0.304 | 0.349 | 0.57 | 1.20 | 0.125 | 0.143 | 0.232 |
| 6,000,000 | 1.89 | 0.357 | 0.410 | 0.67 | 1.31 | 0.147 | 0.168 | 0.274 |
| 6,500,000 | 2.05 | 0.414 | 0.475 | 0.78 | 1.42 | 0.170 | 0.195 | 0.316 |
| 7,000,000 | 2.21 | 0.474 | 0.55 | 0.89 | 1.53 | 0.196 | 0.224 | 0.365 |
| 7,500,000 | 2.36 | 0.54 | 0.62 | 1.01 | 1.64 | 0.221 | 0.253 | 0.411 |
| 8,000,000 | 2.52 | 0.61 | 0.70 | 1.13 | 1.75 | 0.250 | 0.288 | 0.467 |
| 8,500,000 | 2.68 | 0.68 | 0.78 | 1.27 | 1.86 | 0.280 | 0.320 | 0.52 |
| 9,000,000 | 2.84 | 0.76 | 0.87 | 1.42 | 1.97 | 0.311 | 0.358 | 0.58 |
| 10,000,000 | 3.15 | 0.92 | 1.06 | 1.72 | 2.19 | 0.379 | 0.434 | 0.71 |
| 11,000,000 | 3.47 | 1.09 | 1.26 | 2.06 | 2.41 | 0.451 | 0.52 | 0.84 |
| 12,000,000 | 3.78 | 1.28 | 1.47 | 2.41 | 2.63 | 0.53 | 0.61 | 0.99 |
| 13,000,000 | 4.10 | 1.50 | 1.72 | 2.79 | 2.85 | 0.62 | 0.71 | 1.15 |
| 14,000,000 | 4.41 | 1.72 | 1.97 | 3.20 | 3.06 | 0.71 | 0.81 | 1.32 |
| 15,000,000 | 4.73 | 1.95 | 2.24 | 3.64 | 3.28 | 0.80 | 0.92 | 1.49 |
| 16,000,000 | 5.04 | 2.20 | 2.52 | 4.10 | 3.50 | 0.90 | 1.03 | 1.68 |
| 17,000,000 | 5.36 | 2.46 | 2.82 | 4.59 | 3.72 | 1.02 | 1.16 | 1.88 |
| 18,000,000 | 5.67 | 2.74 | 3.14 | 5.10 | 3.94 | 1.12 | 1.29 | 2.10 |
| 19,000,000 | 5.99 | 3.02 | 3.47 | 5.60 | 4.16 | 1.24 | 1.43 | 2.32 |
| 20,000,000 | 6.30 | 3.33 | 3.81 | 6.20 | 4.38 | 1.37 | 1.57 | 2.55 |
| 22,000,000 | 6.93 | 3.96 | 4.55 | 7.40 | 4.82 | 1.63 | 1.87 | 3.04 |
| 24,000,000 | 7.56 | 4.65 | 5.40 | 8.70 | 5.25 | 1.92 | 2.20 | 3.58 |
| 26,000,000 | 8.20 | 5.40 | 6.20 | 10.10 | 5.69 | 2.22 | 2.55 | 4.14 |

# Flow Capacity of Cast Iron Water Pipe

Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 42-Inch Pipe | | | | 48-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 3,000,000 | 0.48 | 0.019 | 0.022 | 0.036 | 0.37 | 0.010 | 0.012 | 0.019 |
| 4,000,000 | 0.64 | 0.033 | 0.038 | 0.061 | 0.49 | 0.017 | 0.020 | 0.032 |
| 5,000,000 | 0.80 | 0.050 | 0.057 | 0.092 | 0.62 | 0.026 | 0.030 | 0.048 |
| 6,000,000 | 0.96 | 0.070 | 0.080 | 0.129 | 0.74 | 0.036 | 0.042 | 0.068 |
| 7,000,000 | 1.13 | 0.092 | 0.106 | 0.172 | 0.86 | 0.048 | 0.055 | 0.090 |
| 8,000,000 | 1.29 | 0.118 | 0.136 | 0.220 | 0.98 | 0.062 | 0.071 | 0.115 |
| 9,000,000 | 1.45 | 0.147 | 0.168 | 0.273 | 1.11 | 0.077 | 0.088 | 0.143 |
| 10,000,000 | 1.61 | 0.178 | 0.207 | 0.332 | 1.23 | 0.094 | 0.107 | 0.174 |
| 12,000,000 | 1.93 | 0.251 | 0.288 | 0.468 | 1.48 | 0.131 | 0.150 | 0.243 |
| 14,000,000 | 2.25 | 0.333 | 0.382 | 0.62 | 1.72 | 0.174 | 0.199 | 0.324 |
| 16,000,000 | 2.57 | 0.428 | 0.49 | 0.80 | 1.97 | 0.222 | 0.256 | 0.417 |
| 18,000,000 | 2.89 | 0.53 | 0.61 | 0.99 | 2.22 | 0.277 | 0.319 | 0.52 |
| 20,000,000 | 3.22 | 0.64 | 0.74 | 1.21 | 2.46 | 0.338 | 0.387 | 0.63 |
| 22,000,000 | 3.53 | 0.77 | 0.88 | 1.44 | 2.71 | 0.401 | 0.46 | 0.75 |
| 24,000,000 | 3.86 | 0.90 | 1.04 | 1.68 | 2.96 | 0.472 | 0.54 | 0.88 |
| 26,000,000 | 4.18 | 1.05 | 1.21 | 1.96 | 3.20 | 0.55 | 0.63 | 1.02 |
| 28,000,000 | 4.50 | 1.21 | 1.38 | 2.25 | 3.45 | 0.63 | 0.72 | 1.17 |
| 30,000,000 | 4.82 | 1.37 | 1.57 | 2.56 | 3.69 | 0.72 | 0.82 | 1.33 |
| 32,000,000 | 5.15 | 1.54 | 1.77 | 2.88 | 3.94 | 0.80 | 0.92 | 1.50 |
| 34,000,000 | 5.47 | 1.73 | 1.98 | 3.21 | 4.19 | 0.90 | 1.03 | 1.68 |
| 36,000,000 | 5.79 | 1.92 | 2.20 | 3.58 | 4.43 | 1.00 | 1.15 | 1.87 |
| 38,000,000 | 6.11 | 2.12 | 2.43 | 3.95 | 4.68 | 1.11 | 1.27 | 2.07 |
| 40,000,000 | 6.45 | 2.33 | 2.68 | 4.35 | 4.92 | 1.22 | 1.39 | 2.28 |
| 42,000,000 | 6.75 | 2.56 | 2.92 | 4.76 | 5.17 | 1.33 | 1.53 | 2.49 |
| 44,000,000 | 7.08 | 2.78 | 3.19 | 5.20 | 5.42 | 1.45 | 1.67 | 2.71 |
| 46,000,000 | 7.40 | 3.02 | 3.48 | 5.60 | 5.66 | 1.58 | 1.81 | 2.94 |
| 48,000,000 | 7.72 | 3.28 | 3.76 | 6.10 | 5.91 | 1.71 | 1.96 | 3.19 |
| 50,000,000 | 8.04 | 3.52 | 4.05 | 6.60 | 6.16 | 1.84 | 2.12 | 3.44 |
| 55,000,000 | 8.84 | 4.21 | 4.82 | 7.80 | 6.77 | 2.19 | 2.52 | 4.09 |
| 60,000,000 | 9.65 | 4.94 | 5.70 | 9.20 | 7.39 | 2.58 | 2.97 | 4.80 |

## Flow Capacity of Cast Iron Water Pipe

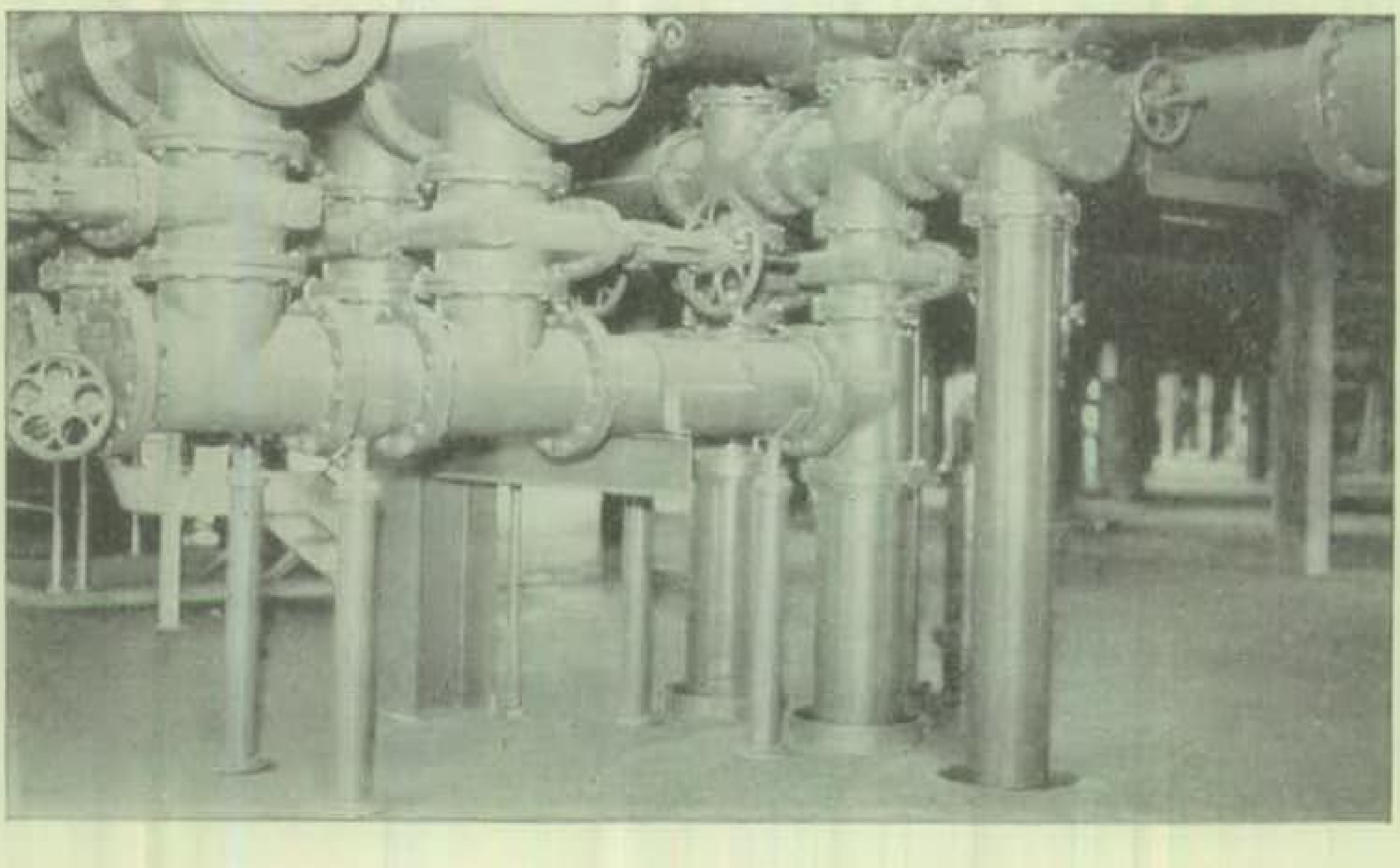
Williams-Hazen Formula

Loss of Head Per 1,000 Feet of Pipe

| Flow in Gallons Per 24 Hours | 54-Inch Pipe | | | | 60-Inch Pipe | | | |
|---|---|---|---|---|---|---|---|---|
| | Velocity in Feet Per Second | Loss of Head in Feet | | | Velocity in Feet Per Second | Loss of Head in Feet | | |
| | | C=140 | C=130 | C=100 | | C=140 | C=130 | C=100 |
| 6,000,000 | 0.58 | 0.020 | 0.023 | 0.038 | 0.47 | 0.012 | 0.014 | 0.023 |
| 8,000,000 | 0.78 | 0.035 | 0.040 | 0.065 | 0.63 | 0.021 | 0.024 | 0.039 |
| 10,000,000 | 0.97 | 0.053 | 0.060 | 0.098 | 0.79 | 0.032 | 0.036 | 0.059 |
| 12,000,000 | 1.17 | 0.074 | 0.085 | 0.137 | 0.95 | 0.044 | 0.051 | 0.082 |
| 14,000,000 | 1.36 | 0.098 | 0.113 | 0.183 | 1.10 | 0.059 | 0.068 | 0.109 |
| 16,000,000 | 1.56 | 0.126 | 0.144 | 0.235 | 1.26 | 0.075 | 0.086 | 0.140 |
| 18,000,000 | 1.75 | 0.157 | 0.179 | 0.291 | 1.42 | 0.094 | 0.107 | 0.174 |
| 20,000,000 | 1.95 | 0.190 | 0.218 | 0.354 | 1.58 | 0.113 | 0.131 | 0.212 |
| 22,000,000 | 2.14 | 0.227 | 0.260 | 0.422 | 1.73 | 0.136 | 0.156 | 0.253 |
| 24,000,000 | 2.33 | 0.267 | 0.306 | 0.496 | 1.89 | 0.159 | 0.183 | 0.298 |
| 26,000,000 | 2.53 | 0.309 | 0.354 | 0.58 | 2.05 | 0.185 | 0.212 | 0.346 |
| 28,000,000 | 2.72 | 0.353 | 0.406 | 0.66 | 2.21 | 0.212 | 0.243 | 0.395 |
| 30,000,000 | 2.92 | 0.402 | 0.461 | 0.75 | 2.36 | 0.241 | 0.277 | 0.449 |
| 32,000,000 | 3.11 | 0.453 | 0.52 | 0.85 | 2.52 | 0.271 | 0.310 | 0.51 |
| 34,000,000 | 3.31 | 0.51 | 0.58 | 0.95 | 2.68 | 0.303 | 0.349 | 0.57 |
| 36,000,000 | 3.50 | 0.56 | 0.65 | 1.05 | 2.84 | 0.338 | 0.388 | 0.63 |
| 38,000,000 | 3.70 | 0.62 | 0.72 | 1.17 | 2.99 | 0.372 | 0.428 | 0.70 |
| 40,000,000 | 3.89 | 0.68 | 0.79 | 1.28 | 3.15 | 0.41 | 0.47 | 0.76 |
| 45,000,000 | 4.37 | 0.85 | 0.97 | 1.59 | 3.55 | 0.51 | 0.59 | 0.95 |
| 50,000,000 | 4.86 | 1.04 | 1.19 | 1.94 | 3.94 | 0.62 | 0.71 | 1.16 |
| 55,000,000 | 5.35 | 1.24 | 1.42 | 2.30 | 4.33 | 0.74 | 0.85 | 1.38 |
| 60,000,000 | 5.84 | 1.46 | 1.67 | 2.71 | 4.73 | 0.87 | 1.00 | 1.62 |
| 65,000,000 | 6.32 | 1.68 | 1.93 | 3.14 | 5.12 | 1.02 | 1.16 | 1.88 |
| 70,000,000 | 6.81 | 1.93 | 2.22 | 3.61 | 5.52 | 1.16 | 1.33 | 2.17 |
| 75,000,000 | 7.30 | 2.20 | 2.52 | 4.10 | 5.91 | 1.32 | 1.51 | 2.46 |
| 80,000,000 | 7.78 | 2.48 | 2.84 | 4.61 | 6.30 | 1.48 | 1.70 | 2.78 |
| 85,000,000 | 8.27 | 2.78 | 3.18 | 5.20 | 6.70 | 1.66 | 1.90 | 3.09 |
| 90,000,000 | 8.76 | 3.08 | 3.52 | 5.80 | 7.09 | 1.84 | 2.12 | 3.44 |
| 95,000,000 | 9.24 | 3.41 | 3.91 | 6.40 | 7.49 | 2.03 | 2.34 | 3.80 |
| 100,000,000 | 9.73 | 3.75 | 4.30 | 7.00 | 7.88 | 2.24 | 2.57 | 4.19 |

# SECTION 7

## Cast Iron Pipe for Sewerage Systems and Sewage Treatment Works



# SECTION 7

## Cast Iron Pipe for Sewerage Systems and Sewage Treatment Works

SEWAGE disposal has been defined as "the collection, transportation, treatment and ultimate disposal of domestic and industrial wastes finding their way into the sewer system."

Nearly all of our urban population is served by sewer systems, and about one-half by sewage treatment plants. Considerable progress has also been made in the treatment of industrial wastes.

Needless to say, the prime function of a municipal treatment plant is to treat domestic sewage. The size of the plant, required investment and operating cost are governed by the volume of domestic sewage to be treated. To insure that the influent will be confined to sewage alone requires separate storm and sanitary sewers.

Many cities, particularly in their older districts, are served by *combined* sewers carrying both storm water and domestic sewage. Unfortunately, the sewer mains in combined systems were frequently constructed of materials that permitted infiltration of water to increase the load on both sewers and sewage treatment plants.

Thus, one important factor in solving the problem of sewage disposal—the construction of treatment plants—brought in its wake an attendant problem of efficient sewage transportation. The problem has been met in many cases by separate sanitary sewers constructed of infiltration-proof cast iron pipe with permanently tight joints.

### SANITARY SEWERS

One of the chief requirements of a sanitary sewer is that it shall be *permanently* tight to prevent leakage and infiltration.

Leakage permits polluted water to saturate surrounding soil, creating unsanitary conditions and possible odor nuisance and, if located close to a source of water supply, to contaminate the water.

Infiltration decreases the capacity of the sewer as a conveyor of sanitary sewage and, if the sewage is to be treated, the treatment plant must be larger than otherwise necessary to handle the increased flow.

Cast iron pipe provides a permanently tight sewer because it is impermeable; because its joints are tight and stay tight; and because it effectively resists corrosion.

Frequently, sanitary sewers must be built in deep excavations and are therefore required to withstand high external pressures; or they may be built in shallow cuts and must withstand external pressures due to heavy traffic loads.

The known ability of cast iron pipe to meet such service stresses is due to wide margins of safety in beam-strength, compressive-strength and impact-resistance. This structural strength, plus effective resistance to corrosion, keeps maintenance cost down to a negligible minimum.

#### OUTFALL SEWERS

Any sewer discharging raw sewage, treatment plant effluent, or storm water into a body of water or stream, is commonly known as an outfall sewer. To avoid pollution of water supply, bathing beaches, shellfish areas, or fishing grounds, as well as for better diffusion of the sewage or effluent in the diluting water, outfall sewers often extend for considerable distances into the body of water in which they discharge. As a prime requirement of such installations is that they shall permit no leakage, cast iron pipe is widely used in their construction.

The land sections of outfall sewers may be exposed to wet and dry conditions, both internally and externally, and, therefore, must resist corrosion, especially when laid in muck soil or when submerged in salt water at high tide. Indeed, one of the most rigorous tests a pipe line material is called upon to meet is in subaqueous service where the line is alternately submerged and exposed to sun and air with the changing tides.

About 40 years ago, the City of Pensacola, Florida, installed two cast iron subaqueous outfall sewers. One sewer was 20-inch and the other, 24-inch cast iron pipe. These outfalls carried raw sewage for 3,000 feet into Pensacola Bay where there is a tidal variation of between one and two feet, causing a portion of the pipe to submerge for part of each day when not exposed to air and sun. Upon inspection after 30 years' service, it was found that a scale had formed over the pipe which, when removed, revealed a metallic surface like that of newly cast pipe and some of the original coating was intact.

Cast iron pipe, with either ball and socket or mechanical joints has successfully met the arduous requirements of outfall sewers in a great number of installations over the past fifty years.

### PRESSURE SEWERS

The growing use of cast iron pressure sewers stems from the advent of sewage treatment. Transporting the sewage from the point of origin to the treatment plant frequently requires a pressure sewer. Gravity sewers in many cases, were not constructed of materials that could withstand pressures.

An important feature of a pressure sewer is that it can follow the contour of the ground surface. Thus the initial cost of the sewer is reduced due to the smaller diameter required and to the fact that a trench shallower than generally needed for gravity sewers is possible.

Flow tests on pressure sewers and waste sludge lines, in service for long periods, indicate that ordinary hydraulic tables can be used for calculating the capacity of cast iron pipe in such service. The following test results on a sludge line in Chicago provide a typical example:

Twenty years ago, a 14-inch cast iron pipe sludge line was placed in operation for the Sanitary District of Chicago. The sludge from the activated sludge process at the North Side Sewage Treatment Plant was pumped at a pressure of 90 lbs. per sq. in. for some 90,000 feet to the West Side Treatment Works for disposal. The line was tested for leakage at a pressure of 175 lbs. per sq. in. The allowable leakage was 2400 gallons per 24 hours per mile of pipe; the actual leakage was less than half of the allowable amount. Friction tests, made on the line immediately after being put in operation, indicated a value of "C" in the Williams-Hazen formula of 141.

Sewage and sludge pumping and the use of pressure sewers to force sewage to treatment plants have greatly contributed to economical sewage treatment and disposal. The development of highly efficient sewage pumps and the use of cast iron pipe for pressure sewers have been important factors in reducing total sewage treatment costs.

### ACTIVATED SLUDGE TREATMENT PLANTS

The activated sludge process of sewage treatment is designed for communities requiring a high degree of purification the year around. This process provides complete treatment with effluents purified 90% or more, in terms of oxygen demand. Purification is effected quickly and without nuisances. The sludge resulting from the process may be disposed of by various accepted methods, and, if properly dried, is a fertilizer of commercial value.

Cast iron pipe is used extensively in the activated sludge process for influent, effluent and distribution conduits, air mains and leaders, sludge draw-off lines and drains. A substantial amount of the piping is placed underground or in concrete and is not easily accessible for repairs. Conduits, mains and lines must be permanently tight to insure against leaks which would result in power losses or nuisances.

### CHEMICAL PRECIPITATION PLANTS

The chemical precipitation process is generally used by communities which do not require a high degree of purification the year around, but which require efficiencies higher than that afforded by plain primary settling. Most of the chemicals used in the process are highly corrosive. Standard and rubber-lined cast iron pipe are used for all piping in connection with the handling of chemicals and solutions; also for piping for mixing tanks, flocculation tanks and for air conduits.

### IMHOFF TANKS

Imhoff tanks have been used for about 40 years and will no doubt continue to be used in localities where only partial treatment of sewage is required, or where such units precede secondary treatment processes. From 30 to 40% of the B.O.D. and from 50 to 75% of the suspended solids are usually removed by Imhoff tanks and at low operating costs. The treatment is usually preceded by screening and grit removal. Gases and sludge resulting from Imhoff tank operation are corrosive, requiring a piping material with effective resistance to corrosion, such as cast iron pipe.

### TRICKLING FILTERS

Trickling filters have been popular due to their simplicity of operation and ability to meet wide and sudden fluctuations in sewage strength. With efficient screening and settling preceding the filters, and with final settling tanks, the overall purification ranges from 70 to 90 per cent, in terms of removal of B.O.D. (biochemical oxygen demand).

Cast iron pipe, because of its tight joints and corrosion-resistance is widely used in the construction of trickling filters.

# SECTION 8

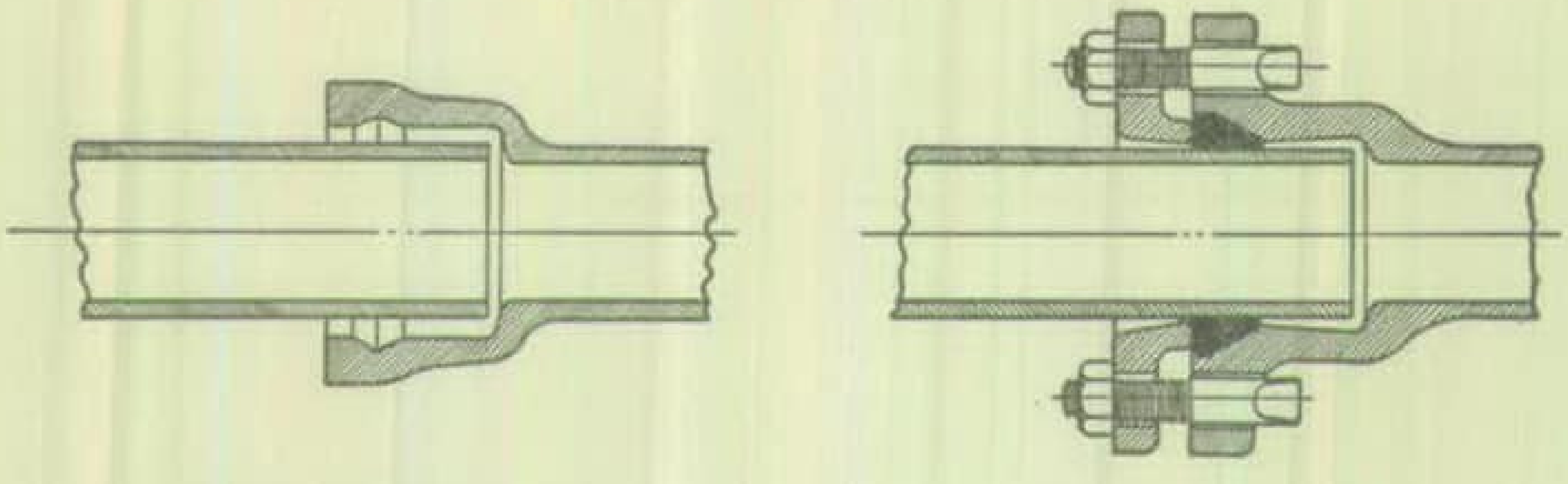
## 2-INCH CAST IRON PIPE

**and other sizes under 3 inches**

# SECTION 8

## 2-INCH CAST IRON PIPE

### and other sizes under 3 inches




While the smallest pipe included in standard Cast Iron Pipe specifications is 3-inch in diameter, smaller sizes have been made for over twenty-five years. These small diameter pipe are made to a manufacturer's specifications that in all essential parts is identical with the specifications under which larger diameter pipe are produced. Small diameter pipe are regularly furnished with Bell and Spigot and Mechanical Joints, and may be furnished with plain ends, screw joints, or roll-on joints.

The fact that over 7,000,000 feet of small diameter pipe are produced each year indicates the acceptance of this pipe by pipe users. The principal uses are:

(1) Water mains where fire protection is available from larger mains.
(2) The development of new subdivisions.
(3) Gas mains—low and high pressure.
(4) Services for both water and gas.
(5) The secondary main in two-main systems.
(6) Irrigation for golf courses, parks, cemeteries, and private estates.
(7) Filter drains.
(8) Industrial uses.

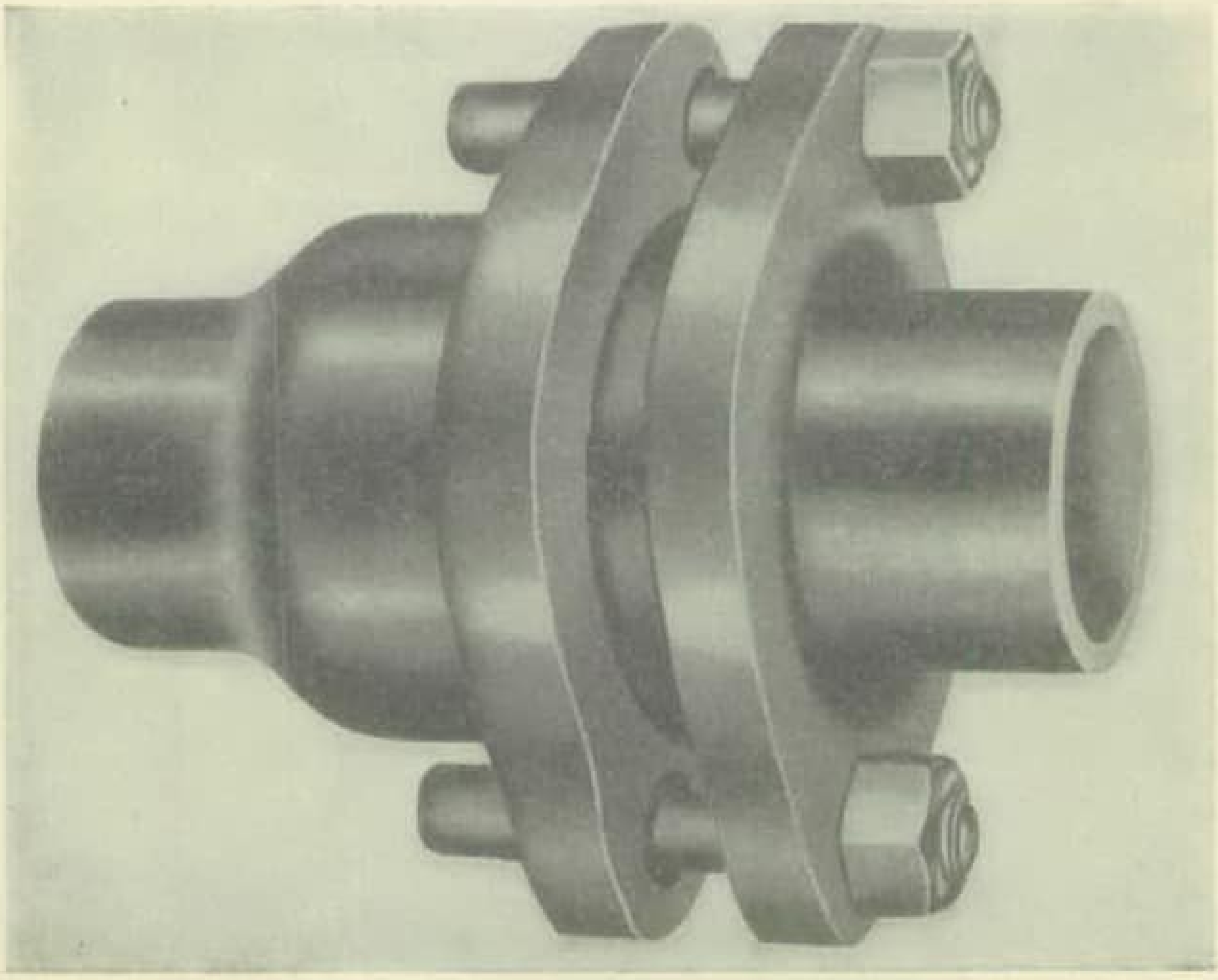
The pipe are made of first quality iron and each length ls subjected to a test pressure of 500 P.S.I. at the foundry. The lengths produced by different manufacturers vary from 5 feet to 12 feet—short lengths may be factory assembled into longer lengths to reduce the number of field joints.

For water use, when required, small diameter pipe can be furnished with a cement lining. Connections may be made either by tapping into tapping collars, by the use of tapping saddles, or by the use of standard fittings.

As an instance of importance of small diameter pipe in gas distribution systems, the footage of various sizes used in a new system constructed in an area adjacent to a large southern city is of interest.

6-inch —11,100 feet
4-inch —21,850 feet
2¼-inch—48,100 feet
2-inch —66,600 feet

The use of small diameter Cast Iron Pipe in distribution system makes it possible to have the same long life and resistance to external stress in these lines as in the larger mains in the system.



2″ Mechanical Joint

# SECTION 9

## A.S.A. Specifications

American Standard

# SPECIFICATIONS

*for*

# CAST IRON PIT CAST PIPE FOR WATER OR OTHER LIQUIDS

Users of this document should make reference to "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe (A.S.A., A21.1)" for complete information concerning the conditions which various thicknesses of pipe are designed to meet. The foreword of the Manual also contains a statement regarding the history of the specifications and references to other related documents.

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ASA
A 21.2

# AMERICAN STANDARD SPECIFICATIONS
## for
# CAST IRON PIT CAST PIPE FOR WATER OR OTHER LIQUIDS

This specification covers cast iron pit cast pipe for water or other liquids. Pit cast pipe are pipe cast vertically with dry sand molds and cores.

**Sect. 2-1. Description of Pipe.** The pipe shall be made with bell and spigot ends, plain ends or such other type of ends as may be agreed upon at the time of purchase. Pipe with bell and spigot ends shall conform accurately to the dimensions given in Table 1. Pipe with other types of ends shall comply with the dimensions agreed upon but in all other respects shall fulfill the specifications hereinafter given. Pipe shall be straight and shall be true circles in section, with their inner and outer surfaces concentric. They shall be at least 12 ft. in nominal laying length, except as provided for cut pipe in Sect. 2-10.

**Sect. 2-2. Casting of Pipe.** The pipe shall be cast in dry sand molds in a vertical position. Pipe 16 inches or less in diameter shall be cast with the bell end up or down as specified in the proposals. Pipe 18 inches or more in diameter shall be cast with the bell end down. The pipe shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

**Sect. 2-3. Quality of Iron.**

(a) All pipes shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the pipe to be cast, that the iron in the pipe shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting and it shall comply with the physical specifications given in Sect. 2-16, 2-17 and 2-18. The metal shall be remelted in a cupola or other suitable furnace.

(b) The iron in the pipe shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulphur. Samples for chemical analysis shall be taken by drilling completely through from skin to skin each of the acceptance test specimens; but not to exceed three specimens per heat.

**Sect. 2-4. Quality of Castings.** The pipe shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

**Sect. 2-5. Foundry Records.** A record of the following tests shall be made and retained for at least one year. Upon request, such record will be available to the purchaser at the foundry. If written transcripts of any of these tests are desired, this fact shall be noted in the order for pipe, naming the tests of which transcripts are desired.

(a) *Chemical Analyses.* Chemical analyses of each iron mixture used directly in pouring of pipe, obtained as in Sect. 2-3(b), shall be made for silicon, sulphur, manganese, phosphorus and total carbon during the first hour and at intervals not to exceed three hours throughout the heat. If pipe is poured directly from the cupola, chemical analyses shall be made of iron from the first and from the last ladle. If the mixture is changed one or more times during a heat in order to produce a different iron, the time of taking samples shall be varied in such a way as to obtain representative tests of iron at least at the beginning and end of each period during which the iron is intended to be constant in quality.

(b) *Pouring Temperature.* The pouring temperature of the iron shall be taken at the casting ladle for each size of pipe at least once each hour.

(c) *Test Bar Tests.* See Sect. 2-17.

(d) *Ring Tests and Talbot Strip Tests.* See Sections 2-17(d) and 2-18.

(e) *Full-Length Bursting Tests.* See Sect. 2-19.

**Sect. 2-6. Marking Pipe.** Every pipe shall have distinctly cast upon it the initials of the maker's name. When cast especially to order, each pipe larger than 4-inch may also have cast upon it figures showing the year in which it was cast and a number signifying the order in point of time in which it was cast, the figures denoting the year being above and the number below, thus:

| | | |
|---|---|---|
| 1950 | 1950 | 1950 |
| 1 | 2 | 3 |

etc., also any initials, not exceeding four, which may be required by the purchaser. The letters and figures shall be cast on the outside and shall have dimensions as indicated below.

| Diameters of Pipe, Inches. Inclusive | Height of Letter, Inches | Relief, Inch |
|---|---|---|
| 3 to 10 | $\frac{3}{4}$ | $\frac{3}{32}$ |
| 12 to 20 | $1\frac{1}{4}$ | $\frac{3}{32}$ |
| 24 & larger | $1\frac{3}{4}$ | $\frac{1}{8}$ |

The weight and the class shall be conspicuously painted in white in the inside or outside of each pipe after the coating has become hard.

**Sect. 2-7. Inspection by Purchaser.**

(a) *Definition of Word "Purchaser."* Wherever the word "Purchaser" is used herein it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

(b) *Power of Purchaser to Inspect.* The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, the pattern work, molding, casting, coating and lining of the pipe. The forms, sizes, uniformity and conditions of all pipe herein referred to shall be subject to his inspection and approval, and he may reject, without subjection to hydrostatic test, any pipe which is not in conformity with the specifications or drawings. Any pipe rejected shall be marked "rejected" and any marks pertaining to the purchaser shall be chipped or erased from such pipe.

(c) *Manufacturer to Furnish Men and Material.* The manufacturer shall provide all tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the pipe at the foundry.

(d) *Report of Purchaser's Inspection.* The purchaser shall make written report daily at the foundry office of all pipe rejected, noting causes for rejection.

**Sect. 2-8. Inspection and Certification by Manufacturer.** Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made as specified, this statement to contain the results of all specified tests.

**Sect. 2-9. Pipe to be Delivered Sound.** All the pipe must be delivered in all respects sound and comformable to these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this respect, and any defective pipe which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for pipe found to be cracked after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the pipe not to injure the coating or lining and no pipe or other material of any kind shall be placed in the pipe during transportation or at any other time after they have received the coating or lining.

**Sect. 2-10. Cut Pipe.** Defective spigot ends on pipe may be cut off in a manner which will produce a square end. Cut pipe shall be shipped with plain ends or shall have an iron or steel band shrunk into a groove or welded securely on the pipe, as may be agreed upon at time of purchase. Not more than 8 per cent of the total number of pipe of each size shall be cut, and no cut pipe shall be furnished which is less than 11 ft. 0 in. in laying length, unless it has been used by purchaser's order for strip and ring tests in which case a length of not less than 10 ft. 0 in. shall be accepted.

**Sect. 2-11. Tolerances or Maximum Permitted Variations from Standard.**

(a) *Tolerances in Diameter of Pipe and Sockets.* Outside diameters of pipe barrels and spigot beads and diameters of sockets shall be kept as nearly as practicable to the specified dimensions. They shall be tested with circular gauges. Tolerances or maximum permitted variations from standard dimensions are listed below:

| Nominal Diameter in Inches | Tolerance, Plus or Minus, in Inches |
|---|---|
| 3 to 16 | .06 |
| 18, 20 & 24 | .08 |
| 30, 36 & 42 | .10 |
| 48 | .12 |
| 54 | .15 |
| 60 | .15 |

(b) *Tolerances in Thickness.* The tolerances, or maximum permitted variations from standard in thickness of pipe and in dimensions of bells are listed below:

| Nominal Diameter in Inches, inclusive | Tolerance, Plus or Minus, in Inches |
|---|---|
| 3 to 8 | .07 |
| 10 to 24 | .08 |
| 30 to 60 | .10 |

*NOTE:* In pipe barrel thickness, tolerances .02 inch greater than those listed above shall be permissible over areas not exceeding 8 inches in length in any direction.

(c) *Allowable Percentage of Variation in Weight.* The weight of no single pipe shall be less than the nominal tabulated weight by more than 5% for pipe 16 inches or less in diameter, and 4% for pipe more than 16 inches in diameter. The total excess weight to be paid for on orders of 25 tons or more shall not exceed 2% of the nominal weight, and on orders less than 25 tons shall not exceed 5% of the nominal weight. An order is hereby defined as including all the pipe ordered under the terms of a specific contract or purchase order or a single order placed under the terms of a standing contract.

**Sect. 2-12. Cleaning and Inspecting.** All pipe shall have gates, fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful surface inspection, a hammer test, and a rolling test, before being coated or lined.

**Sect. 2-13. Hydrostatic Test.** Each pipe shall be subjected to a hydrostatic proof test. This test may be made either before or after the tar dip or the priming coat for bituminous enamel has been applied but shall be made before the cement mortar lining, bituminous enamel lining, or any other special lining has been applied to pipe for which such a lining is specified.

The pipe shall be under the test pressure for at least one-half minute, and while under pressure shall be subjected to a hammer or shock test. Any pipe showing defects by leaking, sweating, or otherwise, shall be rejected. The test pressures shall be in accordance with the table on the following page.

**Sect. 2-14. Weighing.** Each length of pipe shall be weighed and the weight and class plainly marked on the outside or inside of the bell or spigot end. Pipe which is to be lined with cement mortar or coated on the inside or outside, or both, with bituminous enamel or other special material shall be weighed before the application of such

TABLE OF PRESSURES FOR HYDROSTATIC TESTS

| Nominal Diameter of Pipe, Inches | Barrel Thickness, Inches From | To | Test Pressures, Lb. per sq.in. |
|---|---|---|---|
| 3 to 12 | All Thicknesses | | 400 |
| 14 | .50 | .70 | 300 |
| 14 | .71 | .85 | 350 |
| 14 | .86 | 1.20 | 450 |
| 16 | .55 | .75 | 300 |
| 16 | .76 | .95 | 350 |
| 16 | .96 | 1.25 | 450 |
| 18 | .60 | .80 | 300 |
| 18 | .81 | 1.00 | 350 |
| 18 | 1.01 | 1.35 | 450 |
| 20 | .65 | .85 | 250 |
| 20 | .86 | 1.05 | 350 |
| 20 | 1.06 | 1.45 | 450 |
| 24 | .70 | .90 | 200 |
| 24 | .91 | 1.00 | 300 |
| 24 | 1.01 | 1.60 | 400 |
| 30 | .85 | 1.05 | 200 |
| 30 | 1.06 | 1.30 | 300 |
| 30 | 1.31 | 1.75 | 400 |
| 36 | .95 | 1.15 | 200 |
| 36 | 1.16 | 1.45 | 300 |
| 36 | 1.46 | 1.95 | 350 |
| 42 | 1.05 | 1.35 | 200 |
| 42 | 1.36 | 1.60 | 300 |
| 42 | 1.61 | 1.75 | 350 |
| 48 | 1.15 | 1.50 | 200 |
| 48 | 1.51 | 1.90 | 300 |
| 48 | 1.91 | 2.05 | 350 |
| 54 | 1.30 | 1.55 | 200 |
| 54 | 1.56 | 1.80 | 250 |
| 54 | 1.81 | 2.05 | 300 |
| 54 | 2.06 | 2.25 | 350 |
| 60 | 1.35 | 1.75 | 200 |
| 60 | 1.76 | 2.05 | 250 |
| 60 | 2.06 | 2.30 | 300 |
| 60 | 2.31 | 2.40 | 350 |

*Note:* Unless otherwise arranged between the manufacturer and the purchaser, pipe thicker than those listed in the above table shall be tested at the highest pressures listed for the given diameter.

a lining or coating. If desired by the purchaser, pipe not lined or coated with cement mortar, bituminous enamel or other special material shall be weighed after delivery and the weights so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weigh master. Unless otherwise stated in the contract, a ton shall be 2,000 lb. avoirdupois.

**Sect. 2-15. Linings and Exterior Coatings.** Any particular lining or coating which is to be applied to the pipe shall be specified in the agreement made at the time of purchase. Separate specifications for a cement-mortar lining have been provided in connection with these specifications for pipe. (See specification ASA A21.4–1952.)

No pipe or specials for waterworks service shall be furnished without protective coating unless specifically ordered by the purchaser.

**Sect. 2-16. Tests of Material.** The acceptability of iron used in the cast iron pipe herein specified as regards physical characteristics shall be determined by the testing of bars cast from the same iron as the pipe, or, if specified by the purchaser, by the testing of Talbot strips and/or rings cut from the pipe as described in Sect. 2–18, or by full-length bursting tests (see Sect. 2–19) in addition to Talbot strips and rings. Such strip tests, ring tests and full-length bursting tests shall be paid for by the purchaser at prices to be agreed upon. In any case the test bars shall be made and tested and results given to the purchaser if requested. The smallest pipe on which ring tests may be required is the 6-inch. The observations and the computed results hereinafter required shall be recorded and if requested reported to the purchaser.

**Sect. 2-17. Test Bars.**

(a) *Dimensions.* Test bars shall be 2 inches wide, 1 inch thick, and not less than 26 inches long. Individual test bars may vary as much as 2 per cent from standard width, or standard thickness, or both, but the patterns and molding practice shall be such that the errors shall in general not exceed 1 per cent.

(b) *Methods of Casting.* The bars shall be cast vertically in well-faced, dry sand molds provided with suitable pouring basin and mounted on a suitable refractory foundation. Metal for the bars shall be obtained by using a small heated ladle taking its metal from the main ladle from which the pipe is to be poured and after all alloys and other additional metal, except cast iron pipe for cooling, have been added to the main ladle and become melted. The bars shall not be removed from the mold before they have cooled to 500°F.

(c) *When Cast and to What Pipe Applicable.* Except as hereinafter provided for special cases, one pair of test bars of the metal used shall be cast with iron from the first ladle, another pair with iron from the approximately middle ladle, and a third pair with iron from the last ladle of iron taken during a day's run or heat from the cupola in which the iron for the pipe is melted. If the heat lasts for more than 6 hours, then additional pairs of bars shall be cast at approximately uniform intervals so as to give an extra pair of bars for each 3 hours during which the heat lasts in excess of 6 hours. In case the charging of the cupola is to be changed one or more times during the day's run or heat in order to produce a different iron, the time of taking test bars shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality; and in case such period exceeds four hours additional pairs of bars shall be taken at such times as will provide a pair of bars for each two hours during which this special mixture is used. At least one bar from each pair shall be broken, but the manufacturer shall have the right to break both bars in which case the better bar shall be taken as representative. Bars showing flaws in fracture may be disregarded.

(d) *Test Bar Requirements to Indicate Acceptable Iron; Retests may be made at Contractor's Option using Talbot Strips and/or Rings.* In order that the iron shall be acceptable the average results from the single bars representing the respective pairs of bars cast during the heat or period shall comply with the requirements hereinafter specified and, in addition, no representative bar shall be more than 5 percent below the minimum requirements in either corrected breaking load or corrected deflection. In case the test bars do not measure up to these requirements the manufacturer may make one or more Talbot strip tests and/or ring tests of specimens cut from such of the pipe as may be agreed upon as best representing the iron at the time when the deficient test bars were cast. In the absence of the purchaser the manufacturer may select the pipe from which rings and/or strips shall be cut. The results from these rings and/or strips shall be kept as a foundry record available to any purchaser who requires a report of tests on the 2-inch by 1-inch bars. Any Talbot strip tests or ring tests made under this provision shall be at the expense of the manufacturer. If these supplementary Talbot strip tests and/or ring tests do not meet the requirements, the pipe cast in that heat or period, or such a part thereof as may be agreed to by the purchaser, shall be rejected.

(e) *Method of Testing.* The bars shall be broken as beams by placing them flatwise on supports 24 inches apart and applying the load at the center of the span. The breaking load and the corresponding deflection shall be observed and recorded.

(f) *Correcting Observed Breaking Loads and Deflections.* The bars shall be measured at the point of application of the load and the results corrected to standard 2 inch by 1 inch cross section by the conventional beam formula as follows:

Corrected breaking load = observed breaking load multiplied by $\frac{2}{bd^2}$

Corrected deflection at breaking = observed deflection at breaking multiplied by $d$

where $b$ = measured width and
$d$ = measured depth
of the bar at point of application of load

In the formulae above the deflection and all dimensions are in inches.

(g) *Requirements as to Strength and Deflection of 2 inch by 1 inch Bars.* In order to indicate acceptable metal, the corrected breaking loads and deflections of the representative 2 inch by 1 inch test bars for a given heat or period interpreted as provided in paragraph (d) above, shall comply with such of the following tabulated requirements as pertain to the thickness range within which fall the particular pipes which are under consideration.

Table of Minimum Corrected Breaking Loads & Deflections

| Metal Thickness of Pipe, Inch | Minimum Center Breaking Load, Pounds | Minimum Center Deflection at Breaking, Inch |
|---|---|---|
| Below .61 | 1900 | .30 + .0001 (Breaking Load − 1900) |
| .61 to .90 | 2000 | .30 + .0001 (Breaking Load − 2000) |
| .91 to 1.60 | 2200 | .30 + .0001 (Breaking Load − 2200) |
| 1.61 to 2.50 | 2300 | .30 + .0001 (Breaking Load − 2300) |

*Note:* For thicknesses exceeding 2.50 inches the form of test specimen and the test requirements shall be as agreed upon in the purchase contract.

### Sect. 2-18. Talbot Strip Tests and Ring Tests.

(a) *Dimensions.* Rings shall have a length equal to half the nominal diameter of the pipe unless the diameter exceeds 24 inches, in which case the length of ring shall be 12 inches. Strips shall be not less than 11 inches long and for 24-inch and larger pipe may be cut from the least stressed portions of rings (see Sect. 2-18 (d) after the rings have been broken. The end 2 inches of the pipe shall not be included in ring or strip.

Note: To make both ring and strip tests on a pipe will therefore require at the least (on 6 inch pipe) 16 inches of pipe, at the most (on 20 inch pipe) 23 inches of pipe, and on pipe larger than 20 inches, 14 inches of pipe.

(b) *Method of Sampling.* The purchaser who has expressly specified Talbot strip tests and/or ring tests as acceptance tests of the pipe may select at random from each run, or heat, one or more pipe from which test specimens are to be cut. In the absence of the purchaser or his representative, the pipe from which test specimens are to be taken may be selected by the manufacturer. If the purchaser should wish to test the uniformity of a run or heat, he may divide it into two or more periods and have a separate set of acceptance tests for pipe in each period.

(c) *Defective Specimens; Retests.* If any test specimen shows defective machining or obvious lack of continuity of metal, it shall be discarded and replaced by another specimen selected by the purchaser. If the test specimens first selected fail to meet the require-

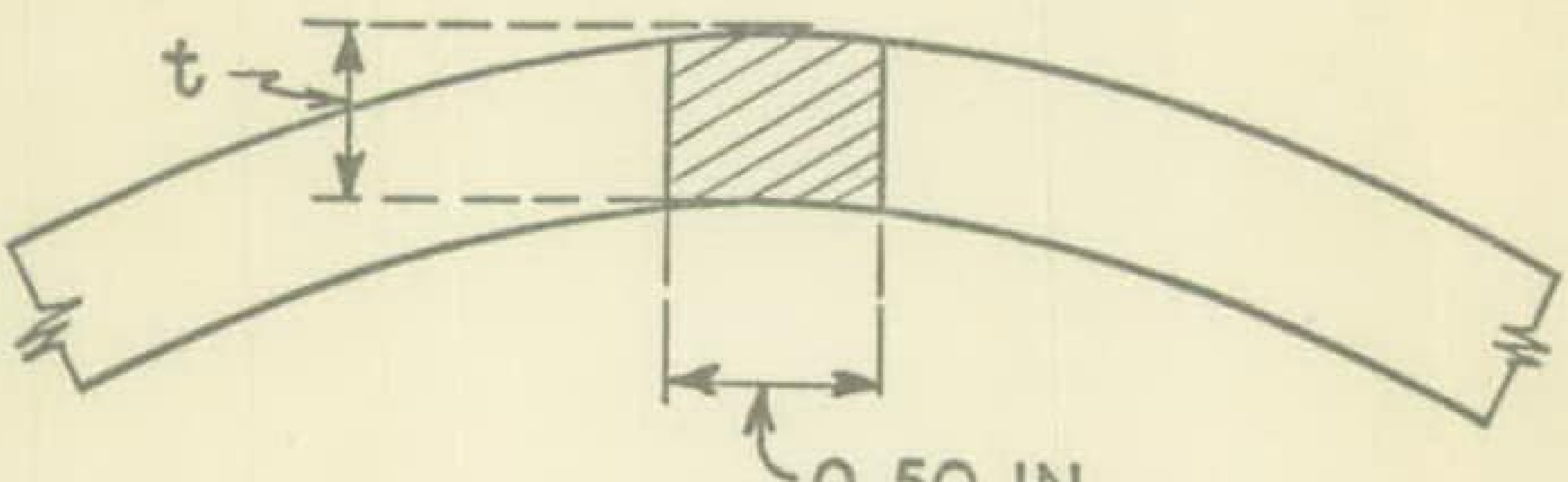



Fig. 1. Position from which Talbot Strip Is Cut

ments specified hereinafter and the purchaser permits a retest, at least twice the number of specimens that failed shall be selected by the purchaser for retest from a pipe cast in the same run or period. In case a ring from a pipe 24 inches in diameter or larger fails to meet specifications, the purchaser may accept strip tests, two specimens to be cut from the failed ring at points of low stress as described in Sect. 2-18 (d). In any case of retest the pipe cast during the run or period shall be acceptable only when all retest specimens meet the requirements. All retests shall be made at the expense of the manufacturer.

(d) *Talbot Strip Tests.* Two Talbot strips shall be machined longitudinally from each pipe selected by the purchaser for testing by this method. If ring tests are also made and the pipe are 24 inches or larger these Talbot strips may be cut from a part of the ring little stressed in the ring test, i.e., near one of the elements marked (a) in Fig. 2. (See Sect. 2-18 (e).) The strips in any case will be in cross section as indicated in Fig. 1, i.e., will have for their width the thickness of the pipe and for their thickness 0.50 inch. Their length will be the length of the ring, 12 inches; or, if not cut from a ring, at least 11 inches. These strips shall be tested as a beam on supports 10 inches apart with loads applied perpendicularly to the machined faces at two points 3⅓ inches from the supports. The breaking load and the corresponding deflection shall be observed and recorded.

The strip shall be accurately calipered at point of rupture and the modulus of rupture, $R$, shall be calculated by the usual beam formula which for this case reduces to the expression:

$$R = \frac{10W}{td^2}$$

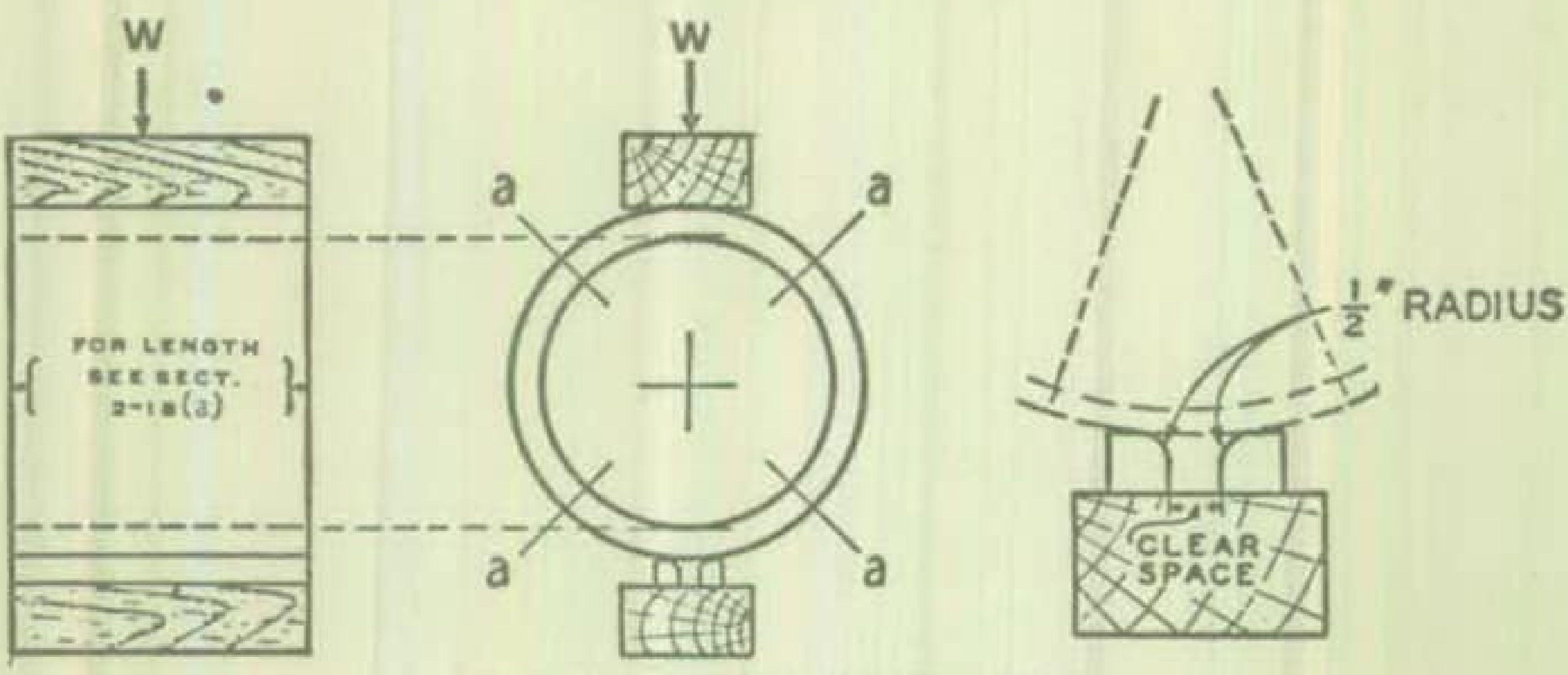



FIG. 2. Assembly for Ring Test

The secant modulus of elasticity $E_s$, in lb. per sq.in. shall be computed by the formula:

$$E_s = \frac{213W}{td^3y} = \frac{21.3R}{dy}$$

where $R$ = modulus of rupture, lb. per sq.in.
$E_s$ = secant modulus of elasticity, lb. per sq.in.
$W$ = breaking load, lb.
$d$ = depth of strip in inches (intended to be 0.50 in.)
$t$ = width of strip, inches (pipe thickness)
$y$ = deflection of strip at center at breaking load, inches.

To be acceptable a Talbot strip shall have the modulus of rupture, $R$, not less than 30,000 lb. per sq.in. and the secant modulus of elasticity, $E_s$, not more than 10,000,000 lb. per sq.in. If the results from either strip are up to the specifications the test shall be regarded as satisfactory.

(e) *Ring Tests.* Each ring shall be tested by the three-edge-bearing method as indicated in Fig. 2. The lower bearing for the ring shall consist of two strips with vertical sides having their interior top corners rounded to a radius of approximately $\frac{1}{2}$ inch. The strips shall be of hard wood or of metal. If of metal a piece of leather belting about $\frac{3}{16}$ inch thick shall be laid over them. They shall be straight and shall be securely fastened to a rigid block with their interior vertical faces spaced at a distance apart as given in the following table:

| Diam. of Pipe | Clear Space |
|---|---|
| 12-inch and smaller | $\frac{1}{2}$ inch |
| 14-inch to 24-inch inclusive | 1 inch |
| 30-inch and larger | 2 inch |

The upper bearing shall be a rigid wooden block, straight and true from end to end. The upper and lower bearings shall extend the full length of the outside of the ring. The ring shall be placed symmetrically between the two bearings, and the center of application of the load shall be so placed that the vertical deformations at the two ends of the ring shall be equal. If the ring is not uniform in thickness, it shall be so placed that the thick and thin portions are near the ends of the horizontal diameter. A record of the breaking load and the corresponding vertical deformation of each ring tested shall be made. In order to be acceptable the modulus of rupture computed from the formula

$$R = 0.954\,\frac{W(d + t)}{bt^2}$$

shall be not less than 31,000 lb. per sq.in., and the secant modulus of elasticity computed from the formula

$$E_s = \frac{0.225\,W(d + t)^3}{bt^3y} = \frac{0.236\,R(d + t)^2}{ty}$$

shall not exceed 15,000,000 lb. per sq.in.

$b$ = length of ring, inches
$d$ = average inside diameter of ring, inches
$t$ = average thickness of metal along line of fracture, inches
$y$ = maximum vertical deflection of ring, inches
$W$ = breaking load, in lb.
$R$ = modulus of rupture, lb. per sq.in.
$E$ = secant modulus of elasticity, lb. per sq.in.

The modulus of elasticity shall not be determined in rings from pipe less than 12 inches in diameter.

**Sect. 2-19. Full-Length Bursting Tests.** The bursting tensile strength shall be determined by testing full-length pipe (less the amount cut off for ring and strip test specimens) to destruction by hydraulic pressure. Bells may be removed to facilitate testing. A suitable means for holding the end thrust shall be used which will not subject the pipe to endwise tension or compression, or other parasitic stresses. A calibrated pressure gage shall be used for determining the bursting pressure. This gage shall be connected to the interior of the test pipe by a separate connection from that which supplies water for the test. The unit tensile strength in bursting shall be obtained by the use of the formula:

$$S = \frac{Pd}{2t}$$

in which $S$ is the bursting tensile strength (psi.) of the iron, $P$ is the internal pressure (psi.) at bursting, $d$ is the average inside diameter (in.) of the pipe and $t$ is the minimum average thickness (in.) of the pipe along the principal line of break.

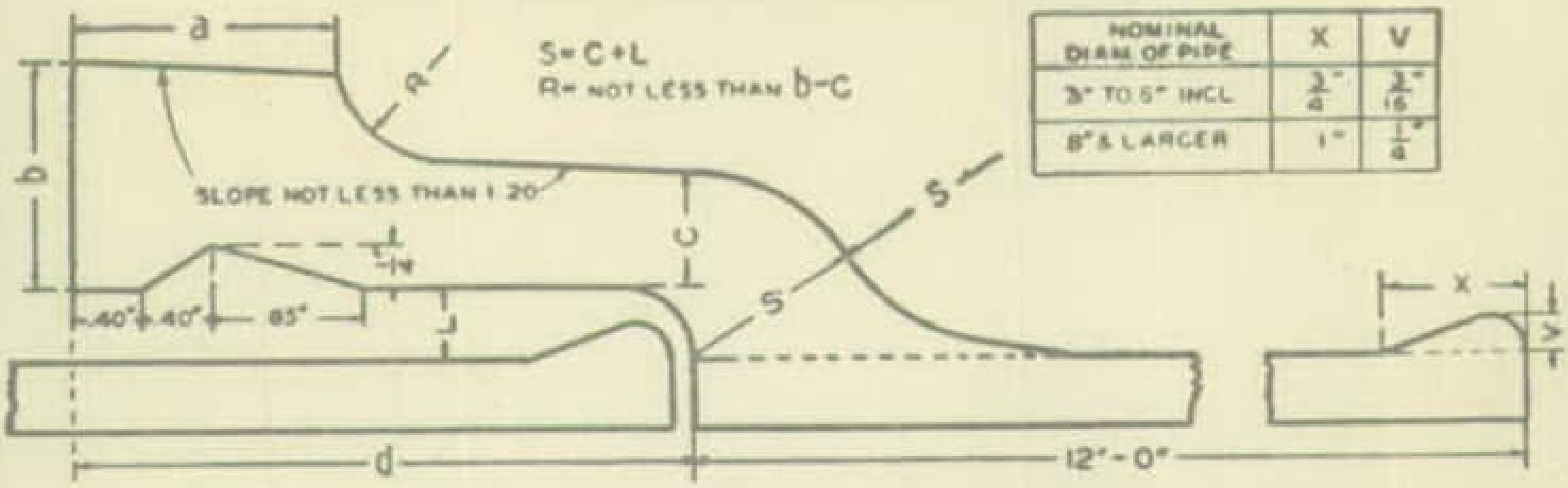
Measurements of thickness shall be taken along the principal line of break at 1-ft. intervals.

The minimum average thickness along the principal line of break shall be obtained by averaging the measurements at the thinnest section at a weight of two and at the adjacent sections on each side at a weight of one each; or, if the thinnest section is at the end of the break, by averaging this thinnest-section measurement at a weight of two and the measurements of the adjacent section and the next section at a weight of one each.

In order to be acceptable, the bursting tensile strength shall not be less than 11,000 psi.

## Table No. 1

### STANDARD DIMENSIONS OF BELLS, SOCKETS, SPIGOT BEADS and OUTSIDE DIAMETERS of PIT CAST PIPE also WEIGHTS OF BELLS AND OF SPIGOT BEADS




| Nominal Diam. | Thickness of pipe: From | Thickness of pipe: To | Out-Side Diam. of Pipe | Dimensions of Bells: Diam. of Socket | Thickness of Joint L | Depth of Socket d | a | b | c | Wt. of Bell | Wt. of Spigot Bead |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | .37 | 45 | 3 80 | 4.60 | 40 | 3 50 | 1 25 | 1 30 | 65 | 19 | 3 |
| | 46 | 53 | 3 96 | 4.76 | 40 | 3.50 | 1 25 | 1 30 | 65 | 20 | .3 |
| 4 | 40 | .45 | 4 80 | 5.60 | .40 | 3 50 | 1.50 | 1 30 | .65 | 23 | .3 |
| | .46 | .55 | 5.00 | 5.80 | 40 | 3.50 | 1.50 | 1.30 | 65 | 24 | .4 |
| 6 | .43 | 50 | 6 90 | 7.70 | 40 | 3.50 | 1.50 | 1 40 | 70 | 33 | .5 |
| | 51 | .60 | 7.10 | 7.90 | .40 | 3.50 | 1.50 | 1 40 | 70 | 34 | .5 |
| | .61 | .66 | 7.22 | 8.02 | .40 | 4.00 | 1.50 | 1 75 | 75 | 56 | .9 |
| | 67 | 74 | 7.38 | 8.18 | 40 | 4.00 | 1.50 | 1.85 | .85 | 62 | .9 |
| 8 | .46 | .57 | 9.05 | 9.85 | .40 | 4.00 | 1.50 | 1.50 | 75 | 48 | 1.1 |
| | 58 | .70 | 9.30 | 10.10 | 40 | 4.00 | 1.50 | 1.50 | .75 | 49 | 1.2 |
| | .71 | .76 | 9 42 | 10.22 | 40 | 4.00 | 1.50 | 1.85 | .85 | 75 | 1.2 |
| | .77 | .85 | 9.60 | 10.40 | 40 | 4.00 | 1.50 | 1.95 | 95 | 84 | 1.3 |
| 10 | .50 | .60 | 11.10 | 11.90 | 40 | 4.00 | 1.50 | 1.50 | .75 | 58 | 1.4 |
| | 61 | .75 | 11.40 | 12.20 | 40 | 4.00 | 1.50 | 1.60 | .80 | 64 | 1.4 |
| | .76 | .85 | 11.60 | 12.40 | 40 | 4 50 | 1.75 | 1.95 | .95 | 99 | 1.4 |
| | .86 | .97 | 11.84 | 12.64 | .40 | 4.50 | 1.75 | 2.05 | 1.05 | 110 | 1.5 |
| 12 | 54 | .65 | 13.20 | 14.00 | .40 | 4.00 | 1.50 | 1.60 | .80 | 72 | 1.6 |
| | 66 | 80 | 13.50 | 14.30 | .40 | 4.00 | 1.50 | 1.70 | 85 | 78 | 1.7 |
| | .81 | 94 | 13 78 | 14.58 | .40 | 4.50 | 1.75 | 2.05 | 1.05 | 125 | 1.7 |
| | 95 | 1.09 | 14.08 | 14.88 | 40 | 4.50 | 1 75 | 2.20 | 1.20 | 144 | 1.7 |
| 14 | 54 | .62 | 15 30 | 16.10 | .40 | 4.00 | 1.50 | 1.70 | 85 | 88 | 1.9 |
| | .63 | .87 | 15.65 | 16.45 | .40 | 4.00 | 1.50 | 1.80 | 90 | 96 | 1.9 |
| | .88 | 1.04 | 15.98 | 16.78 | .40 | 4.50 | 2.00 | 2.15 | 1 15 | 148 | 2.0 |
| | 1.05 | 1.21 | 16.32 | 17.12 | .40 | 4.50 | 2.00 | 2.35 | 1.35 | 183 | 2.0 |
| 16 | .58 | .67 | 17.40 | 18.40 | 50 | 4.00 | 1.75 | 1.80 | 90 | 114 | 2.1 |
| | .68 | .95 | 17.80 | 18.80 | 50 | 4.00 | 1.75 | 1.90 | 1 00 | 128 | 2.2 |
| | 96 | 1.13 | 18.16 | 18.96 | 40 | 4.50 | 2.00 | 2.30 | 1.25 | 180 | 2.2 |
| | 1.14 | 1.32 | 18.54 | 19.34 | 40 | 4.50 | 2.00 | 2 55 | 1 45 | 224 | 2.3 |
| 18 | 63 | .72 | 19.50 | 20.50 | .50 | 4.00 | 1 75 | 1.90 | 95 | 133 | 2.4 |
| | 73 | 1.01 | 19.92 | 20.92 | .50 | 4 00 | 1.75 | 2.10 | 1 05 | 154 | 2.4 |
| | 1 02 | 1 22 | 20.34 | 21.14 | .40 | 4.50 | 2.25 | 2 45 | 1 40 | 222 | 2.5 |
| | 1 23 | 1.44 | 20.78 | 21.58 | .40 | 4.50 | 2.25 | 2.75 | 1.65 | 283 | 2.5 |

All dimensions given in inches. All weights given in pounds.

Table No. 1 (continued)

STANDARD DIMENSIONS OF BELLS, SOCKETS, SPIGOT BEADS and OUTSIDE DIAMETERS of PIT CAST PIPE also WEIGHTS OF BELLS AND OF SPIGOT BEADS

| Nominal Diam. | Thickness of pipe | | Out-Side Diam. of Pipe | DIMENSIONS OF BELLS | | | | | | Wt. of Bell | Wt. of Spigot Bead |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | Diam. of Socket | Thickness of Joint L | Depth of Socket d | a | b | c | | |
| 20 | .66 | .82 | 21.60 | 22.60 | .50 | 4.00 | 1.75 | 2.00 | 1.00 | 156 | 2.6 |
| | .83 | 1.08 | 22.06 | 23.06 | .50 | 4.00 | 1.75 | 2.30 | 1.15 | 189 | 2.7 |
| | 1.09 | 1.32 | 22.54 | 23.34 | .40 | 4.50 | 2.25 | 2.55 | 1.50 | 260 | 2.8 |
| | 1.33 | 1.56 | 23.02 | 23.82 | .40 | 4.50 | 2.25 | 2.85 | 1.75 | 328 | 2.8 |
| 24 | .74 | .92 | 25.80 | 26.80 | .50 | 4.00 | 2.00 | 2.10 | 1.05 | 199 | 3.2 |
| | .93 | 1.21 | 26,32 | 27.32 | .50 | 4.00 | 2.00 | 2.50 | 1.25 | 250 | 3.2 |
| | 1.22 | 1.50 | 26.90 | 27.90 | .50 | 5.00 | 2.25 | 2.75 | 1.70 | 349 | 3.3 |
| | 1.51 | 1.93 | 27.76 | 28.56 | .40 | 5.00 | 2.25 | 3.15 | 1.95 | 489 | 3.4 |
| 30 | .87 | .92 | 31.74 | 32.74 | .50 | 4.50 | 2.00 | 2.30 | 1.15 | 296 | 3.9 |
| | .93 | 1.05 | 32.00 | 33.00 | .50 | 4.50 | 2.00 | 2.30 | 1.15 | 298 | 3.9 |
| | 1.06 | 1.18 | 32.40 | 33.40 | .50 | 4.50 | 2.00 | 2.60 | 1.32 | 351 | 4.0 |
| | 1.19 | 1.42 | 32.74 | 33.74 | .50 | 4.50 | 2.00 | 3.00 | 1.50 | 416 | 4.0 |
| | 1.43 | 1.60 | 33.10 | 34.10 | .50 | 5.00 | 2.25 | 3.25 | 1.80 | 557 | 4.0 |
| | 1.61 | 1.78 | 33.46 | 34.46 | .50 | 5.00 | 2.25 | 3.50 | 2.00 | 626 | 4.1 |
| 36 | .97 | 1.03 | 37.96 | 38.96 | .50 | 4.50 | 2.00 | 2.50 | 1.25 | 383 | 4.6 |
| | 1.04 | 1.20 | 38.30 | 39.30 | .50 | 4.50 | 2.00 | 2.80 | 1.40 | 446 | 4.7 |
| | 1.21 | 1.40 | 38.70 | 39.70 | .50 | 4.50 | 2.00 | 3.10 | 1.60 | 512 | 4.7 |
| | 1.41 | 1.63 | 39.16 | 40.16 | .50 | 4.50 | 2.00 | 3.40 | 1.80 | 586 | 4.8 |
| | 1.64 | 1.85 | 39.60 | 40.60 | .50 | 5.00 | 2.25 | 3.70 | 2.05 | 770 | 4.8 |
| | 1.86 | 2.07 | 40.04 | 41.04 | .50 | 5.00 | 2.25 | 4.00 | 2.30 | 876 | 4.9 |
| 42 | 1.07 | 1.15 | 44.20 | 45.20 | .50 | 5.00 | 2.00 | 2.80 | 1.40 | 539 | 5.4 |
| | 1.16 | 1.30 | 44.50 | 45.50 | .50 | 5.00 | 2.00 | 3.00 | 1.50 | 586 | 5.4 |
| | 1.31 | 1.57 | 45.10 | 46.10 | .50 | 5.00 | 2.00 | 3.40 | 1.75 | 701 | 5.5 |
| | 1.58 | 1.84 | 45.58 | 46.58 | .50 | 5.00 | 2.00 | 3.80 | 1.95 | 805 | 5.8 |
| 48 | 1.18 | 1.30 | 50.50 | 51.50 | .50 | 5.00 | 2.00 | 3.00 | 1.50 | 660 | 6.1 |
| | 1.31 | 1.45 | 50.80 | 51.80 | .50 | 5.00 | 2.00 | 3.30 | 1.65 | 745 | 6.2 |
| | 1.46 | 1.72 | 51.40 | 52.40 | .50 | 5.00 | 2.00 | 3.80 | 1.95 | 900 | 6.2 |
| | 1.73 | 2.04 | 51.98 | 52.98 | .50 | 5.00 | 2.00 | 4.20 | 2.20 | 1046 | 6.3 |
| 54 | 1.30 | 1.38 | 56.66 | 57.66 | .50 | 5.50 | 2.25 | 3.20 | 1.60 | 855 | 6.9 |
| | 1.39 | 1.60 | 57.10 | 58.10 | .50 | 5.50 | 2.25 | 3.60 | 1.80 | 993 | 6.9 |
| | 1.61 | 1.89 | 57.80 | 58.80 | .50 | 5.50 | 2.25 | 4.00 | 2.15 | 1189 | 7.0 |
| | 1.90 | 2.25 | 58.40 | 59.40 | .50 | 5.50 | 2.25 | 4.40 | 2.45 | 1391 | 7.1 |
| 60 | 1.39 | 1.45 | 62.80 | 63.80 | .50 | 5.50 | 2.25 | 3.40 | 1.70 | 1021 | 7.6 |
| | 1.46 | 1.75 | 63.40 | 64.40 | .50 | 5.50 | 2.25 | 3.70 | 1.90 | 1145 | 7.7 |
| | 1.76 | 2.15 | 64.20 | 65.20 | .50 | 5.50 | 2.25 | 4.20 | 2.25 | 1393 | 7.8 |
| | 2.16 | 2.46 | 64.82 | 65.82 | .50 | 5.50 | 2.25 | 4.70 | 2.60 | 1647 | 7.9 |

All dimensions given in inches. All weights given in pounds.

NOTE: Pipe for pressures greater than 200 pounds per square inch may be supplied with double lead groove if desired.

Table 2

## STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIT CAST PIPE

Dimensions in Inches — Weights in Pounds

| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Ft. | Wt. of Bell | Wt. Based on 12 Ft. Length* Per Length | Wt. Based on 12 Ft. Length* Avg. Per Foot |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3 | 1 | .37 | 3.80 | 3.06 | 12.4 | 19 | 170 | 14.2 |
| | 2 | .40 | 3.80 | 3.00 | 13.3 | 19 | 180 | 15.0 |
| | 3 | .43 | 3.80 | 2.94 | 14.2 | 19 | 190 | 15.8 |
| | 4 | .46 | 3.96 | 3.04 | 15.8 | 20 | 210 | 17.5 |
| | 5 | .50 | 3.96 | 2.96 | 17.0 | 20 | 225 | 18.8 |
| 4 | 1 | .40 | 4.80 | 4.00 | 17.3 | 23 | 230 | 19.2 |
| | 2 | .43 | 4.80 | 3.94 | 18.4 | 23 | 245 | 20.4 |
| | 3 | .46 | 5.00 | 4.08 | 20.5 | 24 | 270 | 22.5 |
| | 4 | .50 | 5.00 | 4.00 | 22.4 | 24 | 290 | 24.2 |
| | 5 | .54 | 5.00 | 3.92 | 23.6 | 24 | 310 | 25.8 |
| 6 | 1 | .43 | 6.90 | 6.04 | 27.3 | 33 | 360 | 30.0 |
| | 2 | .46 | 6.90 | 5.98 | 29.0 | 33 | 380 | 31.7 |
| | 3 | .50 | 6.90 | 5.90 | 31.4 | 33 | 410 | 34.2 |
| | 4 | .54 | 7.10 | 6.02 | 34.7 | 34 | 450 | 37.5 |
| | 5 | .58 | 7.10 | 5.94 | 37.1 | 34 | 480 | 40.0 |
| | 6 | .63 | 7.22 | 5.96 | 40.7 | 56 | 545 | 45.4 |
| | 7 | .68 | 7.38 | 6.02 | 44.7 | 62 | 600 | 50.0 |
| | 8 | .73 | 7.38 | 5.92 | 47.6 | 62 | 635 | 52.9 |
| 8 | 1 | .46 | 9.05 | 8.13 | 38.7 | 48 | 515 | 42.9 |
| | 2 | .50 | 9.05 | 8.05 | 41.9 | 48 | 550 | 45.8 |
| | 3 | .54 | 9.05 | 7.97 | 45.0 | 48 | 590 | 49.2 |
| | 4 | .58 | 9.30 | 8.14 | 49.6 | 49 | 645 | 53.8 |
| | 5 | .63 | 9.30 | 8.04 | 53.5 | 49 | 690 | 57.5 |
| | 6 | .68 | 9.30 | 7.94 | 37.5 | 49 | 740 | 61.7 |
| | 7 | .73 | 9.42 | 7.96 | 62.2 | 75 | 825 | 68.8 |
| | 8 | .79 | 9.60 | 8.02 | 68.2 | 84 | 905 | 75.4 |
| | 9 | .85 | 9.60 | 7.90 | 72.9 | 84 | 960 | 80.0 |
| 10 | 1 | .50 | 11.10 | 10.10 | 52.0 | 58 | 685 | 57.1 |
| | 2 | .54 | 11.10 | 10.02 | 55.9 | 58 | 730 | 60.8 |
| | 3 | .58 | 11.10 | 9.94 | 59.8 | 58 | 775 | 64.6 |
| | 4 | .63 | 11.40 | 10.14 | 66.5 | 64 | 865 | 72.1 |
| | 5 | .68 | 11.40 | 10.04 | 71.5 | 64 | 925 | 77.1 |
| | 6 | .73 | 11.40 | 9.94 | 76.4 | 64 | 980 | 81.7 |
| | 7 | .79 | 11.60 | 10.02 | 83.7 | 99 | 1105 | 92.1 |
| | 8 | .85 | 11.60 | 9.90 | 89.6 | 99 | 1175 | 97.9 |
| | 9 | .92 | 11.84 | 10.00 | 98.5 | 110 | 1205 | 107.9 |
| 12 | 1 | .54 | 13.20 | 12.12 | 67.0 | 72 | 880 | 73.3 |
| | 2 | .58 | 13.20 | 12.04 | 71.8 | 72 | 935 | 77.9 |
| | 3 | .63 | 13.20 | 11.94 | 77.6 | 72 | 1005 | 83.8 |
| | 4 | .68 | 13.50 | 12.14 | 85.5 | 78 | 1105 | 92.1 |
| | 5 | .73 | 13.50 | 12.04 | 91.4 | 78 | 1175 | 97.9 |
| | 6 | .79 | 13.50 | 11.92 | 98.4 | 78 | 1260 | 105.0 |
| | 7 | .85 | 13.78 | 12.08 | 107.7 | 125 | 1420 | 118.3 |
| | 8 | .92 | 13.78 | 11.94 | 116.0 | 125 | 1520 | 126.7 |
| | 9 | .99 | 14.08 | 12.10 | 127.0 | 144 | 1670 | 139.2 |
| | 10 | 1.07 | 14.08 | 11.94 | 136.4 | 144 | 1785 | 148.8 |
| 14 | 1 | .54 | 15.30 | 14.22 | 78.1 | 88 | 1025 | 85.4 |
| | 2 | .58 | 15.30 | 14.14 | 83.7 | 88 | 1095 | 91.3 |
| | 3 | .63 | 15.65 | 14.39 | 92.8 | 96 | 1210 | 100.8 |
| | 4 | .68 | 15.65 | 14.29 | 99.8 | 96 | 1295 | 107.9 |
| | 5 | .73 | 15.65 | 14.19 | 106.8 | 96 | 1380 | 115.0 |
| | 6 | .79 | 15.65 | 14.07 | 115.1 | 96 | 1480 | 123.3 |
| | 7 | .85 | 15.65 | 13.95 | 123.3 | 96 | 1580 | 131.7 |
| | 8 | .92 | 15.98 | 14.14 | 135.8 | 148 | 1780 | 148.3 |
| | 9 | .99 | 15.98 | 14.00 | 145.5 | 148 | 1895 | 157.9 |

*Including Bell and Spigot Bead. Calculated weight of Pipe rounded off to nearest 5 pounds.

Table 2 (continued)

## STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIT CAST PIPE

Dimensions in Inches — Weights in Pounds

| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Ft. | Wt. of Bell | Wt. Based on 12 Ft. Length* Per Length | Avg. Per Foot |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 14 | 10 | 1.07 | 16.32 | 14.18 | 160.0 | 183 | 2105 | 175.4 |
| | 11 | 1.16 | 16.32 | 14.00 | 172.4 | 183 | 2255 | 187.9 |
| 16 | 1 | .58 | 17.40 | 16.24 | 95.6 | 114 | 1265 | 105.4 |
| | 2 | .63 | 17.40 | 16.14 | 103.6 | 114 | 1360 | 113.3 |
| | 3 | .68 | 17.80 | 16.44 | 114.1 | 128 | 1500 | 125.0 |
| | 4 | .73 | 17.80 | 16.34 | 122.1 | 128 | 1595 | 132.9 |
| | 5 | .79 | 17.80 | 16.22 | 131.7 | 128 | 1710 | 142.5 |
| | 6 | .85 | 17.80 | 16.10 | 141.2 | 128 | 1825 | 152.1 |
| | 7 | .92 | 17.80 | 15.96 | 152.2 | 128 | 1955 | 162.9 |
| | 8 | .99 | 18.16 | 16.18 | 166.6 | 180 | 2180 | 181.7 |
| | 9 | 1.07 | 18.16 | 16.02 | 179.2 | 180 | 2335 | 194.6 |
| | 10 | 1.16 | 18.54 | 16.22 | 197.6 | 224 | 2600 | 216.7 |
| | 11 | 1.25 | 18.54 | 16.04 | 211.8 | 224 | 2770 | 230.8 |
| 18 | 1 | .63 | 19.50 | 18.24 | 116.5 | 133 | 1535 | 127.9 |
| | 2 | .68 | 19.50 | 18.14 | 125.4 | 133 | 1640 | 136.7 |
| | 3 | .73 | 19.92 | 18.46 | 137.3 | 154 | 1805 | 150.4 |
| | 4 | .79 | 19.92 | 18.34 | 148.1 | 154 | 1935 | 161.3 |
| | 5 | .85 | 19.92 | 18.22 | 158.9 | 154 | 2065 | 172.1 |
| | 6 | .92 | 19.92 | 18.08 | 171.3 | 154 | 2210 | 184.2 |
| | 7 | .99 | 19.92 | 17.94 | 183.7 | 154 | 2360 | 196.7 |
| | 8 | 1.07 | 20.34 | 18.20 | 202.1 | 222 | 2650 | 220.8 |
| | 9 | 1.16 | 20.34 | 18.02 | 218.1 | 222 | 2840 | 236.7 |
| | 10 | 1.25 | 20.78 | 18.28 | 239.3 | 283 | 3155 | 262.9 |
| | 11 | 1.35 | 20.78 | 18.08 | 257.1 | 283 | 3370 | 280.8 |
| 20 | 1 | .66 | 21.60 | 20.28 | 135.5 | 156 | 1785 | 148.8 |
| | 2 | .71 | 21.60 | 20.18 | 145.4 | 156 | 1905 | 158.8 |
| | 3 | .77 | 21.60 | 20.06 | 157.2 | 156 | 2045 | 170.4 |
| | 4 | .83 | 22.06 | 20.40 | 172.7 | 189 | 2265 | 188.8 |
| | 5 | .90 | 22.06 | 20.26 | 186.7 | 189 | 2430 | 202.5 |
| | 6 | .97 | 22.06 | 20.12 | 200.5 | 189 | 2600 | 216.7 |
| | 7 | 1.05 | 22.06 | 19.96 | 216.2 | 189 | 2785 | 232.1 |
| | 8 | 1.13 | 22.54 | 20.28 | 237.1 | 260 | 3110 | 259.2 |
| | 9 | 1.22 | 22.54 | 20.10 | 255.0 | 260 | 3325 | 277.1 |
| | 10 | 1.32 | 22.54 | 19.90 | 274.6 | 260 | 3560 | 296.7 |
| | 11 | 1.43 | 23.02 | 20.16 | 302.6 | 326 | 3960 | 330.0 |
| 24 | 1 | .74 | 25.80 | 24.32 | 181.8 | 199 | 2385 | 198.8 |
| | 2 | .80 | 25.80 | 24.20 | 196.0 | 199 | 2555 | 212.9 |
| | 3 | .86 | 25.80 | 24.08 | 210.2 | 199 | 2725 | 227.1 |
| | 4 | .93 | 26.32 | 24.46 | 231.5 | 250 | 3030 | 252.5 |
| | 5 | 1.00 | 26.32 | 24.32 | 248.2 | 250 | 3230 | 269.2 |
| | 6 | 1.08 | 26.32 | 24.16 | 267.2 | 250 | 3460 | 288.3 |
| | 7 | 1.17 | 26.32 | 23.98 | 288.4 | 250 | 3715 | 309.6 |
| | 8 | 1.26 | 26.90 | 24.38 | 316.7 | 349 | 4155 | 346.2 |
| | 9 | 1.36 | 26.90 | 24.18 | 340.5 | 349 | 4440 | 370.0 |
| | 10 | 1.47 | 26.90 | 23.96 | 366.4 | 349 | 4750 | 395.8 |
| | 11 | 1.59 | 27.76 | 24.58 | 407.9 | 489 | 5385 | 448.8 |
| | 12 | 1.72 | 27.76 | 24.32 | 439.0 | 489 | 5760 | 480.0 |
| | 13 | 1.86 | 27.76 | 24.04 | 472.2 | 489 | 6160 | 513.3 |
| 30 | 1 | .87 | 31.74 | 30.00 | 263.3 | 296 | 3460 | 288.3 |
| | 2 | .94 | 32.00 | 30.12 | 286.2 | 298 | 3735 | 311.3 |
| | 3 | 1.02 | 32.00 | 29.96 | 309.7 | 298 | 4020 | 335.0 |
| | 4 | 1.10 | 32.40 | 30.20 | 337.5 | 351 | 4405 | 367.1 |
| | 5 | 1.19 | 32.74 | 30.36 | 368.0 | 416 | 4835 | 402.9 |
| | 6 | 1.29 | 32.74 | 30.16 | 397.7 | 416 | 5190 | 432.5 |
| | 7 | 1.39 | 32.74 | 29.96 | 427.1 | 416 | 5545 | 462.1 |

*Including Bell and Spigot Bead. Calculated weight of Pipe rounded off to nearest 5 pounds.

Table 2 (continued)

## STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIT CAST PIPE

Dimensions in Inches — Weights in Pounds

| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Ft. | Wt. of Bell | Wt. Based on 12 Ft. Length* | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length | Avg. Per Foot |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 30 | 8 | 1.50 | 33.10 | 30.10 | 464.6 | 557 | 6135 | 511.3 |
| | 9 | 1.62 | 33.46 | 30.22 | 505.6 | 626 | 6695 | 557.9 |
| | 10 | 1.75 | 33.46 | 29.96 | 543.9 | 626 | 7155 | 596.3 |
| 36 | 1 | .97 | 37.96 | 36.02 | 351.7 | 383 | 4610 | 384.2 |
| | 2 | 1.05 | 38.30 | 36.20 | 383.4 | 446 | 5050 | 420.8 |
| | 3 | 1.13 | 38.30 | 36.04 | 411.7 | 446 | 5390 | 449.2 |
| | 4 | 1.22 | 38.70 | 36.26 | 448.2 | 512 | 5895 | 491.3 |
| | 5 | 1.32 | 38.70 | 36.06 | 483.6 | 512 | 6320 | 526.7 |
| | 6 | 1.43 | 39.16 | 36.30 | 528.9 | 586 | 6940 | 578.3 |
| | 7 | 1.54 | 39.16 | 36.08 | 567.9 | 586 | 7405 | 617.1 |
| | 8 | 1.66 | 39.60 | 36.28 | 617.3 | 770 | 8180 | 681.7 |
| | 9 | 1.79 | 39.60 | 36.02 | 663.4 | 770 | 8735 | 727.9 |
| | 10 | 1.93 | 40.04 | 36.18 | 720.9 | 876 | 9530 | 794.2 |
| 42 | 1 | 1.07 | 44.20 | 42.06 | 452.3 | 539 | 5970 | 497.5 |
| | 2 | 1.16 | 44.50 | 42.18 | 492.8 | 586 | 6505 | 542.1 |
| | 3 | 1.25 | 44.50 | 42.00 | 529.9 | 586 | 6950 | 579.2 |
| | 4 | 1.35 | 45.10 | 42.40 | 578.9 | 701 | 7655 | 637.9 |
| | 5 | 1.46 | 45.10 | 42.18 | 624.5 | 701 | 8200 | 683.3 |
| | 6 | 1.58 | 45.58 | 42.42 | 681.4 | 805 | 8990 | 749.2 |
| | 7 | 1.71 | 45.58 | 42.16 | 735.3 | 805 | 9635 | 802.9 |
| 48 | 1 | 1.18 | 50.50 | 48.14 | 570.4 | 660 | 7510 | 625.8 |
| | 2 | 1.27 | 50.50 | 47.96 | 612.8 | 660 | 8020 | 668.3 |
| | 3 | 1.37 | 50.80 | 48.06 | 663.8 | 745 | 8715 | 726.3 |
| | 4 | 1.48 | 51.40 | 48.44 | 724.2 | 900 | 9595 | 799.6 |
| | 5 | 1.60 | 51.40 | 48.20 | 781.0 | 900 | 10280 | 856.7 |
| | 6 | 1.73 | 51.98 | 48.52 | 852.1 | 1046 | 11280 | 940.0 |
| | 7 | 1.87 | 51.98 | 48.24 | 918.5 | 1046 | 12075 | 1006.3 |
| | 8 | 2.02 | 51.98 | 47.94 | 989.2 | 1046 | 12925 | 1077.1 |
| 54 | 1 | 1.30 | 56.66 | 54.06 | 705.4 | 855 | 9325 | 777.1 |
| | 2 | 1.40 | 57.10 | 54.30 | 764.3 | 993 | 10170 | 847.5 |
| | 3 | 1.51 | 57.10 | 54.08 | 822.8 | 993 | 10875 | 906.3 |
| | 4 | 1.63 | 57.80 | 54.54 | 897.4 | 1189 | 11965 | 997.1 |
| | 5 | 1.76 | 57.80 | 54.28 | 966.8 | 1189 | 12800 | 1066.7 |
| | 6 | 1.90 | 58.40 | 54.60 | 1052.2 | 1391 | 14025 | 1168.8 |
| | 7 | 2.05 | 58.40 | 54.30 | 1132.3 | 1391 | 14985 | 1248.8 |
| | 8 | 2.21 | 58.40 | 53.98 | 1217.2 | 1391 | 16005 | 1333.8 |
| 60 | 1 | 1.39 | 62.80 | 60.02 | 836.7 | 1021 | 11070 | 922.5 |
| | 2 | 1.50 | 63.40 | 60.40 | 910.1 | 1145 | 12075 | 1006.3 |
| | 3 | 1.62 | 63.40 | 60.16 | 981.0 | 1145 | 12925 | 1077.1 |
| | 4 | 1.75 | 63.40 | 59.90 | 1057.5 | 1145 | 13845 | 1153.8 |
| | 5 | 1.89 | 64.20 | 60.42 | 1154.3 | 1393 | 15250 | 1270.9 |
| | 6 | 2.04 | 64.20 | 60.12 | 1242.9 | 1393 | 16315 | 1359.6 |
| | 7 | 2.20 | 64.82 | 60.42 | 1350.3 | 1647 | 17800 | 1488.3 |
| | 8 | 2.38 | 64.82 | 60.06 | 1456.6 | 1647 | 19135 | 1594.6 |

NOTE: When pipe is to be cement lined, patterns and cores giving larger outside and inside diameter without change of thickness will be used if ordered.

*Including Bell and Spigot Bead. Calculated weight of Pipe rounded off to nearest 5 pounds.

Table No. 3

## STANDARD THICKNESSES AND WEIGHTS OF CAST IRON PIT CAST PIPE

NOTE: These weights are for pipe laid without blocks, on flat bottom trench, with tamped backfill, under 5 feet of cover. For other conditions see Table 4 hereof and the Manual.

| Size Inches | CLASS 50 50 Lb. Pressure 115 Feet Head | | | CLASS 100 100 Lb. Pressure 231 Feet Head | | | CLASS 150 150 Lb. Pressure 346 Feet Head | | | CLASS 200 200 Lb. Pressure 462 Feet Head | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wt Based on 12 Ft. Lgh.* | | | Wt. Based on 12 Ft. Lgh.* | | | Wt. Based on 12 Ft. Lgh.* | | | Wt. Based on 12 Ft. Lgh.* | |
| | Thickness Inches | Avg. Per Foot | Per Length | Thickness Inches | Avg. Per Foot | Per Length | Thickness Inches | Avg. Per Foot | Per Length | Thickness Inches | Avg. Per Foot | Per Length |
| 3 | .37 | 14.2 | 170 | .37 | 14.2 | 170 | .37 | 14.2 | 170 | .37 | 14.2 | 170 |
| 4 | .40 | 19.2 | 230 | .40 | 19.2 | 230 | .40 | 19.2 | 230 | .40 | 19.2 | 230 |
| 6 | .43 | 30.0 | 360 | .43 | 30.0 | 360 | .43 | 30.0 | 360 | .43 | 30.0 | 360 |
| 8 | .46 | 42.9 | 515 | .46 | 42.9 | 515 | .46 | 42.9 | 515 | .46 | 42.9 | 515 |
| 10 | .50 | 57.1 | 685 | .50 | 57.1 | 685 | .54 | 60.8 | 730 | .58 | 64.6 | 775 |
| 12 | .54 | 73.3 | 880 | .54 | 73.3 | 880 | .58 | 77.9 | 935 | .63 | 83.8 | 1005 |
| 14 | .54 | 85.4 | 1025 | .58 | 91.3 | 1095 | .63 | 100.8 | 1210 | .68 | 107.9 | 1295 |
| 16 | .58 | 105.4 | 1265 | .63 | 113.3 | 1360 | .68 | 125.0 | 1500 | .79 | 142.5 | 1710 |
| 18 | .63 | 127.9 | 1535 | .68 | 136.7 | 1640 | .79 | 161.3 | 1935 | .85 | 172.1 | 2065 |
| 20 | .66 | 148.8 | 1785 | .71 | 158.8 | 1905 | .83 | 188.8 | 2265 | .90 | 202.5 | 2430 |
| 24 | .74 | 198.8 | 2385 | .80 | 212.9 | 2555 | .93 | 252.5 | 3030 | 1.00 | 269.2 | 3230 |
| 30 | .87 | 288.3 | 3460 | .94 | 311.3 | 3735 | 1.10 | 367.1 | 4405 | 1.19 | 402.9 | 4835 |
| 36 | .97 | 384.2 | 4610 | 1.13 | 449.2 | 5390 | 1.22 | 491.3 | 5895 | 1.43 | 578.3 | 6940 |
| 42 | 1.07 | 497.5 | 5970 | 1.16 | 542.1 | 6505 | 1.35 | 637.9 | 7655 | 1.58 | 749.2 | 8990 |
| 48 | 1.18 | 625.8 | 7510 | 1.37 | 726.3 | 8715 | 1.48 | 799.6 | 9595 | 1.73 | 940.0 | 11280 |
| 54 | 1.30 | 777.1 | 9325 | 1.51 | 906.3 | 10875 | 1.63 | 997.1 | 11965 | 1.90 | 1168.8 | 14025 |
| 60 | 1.39 | 922.5 | 11070 | 1.62 | 1077.1 | 12925 | 1.89 | 1270.9 | 15250 | 2.20 | 1488.3 | 17860 |

*Including Bell and Spigot Bead. Calculated weight of Pipe rounded off to nearest 5 pounds.

## Table No. 3 (Continued)

# STANDARD THICKNESSES AND WEIGHTS OF CAST IRON PIT CAST PIPE

NOTE: These weights are for pipe laid without blocks, on flat bottom trench, with tamped backfill, under 5 feet of cover. For other conditions see Table 4 hereof and the Manual.

| Size Inches | CLASS 250 — 250 Lb. Pressure — 577 Feet Head | | | CLASS 300 — 300 Lb. Pressure — 693 Feet Head | | | CLASS 350 — 350 Lb. Pressure — 808 Feet Head | | |
|---|---|---|---|---|---|---|---|---|---|
| | Thickness Inches | Wt. Based on 12 Ft. Lgh.* | | Thickness Inches | Wt. Based on 12 Ft. Lgh.* | | Thickness Inches | Wt. Based on 12 Ft. Lgh.* | |
| | | Avg. Per Foot | Per Length | | Avg. Per Foot | Per Length | | Avg. Per Foot | Per Length |
| 3 | .37 | 14.2 | 170 | .37 | 14.2 | 170 | .37 | 14.2 | 170 |
| 4 | .40 | 19.2 | 230 | .40 | 19.2 | 230 | 40 | 19.2 | 230 |
| 6 | .43 | 30.0 | 360 | .46 | 31.7 | 380 | .50 | 34.2 | 410 |
| 8 | .50 | 45.8 | 550 | .54 | 49.2 | 590 | .58 | 53.8 | 645 |
| 10 | .63 | 72.1 | 865 | .68 | 77.1 | 925 | .73 | 81.7 | 980 |
| 12 | .68 | 92.1 | 1105 | .73 | 97.9 | 1175 | .79 | 105.0 | 1260 |
| 14 | .79 | 123.3 | 1480 | .85 | 131.7 | 1580 | .92 | 148.3 | 1780 |
| 16 | .85 | 152.1 | 1825 | .92 | 162.9 | 1955 | .99 | 181.7 | 2180 |
| 18 | .92 | 184.2 | 2210 | .99 | 196.7 | 2360 | 1.07 | 220.8 | 2650 |
| 20 | .97 | 216.7 | 2600 | 1.05 | 232.1 | 2785 | 1.22 | 277.1 | 3325 |
| 24 | 1.17 | 309.6 | 3715 | 1.26 | 346.2 | 4155 | 1.36 | 370.0 | 4440 |
| 30 | 1.39 | 462.1 | 5545 | 1.50 | 511.3 | 6135 | 1.62 | 557.9 | 6695 |
| 36 | 1.54 | 617.1 | 7405 | 1.79 | 727.9 | 8735 | 1.93 | 794.2 | 9530 |
| 42 | 1.71 | 802.9 | 9635 | | | | | | |
| 48 | 2.02 | 1077.1 | 12925 | | | | | | |
| 54 | 2.21 | 1333.8 | 16005 | | | | | | |
| 60 | 2.38 | 1594.6 | 19135 | | | | | | |

*Including Bell and Spigot Bead. Calculated weight of Pipe rounded off to nearest 5 pounds.

Table No. 4

## STANDARD THICKNESSES OF CAST IRON PIT CAST PIPE

Thickness in Inches. Working Pressure in Pounds per Square Inch.
Thicknesses Include Allowances for Water Hammer,
Foundry Practice and Corrosion

Laying Condition A—Flat Bottom Trench, Without Blocks, Untamped Backfill
Laying Condition B—Flat Bottom Trench, Without Blocks, Tamped Backfill
Laying Condition C—Pipe Laid on Blocks, Untamped Backfill
Laying Condition D—Pipe Laid on Blocks, Tamped Backfill

| Size Inches | Working Pressure | 3½ FEET OF COVER Laying Condition | | | | 5 FEET OF COVER Laying Condition | | | | 8 FEET OF COVER Laying Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| 3 | 50 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .43 | .37 |
| | 100 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .43 | .37 |
| | 150 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .37 | .43 | .37 |
| | 200 | .37 | .37 | .37 | .37 | .37 | .37 | .40 | .37 | .37 | .37 | .43 | .37 |
| | 250 | .37 | .37 | .37 | .37 | .37 | .37 | .40 | .37 | .37 | .37 | .46 | .37 |
| | 300 | .37 | .37 | .37 | .37 | .37 | .37 | .40 | .37 | .37 | .37 | .46 | .37 |
| | 350 | .37 | .37 | .37 | .37 | .37 | .37 | .40 | .37 | .37 | .37 | .46 | .37 |
| 4 | 50 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .50 | .40 |
| | 100 | .40 | .40 | .40 | .40 | .40 | .40 | .43 | .40 | .40 | .40 | .50 | .40 |
| | 150 | .40 | .40 | .40 | .40 | .40 | .40 | .43 | .40 | .40 | .40 | .50 | .40 |
| | 200 | .40 | .40 | .40 | .40 | .40 | .40 | .43 | .40 | .40 | .40 | .50 | .40 |
| | 250 | .40 | .40 | .43 | .40 | .40 | .40 | .46 | .40 | .40 | .40 | .50 | .40 |
| | 300 | .40 | .40 | .43 | .40 | .40 | .40 | .46 | .40 | .40 | .40 | .54 | .40 |
| | 350 | .40 | .40 | .43 | .40 | .40 | .40 | .46 | .40 | .40 | .40 | .54 | .40 |
| 6 | 50 | .43 | .43 | .46 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .58 | .43 |
| | 100 | .43 | .43 | .50 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .58 | .43 |
| | 150 | .43 | .43 | .50 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .58 | .43 |
| | 200 | .43 | .43 | .50 | .43 | .43 | .43 | .54 | .43 | .43 | .43 | .58 | .43 |
| | 250 | .43 | .43 | .50 | .43 | .43 | .43 | .54 | .43 | .46 | .46 | .63 | .46 |
| | 300 | .46 | .43 | .54 | .46 | .46 | .46 | .54 | .46 | .50 | .46 | .63 | .46 |
| | 350 | .50 | .50 | .54 | .50 | .50 | .50 | .58 | .50 | .50 | .50 | .63 | .50 |
| 8 | 50 | .46 | .46 | .54 | .46 | .46 | .46 | .54 | .46 | .46 | .46 | .63 | .46 |
| | 100 | .46 | .46 | .54 | .46 | .46 | .46 | .58 | .46 | .46 | .46 | .63 | .50 |
| | 150 | .46 | .46 | .54 | .46 | .46 | .46 | .58 | .46 | .50 | .50 | .68 | .50 |
| | 200 | .46 | .46 | .58 | .46 | .50 | .46 | .58 | .50 | .54 | .50 | .68 | .54 |
| | 250 | .50 | .50 | .58 | .50 | .54 | .50 | .63 | .54 | .54 | .54 | .68 | .58 |
| | 300 | .54 | .54 | .58 | .54 | .54 | .54 | .63 | .58 | .58 | .58 | .73 | .58 |
| | 350 | .58 | .58 | .63 | .58 | .58 | .58 | .68 | .58 | .63 | .63 | .73 | .63 |
| 10 | 50 | .50 | .50 | .58 | .50 | .50 | .50 | .58 | .50 | .54 | .50 | .68 | .54 |
| | 100 | .50 | .50 | .58 | .50 | .50 | .50 | .63 | .50 | .58 | .54 | .73 | .58 |
| | 150 | .50 | .50 | .58 | .50 | .54 | .54 | .63 | .54 | .58 | .58 | .73 | .58 |
| | 200 | .54 | .54 | .63 | .58 | .58 | .58 | .68 | .58 | .63 | .58 | .79 | .63 |
| | 250 | .58 | .58 | .63 | .58 | .63 | .63 | .68 | .63 | .68 | .63 | .79 | .68 |
| | 300 | .63 | .63 | .68 | .63 | .68 | .68 | .73 | .68 | .68 | .68 | .85 | .73 |
| | 350 | .68 | .68 | .73 | .73 | .73 | .73 | .79 | .73 | .73 | .73 | .85 | .73 |
| 12 | 50 | .54 | .54 | .58 | .54 | .54 | .54 | .63 | .54 | .58 | .58 | .73 | .63 |
| | 100 | .54 | .54 | .63 | .54 | .54 | .54 | .63 | .58 | .63 | .58 | .79 | .63 |
| | 150 | .58 | .54 | .63 | .58 | .58 | .58 | .68 | .63 | .68 | .63 | .79 | .68 |
| | 200 | .63 | .58 | .68 | .63 | .63 | .63 | .73 | .63 | .68 | .68 | .85 | .73 |
| | 250 | .68 | .68 | .73 | .68 | .68 | .68 | .79 | .68 | .73 | .73 | .85 | .73 |
| | 300 | .73 | .73 | .79 | .73 | .73 | .73 | .79 | .79 | .79 | .79 | .92 | .79 |
| | 350 | .79 | .79 | .85 | .79 | .79 | .79 | .85 | .85 | .85 | .85 | .92 | .85 |
| 14 | 50 | .54 | .54 | .63 | .58 | .58 | .54 | .68 | .58 | .68 | .63 | .79 | .68 |
| | 100 | .58 | .54 | .68 | .58 | .63 | .58 | .68 | .63 | .68 | .68 | .85 | .73 |
| | 150 | .63 | .63 | .68 | .63 | .68 | .63 | .73 | .68 | .73 | .73 | .85 | .79 |
| | 200 | .68 | .68 | .73 | .68 | .73 | .68 | .79 | .73 | .79 | .79 | .92 | .79 |
| | 250 | .79 | .73 | .79 | .79 | .79 | .79 | .85 | .79 | .85 | .79 | .92 | .85 |
| | 300 | .85 | .85 | .85 | .85 | .85 | .85 | .92 | .85 | .92 | .85 | .99 | .92 |
| | 350 | .92 | .92 | .92 | .92 | .92 | .92 | .99 | .92 | .99 | .92 | 1.07 | .99 |

Table No. 4—Continued

| Size Inches | Working Pressure | 3½ Feet of Cover — Laying Condition A | B | C | D | 5 Feet of Cover — Laying Condition A | B | C | D | 8 Feet of Cover — Laying Condition A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 50 | .58 | .58 | .68 | .63 | .63 | .58 | .73 | .63 | .73 | .68 | .85 | .73 |
| | 100 | .63 | .58 | .73 | .63 | .68 | .63 | .73 | .68 | .73 | .73 | .85 | .79 |
| | 150 | .68 | .68 | .73 | .68 | .73 | .68 | .79 | .73 | .79 | .79 | .92 | .85 |
| | 200 | .73 | .73 | .79 | .73 | .79 | .79 | .85 | .79 | .85 | .85 | .92 | .85 |
| | 250 | .85 | .79 | .85 | .85 | .85 | .85 | .92 | .85 | .92 | .85 | .99 | .92 |
| | 300 | .92 | .92 | .92 | .92 | .92 | .92 | .99 | .92 | .99 | .92 | 1.07 | .99 |
| | 350 | .99 | .99 | .99 | .99 | .99 | .99 | 1.07 | .99 | 1.07 | 1.07 | 1.16 | 1.07 |
| 18 | 50 | .63 | .63 | .73 | .68 | .68 | .63 | .79 | .68 | .79 | .73 | .85 | .79 |
| | 100 | .68 | .63 | .79 | .68 | .73 | .68 | .79 | .73 | .85 | .79 | .92 | .85 |
| | 150 | .73 | .73 | .79 | .73 | .79 | .79 | .85 | .79 | .85 | .85 | .99 | .92 |
| | 200 | .85 | .79 | .85 | .85 | .85 | .85 | .92 | .85 | .92 | .92 | .99 | .99 |
| | 250 | .92 | .92 | .92 | .92 | .92 | .92 | .99 | .92 | .99 | .99 | 1.07 | 1.07 |
| | 300 | .99 | .99 | .99 | .99 | .99 | .99 | 1.07 | 1.07 | 1.07 | 1.07 | 1.16 | 1.07 |
| | 350 | 1.07 | 1.07 | 1.07 | 1.07 | 1.07 | 1.07 | 1.16 | 1.16 | 1.16 | 1.16 | 1.25 | 1.16 |
| 20 | 50 | .71 | .66 | .77 | .71 | .71 | .66 | .83 | .77 | .83 | .77 | .90 | .83 |
| | 100 | .71 | .66 | .83 | .77 | .77 | .71 | .83 | .83 | .90 | .83 | .97 | .90 |
| | 150 | .77 | .77 | .83 | .83 | .83 | .83 | .90 | .83 | .90 | .90 | 1.05 | .97 |
| | 200 | .90 | .83 | .90 | .90 | .90 | .90 | .97 | .90 | .97 | .97 | 1.05 | 1.05 |
| | 250 | .97 | .97 | .97 | .97 | .97 | .97 | 1.05 | 1.05 | 1.05 | 1.05 | 1.13 | 1.13 |
| | 300 | 1.05 | 1.05 | 1.13 | 1.05 | 1.13 | 1.05 | 1.13 | 1.13 | 1.13 | 1.13 | 1.22 | 1.13 |
| | 350 | 1.22 | 1.13 | 1.22 | 1.22 | 1.22 | 1.22 | 1.22 | 1.22 | 1.22 | 1.22 | 1.32 | 1.22 |
| 24 | 50 | .80 | .74 | .86 | .80 | .80 | .74 | .93 | .86 | .93 | .86 | 1.00 | .93 |
| | 100 | .80 | .74 | .93 | .86 | .86 | .80 | .93 | .86 | 1.00 | .93 | 1.08 | 1.00 |
| | 150 | .86 | .86 | .93 | .86 | .93 | .93 | 1.00 | 1.00 | 1.08 | 1.00 | 1.17 | 1.08 |
| | 200 | 1.00 | 1.00 | 1.00 | 1.00 | 1.08 | 1.00 | 1.08 | 1.08 | 1.17 | 1.08 | 1.17 | 1.17 |
| | 250 | 1.08 | 1.08 | 1.17 | 1.08 | 1.17 | 1.17 | 1.17 | 1.17 | 1.26 | 1.17 | 1.26 | 1.26 |
| | 300 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.36 | 1.26 | 1.36 | 1.36 |
| | 350 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.47 | 1.36 | 1.47 | 1.36 | 1.47 | 1.47 |
| 30 | 50 | .94 | .87 | 1.02 | .94 | .94 | .87 | 1.10 | 1.02 | 1.10 | 1.02 | 1.19 | 1.10 |
| | 100 | 1.02 | .87 | 1.02 | .94 | 1.02 | .94 | 1.10 | 1.02 | 1.19 | 1.10 | 1.29 | 1.19 |
| | 150 | 1.10 | 1.02 | 1.10 | 1.10 | 1.19 | 1.10 | 1.19 | 1.19 | 1.29 | 1.19 | 1.29 | 1.29 |
| | 200 | 1.19 | 1.19 | 1.19 | 1.19 | 1.29 | 1.19 | 1.29 | 1.29 | 1.39 | 1.29 | 1.39 | 1.39 |
| | 250 | 1.39 | 1.29 | 1.39 | 1.39 | 1.39 | 1.39 | 1.39 | 1.39 | 1.50 | 1.39 | 1.50 | 1.50 |
| | 300 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.62 | 1.50 | 1.62 | 1.50 | 1.62 | 1.62 |
| | 350 | 1.62 | 1.62 | 1.62 | 1.62 | 1.75 | 1.62 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| 36 | 50 | 1.05 | .97 | 1.13 | 1.05 | 1.13 | .97 | 1.22 | 1.13 | 1.22 | 1.13 | 1.32 | 1.22 |
| | 100 | 1.13 | .97 | 1.22 | 1.13 | 1.22 | 1.13 | 1.22 | 1.13 | 1.32 | 1.22 | 1.43 | 1.32 |
| | 150 | 1.22 | 1.13 | 1.32 | 1.22 | 1.32 | 1.22 | 1.32 | 1.32 | 1.43 | 1.32 | 1.54 | 1.43 |
| | 200 | 1.43 | 1.32 | 1.43 | 1.32 | 1.43 | 1.43 | 1.54 | 1.43 | 1.54 | 1.43 | 1.66 | 1.54 |
| | 250 | 1.54 | 1.54 | 1.54 | 1.54 | 1.66 | 1.54 | 1.66 | 1.66 | 1.66 | 1.66 | 1.79 | 1.66 |
| | 300 | 1.79 | 1.79 | 1.79 | 1.79 | 1.79 | 1.79 | 1.79 | 1.79 | 1.93 | 1.79 | 1.93 | 1.79 |
| | 350 | 1.93 | 1.93 | 1.93 | 1.93 | 1.93 | 1.93 | 1.93 | 1.93 | 2.08 | 1.93 | 2.08 | 2.08 |
| 42 | 50 | 1.16 | 1.07 | 1.25 | 1.16 | 1.25 | 1.07 | 1.35 | 1.25 | 1.35 | 1.25 | 1.46 | 1.35 |
| | 100 | 1.25 | 1.07 | 1.35 | 1.25 | 1.35 | 1.16 | 1.35 | 1.35 | 1.46 | 1.35 | 1.58 | 1.46 |
| | 150 | 1.35 | 1.35 | 1.46 | 1.35 | 1.46 | 1.35 | 1.58 | 1.46 | 1.58 | 1.46 | 1.71 | 1.58 |
| | 200 | 1.58 | 1.46 | 1.58 | 1.58 | 1.58 | 1.58 | 1.71 | 1.58 | 1.71 | 1.58 | 1.85 | 1.71 |
| | 250 | 1.71 | 1.71 | 1.85 | 1.71 | 1.85 | 1.71 | 1.85 | 1.85 | 1.85 | 1.85 | 2.00 | 1.85 |
| 48 | 50 | 1.27 | 1.18 | 1.37 | 1.27 | 1.37 | 1.18 | 1.48 | 1.37 | 1.60 | 1.37 | 1.60 | 1.48 |
| | 100 | 1.37 | 1.27 | 1.48 | 1.37 | 1.48 | 1.37 | 1.60 | 1.48 | 1.60 | 1.48 | 1.73 | 1.60 |
| | 150 | 1.48 | 1.48 | 1.60 | 1.48 | 1.60 | 1.48 | 1.73 | 1.60 | 1.87 | 1.60 | 1.87 | 1.73 |
| | 200 | 1.73 | 1.73 | 1.73 | 1.73 | 1.87 | 1.73 | 1.87 | 1.87 | 2.02 | 1.87 | 2.02 | 1.87 |
| | 250 | 2.02 | 2.02 | 2.02 | 2.02 | 2.02 | 2.02 | 2.02 | 2.02 | 2.18 | 2.02 | 2.18 | 2.18 |
| 54 | 50 | 1.40 | 1.30 | 1.51 | 1.40 | 1.51 | 1.30 | 1.63 | 1.40 | 1.76 | 1.51 | 1.76 | 1.63 |
| | 100 | 1.51 | 1.40 | 1.63 | 1.51 | 1.63 | 1.51 | 1.76 | 1.63 | 1.90 | 1.63 | 1.90 | 1.76 |
| | 150 | 1.63 | 1.63 | 1.76 | 1.63 | 1.76 | 1.63 | 1.90 | 1.76 | 2.05 | 1.76 | 2.05 | 1.90 |
| | 200 | 1.90 | 1.90 | 1.90 | 1.90 | 2.05 | 1.90 | 2.05 | 2.05 | 2.21 | 2.05 | 2.21 | 2.21 |
| | 250 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 | 2.21 | 2.39 | 2.21 | 2.39 | 2.21 | 2.39 | 2.39 |
| 60 | 50 | 1.50 | 1.39 | 1.62 | 1.50 | 1.62 | 1.39 | 1.75 | 1.62 | 1.89 | 1.62 | 1.89 | 1.75 |
| | 100 | 1.62 | 1.50 | 1.75 | 1.62 | 1.75 | 1.62 | 1.89 | 1.75 | 2.04 | 1.75 | 2.04 | 1.89 |
| | 150 | 1.89 | 1.75 | 1.89 | 1.75 | 2.04 | 1.89 | 2.04 | 1.89 | 2.20 | 2.04 | 2.20 | 2.04 |
| | 200 | 2.20 | 2.04 | 2.20 | 2.04 | 2.20 | 2.20 | 2.20 | 2.20 | 2.38 | 2.20 | 2.38 | 2.38 |
| | 250 | 2.38 | 2.38 | 2.38 | 2.38 | 2.57 | 2.38 | 2.57 | 2.38 | 2.57 | 2.57 | 2.78 | 2.57 |

ASA
A.21.3–1952

American Standard

# SPECIFICATIONS

*for*

# CAST IRON PIT CAST PIPE FOR GAS

Users of this document should make reference to "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe" (ASA A21.1) for complete information concerning the conditions which various thicknesses of pipe are designed to meet. The foreword of the Manual also contains a statement regarding the history of the specifications and references to other related documents.

## SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

ASA
A.21.3–1952

# AMERICAN STANDARD SPECIFICATIONS
for
# CAST IRON PIT CAST PIPE FOR GAS

This specification covers cast iron pit cast pipe for gas. Pit cast pipe are pipe cast vertically with dry sand molds and cores.

**Section 3-1. Description of Pipe.** The pipe shall be made with bell and spigot ends, plain ends or such other type of ends as may be agreed upon at the time of purchase. Pipe with bell and spigot ends shall conform accurately to the dimensions given in Table 3.1. Pipe with other types of ends shall comply with the dimensions agreed upon but in all other respects shall fulfill the specifications hereinafter given. Pipe shall be straight and shall be true circles in section, with their inner and outer surfaces concentric. They shall be at least 12 ft. in nominal laying length, except as provided for cut pipe in Sect. 3-10.

**Section 3-2. Casting of Pipe.** The pipe shall be cast in dry sand molds in a vertical position. Pipe 16 inches or less in diameter shall be cast with the bell end up or down as specified in the proposals. Pipe 20 inches or more in diameter shall be cast with the bell end down. The pipe shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

**Section 3-3. Quality of Iron.**

(3-3.1) All pipes shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the pipe to be cast, that the iron in the pipe shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting and it shall comply with the physical specifications given in Sect. 3-16, 3-17, and 3-18. The metal shall be remelted in a cupola or other suitable furnace.

(3-3.2) The iron in the pipe shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulphur. Samples for chemical analysis shall be taken by drilling completely through from skin to skin each of the acceptance test specimens; but not to exceed three specimens per heat.

**Section 3-4. Quality of Castings.** The pipe shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

**Section 3-5. Foundry Records.**

(3-5.1) *Casting*—A record of the melting and pouring temperatures of the iron shall be furnished the purchaser if requested.

(3-5.2) *Chemical Analyses*—Chemical analyses shall be made by the manufacturer from each heat to determine total carbon, manganese, phosphorus, sulphur and silicon; duplicate copies of test reports shall be furnished the purchaser on request.

**Section 3-6. Marking Pipe.** Every pipe shall have distinctly cast upon it the initials of the maker's name. When cast especially to order, each pipe larger than 4-inch may also have cast upon it figures showing the year in which it was cast and a number signifying the order in point of time in which it was cast, the figures denoting the year being above and the number below, thus:

| | | |
|---|---|---|
| 1950 | 1950 | 1950 |
| 1 | 2 | 3 |

etc., also any initials, not exceeding four, which may be required by the purchaser. The letters and figures shall be cast on the outside and shall have dimensions as indicated below.

| Diameters of Pipe, Inches, Inclusive | Height of Letter, Inches | Relief, Inch |
|---|---|---|
| 4 to 10 | ¾ | $\frac{3}{32}$ |
| 12 to 20 | 1¼ | $\frac{3}{32}$ |
| 24 & larger | 1¾ | ⅛ |

The weight and the class shall be conspicuously painted in white in the inside or outside of each pipe after the coating (if used) has become hard.

**Section 3-7 Inspection by Purchaser.**

(3-7.1) *Definition of Word "Purchaser."* Wherever the word "Purchaser" is used herein it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

(3-7.2) *Power of Purchaser to Inspect.* The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, the pattern work, molding, and casting of the pipe, and the coating (if used). The forms, sizes, uniformity and conditions of all pipe herein referred to shall be subject to his inspection and approval, and he may reject, without subjection to hydrostatic test, any pipe which is not in conformity with the specifications or drawings. Any pipe rejected shall be marked "rejected" and any marks pertaining to the purchaser shall be chipped or erased from such pipe.

(3-7.3) *Manufacturer to Furnish Men and Material.* The manufacturer shall provide all tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the pipe at the foundry.

(3-7.4) *Report of Purchaser's Inspection.* The purchaser shall make written report daily at the foundry office of all pipe rejected, noting causes for rejection.

**Section 3-8. Inspection and Certification by Manufacturer.** Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made as specified, this statement to contain the results of all specified tests.

**Section 3-9. Pipe to be Delivered Sound.** All the pipe must be delivered in all respects sound and comformable to these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this respect, and any defective pipe which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for pipe found to be cracked after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the pipe not to injure the coating (if used) and no pipe or other material of any kind shall be placed in the pipe during transportation.

**Section 3-10. Cut Pipe.** Defective spigot ends on pipe may be cut off in a manner which will produce a square end. Cut pipe shall be shipped with plain ends or shall have an iron or steel band shrunk into a groove or welded securely on the pipe, as may be agreed upon at time of purchase. Not more than 8 per cent of the total number of pipe of each size shall be cut, and no cut pipe shall be furnished which is less than 11 ft. 0 in. in laying length, unless it has been used by purchaser's order for strip and ring tests in which case a length of not less than 10 ft. 0 in. shall be accepted.

**Section 3-11. Tolerances or Maximum Permitted Variations from Standard.**

(3-11.1) *Tolerances in Diameter of Pipe and Sockets.* Outside diameters of pipe barrels and spigot beads and diameters of sockets shall be kept as nearly as practicable to the specified dimensions. They shall be tested with circular gauges. Tolerances or maximum permitted variations from standard dimensions are listed below.

| Nominal Diameter in Inches | Tolerance, Plus or Minus in Inches |
|---|---|
| 4 to 16 | .06 |
| 20 & 24 | .08 |
| 30, 36 & 42 | .10 |
| 48 | .12 |
| 54 | .15 |
| 60 | .15 |

(3-11.2) *Tolerances in Thickness.* The tolerances, or maximum permitted variations from standard in thickness of pipe and in dimensions of bells are listed below:

| Nominal Diameter in Inches, inclusive | Tolerance, Plus or Minus, in Inches |
|---|---|
| 4 to 8 | .07 |
| 10 to 24 | .08 |
| 30 to 60 | .10 |

*NOTE:* In pipe barrel thickness, tolerances .02 inch greater than those listed above shall be permissible over areas not exceeding 8 inches in length in any direction.

(3-11.3) *Allowable Percentage of Variation in Weight.* The weight of no single pipe shall be less than the nominal tabulated weight by more than 5% for pipe 16 inches or less in diameter, and 4% for pipe more than 16 inches in diameter. The total excess weight to be paid for on orders of 25 tons or more shall not exceed 2% of the nominal weight, and on orders less than 25 tons shall not exceed 5% of the nominal weight. An order is hereby defined as including all the pipe ordered under the terms of a specific contract or purchase order or a single order placed under the terms of a standing contract.

**Section 3-12. Cleaning and Inspecting.** All pipe shall have gates, fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful surface inspection, a hammer test, and a rolling test, before the coating (if used) is applied.

**Section 3-13. Hydrostatic Test.** Each pipe shall be subjected to a hydrostatic proof test.

The pipe shall be under the test pressure for at least one-half minute, and while under pressure shall be subjected to a hammer or shock test. Any pipe showing defects by leaking, sweating, or otherwise, shall be rejected. The test pressures shall be in accordance with the table on the following page.

**Section 3-14. Weighing.** Each length of pipe shall be weighed and the weight and class plainly marked on the outside or inside of the bell or spigot end. Unless otherwise stated in the contract, a ton shall be 2,000 lb. avoirdupois.

**Section 3-15. Exterior Coatings.** Coating (if used) which is to be applied to the pipe, shall be specified in the agreement made at time of purchase.

**Section 3-16. Tests of Material.** The acceptability of iron used in cast iron pipe as regards physical characteristics shall be determined by the testing of bars cast from the same iron as the pipe, or, if specified by the purchaser, by the testing of Talbot strips and/or rings cut from the pipe as described in Sect. 3-18. Such strip and/or ring tests shall be paid for by the purchaser at prices to be agreed upon. By special arrangement bursting tests of pipe may be made as provided in Sect. 3-19. In any case the test bars shall be made and tested and results given to the purchaser if requested. The smallest pipe on which ring tests may be required is the 6-inch. The observations and the computed results hereinafter required shall be recorded and if requested reported to the purchaser.

TABLE OF PRESSURES FOR HYDROSTATIC TESTS

| Nominal Diameter of Pipe, Inches | Barrel Thickness, Inches From | To | Test Pressures, Lb. per sq.in. |
|---|---|---|---|
| 4 to 12 | All Thicknesses | | 400 |
| 16 | .58 | .75 | 300 |
| 16 | .76 | .95 | 350 |
| 20 | .66 | .85 | 250 |
| 20 | .86 | 1.05 | 350 |
| 24 | .74 | .90 | 200 |
| 24 | .91 | 1.00 | 300 |
| 24 | 1.01 | 1.17 | 400 |
| 30 | .87 | 1.05 | 200 |
| 30 | 1.06 | 1.30 | 300 |
| 30 | 1.31 | 1.39 | 400 |
| 36 | .97 | 1.15 | 200 |
| 36 | 1.16 | 1.45 | 300 |
| 36 | 1.46 | 1.54 | 350 |
| 42 | 1.07 | 1.35 | 200 |
| 42 | 1.36 | 1.60 | 300 |
| 42 | 1.61 | 1.71 | 350 |
| 48 | 1.18 | 1.50 | 200 |
| 48 | 1.51 | 1.90 | 300 |

*Note:* Unless otherwise arranged between the manufacturer and the purchaser, pipe thicker than those listed in the above table shall be tested at the highest pressures listed for the given diameter.

**Section 3-17. Test Bars.**

(3-17.1) *Dimensions.* Test bars shall be 2 inches wide, 1 inch thick, and not less than 26 inches long. Individual test bars may vary as much as 2 per cent from standard width, or standard thickness, or both, but the patterns and molding practice shall be such that the errors shall in general not exceed 1 per cent.

(3-17.2) *Methods of Casting.* The bars shall be cast vertically in well-faced, dry sand molds provided with suitable pouring basin and mounted on a suitable refractory foundation. Metal for the bars shall be obtained by using a small heated ladle taking its metal from the main ladle from which the pipe is to be poured and after all alloys and other additional metal, except cast iron pipe for cooling, have been added to the main ladle and become melted. The bars shall not be removed from the mold before they have cooled to 500°F.

(3-17.3) *When Cast and to What Pipe Applicable.* Except as hereinafter provided for special cases, one pair of test bars of the metal used shall be cast with iron from the first ladle, another pair with iron from the approximately middle ladle, and a third pair with iron from the last ladle of iron taken during a day's run or heat from the cupola in which the iron for the pipe is melted. If the heat lasts for more than 6 hours, then additional pairs of bars shall be cast at approximately uniform intervals so as to give an extra pair of bars for each 3 hours during which the heat lasts in excess of 6 hours. In case the charging of the cupola is to be changed one or more times during the day's run or heat in order to produce a different iron, the time of taking test bars shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality; and in case such period exceeds four hours additional pairs of bars shall be taken at such times as will provide a pair of bars for each two hours during which this special mixture is used. At least one bar from each pair shall be broken, but the manufacturer shall have the right to break both bars in which case the better bar shall be taken as representative. Bars showing flaws in fracture may be disregarded.

(3-17.4) *Test Bar Requirements to Indicate Acceptable Iron; Retests may be made at Contractor's Option using Talbot Strips and/or Rings.* In order that the iron shall be acceptable the average results from the single bars representing the respective pair of bars cast during the heat or period shall comply with the requirements hereinafter specified and, in addition, no representative bar shall be more than 5 percent below the minimum requirements in either corrected breaking load or corrected deflection. In case the test bars do not measure up to these requirements the manufacturer may make one or more Talbot strip tests and/or ring tests of specimens cut from such of the pipe as may be agreed upon as best representing the iron at the time when the deficient test bars were cast. In the absence of the purchaser the manufacturer may select the pipe from which rings and/or strips shall be cut. The results from these rings and/or strips shall be kept as a foundry record available to any purchaser who requires a report of tests on the 2-inch by 1-inch bars. Any Talbot strip tests or ring tests made under this provision shall be at the expense of the manufacturer. If these supplementary Talbot strip tests and/or ring tests do not meet the requirements, the pipe cast in that heat or period, or such a part thereof as may be agreed to by the purchaser, shall be rejected.

(3-17.5) *Method of Testing.* The bars shall be broken as beams by placing them flatwise on supports 24 inches apart and applying the load at the center of the span. The breaking load and the corresponding deflection shall be observed and recorded.

(3-17.6) *Correcting Observed Breaking Loads and Deflections.* The bars shall be measured at the point of application of the load and the results corrected to standard 2 inch by 1 inch cross section by the conventional beam formula as follows:

Corrected breaking load = observed breaking load multiplied by $\frac{2}{bd^2}$

Corrected deflection at breaking = observed deflection at breaking multiplied by $d$

where $b$ = measured width and
$d$ = measured depth
of the bar at point of application of load

In the formula above the deflection and all dimensions are in inches.

(3-17.7) *Requirements as to Strength and Deflection of 2 inch by 1 inch Bars.* In order to indicate acceptable metal, the corrected breaking loads and deflections of the representative 2 inch by 1 inch test bars for a given heat or period interpreted as provided in paragraph 3-17.4 above, shall comply with such of the following tabulated requirements as pertain to the thickness range within which fall the particular pipes which are under consideration.

TABLE OF MINIMUM CORRECTED BREAKING LOADS & DEFLECTIONS

| Metal Thickness of Pipe, Inches | Minimum Center Breaking Load, Pounds | Minimum Center Deflection at Breaking, Inch |
|---|---|---|
| Below .61 | 1900 | .30 + .0001 (Breaking Load — 1900) |
| .61 to .90 | 2000 | .30 + .0001 (Breaking Load — 2000) |
| .91 to 1.60 | 2200 | .30 + .0001 (Breaking Load — 2200) |
| 1.61 to 2.50 | 2300 | .30 + .0001 (Breaking Load — 2300) |

*Note:* For thicknesses exceeding 2.50 inches the form of test specimen and the test requirements shall be as agreed upon in the purchase contract.

**Section 3-18. Talbot Strip Tests and Ring Tests.**

(3-18.1) *Dimensions.* Rings shall have a length equal to half the nominal diameter of the pipe unless the diameter exceeds 24 inches, in which case the length of ring shall be 12 inches. Strips shall be not less than 11 inches long and for 24-inch and larger pipe may be cut from the least stressed portions of rings (see Sect. 3-18.4) after the rings have been broken. The end 2 inches of the pipe shall not be included in ring or strip.

> Note: To make both ring and strip tests on a pipe will therefore require at the least (on 6 inch pipe) 16 inches of pipe, at the most (on 20 inch pipe) 23 inches of pipe, and on pipe larger than 20 inches, 14 inches of pipe.

(3-18.2) *Method of Sampling.* The purchaser who has expressly specified Talbot strip tests and/or ring tests as acceptance tests of the pipe may select at random from each run, or heat, one or more pipe from which test specimens are to be cut. In the absence of the purchaser or his representative, the pipe from which test specimens are to be taken may be selected by the manufacturer. If the purchaser should wish to test the uniformity of a run or heat, he may divide it into two or more periods and have a separate set of acceptance tests for pipe in each period.

(3-18.3) *Defective Specimens; Retests.* If any test specimen shows defective machining or obvious lack of continuity of metal, it shall be discarded and replaced by another specimen selected by the purchaser. If the test specimens first selected fail to meet the requirements specified hereinafter and the purchaser permits a retest, at least twice the number of specimens that failed shall be selected by the purchaser for retest from a pipe cast in the same run or period. In case a ring from a pipe 24 inches in diameter or larger fails to meet specifications, the purchaser may accept strip tests, two specimens to be cut from the failed ring at points of low stress as described in Sect. 3-18.4. In any case of retest the pipe cast during the run or period shall be acceptable only when all retest specimens meet the requirements. All retests shall be made at the expense of the manufacturer.

(3-18.4) *Talbot Strip Tests.* Two Talbot strips shall be machined longitudinally from each pipe selected by the purchaser for testing by this method. If ring tests are also made and the pipe are 24 inches or larger these Talbot strips may be cut from a part of the ring little stressed in the ring test, i.e., near one of the elements marked (a) in

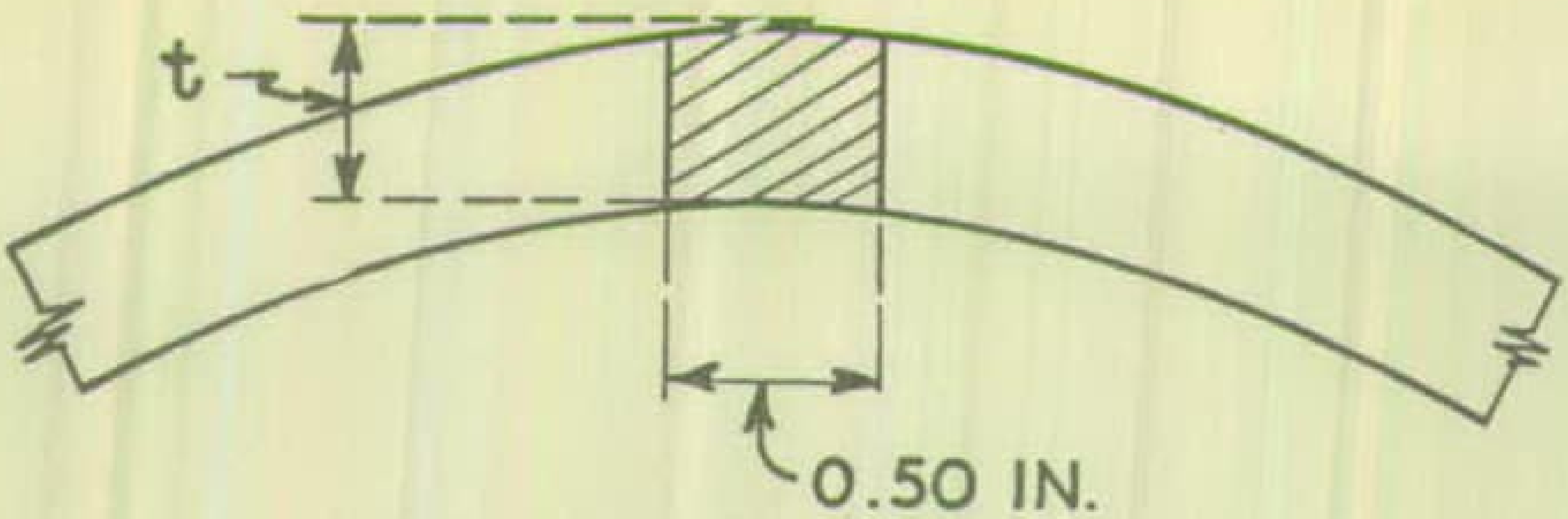



FIG. 3.1. Position from which Talbot Strip Is Cut

Fig. 3.2. (See Sect. 3-18.5.) The strips in any case will be in cross section as indicated in Fig. 3.1, i.e., will have for their width the thickness of the pipe and for their thickness 0.50 inch. Their length will be the length of the ring, 12 inches; or, if not cut from a ring, at least 11 inches. These strips shall be tested as a beam on supports 10 inches apart with loads applied perpendicularly to the machined faces at two points 3⅓ inches from the supports. The breaking load and the corresponding deflection shall be observed and recorded.

The strip shall be accurately calipered at point of rupture and the modulus of rupture, $R$, shall be calculated by the usual beam formula which for this case reduces to the expression:

$$R = \frac{10W}{td^2}$$

The secant modulus of elasticity, $E_s$, in lb. per sq.in. shall be computed by the formula:

$$E_s = \frac{213W}{td^3y} = \frac{21.3R}{dy}$$

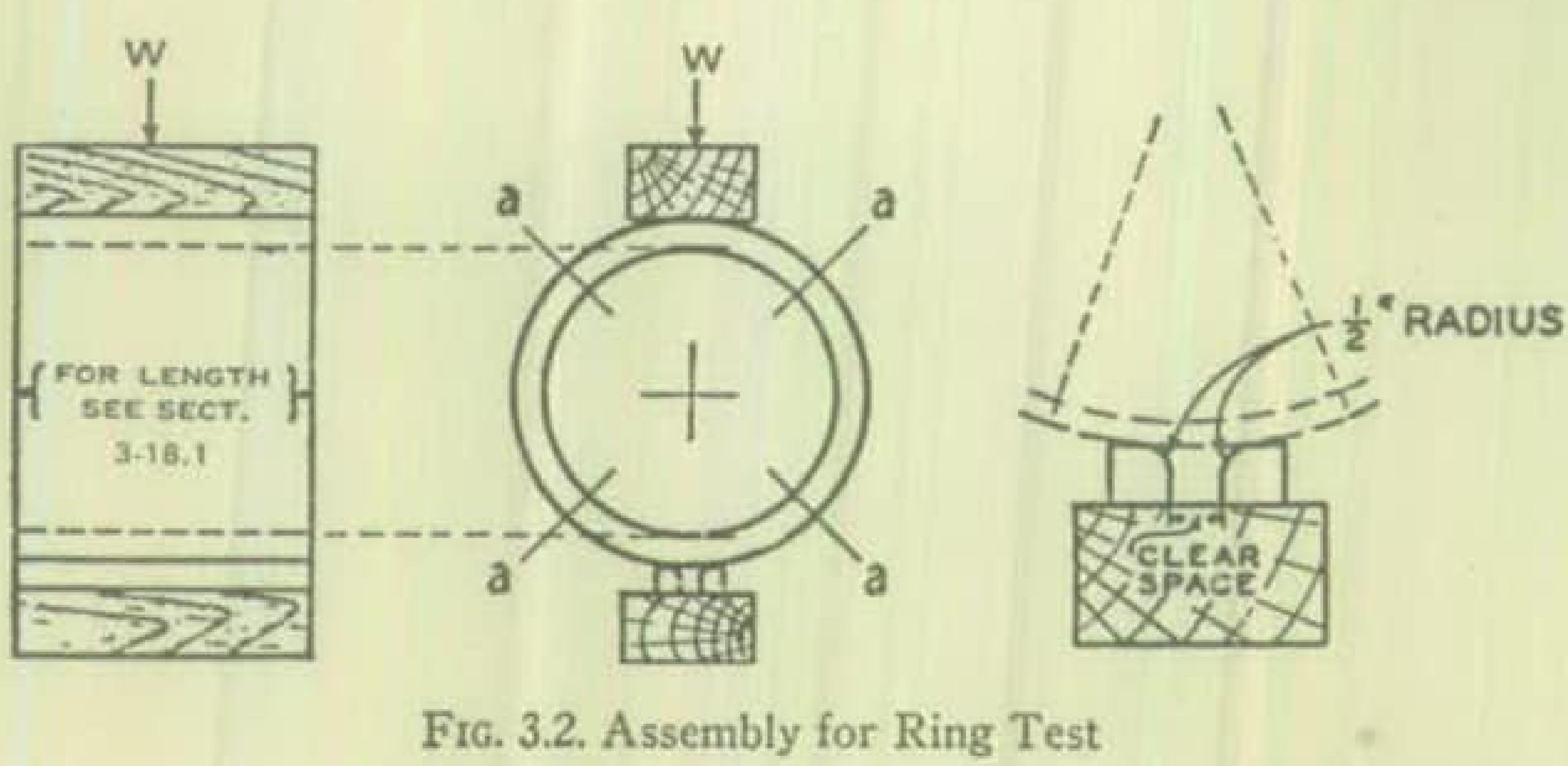



FIG. 3.2. Assembly for Ring Test

where $R$ = modulus of rupture, lb. per sq.in.
$E_s$ = secant modulus of elasticity, lb. per sq.in.
$W$ = breaking load, lb.
$d$ = depth of strip in inches (intended to be 0.50 in.)
$t$ = width of strip, inches (pipe thickness)
$y$ = deflection of strip at center at breaking load, inches.

To be acceptable a Talbot strip shall have the modulus of rupture, $R$, not less than 30,000 lb. per sq.in. and the secant modulus of elasticity, $E_s$, not more than 10,000,000 lb. per sq.in. If the results from either strip are up to the specifications the test shall be regarded as satisfactory.

(3-18.5) *Ring Tests.* Each ring shall be tested by the three-edge-bearing method as indicated in Fig. 3.2. The lower bearing for the ring shall consist of two strips with vertical sides having their interior top corners rounded to a radius of approximately ½ inch. The strips shall be of hard wood or of metal. If of metal a piece of leather belting about 3/16 inch thick shall be laid over them. They shall be straight and shall be securely fastened to a rigid block with their interior vertical faces spaced at a distance apart as given in the following table:

| Diam. of Pipe | Clear Space |
|---|---|
| 12-inch and smaller | ½ inch |
| 16-inch to 24-inch inclusive | 1 inch |
| 30-inch and larger | 2 inch |

The upper bearing shall be a rigid wooden block, straight and true from end to end. The upper and lower bearings shall extend the full length of the outside of the ring. The ring shall be placed symmetrically between the two bearings, and the center of application of the load shall be so placed that the vertical deformations at the two ends of the ring shall be equal. If the ring is not uniform in thickness, it shall be so placed that the thick and thin portions are near the ends of the horizontal diameter. A record of the breaking load and the corresponding vertical deformation of each ring tested shall be made. In order to be acceptable the modulus of rupture computed from the formula

$$R = 0.954 \frac{W(d+t)}{bt^2}$$

shall be not less than 31,000 lb. per sq. in., and the secant modulus of elasticity computed from the formula which follows on page 116.

$$E_s = \frac{0.225\,W(d+t)^3}{bt^3y} = \frac{0.236\,R(d+t)^2}{ty}$$

shall not exceed 15,000,000 lb. per sq.in.

$b$ = length of ring, inches
$d$ = average inside diameter of ring, inches
$t$ = average thickness of metal along line of fracture, inches
$y$ = maximum vertical deflection of ring, inches
$W$ = breaking load, in lb.
$R$ = modulus of rupture, lb. per sq.in.
$E_s$ = secant modulus of elasticity, lb. per sq.in.

The modulus of elasticity shall not be determined in rings from pipe less than 12 inches in diameter.

**Section 3-19. Full-Length Bursting Tests.**

By special arrangement between purchaser and manufacturer, the bursting tensile strength shall be determined by testing full length pipe (less amount cut off for ring and strip test specimens, see Section 3-18.1 and 3-18.2) to destruction by hydraulic pressure. Bells may be removed to facilitate testing. A suitable means for holding the end thrust shall be used which will not subject the pipe to endwise tension or compression, or other parasitic stresses. A calibrated pressure gauge shall be used for determining the bursting pressure. This gauge shall be connected to the interior of the test pipe by a separate connection from that which supplies water for the test. Unit tensile strength in bursting shall be obtained by the use of the formula:

$$S = \frac{Pd}{2t}$$

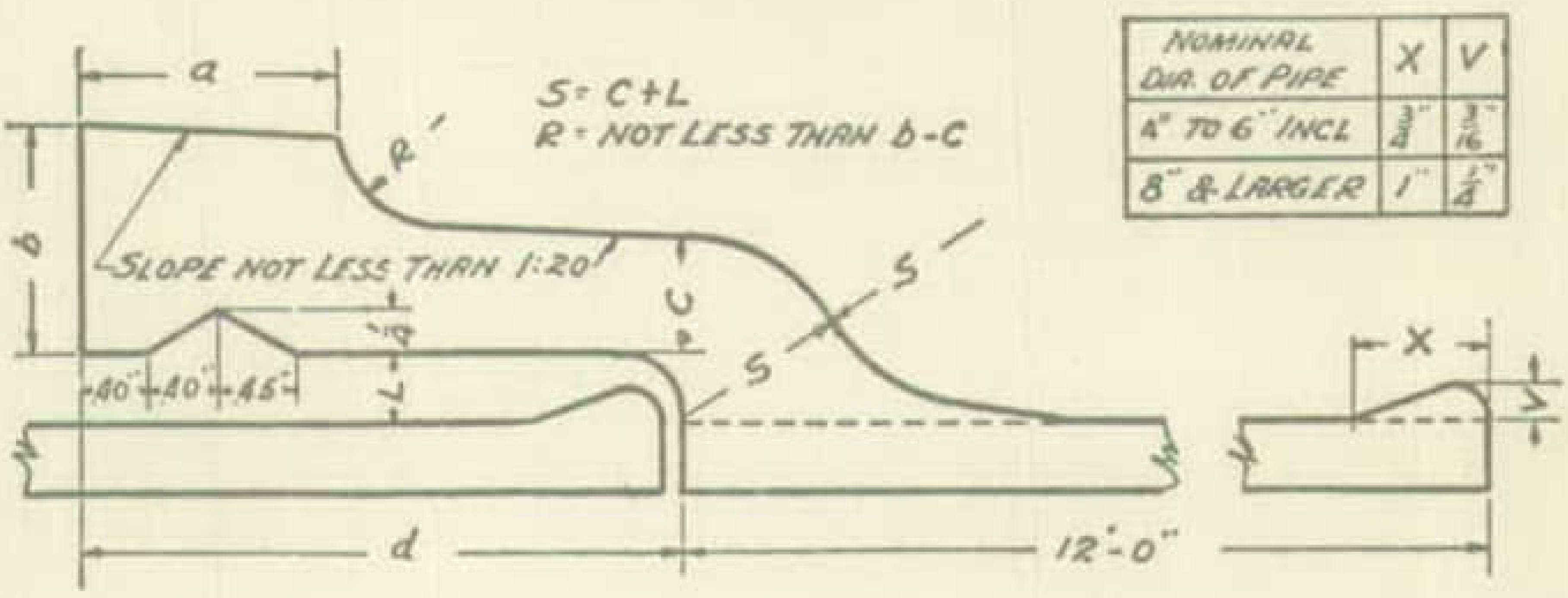
Where: $S$ = bursting tensile strength of the iron, lbs. per sq.in.
$P$ = internal pressure at bursting, lbs. per sq.in.
$d$ = average inside diameter of pipe, inches
$t$ = minimum average thickness of the pipe along the principal line of break, inches

Measurements of thickness shall be taken along the principal line of break at one foot intervals.

The minimum average thickness along the principal line of break shall be obtained by averaging the measurements at the thinnest section at a weight of two and at the adjacent sections on each side at a weight of one each or if the thinnest section is at the end of the break, by averaging this thinnest section measurement at a weight of two and the measurements of the adjacent section and the next section at a weight of one each.

## Table No. 3.1

### STANDARD DIMENSIONS OF BELLS, SOCKETS, SPIGOT BEADS and OUTSIDE DIAMETERS of PIT CAST PIPE FOR GAS also WEIGHTS OF BELLS AND OF SPIGOT BEADS




| Nominal Diam. | Thickness of Pipe From | Thickness of Pipe To | Outside Diam. of Pipe | Dimensions of Bells: Diam. of Socket | Thickness of Joint L | Depth of Socket d | a | b | c | Wt. of Bell | Wt. of Spigot Bead |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | .40 | .50 | 4.80 | 5.80 | 0.50 | 3.50 | 1.50 | 1.30 | .65 | 25.0 | 0.3 |
| 6 | .43 | .58 | 6.90 | 7.90 | 0.50 | 3.50 | 1.50 | 1.40 | .70 | 35.0 | 0.5 |
| 8 | .46 | .63 | 9.05 | 10.05 | 0.50 | 4.00 | 1.50 | 1.53 | .78 | 52.0 | 1.1 |
| 10 | .50 | .60 | 11.10 | 12.10 | 0.50 | 4.00 | 1.50 | 1.50 | .69 | 58.0 | 1.4 |
| | .61 | .68 | 11.10 | 12.10 | 0.50 | 4.00 | 1.50 | 1.65 | .85 | 69.0 | 1.4 |
| 12 | .54 | .65 | 13.20 | 14.20 | 0.50 | 4.00 | 1.50 | 1.50 | .70 | 66.0 | 1.6 |
| | .66 | .79 | 13.20 | 14.20 | 0.50 | 4.00 | 1.50 | 1.75 | .90 | 84.0 | 1.6 |
| 16 | .58 | .67 | 17.40 | 18.66 | 0.63 | 4.00 | 1.75 | 1.67 | .77 | 106.0 | 2.1 |
| | .68 | .85 | 17.40 | 18.66 | 0.63 | 4.00 | 1.75 | 1.90 | 1.00 | 128.0 | 2.1 |
| 20 | .66 | .82 | 21.60 | 22.86 | 0.63 | 4.00 | 1.75 | 1.87 | 0.87 | 146.0 | 2.6 |
| | .83 | .97 | 21.60 | 22.86 | 0.63 | 4.00 | 1.75 | 2.30 | 1.15 | 196.0 | 2.6 |
| 24 | .74 | .85 | 25.80 | 27.06 | 0.63 | 4.00 | 2.00 | 1.97 | 0.92 | 188.0 | 3.2 |
| | .86 | 1.00 | 25.80 | 27.06 | 0.63 | 4.00 | 2.00 | 2.50 | 1.25 | 265.0 | 3.2 |
| 30 | .87 | 1.01 | 31.74 | 33.00 | 0.63 | 4.50 | 2.00 | 2.30 | 1.15 | 309.0 | 3.9 |
| | 1.02 | 1.19 | 31.74 | 33.00 | 0.63 | 4.50 | 2.00 | 2.60 | 1.32 | 376.0 | 3.9 |
| 36 | .97 | 1.12 | 37.96 | 39.22 | 0.63 | 4.50 | 2.00 | 2.50 | 1.25 | 419.0 | 4.6 |
| | 1.13 | 1.32 | 37.96 | 39.22 | 0.63 | 4.50 | 2.00 | 2.80 | 1.44 | 459.0 | 4.6 |
| 42 | 1.07 | 1.30 | 44.20 | 45.46 | 0.63 | 5.00 | 2.00 | 2.80 | 1.40 | 538.0 | 5.4 |
| | 1.31 | 1.46 | 44.20 | 45.46 | 0.63 | 5.00 | 2.00 | 3.02 | 1.52 | 609.0 | 5.4 |
| 48 | 1.18 | 1.30 | 50.50 | 51.76 | 0.63 | 5.00 | 2.00 | 3.00 | 1.50 | 657.0 | 6.1 |
| | 1.31 | 1.50 | 50.50 | 51.76 | 0.63 | 5.00 | 2.00 | 3.32 | 1.67 | 774.0 | 6.1 |
| | 1.51 | 1.60 | 50.50 | 51.76 | 0.63 | 5.00 | 2.00 | 3.80 | 1.95 | 890.0 | 6.1 |

All dimensions given in inches. All weights given in pounds.

## Table No. 3.2

### STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIT CAST PIPE FOR GAS

Dimensions in Inches — Weights in Pounds

| | | | | | | | | Wt. Based on 12 Ft. Length* | |
|---|---|---|---|---|---|---|---|---|---|
| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Ft. | Wt. of Bead | Wt. of Bell | Per Length | Avg. Per Ft. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4 | 1 | .40 | 4.80 | 4.00 | 17.3 | 0.3 | 25.0 | 235 | 19.6 |
| | 2 | .43 | 4.80 | 3.94 | 18.4 | 0.3 | 25.0 | 245 | 20.4 |
| | 3 | .46 | 4.80 | 3.88 | 19.6 | 0.3 | 25.0 | 260 | 21.7 |
| | 4 | .50 | 4.80 | 3.80 | 21.1 | 0.3 | 25.0 | 280 | 23.3 |
| 6 | 1 | .43 | 6.90 | 6.04 | 27.3 | 0.5 | 35.0 | 365 | 30.4 |
| | 2 | .46 | 6.90 | 5.98 | 29.0 | 0.5 | 35.0 | 385 | 32.1 |
| | 3 | .50 | 6.90 | 5.90 | 31.4 | 0.5 | 35.0 | 410 | 34.2 |
| | 4 | .54 | 6.90 | 5.82 | 33.7 | 0.5 | 35.0 | 440 | 36.7 |
| | 5 | .58 | 6.90 | 5.74 | 35.9 | 0.5 | 35.0 | 465 | 38.8 |
| 8 | 1 | .46 | 9.05 | 8.13 | 38.7 | 1.1 | 52.0 | 520 | 43.3 |
| | 2 | .50 | 9.05 | 8.05 | 41.9 | 1.1 | 52.0 | 555 | 46.2 |
| | 3 | .54 | 9.05 | 7.97 | 45.0 | 1.1 | 52.0 | 595 | 49.6 |
| | 4 | .58 | 9.05 | 7.89 | 48.2 | 1.1 | 52.0 | 630 | 52.5 |
| | 5 | .63 | 9.05 | 7.79 | 52.0 | 1.1 | 52.0 | 675 | 56.2 |
| 10 | 1 | .50 | 11.10 | 10.10 | 52.0 | 1.4 | 58.0 | 685 | 57.1 |
| | 2 | .54 | 11.10 | 10.02 | 55.9 | 1.4 | 58.0 | 730 | 60.8 |
| | 3 | .58 | 11.10 | 9.94 | 59.8 | 1.4 | 58.0 | 775 | 64.6 |
| | 4 | .63 | 11.10 | 9.84 | 64.7 | 1.4 | 69.0 | 845 | 70.4 |
| | 5 | .68 | 11.10 | 9.74 | 69.5 | 1.4 | 69.0 | 905 | 75.4 |
| 12 | 1 | .54 | 13.20 | 12.12 | 67.0 | 1.6 | 66.0 | 870 | 72.5 |
| | 2 | .58 | 13.20 | 12.04 | 71.8 | 1.6 | 66.0 | 930 | 77.5 |
| | 3 | .63 | 13.20 | 11.94 | 77.6 | 1.6 | 66.0 | 1000 | 83.3 |
| | 4 | .68 | 13.20 | 11.84 | 83.4 | 1.6 | 84.0 | 1085 | 90.4 |
| | 5 | .73 | 13.20 | 11.74 | 89.2 | 1.6 | 84.0 | 1155 | 96.2 |
| | 6 | .79 | 13.20 | 11.62 | 96.1 | 1.6 | 84.0 | 1240 | 103.3 |
| 16 | 1 | .58 | 17.40 | 16.24 | 95.6 | 2.1 | 106.0 | 1255 | 104.6 |
| | 2 | .63 | 17.40 | 16.14 | 103.6 | 2.1 | 106.0 | 1350 | 112.5 |
| | 3 | .68 | 17.40 | 16.04 | 111.4 | 2.1 | 128.0 | 1465 | 122.1 |
| | 4 | .73 | 17.40 | 15.94 | 119.3 | 2.1 | 128.0 | 1560 | 130.0 |
| | 5 | .79 | 17.40 | 15.82 | 128.6 | 2.1 | 128.0 | 1675 | 139.6 |
| | 6 | .85 | 17.40 | 15.70 | 137.9 | 2.1 | 128.0 | 1785 | 148.8 |
| 20 | 1 | .66 | 21.60 | 20.28 | 135.5 | 2.6 | 146.0 | 1775 | 147.9 |
| | 2 | .71 | 21.60 | 20.18 | 145.4 | 2.6 | 146.0 | 1895 | 157.9 |
| | 3 | .77 | 21.60 | 20.06 | 157.2 | 2.6 | 146.0 | 2035 | 169.6 |
| | 4 | .83 | 21.60 | 19.94 | 169.0 | 2.6 | 196.0 | 2225 | 185.4 |
| | 5 | .90 | 21.60 | 19.80 | 182.6 | 2.6 | 196.0 | 2390 | 199.2 |
| | 6 | .97 | 21.60 | 19.66 | 196.1 | 2.6 | 196.0 | 2550 | 212.5 |
| 24 | 1 | .74 | 25.80 | 24.32 | 181.8 | 3.2 | 188.0 | 2375 | 197.9 |
| | 2 | .80 | 25.80 | 24.20 | 196.0 | 3.2 | 188.0 | 2545 | 212.1 |
| | 3 | .86 | 25.80 | 24.08 | 210.2 | 3.2 | 265.0 | 2790 | 232.5 |
| | 4 | .93 | 25.80 | 23.94 | 226.7 | 3.2 | 265.0 | 2990 | 249.2 |
| | 5 | 1.00 | 25.80 | 23.80 | 243.1 | 3.2 | 265.0 | 3185 | 265.4 |
| 30 | 1 | .87 | 31.74 | 30.00 | 263.3 | 3.9 | 309.0 | 3470 | 289.2 |
| | 2 | .94 | 31.74 | 29.86 | 283.8 | 3.9 | 309.0 | 3720 | 310.0 |
| | 3 | 1.02 | 31.74 | 29.70 | 307.1 | 3.9 | 376.0 | 4065 | 338.8 |
| | 4 | 1.10 | 31.74 | 29.54 | 330.4 | 3.9 | 376.0 | 4345 | 362.1 |
| | 5 | 1.19 | 31.74 | 29.36 | 356.3 | 3.9 | 376.0 | 4655 | 387.9 |
| 36 | 1 | .97 | 37.96 | 36.02 | 351.7 | 4.6 | 419.0 | 4645 | 387.1 |
| | 2 | 1.05 | 37.96 | 35.86 | 379.9 | 4.6 | 419.0 | 4980 | 415.0 |
| | 3 | 1.13 | 37.96 | 35.70 | 407.9 | 4.6 | 459.0 | 5360 | 446.7 |
| | 4 | 1.22 | 37.96 | 35.52 | 439.3 | 4.6 | 459.0 | 5735 | 477.9 |
| | 5 | 1.32 | 37.96 | 35.32 | 474.1 | 4.6 | 459.0 | 6155 | 512.9 |
| 42 | 1 | 1.07 | 44.20 | 42.06 | 452.3 | 5.4 | 538.0 | 5970 | 497.5 |
| | 2 | 1.16 | 44.20 | 41.88 | 489.4 | 5.4 | 538.0 | 6415 | 534.6 |
| | 3 | 1.25 | 44.20 | 41.70 | 526.2 | 5.4 | 538.0 | 6860 | 571.7 |
| | 4 | 1.35 | 44.20 | 41.50 | 567.0 | 5.4 | 609.0 | 7420 | 618.3 |
| | 5 | 1.46 | 44.20 | 41.28 | 611.6 | 5.4 | 609.0 | 7955 | 662.9 |
| 48 | 1 | 1.18 | 50.50 | 48.14 | 570.4 | 6.1 | 657.0 | 7510 | 625.8 |
| | 2 | 1.27 | 50.50 | 47.96 | 612.8 | 6.1 | 657.0 | 8015 | 667.9 |
| | 5 | 1.37 | 50.50 | 47.76 | 659.7 | 6.1 | 774.0 | 8695 | 724.6 |
| | 4 | 1.48 | 50.50 | 47.54 | 711.1 | 6.1 | 774.0 | 9315 | 776.2 |
| | 5 | 1.60 | 50.50 | 47.30 | 766.9 | 6.1 | 890.0 | 10100 | 841.7 |

*Includes Bell and Spigot Bead. Calculated weight of pipe rounded off to nearest 5 pounds.

## Table No. 3.3

### STANDARD THICKNESSES AND WEIGHTS OF CAST IRON PIT CAST PIPE FOR GAS

NOTE: These weights are for pipe laid without blocks, on flat bottom trench, with tamped backfill, under 5 feet of cover. For other conditions see Table 3.2 and 3.4 hereof and the Manual.

| Size Inches | CLASS 10 10 Lb. Pressure | | | CLASS 50 50 Lb. Pressure | | | CLASS 100 100 Lb. Pressure | | | CLASS 150 150 Lb. Pressure | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wt. Based on 12 Ft. Length* | | | Wt. Based on 12 Ft. Length* | | | Wt. Based on 12 Ft. Length* | | | Wt. Based on 12 Ft. Length* | |
| | Thickness Inches | Avg. Per Foot | Per Length | Thickness Inches | Avg. Per Foot | Per Length | Thickness Inches | Avg. Per Foot | Per Length | Thickness Inches | Avg. Per Foot | Per Length |
| 4 | .40 | 19.6 | 235 | .40 | 19.6 | 235 | .40 | 19.6 | 235 | .40 | 19.6 | 235 |
| 6 | .43 | 30.4 | 365 | .43 | 30.4 | 365 | .43 | 30.4 | 365 | .43 | 30.4 | 365 |
| 8 | .46 | 43.3 | 520 | .46 | 43.3 | 520 | .46 | 43.3 | 520 | .46 | 43.3 | 520 |
| 10 | .50 | 57.1 | 685 | .50 | 57.1 | 685 | .50 | 57.1 | 685 | .50 | 57.1 | 685 |
| 12 | .54 | 72.5 | 870 | .54 | 72.5 | 870 | .54 | 72.5 | 870 | .54 | 72.5 | 870 |
| 16 | .58 | 104.6 | 1255 | .58 | 104.6 | 1255 | .58 | 104.6 | 1255 | | | |
| 20 | .66 | 147.9 | 1775 | .66 | 147.9 | 1775 | .71 | 157.9 | 1895 | | | |
| 24 | .74 | 197.9 | 2375 | .74 | 197.9 | 2375 | .80 | 212.1 | 2545 | | | |
| 30 | .87 | 289.2 | 3470 | .87 | 289.2 | 3470 | | | | | | |
| 36 | .97 | 387.1 | 4645 | .97 | 387.1 | 4645 | | | | | | |
| 42 | 1.07 | 497.5 | 5970 | 1.07 | 497.5 | 5970 | | | | | | |
| 48 | 1.18 | 625.8 | 7510 | 1.18 | 625.8 | 7510 | | | | | | |

*Including Bell and Spigot Bead. Calculated weight of Pipe rounded off to nearest 5 pounds.

## Table No. 3.4

### STANDARD THICKNESSES OF CAST IRON PIT CAST PIPE FOR GAS

Thickness in Inches. Working Pressure in Pounds per Square Inch.
Thicknesses Include Allowances for Foundry Practice and Corrosion

Laying Condition A—Flat Bottom Trench, Without Blocks, Untamped Backfill
Laying Condition B—Flat Bottom Trench, Without Blocks, Tamped Backfill
Laying Condition C—Pipe Laid on Blocks, Untamped Backfill
Laying Condition D—Pipe Laid on Blocks, Tamped Backfill

| Size Inches | Working Pressure | 3½ FEET OF COVER Laying Condition | | | | 5 FEET OF COVER Laying Condition | | | | 8 FEET OF COVER Laying Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| 4 | 10 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .46 | .40 |
| | 50 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .40 | .50 | .40 |
| | 100 | .40 | .40 | .40 | .40 | .40 | .40 | .43 | .40 | .40 | .40 | .50 | .40 |
| | 150 | .40 | .40 | .40 | .40 | .40 | .40 | .43 | .40 | .40 | .40 | .50 | .40 |
| 6 | 10 | .43 | .43 | .46 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .54 | .43 |
| | 50 | .43 | .43 | .46 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .54 | .43 |
| | 100 | .43 | .43 | .46 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .58 | .43 |
| | 150 | .43 | .43 | .50 | .43 | .43 | .43 | .50 | .43 | .43 | .43 | .58 | .43 |
| 8 | 10 | .46 | .46 | .50 | .46 | .46 | .46 | .54 | .46 | .46 | .46 | .58 | .46 |
| | 50 | .46 | .46 | .54 | .46 | .46 | .46 | .54 | .46 | .46 | .46 | .63 | .46 |
| | 100 | .46 | .46 | .54 | .46 | .46 | .46 | .58 | .46 | .46 | .46 | .63 | .46 |
| | 150 | .46 | .46 | .54 | .46 | .46 | .46 | .58 | .46 | .46 | .46 | .63 | .46 |
| 10 | 10 | .50 | .50 | .54 | .50 | .50 | .50 | .58 | .50 | .50 | .50 | .68 | .50 |
| | 50 | .50 | .50 | .58 | .50 | .50 | .50 | .58 | .50 | .50 | .50 | .68 | .54 |
| | 100 | .50 | .50 | .58 | .50 | .50 | .50 | .63 | .50 | .54 | .50 | .68 | .54 |
| | 150 | .50 | .50 | .58 | .50 | .50 | .50 | .63 | .50 | .54 | .50 | .68 | .58 |
| 12 | 10 | .54 | .54 | .58 | .54 | .54 | .54 | .63 | .54 | .54 | .54 | .68 | .58 |
| | 50 | .54 | .54 | .58 | .54 | .54 | .54 | .63 | .54 | .58 | .54 | .73 | .58 |
| | 100 | .54 | .54 | .63 | .54 | .54 | .54 | .63 | .54 | .58 | .58 | .73 | .58 |
| | 150 | .54 | .54 | .63 | .58 | .58 | .54 | .68 | .58 | .63 | .58 | .79 | .63 |
| 16 | 10 | .58 | .58 | .68 | .58 | .58 | .58 | .68 | .63 | .68 | .63 | .79 | .68 |
| | 50 | .58 | .58 | .68 | .63 | .63 | .58 | .73 | .63 | .68 | .63 | .79 | .73 |
| | 100 | .63 | .58 | .73 | .63 | .63 | .58 | .73 | .68 | .73 | .68 | .85 | .73 |
| 20 | 10 | .66 | .66 | .77 | .71 | .71 | .66 | .83 | .71 | .77 | .71 | .90 | .83 |
| | 50 | .71 | .66 | .77 | .71 | .71 | .66 | .83 | .77 | .77 | .71 | .90 | .83 |
| | 100 | .71 | .66 | .83 | .77 | .77 | .71 | .83 | .77 | .83 | .77 | .97 | .83 |
| 24 | 10 | .74 | .74 | .80 | .74 | .80 | .74 | .86 | .80 | .86 | .80 | .93 | .86 |
| | 50 | .80 | .74 | .86 | .80 | .80 | .74 | .93 | .86 | .86 | .80 | 1.00 | .93 |
| | 100 | .80 | .74 | .93 | .86 | .86 | .80 | .93 | .86 | .93 | .86 | 1.00 | .93 |
| 30 | 10 | .87 | .87 | .94 | .87 | .94 | .87 | 1.02 | .94 | 1.02 | .87 | 1.10 | 1.02 |
| | 50 | .94 | .87 | 1.02 | .94 | .94 | .87 | 1.10 | 1.02 | 1.10 | .94 | 1.19 | 1.10 |
| 36 | 10 | 1.05 | .97 | 1.05 | .97 | 1.05 | .97 | 1.13 | 1.05 | 1.13 | .97 | 1.22 | 1.13 |
| | 50 | 1.05 | .97 | 1.13 | 1.05 | 1.13 | .97 | 1.22 | 1.13 | 1.22 | 1.05 | 1.32 | 1.22 |
| 42 | 10 | 1.16 | 1.07 | 1.16 | 1.07 | 1.16 | 1.07 | 1.25 | 1.16 | 1.35 | 1.07 | 1.35 | 1.25 |
| | 50 | 1.16 | 1.07 | 1.25 | 1.16 | 1.25 | 1.07 | 1.35 | 1.25 | 1.35 | 1.16 | 1.46 | 1.35 |
| 48 | 10 | 1.27 | 1.18 | 1.37 | 1.18 | 1.37 | 1.18 | 1.37 | 1.27 | 1.48 | 1.18 | 1.60 | 1.37 |
| | 50 | 1.27 | 1.18 | 1.37 | 1.27 | 1.37 | 1.18 | 1.48 | 1.37 | 1.48 | 1.27 | 1.60 | 1.48 |

ASA
A21.4–1952

# AMERICAN STANDARD SPECIFICATIONS
*for*
# CEMENT MORTAR LINING FOR CAST IRON PIPE AND FITTINGS

(A revision of ASA—A21.4 - 1939)

SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

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## AMERICAN STANDARD SPECIFICATIONS
## *for*
## CEMENT MORTAR LINING
## FOR CAST IRON PIPE AND FITTINGS

### Sect. 4–1—Portland Cement

Portland cement shall meet all the requirements of Standard Specifications for Type-2 Portland Cement of the American Society for Testing Materials, A.S.T.M. Designation: C 150, of latest revision.

### Sect. 4–2—Sand

Sand shall consist of hard, strong, durable, uncoated, silicious particles. Under the colorimetric test for organic impurities it shall not produce a color darker than the standard, unless it is shown by adequate tests that the impurities causing the color are not harmful to the strength or other specified properties of the finished lining. It shall lose not more than 3 per cent in the decantation test, and not more than 4 per cent in boiling hydrochloric acid. The sand shall be well graded from fine to coarse so as to produce a lining as nearly as practicable of maximum density and minimum water absorption consistent with the proportion of cement and the lining methods used, with workability of the mortar and with the other specified properties of the lining; provided that, when tested with standard sieves, it shall meet the following requirements:

| | *Per Cent* |
|---|---|
| Total passing sieve having a clear opening of the size nearest to one-half the specified minimum thickness of lining | 100 |
| Passing No. 50 sieve, not more than | 50 |
| Passing No. 100 sieve, not more than | 5 |

### Sect. 4–3—Accepted Specifications

The specified tests of sand shall be made in accordance with the Standard Methods of the American Society for Testing Materials, of latest revision, as follows:

Colorimetric Test: Standard Method of Test for Organic Impurities in Sands for Concrete. A.S.T.M. Designation: C 40.

Decantation Test: Standard Method of Test for Amount of Material Finer than No. 200 Sieve in Aggregates, A.S.T.M. Designation: C 117.

Solubility in hydrochloric acid: Standard Method of Testing Bituminous Mastics, Grouts, and like Mixtures, A.S.T.M. Designation: D 147.

Sampling: Methods of Sampling Stone, Slag, Gravel, Sand and Stone Block for use as Highway Materials, A.S.T.M. Designation: D 75, Sections 14 and 15.

### Sect. 4–4—Water

Water for tempering the mortar and for curing the lining shall be potable water, as defined in U. S. Treasury "Drinking Water Standards" of latest revision.

### Sect. 4–5—Mortar

The mortar shall be an intimate and thorough mixture of portland cement, sand and water of the qualities specified, and shall contain no other ingredient; except that, subject to the approval of the purchaser, other hydraulic cements producing linings having lower water-solubility, less shrinkage or other advantages may be substituted for portland cement in whole or in part, or other ingredients may be incorporated in the mortar. Portland cement mortar for linings not exceeding one-quarter inch in minimum thickness shall contain not less than one part of cement to two parts of dry sand by volume. (1)*

### Sect. 4–6—Preparation of Pipe and Fittings for Lining

All pipe and fittings shall be thoroughly cleaned and surfaces to be lined shall be free from harmful amounts of blacking, grease, dirt, loose sand, rust, slag, soda or other flux, and from tar or other coating, and shall be entirely free from sharp projections of iron which might reduce the thickness of the lining. Required hydrostatic tests shall be made before lining.

### Sect. 4–7—Method of Applying Cement Mortar Linings

The waterway surfaces of pipe and fittings shall be completely covered with as nearly as practicable a uniform thickness of the specified mortar entirely free from holidays or visible bubbles of air and thoroughly compacted throughout. Straight pipe shall be lined by the centrifugal process, combining high speed spinning and vibration, or by some other process producing linings which are equal to such centrifugal linings in accuracy of surface contour, smoothness of surface texture, density, low water absorption, and freedom from shrinkage cracks and loose spots. The consistency of the mortar and the time and speed of spinning shall be so adjusted as to minimize the segregation of the sand from the cement, and to deliver the finished lining free from

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* Numbers in parenthesis such as that above refer to notes following this standard.

laitance. Fittings shall be lined by such process as will produce linings equal, as nearly as practicable, in the above enumerated respects to the linings of straight pipe. Defective linings which have set shall not be patched but the linings on small areas damaged in handling may be completely cut out to the metal, with square edges, the adjoining lining thoroughly wet, and the bare spot recoated by hand troweling or equivalent means and the patch cured as specified in Section 4–12.

### Sect. 4–8—Bell to be Cleaned

All mortar shall be removed from the joint surface of the bell.

### Sect. 4–9—Work to be Protected

The work of lining the pipe and fittings shall be done in a building where the products shall be protected from the direct rays of the sun, and from extreme weather conditions, such as frost, rain, etc. The product shall not be put on the yard until the cement has set sufficiently to avoid injury or damage thereto.

### Sect. 4–10—Thickness of Lining

The thickness of linings for pipe and fittings shall be nowhere less than the following for the respective diameters: 3 to 12 inches, ⅛ inch; 14 to 24 inches, 3/16 inch; 30 to 48 inches, ¼ inch. Linings may taper at the ends. The length of taper shall be as short as practicable and shall not exceed two inches. A plus tolerance of ⅛-inch, but no more, shall be permitted on all sizes of pipe and ¼-inch, but no more, on all sizes and patterns of fittings. Linings of greater thickness will be furnished when specified.

### Sect. 4–11—Determination of Thickness

The thickness of lining may be determined by means of spear measurement, using a hardened steel point not larger than 1/16 inch in diameter or by other approved gage. If tested by spear measurement the inspector shall pierce the lining immediately after it is placed in the pipe, and before the mortar has set, at four diametrically opposite points of the pipe at bell and spigot ends, making two sets of measurements at each end. The first set shall not be more than 4 inches from the respective ends of the pipe and the second set shall be made as far into the interior of the pipe as can readily be reached without injuring the lining.

### Sect. 4–12—Curing

Unless otherwise specified curing shall be effected by the application of a bituminous seal coating which shall cover and seal the cement mortar. This shall be applied while the lining is still moist. If the lining is not to be seal coated it shall be kept constantly damp for at least 24 hours after the lining is placed and as much longer as may be necessary to control separation and cracking. (2) No pipe or fittings shall be shipped until the lining is thoroughly set and hard.

## Sect. 4–13—The Finished Lining

The linings of both pipe and fittings, after curing and drying shall meet the following requirements:

(a) *Surface and contour.* The lining shall have a hard, smooth surface and shall be free from noticeable ridges, corrugations, elevations and depressions. The linings of pipe shall be cylindrical; the linings of fittings shall be as nearly as practicable of uniform thickness throughout and shall afford smooth waterways.

(b) *Water absorption.* When tested for water absorption in accordance with Standard Specifications for Cement Concrete Sewer Pipe, A.S.T.M. Designation: C 14, of latest revision, the lining shall show an absorption not exceeding 12 per cent of its dry weight. Samples for this test may be from linings placed for this purpose in the bell, provided that such linings are of the same thickness and mix, placed and compacted at the same time and by the same methods, and subjected to the same curing as the linings of the waterways. Samples at time of tests shall not be more than 30 days older than the most recently placed of the linings in the shipment or order which they represent. (3)

(c) *Cracks and loose spots.* Pipe showing any loose spot measuring 12 inches or more in greatest dimension, or any crack over 9 inches in length, or any crack of any length standing open perceptibly, shall be rejected. Surface crazing shall not be cause for rejection. (4)

## Sect. 4–14—Outside Coating

Any coating which is to be applied to the outside of cement-mortar-lined pipe or fittings shall be specified in the agreement made at the time of purchase.

No pipe or fittings for water works service shall be furnished without protective coating unless specifically ordered by the purchaser.

## Sect. 4–15—Bituminous Seal Coat

(a) *The Bituminous Seal Coat,* after drying for 48 hours, shall have no deleterious effect upon the quality, color, taste or odor of potable water which has been standing for 48 hours in the pipe. (5) The seal coat shall adhere tenaciously to the mortar lining at all points. The seal coated pipe, when tested in accordance with Section 4–15(b) shall not impart to the water more than 25 parts per million of hardness, nor more than 25 parts per million of total alkalinity, nor any caustic alkalinity.

(b) *Method of Testing.* Except as another form of specimen and test is agreed upon by the purchaser and manufacturer, the sample shall be a 6-inch length of 6- or 8-inch pipe, lathe-cut at both ends. The specimen shall be cut from a pipe whose lining is of the same age and which has been lined, cured and seal-coated in all respects like the product which it represents, the seal-coat being applied 48 hours prior to the test. With this form of specimen the test shall be made by bedding the specimen on end in a shallow pan of melted paraffin, allowing the paraffin to cool, filling the pipe nearly to the top with distilled or demineralized water at laboratory temperature, and covering with a glass plate on a seal of vaseline. The water shall have an electrical resistivity (or resistance) exceeding 50,000 ohm-centimeters, or it shall contain not more than 10 parts per million of the bicarbonates, chlorides and sulfates of potassium, sodium, calcium and magnesium, and it shall contain not more than 3.0 parts per million of free carbon dioxide at the time of filling the test specimen. The water shall be changed and tested after 24 hours contact on each of three successive days, and on each test shall be free from objectionable color, taste and odor, and from hardness and alkalinity in excess of the limits specified in Sect. 4–15(a). Determination of hardness and alkalinity shall be made by methods prescribed in Standard Methods of Water Analysis of the American Public Health Association and the American Water Works Association, most recent edition. The purchaser shall indicate in his request for bids the number of tests and test specimens required. At the purchaser's option, this test may be made by him with the water with which the pipe is to be used.

### Sect. 4–16—Frequency of Tests

A record of all specified tests shall be made and retained for at least one year. This record will be available to the purchaser at the foundry. If written transcripts of the test results or any additional tests are desired, this fact shall be noted on the order.

The several tests shall be made with at least the following frequencies:

*Cement.* (See Sect. 4–1) The manufacturer's analyses and physical tests of the cement of each shipment.

*Sand.* (See Sect. 4–2) One sieve analysis on each carload or, for sand otherwise delivered, one sieve analysis for each 50 tons.

The colorimetric, decantation and hydrochloric acid tests of sand from an established source of supply, once each 6 months; for sand from a new source not less often than once a month for period of 6 months.

*Determination of Thickness.* (See Sect. 4–11) One test for each 100 pipe, well distributed among the different sizes produced.

*Water Absorption.* (See Sect. 4–13(b)) One test a month, well distributed among the different thicknesses of lining produced.

*Bituminous Seal Coat.* (See Sect. 4–15) Leaching Test once a month on pipe selected at random from regular production.

# NOTES

*(These notes are not parts of the standard, but are given for information only.)*

(1) The provision for the use of cements other than standard portland and for other modifications of the mortar, subject to the approval of the purchaser, permits taking advantage of any useful results of the development of hydraulic cements of special properties.

(2) The purchaser who is buying cement-mortar-lined pipe for use with a water that is corrosive to calcium carbonate, such as a soft water of low alkalinity and low pH, is advised, before omitting the seal coat, to satisfy himself by appropriate test that the lining to be furnished will not impart objectionable hardness or alkalinity to the water, *considering the amount of circulation in the proposed pipe line and the amount of blowing off of dead ends that he is prepared to do.* The procedure of Section 4-15(b), omitting the seal coat and substituting for distilled water the water with which the pipe is to be used, is suggested as a convenient form of test.

Another advantage of the seal coat is in prolonging the life of the lining.

(3) The water absorption of cement-mortar linings which have been exposed to the atmosphere diminishes with increasing age of the lining, hence the 30 day limit so that the sample tested shall be reasonably representative of the shipment.

(4) Whitewash may be used to protect the pipe from the heat of the sun which tends to expand the pipe away from the lining. If cement-mortar-lined pipe are to be stored for a long time along the trench or in the purchaser's yard, it is recommended that the whitewash be maintained on all sides exposed to the sun. The need for whitewashing varies with the size of the pipe, the climate and probably other conditions. Pipe 16 inches in diameter and larger are more likely to need whitewashing than smaller pipe.

(5) The following test for tendency of a seal coating material to impart color, taste, and odor to the water has been used: A 2" x 3" x 6" block of the mortar to be used in lining the pipe is dried, painted and exposed to the air for 48 hours; it is then placed in a covered vessel with a volume of the water of the purchaser's supply equal in cubic inches, to twice the area of the block in square inches (the volume-area relation of an 8-inch pipe). After 48 hours at laboratory temperature it is tested for color, taste and odor.

By changing the water and testing for hardness, total and caustic alkalinity for, say, 3 successive days, and thereafter at longer intervals, an indication of the protective value of the seal coat may be had.

ASA
A21.6–1952

## American Standard Specifications

*for*

# CAST IRON PIPE CENTRIFUGALLY CAST IN METAL MOLDS, FOR WATER OR OTHER LIQUIDS

SPONSORS

AMERICAN GAS ASSOCIATION
AMERICAN SOCIETY FOR TESTING MATERIALS
AMERICAN WATER WORKS ASSOCIATION
NEW ENGLAND WATER WORKS ASSOCIATION

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NOTE 1—Tables showing additional thicknesses required for greater depths of cover and other conditions of laying will be found in ASA A21.1.

NOTE 2—Users of these tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

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Users of this document should make reference to "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe" (ASA A21.1) for complete information concerning the conditions which various thicknesses of pipe are designed to meet. The foreword of the Manual also contains a statement regarding the history of the specifications and references to other related documents.

ASA
A21.6–1952

*American Standard Specifications for*

# Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids

*This specification covers cast iron pipe centrifugally cast in metal molds.*

### Sec. 6–1—Definitions

*Purchaser.* Wherever the word "purchaser" is used herein, it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

*Heat.* A heat is a period during which a cupola or furnace is operated continuously.

*Run.* A run is a period of one or more shifts during which a shop is operated continuously.

*Mixture of Iron.* Mixture of iron is a combination of pig iron, scrap, coke and other raw materials charged to a cupola or furnace to give a desired composition of iron; or a combination of molten iron from one or more sources, made in a forehearth or ladle to give a desired composition of iron.

*Source of Iron.* A source of iron is a cupola, furnace or forehearth from which iron is delivered to a transfer or pouring ladle.

*Forehearth.* A forehearth is a refractory-lined receptacle for the temporary storage of molten iron from one or more cupolas or furnaces.

### Sec. 6–2—Description of Pipe

The pipe shall be made with bell and spigot ends, plain ends or such other type of ends as may be agreed upon at the time of purchase. Pipe with bell-and-spigot ends shall conform to the dimensions and weights shown in the tables given in this document. Pipe with other types of ends shall comply with the dimensions agreed upon, but in all other respects shall fulfill the specifications hereinafter given. Pipe shall be straight and shall be true circles in section, with the inner and outer surfaces concentric. Pipe shall be cast at least 12 ft. in nominal laying length. This type of pipe is commonly made at present (1952) in 12- and 18-ft. lengths.

### Sec. 6–3—Casting of Pipe

The pipe shall be centrifugally cast in metal molds, and after withdrawal from the molds pipe shall be heat-treated to meet the requirements of this specification.

### Sec. 6–4—Quality of Iron

6–4.1. All pipe shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the pipe to be cast, that the iron in the pipe shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting, and it shall comply with the physical specifications given in Sec. 6–17 and 6–18. The metal shall be remelted in a cupola or other suitable furnace.

6–4.2. The iron in the pipe shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulphur. Samples for chemical analyses shall be taken by drilling completely through from skin to skin either acceptance test specimens or specimens cast for this purpose, but not to exceed three specimens per heat of approximately eight hours. In case of dispute, analyses will be determined on samples taken from the pipe in question.

### Sec. 6–5—Quality of Castings

The pipe shall be smooth, free from scales, lumps, blisters, sand holes, laps and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

### Sec. 6–6—Foundry Records

A record of the results of the following tests shall be made and retained for at least one year. Upon request such record will be available to the purchaser at the foundry. If written transcripts of the results of any of these tests are desired this fact shall be noted in the order for pipe, naming the tests of which transcripts are desired. The methods of testing and the dimensions of all test specimens are given in the Appendix.

6–6.1. *Chemical analyses.* Chemical analyses of each iron mixture used directly in the pouring of pipe, obtained as in Sec. 6–4.2, shall be made for silicon, sulphur, manganese, phosphorus and total carbon during the first hour and at intervals not to exceed three hours throughout the heat. If pipe are poured directly from the cupola, chemical analyses shall be made of iron from the first and from the last ladle. If the mixture is changed one or more times during a heat in order to produce a different iron, the time of taking samples shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality.

6–6.2. *Pouring temperatures.* The pouring temperature of the iron shall be taken at the casting ladle for each size of pipe at least once each hour.

6–6.3. *Hardness tests.* See Sec. 6–17.2 and Appendix Sec. 6–A1—Talbot Strip Tests.

6–6.4. *Talbot strip tests.* See Sec. 6–17.1.

6–6.5. *Periodic ring, strip and full-length bursting tests.* See Sec. 6–17 and 6–18.

### Sec. 6–7—Marking Pipe

Each pipe shall have the weight and class designation conspicuously painted on it. In addition, each bell-and-spigot pipe shall have distinctly cast or stamped on the face of the bell the manufacturer's mark and the year in which the pipe was cast. When specified by the purchaser, the manufacturer's mark, the year in which the pipe was cast and initials not exceeding four in number shall be distinctly cast on the face of the bell. The size of letters and figures is to be as large as practicable. Pipe with ends other than bell and spigot are to be marked as agreed upon at the time of purchase.

### Sec. 6-8—Inspection by Purchaser

6-8.1. *Power of purchaser to inspect.* The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, pattern work, molding, casting, heat-treating, coating and lining of the pipe. The forms, sizes, uniformity and conditions of all pipe herein referred to shall be subject to his inspection and approval, and he may reject, without subjection to hydrostatic test, any pipe which is not in conformity with the specifications or drawings. Any pipe rejected shall be so marked and any marks pertaining to the purchaser shall be chipped or erased from such pipe.

6-8.2. *Manufacturer to furnish men and materials.* The manufacturer shall provide tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the pipe at the foundry.

6-8.3. *Report of purchaser's inspection.* The purchaser shall make written report daily to the foundry office of all pipe rejected with the causes for rejection.

### Sec. 6-9—Inspection and Certification by Manufacturer

Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made and met as specified. If written transcripts of any of these test results are required, including chemical tests if desired, a request specifying the tests of which transcripts are desired shall accompany the order.

### Sec. 6-10—Pipe to be Delivered Sound

All the pipe shall be delivered in all respects sound and in conformity with these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this respect, and any defective pipe which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for pipe found to be damaged after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the pipe not to injure the coating or lining, and no pipe or other material of any kind shall be placed in the pipe during transportation or at any other time after they have received the coating or lining.

### Sec. 6-11—Cut Pipe

Defective spigot ends on pipe may be cut off in a manner which will produce a square end. Not more than 10 per cent of the total number of pipe of each size of a given order may be shipped as cut pipe. Such cut pipe when cut from 12-ft. lengths shall have a nominal laying length of not less than 11 ft.; pipe originally of 16-ft. or greater length shall not be cut more than 2 ft.

### Sec. 6-12—Tolerances or Maximum Permitted Variations

6-12.1. *Pipe and socket diameters.* Outside diameters of pipe barrels and spigot ends, and inside diameters of sockets, shall be kept as nearly as practicable to the specified dimensions. The inside diameters of the sockets and the outside diameters of the spigot ends shall be tested with circular gages. Tolerances or maximum permitted variations from standard dimensions are listed below:

| Nom. Pipe Diam. *in.* | Tolerances *in.* |
|---|---|
| 3-12 | ±0.06 |
| 14-24 | ±0.08 |

6-12.2. *Thickness.* The minus tolerances from standard thickness of pipe and dimensions *a, b, c* and *d* of the bell are as follows:

| Nom. Pipe Diam. *in.* | Minus Tolerance *in.* |
|---|---|
| 3- 8 | 0.05 |
| 10-12 | 0.06 |
| 14-24 | 0.08 |

Note: In pipe barrel thickness, tolerances 0.02 in. greater than those listed above shall be permissible over areas not exceeding 8 in. in length in any direction.

6-12.3. *Weight.* The weight of no single pipe shall be less than the nominal tabulated weight by more than 5 per cent for pipe 12 in. or smaller in diameter, nor by more than 4 per cent for pipe larger than 12 in. in diameter. The total weight of any order of 25 tons or more shall not be more than 2 per cent under the total nominal weight. The total excess weight to be paid for on orders of 25 tons or more shall not exceed 2 per cent of the nominal weight and on orders of less than 25 tons shall not exceed 5 per cent of the nominal weight. An order is hereby defined as including all the pipe ordered under the terms of a specific contract or purchase order or a single order placed under the terms of a standing contract. Unless otherwise specified in the contract, a ton shall be 2,000 lb. avoirdupois.

### Sec. 6-13—Cleaning and Inspecting

All pipe shall have fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful inspection and a rolling test, before being coated or lined.

### Sec. 6-14—Hydrostatic Test

Each pipe shall be subjected to a hydrostatic proof test. This test may be made either before or after a hot or cold bituminous dip or paint has been applied but shall be made before the cement mortar lining or any other special lining has been applied to pipe for which such lining is specified.

The pipe shall be under the test pressure for at least one-half minute. Any pipe showing defects by leaking, sweating or otherwise shall be rejected. The test pressures shall be in accordance with the table appearing on page 134.

### Sec. 6-15—Weighing

Each length of pipe shall be weighed and the weight plainly marked on the outside or inside of the bell or spigot end. Pipe shall be weighed before the application of any lining or coating other than hot or cold bituminous dip or paint.

PIPE CENTRIFUGALLY CAST IN METAL MOLDS

*Table of Hydrostatic Test Pressures*

| Nom. Pipe Diam. *in.* | Nom. Barrel Thickness *in.* | Test Pressure *psi.* |
|---|---|---|
| 3–12 | all thicknesses | 500 |
| 14 | 0.57 and less | 400 |
| 14 | 0.58 and over | 500 |
| 16 | 0.60 and less | 400 |
| 16 | 0.61 and over | 500 |
| 18 | 0.65 and less | 400 |
| 18 | 0.66 and over | 500 |
| 20 | 0.70 and less | 400 |
| 20 | 0.71 and over | 500 |
| 24 | 0.75 and less | 400 |
| 24 | 0.76 and over | 500 |

## Sec. 6–16—Linings and Exterior Coatings

Any particular lining or coating which is to be applied to the pipe shall be specified in the agreement made at the time of purchase. Separate specifications for a cement-mortar lining have been provided in connection with these specifications for pipe. *See* specification ASA A21.4

No pipe or specials for waterworks service shall be furnished without protective coating unless specifically ordered by the purchaser.

## Sec. 6–17—Acceptance Tests for Physical Properties

The standard acceptance tests for the physical characteristics of the pipe shall be as follows:

### *Sec. 6–17.1—Talbot Strip Tests*

Talbot strip tests shall be used to determine the acceptability of 3-in. to 24-in. pipe for modulus of rupture and secant modulus of elasticity.

17.1.1. *Sampling.* For sampling, every run shall be divided into periods of approximately three hours each, and at least one sample shall be taken during each three-hour period. The sample for the first period of the run shall be taken during the first hour or, if casting is direct from the cupola, from the first ladle. Samples shall be taken so that each size of pipe cast for two hours or longer during the run and each mixture or source of iron used for two hours or longer during the run shall be fairly represented.

17.1.2. *Method of testing.* The method of testing Talbot strips is given in Sec. 6–A1 of the Appendix.

17.1.3. *Acceptance values.* The acceptance values for tests on Talbot strips from 3-in. to 24-in. pipe shall be as follows:

Modulus of rupture: 40,000 psi. minimum

Secant modulus of elasticity: 12,000,-000 psi. maximum

If the modulus of elasticity exceeds 12,000,000, the modulus of rupture shall exceed 40,000 in at least the same proportion.

### *Sec. 6–17.2—Hardness Tests*

On the outside of each pipe a hardness determination shall be made with a portable instrument. The Rockwell hardness number or its equivalent shall not exceed B–95, using a ball having a diameter of 1.59 mm. ($\frac{1}{16}$ in.) and a weight of 100 kg. (220.5 lb.). Any harder pipe may be re-heat-treated to meet this requirement. For the purpose of the foundry records (Sec. 6–6.3), hardness tests shall be made also on Talbot strips as noted in the Appendix under "Talbot Strip Tests" —viz., a Rockwell hardness test at three well distributed points each on the outside of the pipe and on one machined face shall be made and recorded.

## Sec. 6–18—Periodic Ring Tests and Full-Length Bursting Tests

The manufacturer shall periodically make such bursting tests and ring tests in conjunction with strip tests that he can certify the design values of the modulus of rupture (40,000 psi.) and the tensile strength of the iron in the pipe (18,000 psi.). These tests shall be made in accordance with dimensions and methods given in the Appendix.

Pipe for these periodic ring and bursting tests shall be so selected that they will be representative of the sizes and various thicknesses of each size cast. Ring tests shall not be made on 3-in. and 4-in. pipe.

Tests of Talbot strips cut from the ring and hardness tests as provided in the Appendix shall be made in conjunction with ring and bursting tests. At least three Talbot strips shall be tested from each burst pipe and one of these strips shall come from the ring. For pipe for which rings less than 10½ in. long are used, the Talbot strip shall come from parts other than the ring.

Tests and records shall include the modulus of rupture of each strip and ring, the modulus of elasticity of each strip and of each ring 12 in. and larger, and a hardness test on all strips.

At the purchaser's request, the manufacturer shall furnish a written transcript of ring and bursting tests and tests on Talbot strips made in connection therewith for a period not exceeding one year and for such sizes as requested.

**Sec. 6–19—Additional Tests Required by Purchaser**

If more or other tests than those provided in these specifications are required by the purchaser, such tests shall be specified in the invitation for bids.

**Sec. 6–20—Defective Specimens and Retests**

If any test specimen shows defective machining or lack of continuity of metal, it may be discarded and replaced by another specimen. If any sound test specimen fails to meet the specified requirements, the purchaser may permit a retest on two additional sound specimens from pipe cast in the same period as the specimen which failed; both of the additional specimens shall meet the prescribed tests to be acceptable.

**Sec. 6–21—Rejection of Pipe**

If any routine chemical analysis fails to meet the chemical requirements of Sec. 6–4.2, or if any acceptance test fails to meet the requirements of Sec. 6–17.1.3, 6–17.2 and 6–20, the pipe cast in the period shall be rejected except as subject to the provisions of Sec. 6–22.

**Sec. 6–22—Limiting Rejection**

The manufacturer may limit the amount of rejection by making similar additional tests of pipe of the same size as that rejected until the rejected lot is bracketed in order of manufacture by two acceptable tests. If a period is rejected, the acceptability of pipe of different sizes from that rejected may be established by making the routine acceptance tests for these sizes.

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# Appendix*

## Table of Contents



## Tables†



* This Appendix is a part of ASA A21.6—American Standard Specifications for Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids.

† Data on thicknesses required for greater depths of cover and conditions of laying other than those assumed in the following tables will be found in Appendix B of ASA A21.1—American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe.

Users of the following tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

### Sec. 6-A1—Talbot Strip Tests

Talbot strips (Fig. 6.1) shall be machined longitudinally from each pipe specimen selected for testing by this method. These Talbot strips may be cut from a part of the ring little stressed in the ring test—i.e., near one of the elements marked *a* in the illustration of the ring test (Fig. 6.2). The strips in any case will be in cross section as indicated in Fig. 6.1—i.e., will have for their width the thickness of the pipe and for their depth 0.50 in. Their length shall be at least 10½ in. These strips shall be tested as beams on supports 10 in. apart with loads applied perpendicularly to the machined faces at two points 3⅓ in. from the supports. The breaking load and the deflection shall be observed and recorded. For

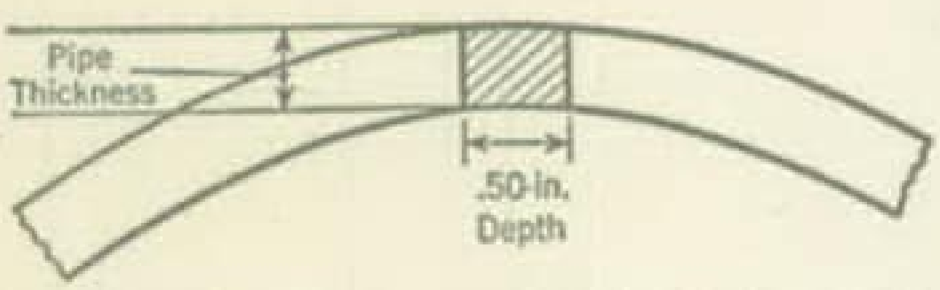


Fig. 6.1. Position From Which Talbot Strip Is Cut

purposes of Sec. 6-6.3—Foundry Records, a Rockwell hardness test at three well distributed points each on the outside of the pipe and on one machined face shall be made and recorded.

The strip shall be accurately calipered at the point of rupture and the modulus of rupture, *R*, shall be calculated by the usual beam formula, which for this case reduces to the expression:

$$R = \frac{10W}{td^2}$$

The secant modulus of elasticity, $E_s$, in pounds per square inch, shall be computed by the formula:

$$E_s = \frac{21.3R}{dy}$$

In the above formulas, $R$ is the modulus of rupture (psi.), $E_s$ is the secant modulus of elasticity (psi.), $W$ is the breaking load (lb.), $d$ is the depth (in.) of the strip (intended to be 0.50 in.), $t$ is the width (in.) of the strip (pipe thickness) and $y$ is the deflection (in.) of the strip at the center at breaking load.

### Sec. 6-A2—Ring Tests

The maximum length of any ring shall not exceed 12 in.; for pipe 14 in. and larger, the minimum length shall be 10½ in.; for pipe 12 in. and smaller, the minimum length shall be one-half the nominal diameter of the pipe. Each ring shall be tested by the three-edge

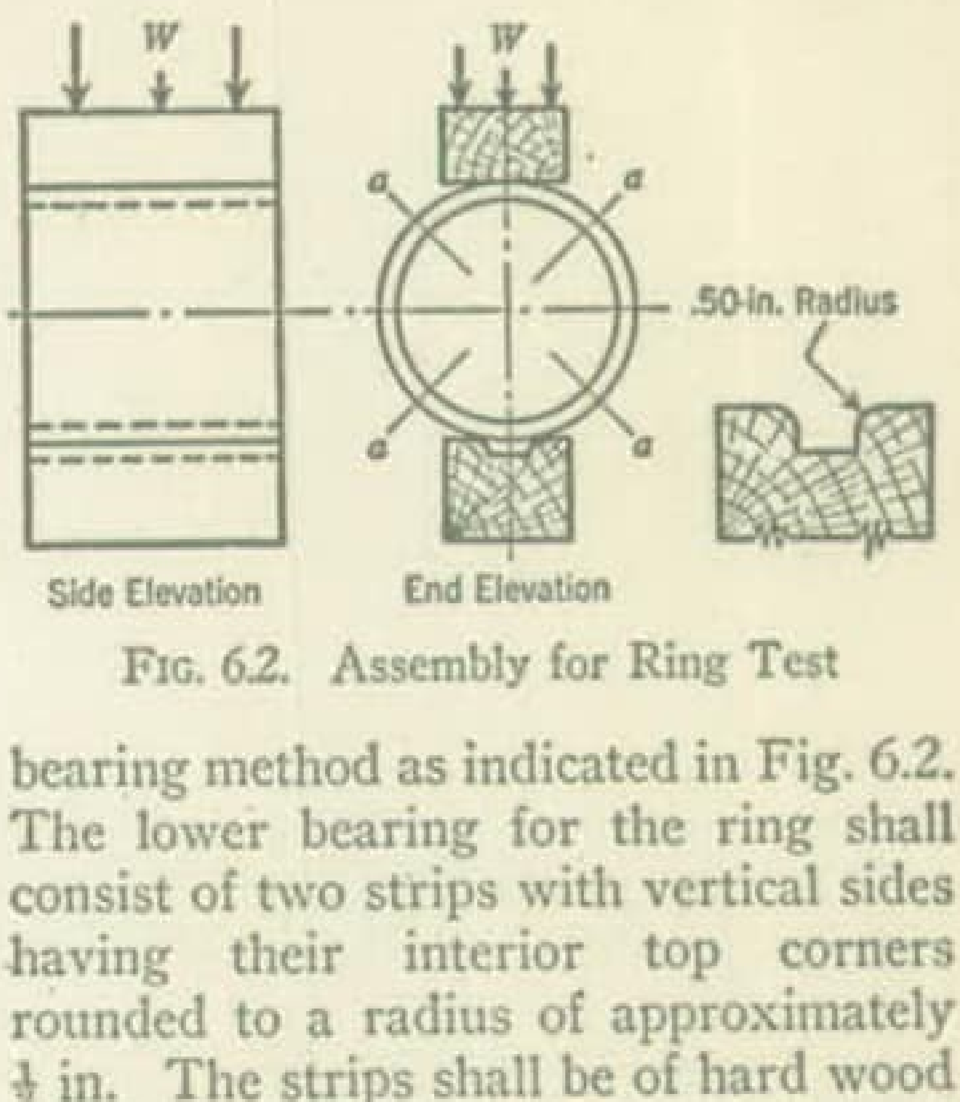


Fig. 6.2. Assembly for Ring Test

bearing method as indicated in Fig. 6.2. The lower bearing for the ring shall consist of two strips with vertical sides having their interior top corners rounded to a radius of approximately ½ in. The strips shall be of hard wood or of metal. If of metal, a piece of fabric or leather approximately $\frac{3}{16}$ in. thick shall be laid over them. They shall be straight and shall be securely fastened to a rigid block with their interior vertical faces the following distances apart:

| Nom. Pipe Diam. *in.* | Bearing Strip Spacing *in.* |
|---|---|
| 3–12 | ½ |
| 14–24 | 1 |

The upper bearing shall be an oak block, straight and true from end to end. The upper and lower bearings shall extend the full length of the ring. The ring shall be placed symmetrically between the two bearings, and the center of application of the load shall be so placed that the vertical deformation at the two ends of the ring shall be approximately equal. If the ring is not uniform in thickness, it shall be so placed that the thick and thin portions are near the ends of the horizontal diameter.

A record of the breaking load and the vertical deformation of each ring tested shall be made. The modulus of rupture and modulus of elasticity are computed from the formulas:

$$R = 0.954 \frac{W(d+t)}{bt^2}$$

$$E = \frac{0.225W(d+t)^3}{bt^3y} = \frac{0.236R(d+t)^2}{ty}$$

in which $R$ is the modulus of rupture (psi.), $W$ is the breaking load (lb.), $d$ is the average inside diameter (in.) of the ring, $t$ is the average thickness (in.) of metal along the line of fracture, $b$ is the length (in.) of the ring, $E$ is the modulus of elasticity (psi.) and $y$ is the vertical deformation (in.) of the ring at the center.

### Sec. 6–A3—Full-Length Bursting Tests

The bursting tensile strength shall be determined by testing full-length pipe (less the amount cut off for ring and strip test specimens) to destruction by hydraulic pressure. Bells may be removed to facilitate testing. A suitable means for holding the end thrust shall be used which will not subject the pipe to endwise tension or compression, or other parasitic stresses. A calibrated pressure gage shall be used for determining the bursting pressure. This gage shall be connected to the interior of the test pipe by a separate connection from that which supplies water for the test. The unit tensile strength in bursting shall be obtained by the use of the formula:

$$S = \frac{Pd}{2t}$$

in which $S$ is the bursting tensile strength (psi.) of the iron, $P$ is the internal pressure (psi.) at bursting, $d$ is the average inside diameter (in.) of the pipe and $t$ is the minimum average thickness (in.) of the pipe along the principal line of break.

Measurements of thickness shall be taken along the principal line of break at 1-ft. intervals.

The minimum average thickness along the principal line of break shall be obtained by averaging the measurements at the thinnest section at a weight of two and at the adjacent sections on each side at a weight of one each; or, if the thinnest section is at the end of the break, by averaging this thinnest-section measurement at a weight of two and the measurements of the adjacent section and the next section at a weight of one each.

### Sec. 6–A4—Deflection Measurements

All deflection measurements required by these specifications shall be that of the specimen and shall not include any compression of the supports or loading blocks, or backlash or distortion of the testing machine.

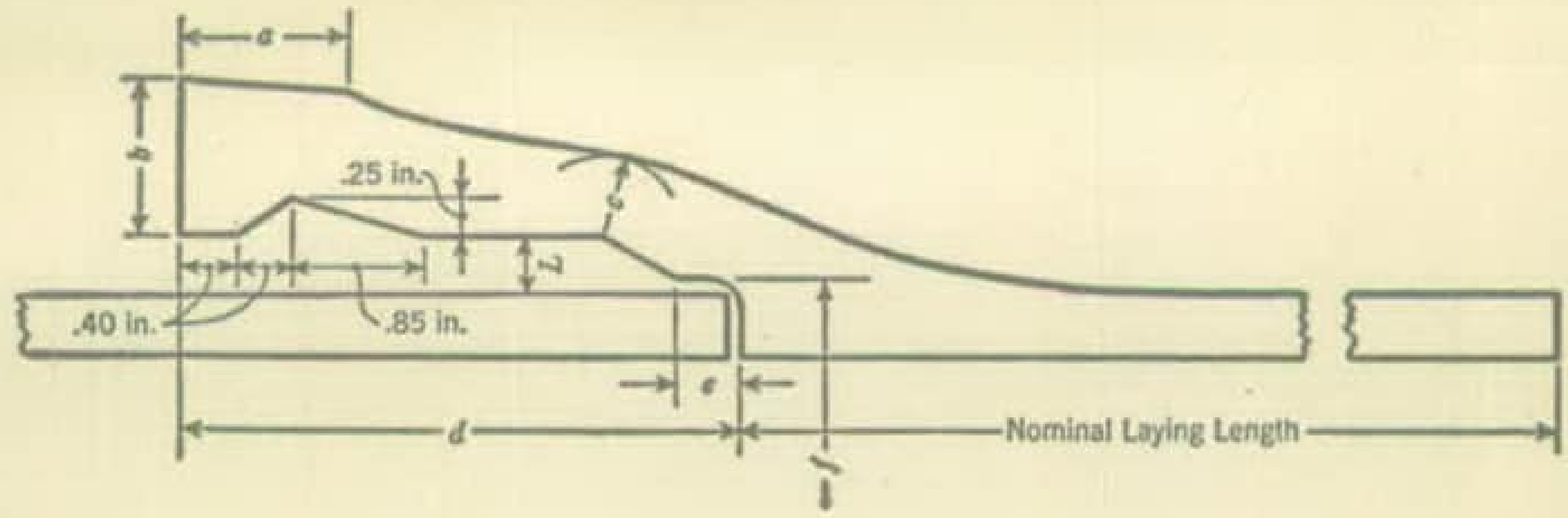


**TABLE 6.1**

**STANDARD DIMENSIONS OF BELLS, SOCKETS AND OUTSIDE DIAMETERS—AND WEIGHTS OF BELLS—OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS**

| Nom. Diam. | Pipe Thickness | | Pipe Outside Diam. | Dimensions of Bells | | | | | | | | Bell Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | Socket Diam. | Joint Thickness *L* | Socket Depth *d* | Centering Shoulder Depth *e* | Centering Shoulder Inside Diam. *f* | *a* | *b* | *c* | |
| | *in.* | | | | | | | | | | | *lb.* |
| 3 | 0.32 | 0.38 | 3.96 | 4.76 | 0.40 | 3.30 | 0.30 | 4.10 | 0.88 | 1.02 | 0.41 | 11 |
| 4 | 0.35 | 0.44 | 4.80 | 5.60 | 0.40 | 3.30 | 0.30 | 4.94 | 1.00 | 1.06 | 0.47 | 14 |
| | 0.35 | 0.44 | 5.00 | 5.80 | 0.40 | 3.30 | 0.30 | 5.14 | 1.00 | 1.06 | 0.47 | 15 |
| 6 | 0.38 | 0.48 | 6.90 | 7.70 | 0.40 | 3.88 | 0.38 | 7.06 | 1.13 | 1.10 | 0.55 | 25 |
| | 0.38 | 0.52 | 7.10 | 7.90 | 0.40 | 3.88 | 0.38 | 7.26 | 1.13 | 1.10 | 0.55 | 26 |
| 8 | 0.41 | 0.56 | 9.05 | 9.85 | 0.40 | 4.38 | 0.38 | 9.21 | 1.13 | 1.28 | 0.64 | 41 |
| | 0.41 | 0.60 | 9.30 | 10.10 | 0.40 | 4.38 | 0.38 | 9.46 | 1.13 | 1.28 | 0.64 | 42 |
| 10 | 0.44 | 0.60 | 11.10 | 11.90 | 0.40 | 4.38 | 0.38 | 11.28 | 1.13 | 1.38 | 0.69 | 54 |
| | 0.44 | 0.65 | 11.40 | 12.20 | 0.40 | 4.38 | 0.38 | 11.58 | 1.13 | 1.38 | 0.69 | 56 |
| 12 | 0.48 | 0.65 | 13.20 | 14.00 | 0.40 | 4.38 | 0.38 | 13.38 | 1.13 | 1.42 | 0.71 | 66 |
| | 0.48 | 0.60 | 13.50 | 14.30 | 0.40 | 4.38 | 0.38 | 13.68 | 1.13 | 1.42 | 0.71 | 67 |
| | 0.65 | 0.76 | 13.50 | 14.30 | 0.40 | 4.38 | 0.38 | 13.68 | 1.13 | 1.62 | 0.81 | 78 |
| 14 | 0.48 | 0.69 | 15.30 | 16.10 | 0.40 | 4.50 | 0.50 | 15.52 | 1.25 | 1.46 | 0.73 | 78 |
| | 0.48 | 0.64 | 15.65 | 16.45 | 0.40 | 4.50 | 0.50 | 15.87 | 1.25 | 1.46 | 0.73 | 80 |
| | 0.69 | 0.81 | 15.65 | 16.45 | 0.40 | 4.50 | 0.50 | 15.87 | 1.25 | 1.76 | 0.88 | 101 |
| 16 | 0.50 | 0.73 | 17.40 | 18.40 | 0.50 | 4.50 | 0.50 | 17.62 | 1.25 | 1.54 | 0.77 | 96 |
| | 0.50 | 0.68 | 17.80 | 18.80 | 0.50 | 4.50 | 0.50 | 18.02 | 1.25 | 1.54 | 0.77 | 98 |
| | 0.73 | 0.85 | 17.80 | 18.80 | 0.50 | 4.50 | 0.50 | 18.02 | 1.25 | 1.86 | 0.93 | 121 |
| 18 | 0.54 | 0.79 | 19.50 | 20.50 | 0.50 | 4.50 | 0.50 | 19.72 | 1.25 | 1.64 | 0.82 | 114 |
| | 0.54 | 0.73 | 19.92 | 20.92 | 0.50 | 4.50 | 0.50 | 20.14 | 1.25 | 1.64 | 0.82 | 116 |
| | 0.79 | 0.92 | 19.92 | 20.92 | 0.50 | 4.50 | 0.50 | 20.14 | 1.25 | 1.98 | 0.99 | 145 |
| 20 | 0.57 | 0.84 | 21.60 | 22.60 | 0.50 | 4.50 | 0.50 | 21.82 | 1.25 | 1.74 | 0.87 | 133 |
| | 0.57 | 0.78 | 22.06 | 23.06 | 0.50 | 4.50 | 0.50 | 22.28 | 1.25 | 1.74 | 0.87 | 136 |
| | 0.84 | 0.98 | 22.06 | 23.06 | 0.50 | 4.50 | 0.50 | 22.28 | 1.25 | 2.10 | 1.05 | 171 |
| 24 | 0.63 | 0.92 | 25.80 | 26.80 | 0.50 | 4.50 | 0.50 | 26.02 | 1.25 | 1.94 | 0.97 | 179 |
| | 0.63 | 0.85 | 26.32 | 27.32 | 0.50 | 4.50 | 0.50 | 26.54 | 1.25 | 1.94 | 0.97 | 182 |
| | 0.92 | 1.07 | 26.32 | 27.32 | 0.50 | 4.50 | 0.50 | 26.54 | 1.25 | 2.36 | 1.18 | 229 |

PIPE CENTRIFUGALLY CAST IN METAL MOLDS

TABLE 6.2

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS

| Nom. Diam. *in.* | Thick-ness Class | Thick-ness | Outside Diam. | Inside Diam. | Barrel Weight Per Foot | Bell Weight | Weight Based on 12-ft. Laying Length | | Weight Based on 18-ft. Laying Length | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length* | Avg. Per Foot† | Per Length* | Avg. Per Foot† |
| | | *in.* | | | *lb.* | | | | | |
| 3 | 22 | 0.32 | 3.96 | 3.32 | 11.4 | 11 | 150 | 12.5 | 215 | 12.0 |
| | 23 | 0.35 | 3.96 | 3.26 | 12.4 | 11 | 160 | 13.5 | 235 | 13.0 |
| | 24 | 0.38 | 3.96 | 3.20 | 13.3 | 11 | 170 | 14.3 | 250 | 13.9 |
| 4 | 22 | 0.35 | 4.80 | 4.10 | 15.3 | 14 | 200 | 16.6 | 290 | 16.1 |
| | 23 | 0.38 | 4.80 | 4.04 | 16.5 | 14 | 210 | 17.7 | 310 | 17.3 |
| | 24 | 0.41 | 4.80 | 3.98 | 17.6 | 14 | 225 | 18.8 | 330 | 18.4 |
| | 25 | 0.44 | 4.80 | 3.92 | 18.8 | 14 | 240 | 20.0 | 350 | 19.5 |
| | 22 | 0.35 | 5.00 | 4.30 | 16.0 | 15 | 205 | 17.2 | 305 | 16.9 |
| | 23 | 0.38 | 5.00 | 4.24 | 17.2 | 15 | 220 | 18.5 | 325 | 18.0 |
| | 24 | 0.41 | 5.00 | 4.18 | 18.4 | 15 | 235 | 19.7 | 345 | 19.2 |
| | 25 | 0.44 | 5.00 | 4.12 | 19.7 | 15 | 250 | 21.0 | 370 | 20.5 |
| 6 | 22 | 0.38 | 6.90 | 6.14 | 24.3 | 25 | 315 | 26.4 | 460 | 25.6 |
| | 23 | 0.41 | 6.90 | 6.08 | 26.1 | 25 | 340 | 28.2 | 495 | 27.5 |
| | 24 | 0.44 | 6.90 | 6.02 | 27.9 | 25 | 360 | 30.0 | 525 | 29.3 |
| | 25 | 0.48 | 6.90 | 5.94 | 30.2 | 25 | 385 | 32.2 | 570 | 31.7 |
| | 22 | 0.38 | 7.10 | 6.34 | 25.0 | 26 | 325 | 27.2 | 475 | 26.4 |
| | 23 | 0.41 | 7.10 | 6.28 | 26.9 | 26 | 350 | 29.1 | 510 | 28.2 |
| | 24 | 0.44 | 7.10 | 6.22 | 28.7 | 26 | 370 | 30.9 | 545 | 30.2 |
| | 25 | 0.48 | 7.10 | 6.14 | 31.1 | 26 | 400 | 33.3 | 585 | 32.5 |
| | 26 | 0.52 | 7.10 | 6.06 | 33.5 | 26 | 430 | 35.7 | 630 | 34.9 |
| 8 | 22 | 0.41 | 9.05 | 8.23 | 34.7 | 41 | 455 | 38.1 | 665 | 36.9 |
| | 23 | 0.44 | 9.05 | 8.17 | 37.1 | 41 | 485 | 40.5 | 710 | 39.4 |
| | 24 | 0.48 | 9.05 | 8.09 | 40.3 | 41 | 525 | 43.7 | 765 | 42.6 |
| | 25 | 0.52 | 9.05 | 8.01 | 43.5 | 41 | 565 | 46.9 | 825 | 45.8 |
| | 26 | 0.56 | 9.05 | 7.93 | 46.6 | 41 | 600 | 50.0 | 880 | 48.9 |
| | 22 | 0.41 | 9.30 | 8.48 | 35.7 | 42 | 470 | 39.2 | 685 | 38.0 |
| | 23 | 0.44 | 9.30 | 8.42 | 38.2 | 42 | 500 | 41.7 | 730 | 40.5 |
| | 24 | 0.48 | 9.30 | 8.34 | 41.5 | 42 | 540 | 45.0 | 790 | 43.8 |
| | 25 | 0.52 | 9.30 | 8.26 | 44.8 | 42 | 580 | 48.3 | 850 | 47.1 |
| | 26 | 0.56 | 9.30 | 8.18 | 48.0 | 42 | 620 | 51.5 | 905 | 50.3 |
| | 27 | 0.60 | 9.30 | 8.10 | 51.2 | 42 | 655 | 54.7 | 965 | 53.5 |
| 10 | 22 | 0.44 | 11.10 | 10.22 | 46.0 | 54 | 605 | 50.5 | 880 | 49.0 |
| | 23 | 0.48 | 11.10 | 10.14 | 50.0 | 54 | 655 | 54.5 | 955 | 53.0 |
| | 24 | 0.52 | 11.10 | 10.06 | 53.9 | 54 | 700 | 58.4 | 1025 | 56.9 |
| | 25 | 0.56 | 11.10 | 9.98 | 57.9 | 54 | 750 | 62.4 | 1095 | 60.9 |
| | 26 | 0.60 | 11.10 | 9.90 | 61.8 | 54 | 795 | 66.3 | 1165 | 64.8 |
| | 22 | 0.44 | 11.40 | 10.52 | 47.3 | 56 | 625 | 52.0 | 905 | 50.4 |
| | 23 | 0.48 | 11.40 | 10.44 | 51.4 | 56 | 675 | 56.1 | 980 | 54.5 |
| | 24 | 0.52 | 11.40 | 10.36 | 55.5 | 56 | 720 | 60.2 | 1055 | 58.6 |
| | 25 | 0.56 | 11.40 | 10.28 | 59.5 | 56 | 770 | 64.2 | 1125 | 62.6 |
| | 26 | 0.60 | 11.40 | 10.20 | 63.5 | 56 | 820 | 68.2 | 1200 | 66.6 |
| | 27 | 0.65 | 11.40 | 10.10 | 68.5 | 56 | 880 | 73.2 | 1290 | 71.6 |
| 12 | 22 | 0.48 | 13.20 | 12.24 | 59.8 | 66 | 785 | 65.3 | 1140 | 63.4 |
| | 23 | 0.52 | 13.20 | 12.16 | 64.6 | 66 | 840 | 70.1 | 1230 | 68.3 |
| | 24 | 0.56 | 13.20 | 12.08 | 69.4 | 66 | 900 | 74.9 | 1315 | 73.1 |
| | 25 | 0.60 | 13.20 | 12.00 | 74.1 | 66 | 955 | 79.6 | 1400 | 77.8 |
| | 26 | 0.65 | 13.20 | 11.90 | 80.0 | 66 | 1025 | 85.5 | 1505 | 83.7 |
| | 22 | 0.48 | 13.50 | 12.54 | 61.3 | 67 | 805 | 66.9 | 1170 | 65.0 |
| | 23 | 0.52 | 13.50 | 12.46 | 66.2 | 67 | 860 | 71.8 | 1260 | 69.9 |
| | 24 | 0.56 | 13.50 | 12.38 | 71.0 | 67 | 920 | 76.6 | 1345 | 74.8 |
| | 25 | 0.60 | 13.50 | 12.30 | 75.9 | 67 | 980 | 81.5 | 1435 | 79.7 |
| | 26 | 0.65 | 13.50 | 12.20 | 81.9 | 78 | 1060 | 88.4 | 1550 | 86.2 |
| | 27 | 0.70 | 13.50 | 12.10 | 87.8 | 78 | 1130 | 94.3 | 1660 | 92.1 |
| | 28 | 0.76 | 13.50 | 11.98 | 94.9 | 78 | 1215 | 101.4 | 1785 | 99.2 |
| 14 | 21 | 0.48 | 15.30 | 14.34 | 69.7 | 78 | 915 | 76.2 | 1335 | 74.1 |
| | 22 | 0.51 | 15.30 | 14.28 | 73.9 | 78 | 965 | 80.4 | 1410 | 78.2 |
| | 23 | 0.55 | 15.30 | 14.20 | 79.5 | 78 | 1030 | 86.0 | 1510 | 83.8 |
| | 24 | 0.59 | 15.30 | 14.12 | 85.1 | 78 | 1100 | 91.6 | 1610 | 89.5 |
| | 25 | 0.64 | 15.30 | 14.02 | 92.0 | 78 | 1180 | 98.5 | 1735 | 96.5 |
| | 26 | 0.69 | 15.30 | 13.92 | 98.8 | 78 | 1265 | 105.3 | 1855 | 103.1 |

* Including bell. Calculated weight of pipe rounded off to nearest 5 lb.
† Average weight per foot based on calculated weight of pipe before rounding.

TABLE 6.2 (contd.)

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS

| Nom. Diam. *in.* | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Barrel Weight Per Foot | Bell Weight | Weight Based on 12-ft. Laying Length: Per Length* | Weight Based on 12-ft. Laying Length: Avg. Per Foot† | Weight Based on 18-ft. Laying Length: Per Length* | Weight Based on 18-ft. Laying Length: Avg. Per Foot† |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *in.* | | | *lb.* | | | | | |
| 14 | 21 | 0.48 | 15.65 | 14.69 | 71.4 | 80 | 935 | 78.1 | 1365 | 75.8 |
| | 22 | 0.51 | 15.65 | 14.63 | 75.7 | 80 | 990 | 82.4 | 1445 | 80.2 |
| | 23 | 0.55 | 15.65 | 14.55 | 81.4 | 80 | 1055 | 88.1 | 1545 | 85.8 |
| | 24 | 0.59 | 15.65 | 14.47 | 87.1 | 80 | 1125 | 93.8 | 1650 | 91.6 |
| | 25 | 0.64 | 15.65 | 14.37 | 94.2 | 80 | 1210 | 100.9 | 1775 | 98.7 |
| | 26 | 0.69 | 15.65 | 14.27 | 101.2 | 101 | 1315 | 109.6 | 1925 | 106.9 |
| | 27 | 0.75 | 15.65 | 14.15 | 109.5 | 101 | 1415 | 117.9 | 2070 | 115.1 |
| | 28 | 0.81 | 15.65 | 14.03 | 117.8 | 101 | 1515 | 126.2 | 2220 | 123.4 |
| 16 | 21 | 0.50 | 17.40 | 16.40 | 82.8 | 96 | 1090 | 90.8 | 1585 | 88.1 |
| | 22 | 0.54 | 17.40 | 16.32 | 89.2 | 96 | 1165 | 97.2 | 1700 | 94.5 |
| | 23 | 0.58 | 17.40 | 16.24 | 95.6 | 96 | 1245 | 103.6 | 1815 | 100.9 |
| | 24 | 0.63 | 17.40 | 16.14 | 103.6 | 96 | 1340 | 111.6 | 1960 | 109.0 |
| | 25 | 0.68 | 17.40 | 16.04 | 111.4 | 96 | 1435 | 119.4 | 2100 | 116.8 |
| | 26 | 0.73 | 17.40 | 15.94 | 119.3 | 96 | 1530 | 127.3 | 2245 | 124.8 |
| | 21 | 0.50 | 17.80 | 16.80 | 84.8 | 98 | 1115 | 93.0 | 1625 | 90.2 |
| | 22 | 0.54 | 17.80 | 16.72 | 91.4 | 98 | 1195 | 99.6 | 1745 | 96.9 |
| | 23 | 0.58 | 17.80 | 16.64 | 97.9 | 98 | 1275 | 106.1 | 1860 | 103.3 |
| | 24 | 0.63 | 17.80 | 16.54 | 106.0 | 98 | 1370 | 114.2 | 2005 | 111.5 |
| | 25 | 0.68 | 17.80 | 16.44 | 114.1 | 98 | 1465 | 122.2 | 2150 | 119.5 |
| | 26 | 0.73 | 17.80 | 16.34 | 122.1 | 121 | 1585 | 132.2 | 2320 | 128.8 |
| | 27 | 0.79 | 17.80 | 16.22 | 131.7 | 121 | 1700 | 141.8 | 2490 | 138.4 |
| | 28 | 0.85 | 17.80 | 16.10 | 141.2 | 121 | 1815 | 151.3 | 2665 | 148.0 |
| 18 | 21 | 0.54 | 19.50 | 18.42 | 100.4 | 114 | 1320 | 109.9 | 1920 | 106.7 |
| | 22 | 0.58 | 19.50 | 18.34 | 107.6 | 114 | 1405 | 117.1 | 2050 | 113.9 |
| | 23 | 0.63 | 19.50 | 18.24 | 116.5 | 114 | 1510 | 126.0 | 2210 | 122.8 |
| | 24 | 0.68 | 19.50 | 18.14 | 125.4 | 114 | 1620 | 134.9 | 2370 | 131.8 |
| | 25 | 0.73 | 19.50 | 18.04 | 134.3 | 114 | 1725 | 143.8 | 2530 | 140.6 |
| | 26 | 0.79 | 19.50 | 17.92 | 144.9 | 114 | 1855 | 154.4 | 2720 | 151.2 |
| | 21 | 0.54 | 19.92 | 18.84 | 102.6 | 116 | 1345 | 112.2 | 1965 | 109.1 |
| | 22 | 0.58 | 19.92 | 18.76 | 109.9 | 116 | 1435 | 119.6 | 2095 | 116.3 |
| | 23 | 0.63 | 19.92 | 18.66 | 119.1 | 116 | 1545 | 128.8 | 2260 | 125.5 |
| | 24 | 0.68 | 19.92 | 18.56 | 128.2 | 116 | 1655 | 137.9 | 2425 | 134.8 |
| | 25 | 0.73 | 19.92 | 18.46 | 137.3 | 116 | 1765 | 147.0 | 2585 | 143.7 |
| | 26 | 0.79 | 19.92 | 18.34 | 148.1 | 145 | 1920 | 160.2 | 2810 | 156.1 |
| | 27 | 0.85 | 19.92 | 18.22 | 158.9 | 145 | 2050 | 171.0 | 3005 | 166.9 |
| | 28 | 0.92 | 19.92 | 18.08 | 171.3 | 145 | 2200 | 183.4 | 3230 | 179.4 |
| 20 | 21 | 0.57 | 21.60 | 20.46 | 117.5 | 133 | 1545 | 128.6 | 2250 | 124.9 |
| | 22 | 0.62 | 21.60 | 20.36 | 127.5 | 133 | 1665 | 138.6 | 2430 | 134.9 |
| | 23 | 0.67 | 21.60 | 20.26 | 137.5 | 133 | 1785 | 148.6 | 2610 | 144.9 |
| | 24 | 0.72 | 21.60 | 20.16 | 147.4 | 133 | 1900 | 158.5 | 2785 | 154.8 |
| | 25 | 0.78 | 21.60 | 20.04 | 159.2 | 133 | 2045 | 170.3 | 3000 | 166.8 |
| | 26 | 0.84 | 21.60 | 19.92 | 170.9 | 133 | 2185 | 182.0 | 3210 | 178.4 |
| | 21 | 0.57 | 22.06 | 20.92 | 120.1 | 136 | 1575 | 131.4 | 2300 | 127.7 |
| | 22 | 0.62 | 22.06 | 20.82 | 130.3 | 136 | 1700 | 141.6 | 2480 | 137.9 |
| | 23 | 0.67 | 22.06 | 20.72 | 140.5 | 136 | 1820 | 151.8 | 2665 | 148.1 |
| | 24 | 0.72 | 22.06 | 20.62 | 150.6 | 136 | 1945 | 161.9 | 2845 | 158.1 |
| | 25 | 0.78 | 22.06 | 20.50 | 162.7 | 136 | 2090 | 174.0 | 3065 | 170.3 |
| | 26 | 0.84 | 22.06 | 20.38 | 174.7 | 171 | 2265 | 188.9 | 3315 | 184.1 |
| | 27 | 0.91 | 22.06 | 20.24 | 188.7 | 171 | 2435 | 203.0 | 3570 | 198.2 |
| | 28 | 0.98 | 22.06 | 20.10 | 202.5 | 171 | 2600 | 216.8 | 3815 | 212.0 |
| 24 | 21 | 0.63 | 25.80 | 24.54 | 155.4 | 179 | 2045 | 170.3 | 2975 | 165.3 |
| | 22 | 0.68 | 25.80 | 24.44 | 167.4 | 179 | 2190 | 182.3 | 3190 | 177.3 |
| | 23 | 0.73 | 25.80 | 24.34 | 179.4 | 179 | 2330 | 194.3 | 3410 | 189.4 |
| | 24 | 0.79 | 25.80 | 24.22 | 193.7 | 179 | 2505 | 208.6 | 3665 | 203.6 |
| | 25 | 0.85 | 25.80 | 24.10 | 207.9 | 179 | 2675 | 222.8 | 3920 | 217.8 |
| | 26 | 0.92 | 25.80 | 23.96 | 224.4 | 179 | 2870 | 239.3 | 4220 | 234.4 |
| | 21 | 0.63 | 26.32 | 25.06 | 158.6 | 182 | 2085 | 173.8 | 3035 | 168.7 |
| | 22 | 0.68 | 26.32 | 24.96 | 170.9 | 182 | 2235 | 186.1 | 3260 | 181.0 |
| | 23 | 0.73 | 26.32 | 24.86 | 183.1 | 182 | 2380 | 198.3 | 3480 | 193.2 |
| | 24 | 0.79 | 26.32 | 24.74 | 197.7 | 182 | 2555 | 212.9 | 3740 | 207.8 |
| | 25 | 0.85 | 26.32 | 24.62 | 212.2 | 182 | 2730 | 227.4 | 4000 | 222.3 |
| | 26 | 0.92 | 26.32 | 24.48 | 229.0 | 229 | 2975 | 248.1 | 4350 | 241.7 |
| | 27 | 0.99 | 26.32 | 24.34 | 245.8 | 229 | 3180 | 264.9 | 4655 | 258.5 |
| | 28 | 1.07 | 26.32 | 24.18 | 264.8 | 229 | 3405 | 283.9 | 4995 | 277.5 |

* Including bell. Calculated weight of pipe rounded off to nearest 5 lb.
† Average weight per foot based on calculated weight of pipe before rounding.

PIPE CENTRIFUGALLY CAST IN METAL MOLDS

TABLE 6.3

STANDARD THICKNESSES AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS*

| Size | Thickness | Outside Diam. | Weight Based on | | | |
|---|---|---|---|---|---|---|
| | | | 12-ft. Laying Length | | 18-ft. Laying Length | |
| | | | Avg. Per Foot† | Per Length‡ | Avg. Per Foot† | Per Length‡ |
| | *in.* | | *lb.* | | | |
| Class 50—50-psi. Pressure—115-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.44 | 11.10 | 50.5 | 605 | 49.0 | 880 |
| 12 | 0.48 | 13.20 | 65.3 | 785 | 63.4 | 1140 |
| 14 | 0.48 | 15.30 | 76.2 | 915 | 74.1 | 1335 |
| 16 | 0.54 | 17.40 | 97.2 | 1165 | 94.5 | 1700 |
| 18 | 0.54 | 19.50 | 109.9 | 1320 | 106.7 | 1920 |
| 20 | 0.57 | 21.60 | 128.6 | 1545 | 124.9 | 2250 |
| 24 | 0.63 | 25.80 | 170.3 | 2045 | 165.3 | 2975 |
| Class 100—100-psi. Pressure—231-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.44 | 11.10 | 50.5 | 605 | 49.0 | 880 |
| 12 | 0.48 | 13.20 | 65.3 | 785 | 63.4 | 1140 |
| 14 | 0.51 | 15.30 | 80.4 | 965 | 78.2 | 1410 |
| 16 | 0.54 | 17.40 | 97.2 | 1165 | 94.5 | 1700 |
| 18 | 0.58 | 19.50 | 117.1 | 1405 | 113.9 | 2050 |
| 20 | 0.62 | 21.60 | 138.6 | 1665 | 134.9 | 2430 |
| 24 | 0.68 | 25.80 | 182.3 | 2190 | 177.3 | 3190 |
| Class 150—150-psi. Pressure—346-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.44 | 11.10 | 50.5 | 605 | 49.0 | 880 |
| 12 | 0.48 | 13.20 | 65.3 | 785 | 63.4 | 1140 |
| 14 | 0.51 | 15.65 | 82.4 | 990 | 80.2 | 1445 |
| 16 | 0.54 | 17.80 | 99.6 | 1195 | 96.9 | 1745 |
| 18 | 0.58 | 19.92 | 119.6 | 1435 | 116.3 | 2095 |
| 20 | 0.62 | 22.06 | 141.6 | 1700 | 137.9 | 2480 |
| 24 | 0.73 | 26.32 | 198.3 | 2380 | 193.2 | 3480 |

* These thicknesses and weights are for pipe laid without blocks, on flat-bottom trench, with tamped backfill, under 5 ft. of cover. For other conditions, see Tables 6.2 and 6.4 hereof and ASA A21.1, "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

† Average weight per foot based on calculated weight of pipe before rounding.

‡ Including bell. Calculated weight of pipe rounded off to nearest 5 lb.

TABLE 6.3 (contd.)

STANDARD THICKNESSES AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS*

| Size | Thickness | Outside Diam. | Weight Based on | | | |
|---|---|---|---|---|---|---|
| | | | 12-ft. Laying Length | | 18-ft. Laying Length | |
| | | | Avg. Per Foot† | Per Length‡ | Avg. Per Foot† | Per Length‡ |
| | *in.* | | | *lb.* | | |
| Class 200—200-psi. Pressure—462-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.44 | 11.10 | 50.5 | 605 | 49.0 | 880 |
| 12 | 0.48 | 13.20 | 65.3 | 785 | 63.4 | 1140 |
| 14 | 0.55 | 15.65 | 88.1 | 1055 | 85.8 | 1545 |
| 16 | 0.58 | 17.80 | 106.1 | 1275 | 103.3 | 1860 |
| 18 | 0.63 | 19.92 | 128.8 | 1545 | 125.5 | 2260 |
| 20 | 0.67 | 22.06 | 151.8 | 1820 | 148.1 | 2665 |
| 24 | 0.79 | 26.32 | 212.9 | 2555 | 207.8 | 3740 |
| Class 250—250-psi. Pressure—577-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.44 | 11.10 | 50.5 | 605 | 49.0 | 880 |
| 12 | 0.52 | 13.20 | 70.1 | 840 | 68.3 | 1230 |
| 14 | 0.59 | 15.65 | 93.8 | 1125 | 91.6 | 1650 |
| 16 | 0.63 | 17.80 | 114.2 | 1370 | 111.5 | 2005 |
| 18 | 0.68 | 19.92 | 137.9 | 1655 | 134.8 | 2425 |
| 20 | 0.72 | 22.06 | 161.9 | 1945 | 158.1 | 2845 |
| 24 | 0.79 | 26.32 | 212.9 | 2555 | 207.8 | 3740 |
| Class 300—300-psi. Pressure—693-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.48 | 11.10 | 54.5 | 655 | 53.0 | 955 |
| 12 | 0.52 | 13.20 | 70.1 | 840 | 68.3 | 1230 |
| 14 | 0.59 | 15.65 | 93.8 | 1125 | 91.6 | 1650 |
| 16 | 0.68 | 17.80 | 122.2 | 1465 | 119.5 | 2150 |
| 18 | 0.73 | 19.92 | 147.0 | 1765 | 143.7 | 2585 |
| 20 | 0.78 | 22.06 | 174.0 | 2090 | 170.3 | 3065 |
| 24 | 0.85 | 26.32 | 227.4 | 2730 | 222.3 | 4000 |

* These thicknesses and weights are for pipe laid without blocks, on flat-bottom trench, with tamped backfill, under 5 ft. of cover. For other conditions, see Tables 6.2 and 6.4 hereof and ASA A21.1, "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

† Average weight per foot based on calculated weight of pipe before rounding.

‡ Including bell. Calculated weight of pipe rounded off to nearest 5 lb.

PIPE CENTRIFUGALLY CAST IN METAL MOLDS

TABLE 6.3 (contd.)

STANDARD THICKNESSES AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS*

| Size | Thickness | Outside Diam. | Weight Based on 12-ft. Laying Length: Avg. Per Foot† | Weight Based on 12-ft. Laying Length: Per Length‡ | Weight Based on 18-ft. Laying Length: Avg. Per Foot† | Weight Based on 18-ft. Laying Length: Per Length‡ |
|---|---|---|---|---|---|---|
| | *in.* | | *lb.* | | | |
| Class 350—350-psi. Pressure—808-ft. Head | | | | | | |
| 3 | 0.32 | 3.96 | 12.5 | 150 | 12.0 | 215 |
| 4 | 0.35 | 4.80 | 16.6 | 200 | 16.1 | 290 |
| 6 | 0.38 | 6.90 | 26.4 | 315 | 25.6 | 460 |
| 8 | 0.41 | 9.05 | 38.1 | 455 | 36.9 | 665 |
| 10 | 0.52 | 11.10 | 58.4 | 700 | 56.9 | 1025 |
| 12 | 0.56 | 13.20 | 74.9 | 900 | 73.1 | 1315 |
| 14 | 0.64 | 15.65 | 100.9 | 1210 | 98.7 | 1775 |
| 16 | 0.68 | 17.80 | 122.2 | 1465 | 119.5 | 2150 |
| 18 | 0.79 | 19.92 | 160.2 | 1920 | 156.1 | 2810 |
| 20 | 0.84 | 22.06 | 188.9 | 2265 | 184.1 | 3315 |
| 24 | 0.92 | 26.32 | 248.1 | 2975 | 241.7 | 4350 |

* These thicknesses and weights are for pipe laid without blocks, on flat-bottom trench, with tamped backfill, under 5 ft. of cover. For other conditions, see Tables 6.2 and 6.4 hereof and ASA A21.1, "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

† Average weight per foot based on calculated weight of pipe before rounding.

‡ Including bell. Calculated weight of pipe rounded off to nearest 5 lb.

TABLE 6.4

STANDARD THICKNESSES* OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS

Laying Condition A—Flat-Bottom Trench, Without Blocks, Untamped Backfill
Laying Condition B—Flat-Bottom Trench, Without Blocks, Tamped Backfill
Laying Condition C—Pipe Laid on Blocks, Untamped Backfill
Laying Condition D—Pipe Laid on Blocks, Tamped Backfill

| Size *in.* | Working Pressure *psi.* | 3½ ft. of Cover | | | | 5 ft. of Cover | | | | 8 ft. of Cover | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Laying Condition | | | | Laying Condition | | | | Laying Condition | | | |
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| | | Thickness—*in.* | | | | | | | | | | | |
| 3 | 50 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 100 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 150 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 200 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 250 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 300 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 350 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| 4 | 50 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.41 | 0.35 |
| | 100 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.41 | 0.35 |
| | 150 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.41 | 0.35 |
| | 200 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| | 250 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| | 300 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| | 350 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| 6 | 50 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 |
| | 100 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 |
| | 150 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 |
| | 200 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| | 250 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| | 300 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| | 350 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| 8 | 50 | 0.41 | 0.41 | 0.44 | 0.41 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 |
| | 100 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.56 | 0.41 |
| | 150 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.56 | 0.41 |
| | 200 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 | 0.41 | 0.41 | 0.56 | 0.44 |
| | 250 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 | 0.44 | 0.41 | 0.56 | 0.44 |
| | 300 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 | 0.44 | 0.44 | 0.60 | 0.44 |
| | 350 | 0.41 | 0.41 | 0.52 | 0.41 | 0.44 | 0.41 | 0.52 | 0.44 | 0.48 | 0.44 | 0.60 | 0.48 |
| 10 | 50 | 0.44 | 0.44 | 0.48 | 0.44 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.60 | 0.48 |
| | 100 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.52 | 0.44 | 0.48 | 0.44 | 0.60 | 0.48 |
| | 150 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.56 | 0.44 | 0.48 | 0.44 | 0.60 | 0.48 |
| | 200 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.56 | 0.44 | 0.48 | 0.48 | 0.60 | 0.52 |
| | 250 | 0.44 | 0.44 | 0.56 | 0.44 | 0.48 | 0.44 | 0.56 | 0.48 | 0.52 | 0.48 | 0.65 | 0.52 |
| | 300 | 0.48 | 0.44 | 0.56 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.52 | 0.65 | 0.56 |
| | 350 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.52 | 0.60 | 0.52 | 0.56 | 0.52 | 0.65 | 0.56 |
| 12 | 50 | 0.48 | 0.48 | 0.52 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.48 | 0.65 | 0.52 |
| | 100 | 0.48 | 0.48 | 0.56 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.48 | 0.65 | 0.52 |
| | 150 | 0.48 | 0.48 | 0.56 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.52 | 0.65 | 0.56 |
| | 200 | 0.48 | 0.48 | 0.56 | 0.48 | 0.48 | 0.48 | 0.60 | 0.52 | 0.56 | 0.52 | 0.65 | 0.56 |
| | 250 | 0.52 | 0.48 | 0.60 | 0.52 | 0.52 | 0.52 | 0.60 | 0.52 | 0.56 | 0.56 | 0.70 | 0.60 |
| | 300 | 0.52 | 0.52 | 0.60 | 0.52 | 0.56 | 0.52 | 0.60 | 0.56 | 0.60 | 0.56 | 0.70 | 0.60 |
| | 350 | 0.56 | 0.56 | 0.60 | 0.56 | 0.56 | 0.56 | 0.65 | 0.60 | 0.60 | 0.60 | 0.76 | 0.65 |

* Thicknesses include allowances for foundry practice, corrosion, and either water hammer or truck load.

PIPE CENTRIFUGALLY CAST IN METAL MOLDS

**TABLE 6.4 (contd.)**

**STANDARD THICKNESSES* OF PIPE CENTRIFUGALLY CAST IN METAL MOLDS**

Laying Condition A—Flat-Bottom Trench, Without Blocks, Untamped Backfill
Laying Condition B—Flat-Bottom Trench, Without Blocks, Tamped Backfill
Laying Condition C—Pipe Laid on Blocks, Untamped Backfill
Laying Condition D—Pipe Laid on Blocks, Tamped Backfill

| Size *in.* | Working Pressure *psi.* | 3½ ft. of Cover — Laying Condition | | | | 5 ft. of Cover — Laying Condition | | | | 8 ft. of Cover — Laying Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| | | Thickness—*in.* | | | | | | | | | | | |
| 14 | 50 | 0.51 | 0.48 | 0.59 | 0.51 | 0.51 | 0.48 | 0.59 | 0.55 | 0.59 | 0.55 | 0.69 | 0.59 |
| | 100 | 0.51 | 0.48 | 0.59 | 0.55 | 0.55 | 0.51 | 0.64 | 0.55 | 0.59 | 0.55 | 0.69 | 0.64 |
| | 150 | 0.55 | 0.51 | 0.59 | 0.55 | 0.55 | 0.51 | 0.64 | 0.59 | 0.64 | 0.59 | 0.75 | 0.64 |
| | 200 | 0.55 | 0.51 | 0.64 | 0.59 | 0.55 | 0.55 | 0.64 | 0.59 | 0.64 | 0.59 | 0.75 | 0.69 |
| | 250 | 0.59 | 0.55 | 0.64 | 0.59 | 0.59 | 0.59 | 0.69 | 0.59 | 0.64 | 0.64 | 0.75 | 0.69 |
| | 300 | 0.59 | 0.59 | 0.69 | 0.59 | 0.64 | 0.59 | 0.69 | 0.64 | 0.69 | 0.64 | 0.81 | 0.69 |
| | 350 | 0.64 | 0.64 | 0.69 | 0.64 | 0.64 | 0.64 | 0.75 | 0.69 | 0.75 | 0.69 | 0.81 | 0.75 |
| 16 | 50 | 0.54 | 0.50 | 0.63 | 0.58 | 0.58 | 0.54 | 0.63 | 0.58 | 0.63 | 0.58 | 0.73 | 0.63 |
| | 100 | 0.54 | 0.54 | 0.63 | 0.58 | 0.58 | 0.54 | 0.68 | 0.58 | 0.63 | 0.58 | 0.73 | 0.68 |
| | 150 | 0.58 | 0.54 | 0.63 | 0.58 | 0.58 | 0.54 | 0.68 | 0.63 | 0.68 | 0.63 | 0.79 | 0.68 |
| | 200 | 0.58 | 0.58 | 0.68 | 0.63 | 0.63 | 0.58 | 0.68 | 0.63 | 0.68 | 0.63 | 0.79 | 0.73 |
| | 250 | 0.63 | 0.58 | 0.68 | 0.63 | 0.63 | 0.63 | 0.73 | 0.68 | 0.73 | 0.68 | 0.79 | 0.73 |
| | 300 | 0.63 | 0.63 | 0.73 | 0.68 | 0.68 | 0.68 | 0.73 | 0.68 | 0.73 | 0.73 | 0.85 | 0.79 |
| | 350 | 0.68 | 0.68 | 0.73 | 0.68 | 0.73 | 0.68 | 0.79 | 0.73 | 0.79 | 0.73 | 0.85 | 0.79 |
| 18 | 50 | 0.58 | 0.54 | 0.63 | 0.58 | 0.58 | 0.54 | 0.68 | 0.63 | 0.68 | 0.63 | 0.79 | 0.68 |
| | 100 | 0.58 | 0.54 | 0.68 | 0.63 | 0.63 | 0.58 | 0.73 | 0.63 | 0.68 | 0.63 | 0.79 | 0.73 |
| | 150 | 0.63 | 0.58 | 0.68 | 0.63 | 0.63 | 0.58 | 0.73 | 0.68 | 0.73 | 0.68 | 0.79 | 0.73 |
| | 200 | 0.63 | 0.58 | 0.73 | 0.68 | 0.68 | 0.63 | 0.73 | 0.68 | 0.73 | 0.68 | 0.85 | 0.79 |
| | 250 | 0.68 | 0.63 | 0.73 | 0.68 | 0.68 | 0.68 | 0.79 | 0.73 | 0.79 | 0.73 | 0.85 | 0.79 |
| | 300 | 0.68 | 0.68 | 0.79 | 0.73 | 0.73 | 0.73 | 0.79 | 0.79 | 0.79 | 0.79 | 0.92 | 0.85 |
| | 350 | 0.79 | 0.73 | 0.79 | 0.79 | 0.79 | 0.79 | 0.85 | 0.79 | 0.85 | 0.85 | 0.92 | 0.85 |
| 20 | 50 | 0.62 | 0.57 | 0.72 | 0.62 | 0.67 | 0.57 | 0.72 | 0.67 | 0.72 | 0.67 | 0.78 | 0.72 |
| | 100 | 0.62 | 0.57 | 0.72 | 0.67 | 0.67 | 0.62 | 0.78 | 0.67 | 0.72 | 0.67 | 0.84 | 0.78 |
| | 150 | 0.67 | 0.62 | 0.72 | 0.67 | 0.67 | 0.62 | 0.78 | 0.72 | 0.78 | 0.72 | 0.84 | 0.78 |
| | 200 | 0.67 | 0.62 | 0.78 | 0.72 | 0.72 | 0.67 | 0.78 | 0.72 | 0.78 | 0.72 | 0.91 | 0.84 |
| | 250 | 0.72 | 0.67 | 0.78 | 0.72 | 0.78 | 0.72 | 0.84 | 0.78 | 0.84 | 0.78 | 0.91 | 0.84 |
| | 300 | 0.78 | 0.72 | 0.84 | 0.78 | 0.78 | 0.78 | 0.84 | 0.84 | 0.84 | 0.84 | 0.98 | 0.91 |
| | 350 | 0.84 | 0.78 | 0.84 | 0.84 | 0.84 | 0.84 | 0.91 | 0.84 | 0.91 | 0.84 | 0.98 | 0.91 |
| 24 | 50 | 0.68 | 0.63 | 0.79 | 0.68 | 0.73 | 0.63 | 0.79 | 0.73 | 0.79 | 0.73 | 0.85 | 0.79 |
| | 100 | 0.73 | 0.63 | 0.79 | 0.73 | 0.73 | 0.68 | 0.85 | 0.79 | 0.85 | 0.73 | 0.92 | 0.85 |
| | 150 | 0.73 | 0.68 | 0.79 | 0.79 | 0.79 | 0.73 | 0.85 | 0.79 | 0.85 | 0.79 | 0.92 | 0.85 |
| | 200 | 0.79 | 0.73 | 0.85 | 0.79 | 0.79 | 0.79 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.92 |
| | 250 | 0.79 | 0.79 | 0.85 | 0.85 | 0.85 | 0.79 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.99 |
| | 300 | 0.85 | 0.85 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.92 | 0.99 | 0.92 | 1.07 | 0.99 |
| | 350 | 0.92 | 0.92 | 0.99 | 0.92 | 0.99 | 0.92 | 0.99 | 0.99 | 1.07 | 0.99 | 1.07 | 1.07 |

* Thicknesses include allowances for foundry practice, corrosion, and either water hammer or truck load.

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A21.7–1952

American Standard

# SPECIFICATIONS

*for*

# CAST IRON PIPE CENTRIFUGALLY CAST IN METAL MOLDS FOR GAS

SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

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Note 1—Tables showing additional thicknesses required for greater depths of cover and other conditions of laying will be found in ASA A21.1.

Note 2—Users of these tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

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Users of this document should make reference to "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe" (ASA A21.1) for complete information concerning the conditions which various thicknesses of pipe are designed to meet. The foreword of the Manual also contains a statement regarding the history of the specifications and references to other related documents.

ASA
A21.7–1952

# AMERICAN STANDARD SPECIFICATIONS
for
# CAST IRON PIPE CENTRIFUGALLY CAST IN METAL MOLDS FOR GAS

This specification covers cast iron pipe centrifugally cast in metal molds for gas.

**Section 7-1—Definitions**

PURCHASER. Wherever the word "Purchaser" is used herein, it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

HEAT. A heat is a period during which a cupola or furnace is operated continuously.

RUN. A run is a period of one or more shifts during which a shop is operated continuously.

MIXTURE OF IRON. Mixture of iron is a combination of pig iron, scrap, coke and other raw materials charged to a cupola or furnace to give a desired composition of iron; or a combination of molten iron from one or more sources, made in a forehearth or ladle to give a desired composition of iron.

SOURCE OF IRON. A source of iron is a cupola, furnace or forehearth from which iron is delivered to a transfer or pouring ladle.

FOREHEARTH. A forehearth is a refractory-lined receptable for the temporary storage of molten iron from one or more cupolas or furnaces.

**Section 7-2—Description of Pipe**

The pipe shall be made with bell and spigot ends, plain ends or such other type of ends as may be agreed upon at the time of purchase. Pipe with bell and spigot ends shall conform to the dimensions and weights given in the following tables. Pipe with other types of ends shall comply with the dimensions agreed upon, but in all other respects shall fulfill the specifications hereinafter given. Pipe shall be straight and shall be true circles in section, with their inner and outer surfaces concentric. They shall be cast at least 12 feet in nominal laying length. This type of pipe is commonly made at present (1952) in 12- and 18-foot lengths.

### Section 7-3—Casting of Pipe

The pipe shall be centrifugally cast in metal molds and after withdrawal from the molds, pipe shall be heat-treated to meet the requirements of this specification.

### Section 7-4—Quality of Iron

(7-4.1) All pipe shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the pipe to be cast, that the iron in the pipe shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting and it shall comply with the physical specifications given in Sect. 7-17 and 7-18. The metal shall be remelted in a cupola or other suitable furnace.

(7-4.2) The iron in the pipe shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulphur. Samples for chemical analyses shall be taken by drilling completely through from skin to skin either acceptance test specimens or specimens cast for this purpose but not to exceed three specimens per heat of approximately eight hours. In case of dispute, analyses will be determined on samples taken from the pipe in question.

### Section 7-5—Quality of Castings

The pipe shall be smooth, free from scales, lumps, blisters, sand holes, laps, and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

### Section 7-6—Foundry Records

A record of the results of the following tests shall be made and retained for at least one year. Upon request such record will be available to purchaser at the foundry. If written transcripts of the results of any of these tests are desired, this fact shall be noted in the order for pipe, naming tests of which transcripts are desired. The methods of testing and the dimensions of all test specimens are given in the Appendix.

(7-6.1) *Chemical Analyses*

Chemical analyses of each iron mixture used directly in the pouring of pipe, obtained as in Sect. 7-4.2 shall be made for silicon, sulphur, manganese, phosphorus and total carbon during the first hour and at intervals not to exceed three hours throughout the heat. If pipe are poured directly from the cupola, chemical analyses shall be made of iron from the first and from the last ladle. In case the mixture is changed one or more times during a heat in order to produce a different iron, the time of taking samples shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality.

(7-6.2) *Pouring Temperatures*

The pouring temperature of the iron shall be taken at the casting ladle for each size of pipe at least once each hour.

(7-6.3) *Hardness Tests*

(See Sect. 7-17.2, also Appendix under "Talbot Strip Tests.")

(7-6.4) *Talbot Strip Tests*

(See Sect. 7-17.1.)

(7-6.5) *Periodic Ring, Strip and Full Length Bursting Tests*

(See Sect. 7-17 and 7-18.)

**Section 7-7—Marking Pipe**

Each pipe shall have the weight and class designation conspicuously painted on it. In addition, each bell and spigot pipe shall have distinctly cast or stamped on the face of the bell the manufacturer's mark and the year in which the pipe was cast. When specified by the purchaser, the manufacturer's mark, year in which pipe was cast and initials not exceeding four in number shall be distinctly cast on the face of the bell. The size of letters and figures is to be as large as practicable. Pipe with ends other than bell and spigot are to be marked as agreed upon at the time of purchase.

**Section 7-8—Inspection by Purchaser**

(7-8.1) *Power of Purchaser to Inspect*

The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, the pattern work, molding, casting, heat-treating and coating (if used) of the pipe. The forms, sizes, uniformity and conditions of all pipe herein referred to shall be subject to his inspection and approval, and he may reject, without subjection to hydrostatic test, any pipe which is not in conformity with the specifications or drawings. Any pipe rejected shall be marked as rejected and any marks pertaining to the purchaser shall be chipped or erased from such pipe.

(7-8.2) *Manufacturer to Furnish Men and Materials*

The manufacturer shall provide tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the pipe at the foundry.

(7-8.3) *Report of Purchaser's Inspection*

The purchaser shall make written report daily to the foundry office of all pipe rejected with the causes of rejection.

**Section 7-9—Inspection and Certification by Manufacturer**

Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made and met as specified. If written transcripts of any of these test results are required, including chemical tests if desired, a request for same, specifying the tests of which transcripts are desired, shall accompany the order.

**Section 7-10—Pipe to be Delivered Sound**

All the pipe shall be delivered in all respects sound and in conformity with these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this respect, and any defective pipe which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for pipe found to be damaged after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the pipe not to injure the coating (if used) and no pipe or other material of any kind shall be placed in the pipe during transportation.

### Section 7-11—Cut Pipe

Defective spigot ends on pipe may be cut off in a manner which will produce a square end. Not more than 10 per cent of the total number of pipe of each size of a given order may be shipped as cut pipe. Such cut pipe when cut from 12-foot lengths shall have a nominal laying length of not less than 11 feet; pipe originally of 16 feet or greater length shall not be cut more than 2 feet.

### Section 7-12—Tolerances or Maximum Permitted Variations from Standard Dimensions

(7-12.1) *Tolerances in Diameter of Pipe and Sockets*

Outside diameters of pipe barrels, spigot ends and inside diameters of sockets shall be kept as nearly as practicable to the specified dimensions. The inside diameters of the sockets and the outside diameters of the spigot ends shall be tested with circular gauges. Tolerances or maximum permitted variations from standard dimensions are listed in the following table.

| Nominal Pipe Diameter Inches | Tolerances, Plus or Minus Inches |
|---|---|
| 4 to 12 | .06 |
| 16 to 24 | .08 |

(7-12.2) *Tolerances in Thickness*

The minus tolerances from standard thickness of pipe and dimensions a, b, c, and d of the bell are listed in the following table.

| Nominal Pipe Diameter Inches | Minus Tolerances Inches |
|---|---|
| 4 to 8 | .05 |
| 10 to 12 | .06 |
| 16 to 24 | .08 |

*NOTE:* In pipe barrel thickness, tolerances .02 inch greater than those listed above shall be permissible over areas not exceeding 8 inches in length in any direction.

(7-12.3) *Allowable Percentage of Variation in Weight*

The weight of no single pipe shall be less than the nominal tabulated weight by more than 5% for pipe 12 inches or smaller in diameter, nor by more than 4% for pipe larger than 12 inches in diameter. The total weight of any order of 25 tons or more shall not be more than 2% under the total nominal weight. The total excess weight to be paid for on orders of 25 tons or more shall not exceed 2% of the nominal weight and on orders less than 25 tons shall not exceed 5% of the nominal weight. An order is hereby defined as including all the pipe ordered under the terms of a specific contract or purchase order or a single order placed under the terms of a standing contract. Unless otherwise stated in the contract, the ton shall be 2,000 pounds avoirdupois.

### Section 7-13—Cleaning and Inspecting

All pipe shall have fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful inspection and a rolling test before the coating (if used) is applied.

### Section 7-14—Hydrostatic Test

Each pipe shall be subjected to a hydrostatic proof test. The pipe shall be under the test pressure for at least one-half minute. Any pipe showing defects by leaking, sweating, or otherwise, shall be rejected. The test pressures shall be in accordance with the following table.

TABLE OF PRESSURES FOR HYDROSTATIC TESTS

| Nominal Pipe Diameter Inches | Nominal Barrel Thickness Inches | Test Pressures, Lbs. per sq.in. |
|---|---|---|
| 4 to 12 | All Thicknesses | 500 |
| 16 | .60 and less | 400 |
| 16 | .61 and over | 500 |
| 20 | .70 and less | 400 |
| 20 | .71 and over | 500 |
| 24 | .75 and less | 400 |
| 24 | .76 and over | 500 |

### Section 7-15—Weighing

Each length of pipe shall be weighed and the weight plainly marked on the outside or inside of the bell or spigot end.

**Section 7-16—Exterior Coatings**

Any coating (if used) which is to be applied to the pipe, shall be specified in the agreement made at time of purchase.

**Section 7-17—Acceptance Tests for Physical Properties**

The standard acceptance tests for the physical characteristics of the pipe shall be as follows:

(7-17.1) *Talbot Strip Tests*

Talbot strip tests shall be used to determine acceptability of 4 inch to 24 inch pipe for modulus of rupture and secant modulus of elasticity.

(17.1.1) *Sampling.* For sampling, each run shall be divided into periods of approximately three hours each and at least one sample shall be taken during each 3-hour period. The sample for the first period of the run shall be taken during the first hour, or if casting is direct from cupola, from the first ladle. Samples shall be taken so that each size of pipe cast for two hours or longer during the run and each mixture or source of iron used for two hours or longer during the run shall be fairly represented.

(17.1.2) *Method of Testing.* The method of testing Talbot strips is given in the Appendix.

(17.1.3) *Acceptance Values.* The acceptance values for Talbot strip tests shall be as follows:

*Talbot Strips from 4 Inch to 24 Inch Pipe*

| | |
|---|---|
| Modulus of rupture .......... | 40,000 lbs. per sq.in. minimum |
| Secant modulus of elasticity .... | 12,000,000 lbs. per sq.in. maximum |

If modulus of elasticity exceeds 12,000,000, the modulus of rupture shall exceed 40,000 in at least the same proportion.

(7-17.2) *Hardness Tests*

On the outside of each pipe a hardness determination shall be made with a portable instrument. The Rockwell hardness number or its equivalent shall not exceed B-95 using a ball having a diameter of 1.59 millimeters (1/16 inch) and a weight of 100 kilograms (220.5 lbs.). Any harder pipe may be re-heat-treated to meet this requirement. For the purpose of the foundry records, Sect. 7-6.3, hardness tests, shall be made also on Talbot strips as noted in Appendix under Talbot Strip Tests, viz., a Rockwell hardness test shall be made and recorded at three well-distributed points each on outside of pipe and on one machined face.

### Section 7-18—Periodic Ring Tests and Full-Length Bursting Tests

The manufacturer shall periodically make such bursting tests and ring tests in conjunction with strip tests that he can certify the design values of modulus of rupture (40,000 lbs. per sq.in.) and tensile strength of the iron in the pipe (18,000 lbs. per sq.in.). These tests shall be made in accordance with dimensions and methods given in the Appendix.

Pipe for these periodic ring and bursting tests shall be so selected that they will be representative of the sizes and various thicknesses of each size cast. Ring tests shall not be made on 4-inch pipe.

Tests of Talbot strips cut from the ring and hardness tests as provided in the Appendix shall be made in conjunction with ring and bursting tests. At least three Talbot strips shall be tested from each burst pipe and one of these strips shall come from the ring. For pipe for which rings less than 10½ inches long are used, the Talbot strip shall come from parts other than the ring.

Tests and records shall include modulus of rupture of each strip and ring, modulus of elasticity of each strip and of each ring of 12 inches and larger and hardness test on all strips.

At purchaser's request, manufacturer shall furnish a written transcript of ring and bursting tests and tests on Talbot strips made in connection therewith for a period not exceeding one year and for such sizes as requested.

### Section 7-19—Additional Tests Required by Purchaser

If more or other tests than provided in these specifications are required by the purchaser, such tests shall be specified in the invitation for bids.

### Section 7-20—Defective Specimens and Retests

If any test specimen shows defective machining or lack of continuity of metal, it may be discarded and replaced by another specimen. If any sound test specimen fails to meet the specified requirements, the purchaser may permit a retest on two additional sound specimens from pipe cast in the same period as the specimen which failed, in which case both specimens shall meet the prescribed tests to be acceptable.

### Section 7-21—Rejection Due to Failure to Meet the Routine Acceptance Test Requirements

If any routine chemical analysis fails to meet the chemical requirements of Sect. 7-4.2 or if any acceptance test fails to meet the requirements of Sect. 7-17.1.3, 7-17.2 and 7-20, the pipe cast in the period shall be rejected subject to the provisions of Sect. 7-22.

**Section 7-22—Limiting the Rejection Due to Failure to Meet the Routine Acceptance Test Requirements**

The manufacturer may limit the amount of rejection by making similar additional tests on pipe of the same size as that rejected until the rejected lot is bracketed in order of manufacture by two acceptable tests. If a period is rejected, the acceptability of pipe of different sizes from that rejected may be established by making the routine acceptance tests for these sizes.

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## APPENDIX*

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### TABLES†



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### Section 7-A1—Talbot Strip Tests

Talbot strips (Fig. 7.1) shall be machined longitudinally from each pipe specimen selected for testing by this method. These Talbot strips may be cut from a part of the ring little stressed in the ring test—i.e., near one of the elements marked *a* in the illustration of the ring test (Fig. 7.2). The strips in any case will be in cross section as indicated in Fig. 7.1—i.e., will have for their width the thickness of the pipe and for their depth 0.50 in. Their length shall be at least 10½ in. These strips shall be tested as beams on supports 10 in. apart with loads applied perpendicularly to the machined faces at two points 3⅓ in. from

* This Appendix is a part of ASA A21.7—American Standard Specifications for Cast Iron Pipe Centrifugally Cast in Metal Molds, for Gas.

† Data on thicknesses required for greater depths of cover and conditions of laying other than those assumed in the following tables will be found in Appendix B of ASA A21.1—American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe.

Users of the following tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

the supports. The breaking load and the deflection shall be observed and recorded. For purposes of Sec. 7-6.3—Foundry Records, a Rockwell hardness test at three well distributed points each on the outside of the pipe and on one machined face shall be made and recorded.

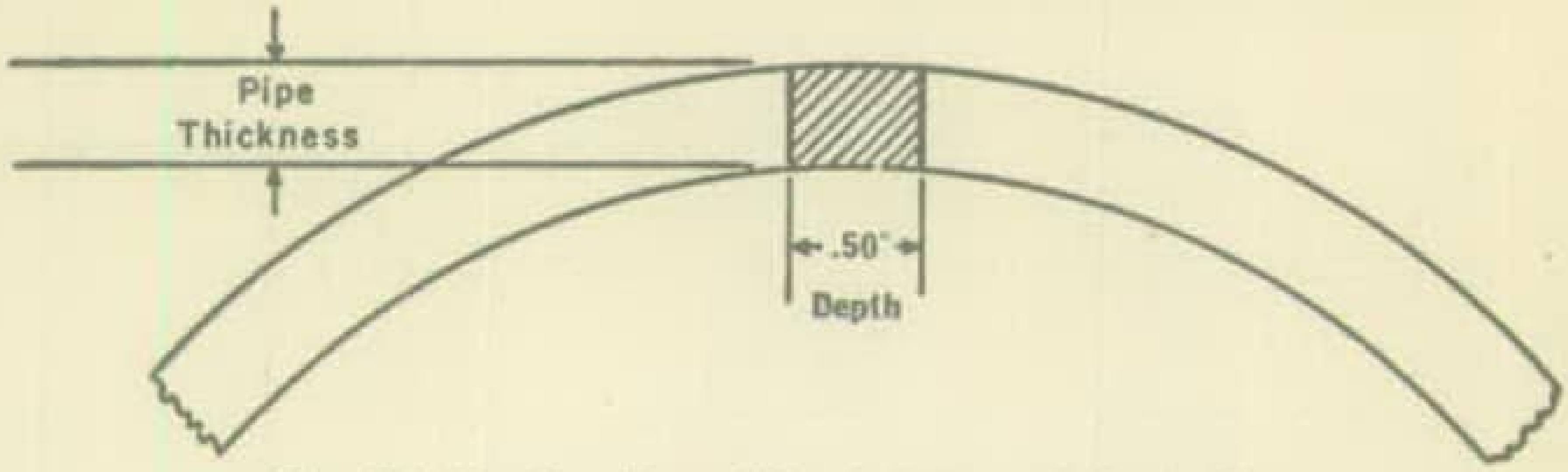



FIG. 7.1. Postion From Which Talbot Strip Is Cut

The strip shall be accurately calipered at the point of rupture and the modulus of rupture, $R$, shall be calculated by the usual beam formula, which for this case reduces to the expression:

$$R = \frac{10W}{td^2}$$

The secant modulus of elasticity, $E_s$, in pounds per square inch, shall be computed by the formula:

$$E_s = \frac{21.3R}{dy}$$

In the above formulas, $R$ is the modulus of rupture lbs. per sq. in., $E_s$ is the secant modulus of elasticity lbs. per sq. in., $W$ is the breaking load (lb.), $d$ is the depth (in.) of the strip (intended to be 0.50 in ), $t$ is the width (in.) of the strip (pipe thickness) and $y$ is the deflection (in.) of the strip at the center at breaking load.

**Section 7-A2—Ring Tests**

The maximum length of any ring shall not exceed 12 in.; for pipe 16 in. and larger, the minimum length shall be 10½ in.; for pipe 12 in. and smaller, the minimum length shall be one-half the nominal diameter of the pipe. Each ring shall be tested by the three-edge bearing method as indicated in Fig. 7.2. The lower bearing for the ring shall consist of two strips with vertical sides having their interior top corners rounded to a radius of approximately ½ in. The strips shall be of hard wood or of metal. If of metal, a piece of fabric or leather approximately

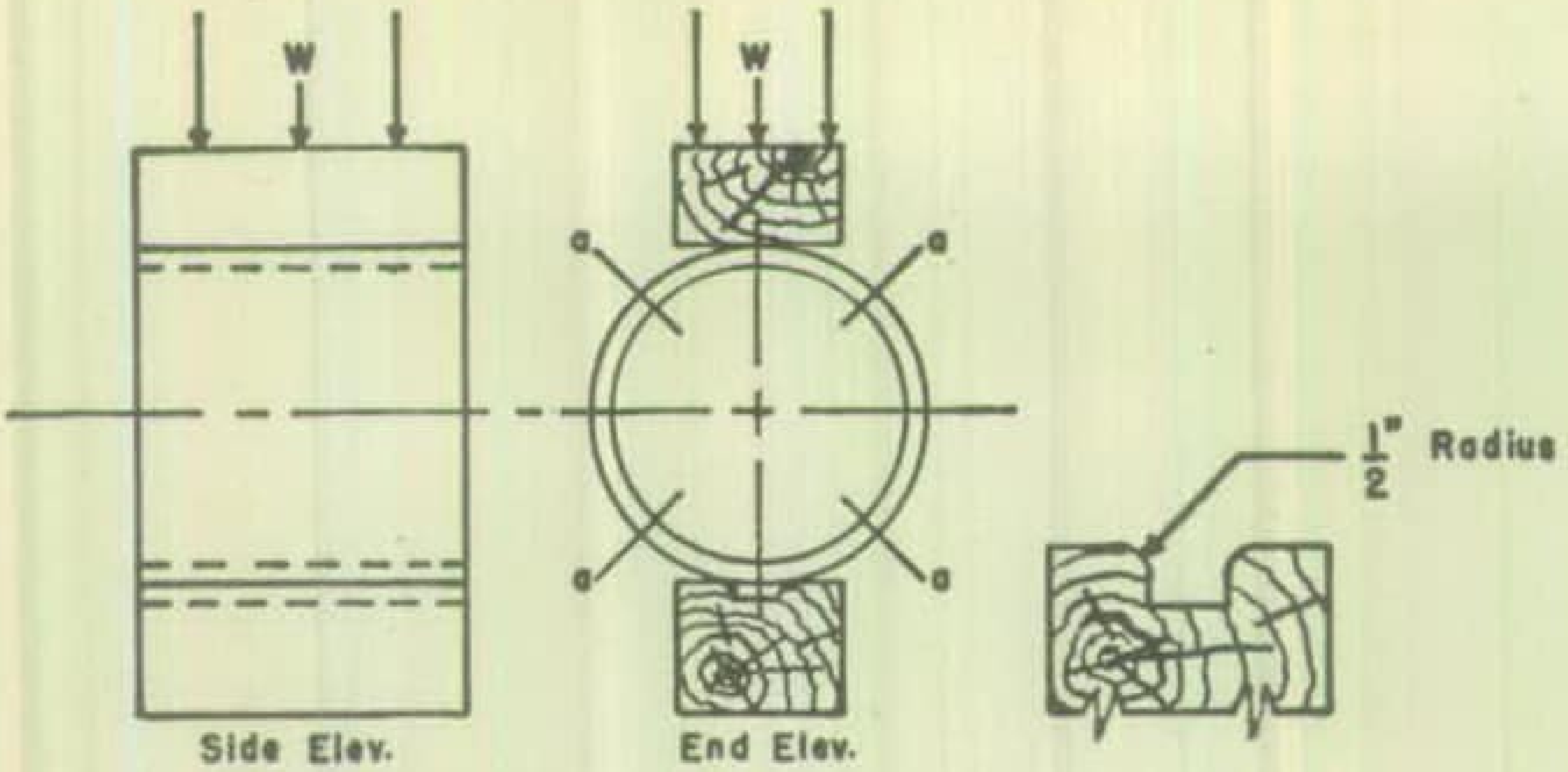



FIG. 7.2. Assembly for Ring Test

3/16 in. thick shall be laid over them. They shall be straight and shall be securely fastened to a rigid block with their interior vertical faces the following distances apart:

| Nom. Pipe Diam. *in.* | Bearing Strip Spacing *in.* |
|---|---|
| 4—12 | ½ |
| 16—24 | 1 |

The upper bearing shall be an oak block, straight and true from end to end. The upper and lower bearings shall extend the full length of the ring. The ring shall be placed symmetrically between the two bearings, and the center of application of the load shall be so placed that the vertical deformation at the two ends of the ring shall be approximately equal. If the ring is not uniform in thickness, it shall be so placed that the thick and thin portions are near the ends of the horizontal diameter.

A record of the breaking load and the vertical deformation of each ring tested shall be made. The modulus of rupture and modulus of elasticity are computed from the formulas:

$$R = 0.954\frac{W(d+t)}{bt^2}$$

$$E = \frac{0.225W(d+t)^3}{bt^3y} = \frac{0.236R(d+t)^2}{ty}$$

in which $R$ is the modulus of rupture lbs. per sq. in., $W$ is the breaking load (lb.), $d$ is the average inside diameter (in.) of the ring, $t$ is the average thickness (in.) of metal along the line of fracture, $b$ is the length (in.) of the ring, $E$ is the modulus of elasticity lbs. per sq. in. and $y$ is the vertical deformation (in.) of the ring at the center.

### Section 7-A3—Full-Length Bursting Tests

The bursting tensile strength shall be determined by testing full-length pipe (less the amount cut off for ring and strip test specimens) to destruction by hydraulic pressure. Bells may be removed to facilitate testing. A suitable means for holding the end thrust shall be used which will not subject the pipe to endwise tension or compression, or other parasitic stresses. A calibrated pressure gage shall be used for determining the bursting pressure. This gage shall be connected to the interior of the test pipe by a separate connection from that which supplies water for the test. The unit tensile strength in bursting shall be obtained by the use of the formula:

$$S = \frac{Pd}{2t}$$

in which $S$ is the bursting tensile strength lbs. per sq. in. of the iron, $P$ is the internal pressure lbs. per sq. in. at bursting, $d$ is the average inside diameter (in.) of the pipe and $t$ is the minimum average thickness (in.) of the pipe along the principal line of break.

Measurements of thickness shall be taken along the principal line of break at 1-ft. intervals.

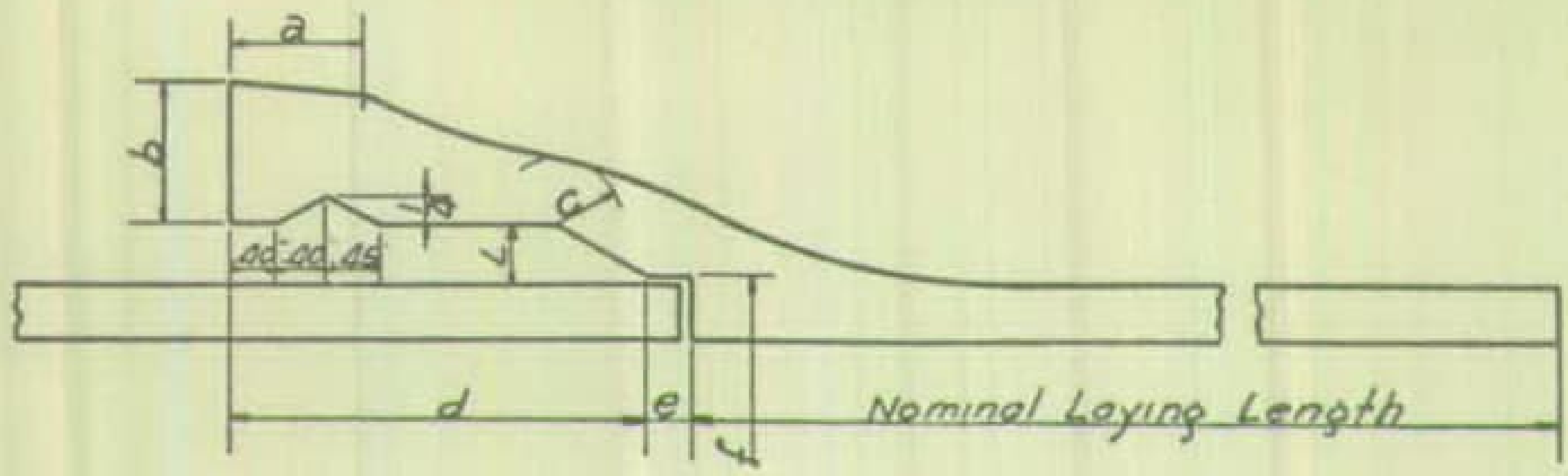
The minimum average thickness along the principal line of break shall be obtained by averaging the measurements at the thinnest section at a weight of two and at the adjacent sections on each side at a weight of one each; or, if the thinnest section is at the end of the break, by averaging this thinnest-section measurement at a weight of two and the measurements of the adjacent section and the next section at a weight of one each.

### Section 7-A4—Deflection Measurements

All deflection measurements required by these specifications shall be that of the specimen and shall not include any compression of the supports or loading blocks, or backlash or distortion of the testing machine.

## Table No. 7.1

### STANDARD DIMENSIONS OF BELLS, SOCKETS and OUTSIDE DIAMETERS FOR GAS PIPE CENTRIFUGALLY CAST IN METAL MOLDS, also WEIGHTS OF BELLS




| Nominal Diam. | Thickness of Pipe | | Out-Side Diam. of Pipe | Dimensions of Bells | | | | | | | | Wt. of Bell |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | Diam. of Socket | Thickness of Joint L | Depth of Socket d | Depth of Centering Shoulder e | Inside Diam. of Centering Shoulder f | a | b | c | |
| 4 | .35 | .41 | 4.80 | 5.80 | .50 | 3.50 | .30 | 4.94 | 1.00 | 1.06 | 0.48 | 17 |
| 6 | .38 | .48 | 6.90 | 7.90 | .50 | 3.50 | .38 | 7.06 | 1.12 | 1.13 | 0.52 | 25 |
| 8 | .41 | .56 | 9.05 | 10.05 | .50 | 4.00 | .38 | 9.21 | 1.12 | 1.28 | 0.64 | 42 |
| 10 | .44 | .60 | 11.10 | 12.10 | .50 | 4.00 | .38 | 11.28 | 1.12 | 1.38 | 0.69 | 55 |
| 12 | .48 | .65 | 13.20 | 14.20 | .50 | 4.00 | .38 | 13.38 | 1.12 | 1.42 | 0.71 | 68 |
| 16 | .50 | .63 | 17.40 | 18.66 | .63 | 4.00 | .50 | 17.62 | 1.25 | 1.50 | 0.75 | 96 |
| | .68 | .73 | 17.40 | 18.66 | .63 | 4.00 | .50 | 17.62 | 1.25 | 1.80 | 0.90 | 116 |
| 20 | .57 | .72 | 21.60 | 22.86 | .63 | 4.00 | .50 | 21.82 | 1.25 | 1.74 | 0.87 | 137 |
| | .78 | .84 | 21.60 | 22.86 | .63 | 4.00 | .50 | 21.82 | 1.25 | 1.94 | 0.97 | 154 |
| 24 | .63 | .79 | 25.80 | 27.06 | .63 | 4.00 | .50 | 26.02 | 1.25 | 1.88 | 0.94 | 174 |
| | .85 | .92 | 25.80 | 27.06 | .63 | 4.00 | .50 | 26.02 | 1.25 | 2.06 | 1.03 | 182 |

All dimensions given in inches. All weights given in pounds.

Table No. 7.2

## STANDARD THICKNESSES, DIAMETERS AND WEIGHTS FOR GAS PIPE CENTRIFUGALLY CAST IN METAL MOLDS

Dimensions in Inches — Weights in Pounds

| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Ft. | Wt. of Bell | Wt. Based On 12 Ft. Length | | Wt. Based On 18 Ft. Length | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length* | Avg. Per Ft.† | Per Length* | Avg. Per Ft.† |
| 4 | 22 | .35 | 4.80 | 4.10 | 15.3 | 17 | 200 | 16.7 | 290 | 16.2 |
| | 23 | .38 | 4.80 | 4.04 | 16.5 | 17 | 215 | 17.9 | 315 | 17.4 |
| | 24 | .41 | 4.80 | 3.98 | 17.6 | 17 | 230 | 19.1 | 335 | 18.6 |
| 6 | 22 | .38 | 6.90 | 6.14 | 24.3 | 25 | 315 | 26.4 | 460 | 25.6 |
| | 23 | .41 | 6.90 | 6.08 | 26.1 | 25 | 340 | 28.2 | 495 | 27.5 |
| | 24 | .44 | 6.90 | 6.02 | 27.9 | 25 | 360 | 30.0 | 525 | 29.3 |
| | 25 | .48 | 6.90 | 5.94 | 30.2 | 25 | 385 | 32.2 | 570 | 31.7 |
| 8 | 22 | .41 | 9.05 | 8.23 | 34.7 | 42 | 460. | 38.2 | 665 | 37.0 |
| | 23 | .44 | 9.05 | 8.17 | 37.1 | 42 | 485 | 40.6 | 710 | 39.4 |
| | 24 | .48 | 9.05 | 8.09 | 40.3 | 42 | 525 | 43.8 | 765 | 42.6 |
| | 25 | .52 | 9.05 | 8.01 | 43.5 | 42 | 565 | 47.0 | 825 | 45.8 |
| | 26 | .56 | 9 05 | 7.93 | 46.6 | 42 | 600 | 50.1 | 880 | 48.9 |
| 10 | 22 | .44 | 11.10 | 10.22 | 46.0 | 55 | 605 | 50.6 | 885 | 49.1 |
| | 23 | .48 | 11.10 | 10.14 | 50.0 | 55 | 655 | 54.6 | 955 | 53.0 |
| | 24 | .52 | 11.10 | 10.06 | 53.9 | 55 | 700 | 58.5 | 1025 | 57.0 |
| | 25 | .56 | 11.10 | 9.98 | 57.9 | 55 | 750 | 62.5 | 1095 | 60.9 |
| | 26 | .60 | 11.10 | 9.90 | 61.8 | 55 | 795 | 66.4 | 1165 | 64.8 |
| 12 | 22 | .48 | 13.20 | 12.24 | 59.8 | 68 | 785 | 65.5 | 1145 | 63.6 |
| | 23 | .52 | 13.20 | 12.16 | 64.6 | 68 | 845 | 70.3 | 1230 | 68.4 |
| | 24 | .56 | 13.20 | 12.08 | 69.4 | 68 | 900 | 75.1 | 1315 | 73.1 |
| | 25 | .60 | 13.20 | 12.00 | 74.1 | 68 | 955 | 79.7 | 1400 | 77.9 |
| | 26 | .65 | 13.20 | 11.90 | 80.0 | 63 | 1030 | 85.7 | 1510 | 83.9 |
| 16 | 21 | .50 | 17.40 | 16.40 | 82.8 | 96 | 1090 | 90.8 | 1585 | 88.1 |
| | 22 | .54 | 17.40 | 16.32 | 89.2 | 96 | 1165 | 97.2 | 1700 | 94.5 |
| | 23 | .58 | 17.40 | 16.24 | 95.6 | 96 | 1245 | 103.6 | 1815 | 100.9 |
| | 24 | .63 | 17.40 | 16.14 | 103.6 | 96 | 1340 | 111.6 | 1960 | 109.0 |
| | 25 | .68 | 17.40 | 16.04 | 111.4 | 116 | 1455 | 121.1 | 2120 | 117.8 |
| | 26 | .73 | 17.40 | 15.94 | 119.3 | 116 | 1550 | 129.0 | 2265 | 125.7 |
| 20 | 21 | .57 | 21.60 | 20.46 | 117.5 | 137 | 1545 | 128.9 | 2250 | 125.1 |
| | 22 | .62 | 21.60 | 20.36 | 127.5 | 137 | 1665 | 138.9 | 2430 | 135.1 |
| | 23 | .67 | 21.60 | 20.26 | 137.5 | 137 | 1785 | 148.9 | 2610 | 145.1 |
| | 24 | .72 | 21.60 | 20.16 | 147.4 | 137 | 1905 | 158.8 | 2790 | 155.0 |
| | 25 | .78 | 21.60 | 20.04 | 159.2 | 154 | 2065 | 172.0 | 3020 | 167.8 |
| | 26 | .84 | 21.60 | 19.92 | 170.9 | 154 | 2205 | 183.7 | 3230 | 179.5 |
| 24 | 21 | .63 | 25.80 | 24.54 | 155.4 | 174 | 2040 | 169.9 | 2970 | 165.1 |
| | 22 | .68 | 25.80 | 24.44 | 167.4 | 174 | 2185 | 181.9 | 3185 | 177.0 |
| | 23 | .73 | 25.80 | 24.34 | 179.4 | 174 | 2325 | 193.9 | 3105 | 189.1 |
| | 24 | .79 | 25.80 | 24.22 | 193.7 | 174 | 2500 | 208.2 | 3660 | 203.4 |
| | 25 | .85 | 25.80 | 24.10 | 207.9 | 182 | 2675 | 223.1 | 3925 | 218.0 |
| | 26 | .92 | 25.80 | 23.96 | 224.4 | 182 | 2875 | 239.6 | 4220 | 234.5 |

*Including Bell. Calculated weight of Pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.

## Table No. 7.3

### STANDARD THICKNESSES AND WEIGHTS FOR CAST IRON GAS PIPE CENTRIFUGALLY CAST IN METAL MOLDS

NOTE: These thicknesses and weights are for pipe laid without blocks, on flat bottom trench, with tamped backfill, under 5 feet of cover. For other conditions see Tables 7.2 and 7.4 hereof and the Manual.

| | CLASS 10 10 Lb. Pressure | | | | | | CLASS 50 50 Lb. Pressure | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Wt. Based on 12 Foot Length | | Wt. Based on 18 Foot Length | | | | Wt. Based on 12 Foot Length | | Wt. Based on 18 Foot Length | |
| Size Inches | Thickness Inches | Outside Diam. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Thickness Inches | Outside Diam. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* |
| 4 | .35[1] | 4.80 | 16.7 | 200 | 16.2 | 290 | .35[1] | 4.80 | 16.7 | 200 | 16.2 | 290 |
| | or .38[2] | 4.80 | 17.9 | 215 | 17.4 | 315 | or .38[2] | 4.80 | 17.9 | 215 | 17.4 | 315 |
| 6 | .38[1] | 6.90 | 26.4 | 315 | 25.6 | 460 | .38[1] | 6.90 | 26.4 | 315 | 25.6 | 460 |
| | or .41[2] | 6.90 | 28.2 | 340 | 27.5 | 495 | or .41[2] | 6.90 | 28.2 | 340 | 27.5 | 495 |
| 8 | .41 | 9.05 | 38.2 | 460 | 37.0 | 665 | .41 | 9.05 | 38.2 | 460 | 37.0 | 665 |
| 10 | .44 | 11.10 | 50.6 | 605 | 49.1 | 885 | .44 | 11.10 | 50.6 | 605 | 49.1 | 885 |
| 12 | .48 | 13.20 | 65.5 | 785 | 63.6 | 1145 | .48 | 13.20 | 65.5 | 785 | 63.6 | 1145 |
| 16 | .50 | 17.40 | 90.8 | 1090 | 88.1 | 1585 | .50 | 17.40 | 90.8 | 1090 | 88.1 | 1585 |
| 20 | .57 | 21.60 | 128.9 | 1545 | 125.1 | 2250 | .57 | 21.60 | 128.9 | 1545 | 125.1 | 2250 |
| 24 | .63 | 25.80 | 169.9 | 2040 | 165.1 | 2970 | .63 | 25.80 | 169.9 | 2040 | 165.1 | 2970 |

*Including Bell. Calculated weight of Pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.
[1]Class 22 thickness.
[2]Class 23 thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

## Table No. 7.3 (Continued)

### STANDARD THICKNESSES AND WEIGHTS FOR CAST IRON GAS PIPE CENTRIFUGALLY CAST IN METAL MOLDS

NOTE: These thicknesses and weights are for pipe laid without blocks, on flat bottom trench, with tamped backfill, under 5 feet of cover. For other conditions see Tables 7.2 and 7.4 hereof and the Manual.

| | CLASS 100 | | | | | | CLASS 150 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 Lb. Pressure | | | | | | 150 Lb. Pressure | | | | | |
| | | | Wt. Based on 12 Foot Length | | Wt. Based on 18 Foot Length | | | | Wt. Based on 12 Foot Length | | Wt. Based on 18 Foot Length | |
| Size Inches | Thickness Inches | Outside Diam. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Thickness Inches | Outside Diam. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* |
| 4 | .35[1] | 4.80 | 16.7 | 200 | 16.2 | 290 | .35[1] | 4.80 | 16.7 | 200 | 16.2 | 290 |
| | or .38[2] | 4.80 | 17.9 | 215 | 17.4 | 315 | or .38[2] | 4.80 | 17.9 | 215 | 17.4 | 315 |
| 6 | .38[1] | 6.90 | 26.4 | 315 | 25.6 | 460 | .38[1] | 6.90 | 26.4 | 315 | 25.6 | 460 |
| | or .41[2] | 6.90 | 28.2 | 340 | 27.5 | 495 | or .41[2] | 6.90 | 28.2 | 340 | 27.5 | 495 |
| 8 | .41 | 9.05 | 38.2 | 460 | 37.0 | 665 | .41 | 9.05 | 38.2 | 460 | 37.0 | 665 |
| 10 | .44 | 11.10 | 50.6 | 605 | 49.1 | 885 | .44 | 11.10 | 50.6 | 605 | 49.1 | 885 |
| 12 | .48 | 13.20 | 65.5 | 785 | 63.6 | 1145 | .48 | 13.20 | 65.5 | 785 | 63.6 | 1145 |
| 16 | .54 | 17.40 | 97.2 | 1165 | 94.5 | 1700 | | | | | | |
| 20 | .62 | 21.60 | 138.9 | 1665 | 135.1 | 2430 | | | | | | |
| 24 | .68 | 25.80 | 181.9 | 2185 | 177.0 | 3185 | | | | | | |

*Including Bell. Calculated weight of Pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.
[1]Class 22 thickness.
[2]Class 23 thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

## Table No. 7.4

### STANDARD THICKNESSES FOR CAST IRON GAS PIPE CENTRIFUGALLY CAST IN METAL MOLDS

**Thickness in Inches. Working Pressure in Pounds per Square Inch. Thicknesses Include Allowances for Foundry Practice and Corrosion**

Laying Condition A—Flat Bottom Trench, Without Blocks, Untamped Backfill
Laying Condition B—Flat Bottom Trench, Without Blocks, Tamped Backfill
Laying Condition C—Pipe Laid on Blocks, Untamped Backfill
Laying Condition D—Pipe Laid on Blocks, Tamped Backfill

| Size Inches | Working Pressure | 3½ FEET OF COVER — Laying Condition | | | | 5 FEET OF COVER — Laying Condition | | | | 8 FEET OF COVER — Laying Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| 4 | 10 | [1].35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| | 50 | [1].35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| | 100 | [1].35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| | 150 | [1].35 | .35 | .35 | .35 | .35 | .35 | .38 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| 6 | 10 | [1].38 | .38 | .41 | .38 | .38 | .38 | .41 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .48 | .41 |
| | 50 | [1].38 | .38 | .41 | .38 | .38 | .38 | .41 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .48 | .41 |
| | 100 | [1].38 | .38 | .41 | .38 | .38 | .38 | .44 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 |
| | 150 | [1].38 | .38 | .41 | .38 | .38 | .38 | .44 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 |
| 8 | 10 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .52 | .41 |
| | 50 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .52 | .41 |
| | 100 | .41 | .41 | .48 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .56 | .41 |
| | 150 | .41 | .41 | .48 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .56 | .41 |
| 10 | 10 | .44 | .44 | .48 | .44 | .44 | .44 | .52 | .44 | .44 | .44 | .60 | .44 |
| | 50 | .44 | .44 | .48 | .44 | .44 | .44 | .52 | .44 | .44 | .44 | .60 | .44 |
| | 100 | .44 | .44 | .52 | .44 | .44 | .44 | .52 | .44 | .44 | .44 | .60 | .48 |
| | 150 | .44 | .44 | .52 | .44 | .44 | .44 | .56 | .44 | .48 | .44 | .60 | .48 |
| 12 | 10 | .48 | .48 | .52 | .48 | .48 | .48 | .56 | .48 | .48 | .48 | .60 | .52 |
| | 50 | .48 | .48 | .52 | .48 | .48 | .48 | .56 | .48 | .48 | .48 | .60 | .52 |
| | 100 | .48 | .48 | .56 | .48 | .48 | .48 | .56 | .48 | .52 | .48 | .65 | .52 |
| | 150 | .48 | .48 | .56 | .48 | .48 | .48 | .56 | .48 | .52 | .48 | .65 | .52 |
| 16 | 10 | .54 | .50 | .58 | .54 | .54 | .50 | .63 | .58 | .58 | .54 | .73 | .63 |
| | 50 | .54 | .50 | .63 | .54 | .54 | .50 | .63 | .58 | .63 | .58 | .73 | .63 |
| | 100 | .54 | .54 | .63 | .58 | .58 | .54 | .68 | .58 | .63 | .58 | .73 | .68 |
| 20 | 10 | .62 | .57 | .67 | .62 | .62 | .57 | .72 | .67 | .67 | .62 | .78 | .72 |
| | 50 | .62 | .57 | .72 | .62 | .67 | .57 | .72 | .67 | .72 | .62 | .78 | .72 |
| | 100 | .62 | .57 | .72 | .67 | .67 | .62 | .78 | .67 | .72 | .67 | .84 | .78 |
| 24 | 10 | .63 | .63 | .73 | .68 | .73 | .63 | .79 | .73 | .79 | .68 | .85 | .79 |
| | 50 | .68 | .63 | .79 | .68 | .73 | .63 | .79 | .73 | .79 | .73 | .85 | .79 |
| | 100 | .73 | .63 | .79 | .73 | .73 | .68 | .85 | .79 | .79 | .73 | .92 | .85 |

[1]Class 22 thickness.
[2]Class 23 thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

ASA
A21.8–1952

# American Standard Specifications

*for*

# CAST IRON PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS, FOR WATER OR OTHER LIQUIDS

SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

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### Appendix—pp. 176-179



### Tables—pp. 180-190



NOTE 1—Tables showing additional thicknesses required for greater depths of cover and other conditions of laying will be found in ASA A21.1.

NOTE 2—Users of these tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

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Users of this document should make reference to "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe" (ASA A21.1) for complete information concerning the conditions which various thicknesses of pipe are designed to meet. The foreword of the Manual also contains a statement regarding the history of the specifications and references to other related documents.

ASA
A21.8–1952

*American Standard Specifications for*

# Cast Iron Pipe Centrifugally Cast in Sand-lined Molds, for Water or Other Liquids

*This specification covers cast iron pipe centrifugally cast in sand-lined molds.*

## Sec. 8–1—Definitions

*Purchaser.* Wherever the word "purchaser" is used herein, it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

*Heat.* A heat is a period during which a cupola or furnace is operated continuously.

*Run.* A run is a period of one or more shifts during which a shop is operated continuously.

*Mixture of Iron.* Mixture of iron is a combination of pig iron, scrap, coke and other raw materials charged to a cupola or furnace to give a desired composition of iron; or a combination of molten iron from one or more sources, made in a forehearth or ladle to give a desired composition of iron.

*Source of Iron.* A source of iron is a cupola, furnace or forehearth from which iron is delivered to a transfer or pouring ladle.

*Forehearth.* A forehearth is a refractory-lined receptacle for the temporary storage of molten iron from one or more cupolas or furnaces.

## Sec. 8–2—Description of Pipe

The pipe shall be made with bell and spigot ends with beads cast on, or with plain ends or such other type of ends as may be agreed upon at the time of purchase. Pipe with bell-and-spigot ends shall conform to the dimensions and weights shown in the tables given in this document. Pipe with other types of ends shall comply with the dimensions agreed upon, but in all other respects shall fulfill the specifications hereinafter given. Pipe shall be straight and shall be true circles in sections, with the inner and outer surfaces concentric. Pipe shall be cast at least 12 ft. in nominal laying length. This type of pipe is commonly made at present (1952) in 16-, 16½- and 20-ft. lengths.

## Sec. 8–3—Casting of Pipe

The pipe shall be centrifugally cast in sand-lined molds and shall remain in the sand for a sufficient length of time to prevent unequal contraction during cooling.

## Sec. 8–4—Quality of Iron

8–4.1. All pipe shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the pipe to be cast, that the iron in the pipe shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting, and it shall comply with the physical specifications given in Sec. 8–17 and 8–18. The metal shall be remelted in a cupola or other suitable furnace.

8–4.2. The iron in the pipe shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulphur. Samples for chemical analyses shall be taken by drilling completely through from skin to skin either acceptance test specimens or specimens cast for this purpose, but not to exceed three specimens per heat of approximately eight hours. In case of dispute, analyses will be determined on samples taken from the pipe in question.

### Sec. 8–5—Quality of Castings

Pipe shall be smooth, free from scales, lumps, blisters, sand holes, laps and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

### Sec. 8–6—Foundry Records

A record of the results of the following tests shall be made and retained for at least one year. Upon request such record will be available to the purchaser at the foundry. If written transcripts of the results of any of these tests are desired this fact shall be noted in the order for pipe, naming the tests of which transcripts are desired. The methods of testing and the dimensions of all test specimens are given in the Appendix.

8–6.1. *Chemical analyses.* Chemical analyses of each iron mixture used directly in the pouring of pipe, obtained as in Sec. 8–4.2, shall be made for silicon, sulphur, manganese, phosphorus and total carbon during the first hour and at intervals not to exceed three hours throughout the heat. If pipe are poured directly from the cupola, chemical analyses shall be made of iron from the first and from the last ladle. If the mixture is changed one or more times during a heat in order to produce a different iron, the time of taking samples shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality.

8–6.2. *Pouring temperatures.* The pouring temperature of the iron shall be taken at the casting ladle for each size of pipe at least once each hour.

8–6.3. *Talbot strip tests.* See Sec. 8–17.1.

8–6.4. *Test bar tests.* See Sec. 8–17.2.

8–6.5. *Periodic ring, strip and full-length bursting tests.* See Sec. 8–17 and 8–18.

### Sec. 8–7—Marking Pipe

Each pipe shall have the weight and class designation conspicuously painted on it. In addition, each pipe shall have cast on it the manufacturer's mark, the year in which the pipe was cast and, when specified by the purchaser, initials not exceeding four in number. The letters and figures shall be on the outside surface of the pipe, and cast marks shall have dimensions not less than those indicated in the following table:

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Pipe Diam. *in.* | Height of Letter *in.* | Relief of Letter *in.* |
|---|---|---|
| 3–4 | $\frac{1}{2}$ | $\frac{1}{16}$ |
| 6–12 | $\frac{3}{4}$ | $\frac{3}{32}$ |
| 14–20 | $1\frac{1}{2}$ | $\frac{1}{8}$ |
| 24–48 | 2 | $\frac{1}{8}$ |

### Sec. 8–8—Inspection by Purchaser

8–8.1. *Power of purchaser to inspect.* The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, pattern work, molding, casting, coating and lining of the pipe. The forms, sizes, uniformity and conditions of all pipe herein referred to shall be subject to his inspection and approval, and he may reject, without subjection to hydrostatic test, any pipe which is not in conformity with the specifications or drawings. Any pipe rejected shall be so marked and any marks pertaining to the purchaser shall be chipped or erased from such pipe.

8–8.2. *Manufacturer to furnish men and materials.* The manufacturer shall provide tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the pipe at the foundry.

8–8.3. *Report of purchaser's inspection.* The purchaser shall make written report daily to the foundry office of all pipe rejected with the causes for rejection.

### Sec. 8–9—Inspection and Certification by Manufacturer

Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all the tests have been made and met as specified. If written transcripts of any of these test results are required, including chemical tests if desired, a request specifying the tests of which transcripts are desired shall accompany the order.

### Sec. 8–10—Pipe to be Delivered Sound

All the pipe shall be delivered in all respects sound and in conformity with these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this respect, and any defective pipe which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for pipe found to be damaged after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the pipe not to injure the coating or lining, and no pipe or other material of any kind shall be placed in the pipe during transportation or at any other time after they have received the coating or lining.

### Sec. 8–11—Cut Pipe

Defective spigot ends on pipe may be cut off in a manner which will produce a square end. Not more than 10 per cent of the total number of pipe of each size of a given order may be shipped as cut pipe. Such cut pipe when cut from 12-ft. lengths shall have a nominal laying length of not less than 11 ft.; pipe originally of 16-ft. or greater length shall not be cut more than 2 ft.

**Sec. 8-12—Tolerances or Maximum Permitted Variations**

8-12.1. *Pipe and socket diameters.* Outside diameters of pipe barrels and spigot ends, and inside diameters of sockets, shall be kept as nearly as practicable to the specified dimensions. The inside diameters of the sockets and the outside diameters of the spigot ends shall be tested with circular gages. Tolerances or maximum permitted variations from standard dimensions are listed below:

| Nom. Pipe Diam. *in.* | Tolerances *in.* |
|---|---|
| 3-12 | ±0.06 |
| 14-24 | ±0.08 |
| 30-36 | ±0.10 |
| 42-48 | ±0.12 |

8-12.2. *Thickness.* The minus tolerances from standard thickness of pipe and dimensions *a, b, c* and *d* of the bells are as follows:

| Nom. Pipe Diam. *in.* | Minus Tolerance *in.* |
|---|---|
| 3-8 | 0.05 |
| 10-12 | 0.06 |
| 14-24 | 0.08 |
| 30-48 | 0.10 |

Note: In pipe barrel thickness, tolerances 0.02 in. greater than those listed above shall be permissible over areas not exceeding 8 in. in length in any direction.

8-12.3. *Weight.* The weight of no single pipe shall be less than the nominal tabulated weight by more than 5 per cent for pipe 12 in. or smaller in diameter, nor by more than 4 per cent for pipe larger than 12 in. in diameter. The total weight of any order of 25 tons or more shall not be more than 2 per cent under the total nominal weight. The total excess weight to be paid for on orders of 25 tons or more shall not exceed 2 per cent of the nominal weight, and on orders of less than 25 tons shall not exceed 5 per cent of the nominal weight. An order is hereby defined as including all the pipe ordered under the terms of a specific contract or purchase order or a single order placed under the terms of a standing contract. Unless otherwise specified in the contract, a ton shall be 2,000 lb. avoirdupois.

**Sec. 8-13—Cleaning and Inspecting**

All pipe shall have fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful inspection and a rolling test, before being coated or lined.

**Sec. 8-14—Hydrostatic Test**

Each pipe shall be subjected to a hydrostatic proof test. This test may be made either before or after a hot or cold bituminous dip or paint has been applied but shall be made before the cement mortar lining or any other special lining has been applied to pipe for which such lining is specified.

The pipe shall be under the test pressure for at least one-half minute. Any pipe showing defects by leaking, sweating or otherwise shall be rejected. The test pressures shall be in accordance with the table appearing on page 5.

**Sec. 8-15—Weighing**

Each length of pipe shall be weighed and the weight plainly marked on the outside or inside of the bell or spigot end. Pipe shall be weighed before the application of any lining or coating other than hot or cold bituminous dip or paint.

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

*Table of Hydrostatic Test Pressures*

| Nom. Pipe Diam. *in.* | Nom. Barrel Thickness *in.* | Test Pressure *psi.* |
|---|---|---|
| 3–12 | all thicknesses | 500 |
| 14 | 0.57 and less | 400 |
| 14 | 0.58 and over | 500 |
| 16 | 0.60 and less | 400 |
| 16 | 0.61 and over | 500 |
| 18 | 0.65 and less | 400 |
| 18 | 0.66 and over | 500 |
| 20 | 0.70 and less | 400 |
| 20 | 0.71 and over | 500 |
| 24 | 0.75 and less | 400 |
| 24 | 0.76 and over | 500 |
| 30 | 0.88 and less | 400 |
| 30 | 0.89 and over | 500 |
| 36 | 0.98 and less | 400 |
| 36 | 0.99 and over | 500 |
| 42 | 1.09 and less | 400 |
| 42 | 1.10 and over | 500 |
| 48 | 1.18 and less | 400 |
| 48 | 1.19 and over | 500 |

## Sec. 8–16—Linings and Exterior Coatings

Any particular lining or coating which is to be applied to the pipe shall be specified in the agreement made at the time of purchase. Separate specifications for a cement-mortar lining have been provided in connection with these specifications for pipe. *See* specification ASA A21.4

No pipe or specials for waterworks service shall be furnished without protective coating unless specifically ordered by the purchaser.

## Sec. 8–17—Acceptance Tests for Physical Properties

The standard acceptance tests for the physical characteristics of the pipe shall be as follows:

*Sec. 8–17.1—Talbot Strip Tests*

Talbot strip tests shall be used to determine the acceptability of 3-in. to 24-in. pipe for modulus of rupture and secant modulus of elasticity.

17.1.1. *Sampling.* For sampling, every run shall be divided into periods of approximately three hours each, and at least one sample shall be taken during each three-hour period. The sample for the first period of the run shall be taken during the first hour or, if casting is direct from the cupola, from the first ladle. Samples shall be taken so that each size of pipe cast for two hours or longer during the run and each mixture or source of iron used for two hours or longer during the run shall be fairly represented.

17.1.2. *Method of testing.* The method of testing Talbot strips is given in Sec. 8–A1 of the Appendix.

17.1.3. *Acceptance values.* The acceptance values for tests on Talbot strips from 3-in. to 24-in. pipe shall be as follows:

Modulus of rupture: 40,000 psi. minimum.

Secant modulus of elasticity: 10,000,000 psi. maximum.

If the modulus of elasticity exceeds 10,000,000, the modulus of rupture shall exceed 40,000 in at least the same proportion.

*Sec. 8–17.2—Two-Inch Test Bar Tests*

A.S.T.M. standard (A48 Bar C) 2-in. diameter by 27-in. test bar tests shall be used to determine the acceptability of 30-in. to 48-in. pipe.

From each mixture of iron used to cast pipe of 30-in. to 48-in. sizes, 2-in. diameter test bars shall be cast and tested from the first ladle of iron, and at intervals not to exceed three hours during the heat.

For the record, from every 200 lengths, but from at least one pipe of each size each week, one Talbot strip shall be cut and tested, and shall meet the requirements of Sec. 8–17.1.3.

At the manufacturer's option, Talbot strips may be tested instead of test bars. If Talbot strips are tested, they shall meet the requirements of Sec. 8–17.1.3.

Test bars shall have a minimum breaking load of 6,000 lb. and a deflection of 0.15 in. plus 0.01 in. for each 500 lb. that the breaking load exceeds 6,000 lb.

These test bar values apply only to thickness classes 21 to 25 in pipe designed with an 18,000-psi. tensile strength in bursting and a 40,000-psi. modulus of rupture of the ring.

### Sec. 8–18—Periodic Ring Tests and Full-Length Bursting Tests

The manufacturer shall periodically make such bursting tests and ring tests in conjunction with strip tests that he can certify the design values of the modulus of rupture (40,000 psi.) and the tensile strength of the iron in the pipe (18,000 psi.). These tests shall be made in accordance with dimensions and methods given in the Appendix.

Pipe for these periodic ring and bursting tests shall be so selected that they will be representative of the sizes and various thicknesses of each size cast. Ring tests shall not be made on 3-in. and 4-in. pipe.

Tests of Talbot strips cut from the ring, as provided in the Appendix, shall be made in conjunction with ring and bursting tests. At least three Talbot strips shall be tested from each burst pipe and one of these strips shall come from the ring. For pipe for which rings less than 10½ in. long are used, the Talbot strip shall come from parts other than the ring.

Tests and records shall include the modulus of rupture of each strip and ring and also the modulus of elasticity of each strip and of each ring 12 in. and larger; the breaking load and deflection of each test bar shall also be included.

At the purchaser's request, the manufacturer shall furnish a written transcript of ring and bursting tests and tests on Talbot strips made in connection therewith for a period not exceeding one year and for such sizes as requested.

Unless there is a record of satisfactory tests equivalent to those hereinafter described, extending to within three months or less of the time to begin manufacture of an order for pipe of any size from 30 in. to 48 in., the producer shall test three pipe from the first day's production and one each succeeding day for the next four days. If all the tests meet the specifications, he shall test one pipe every five days for the next three weeks, and if all those meet the specifications, he shall test one pipe each month. In the case of a failure of any test, the same series of tests as above specified shall be repeated. If there is a lapse of more than one month in the manufacture of such pipe, the monthly test shall be made on a pipe from the first day's run. If the tests are all satisfactory, the number of pipe tested shall not exceed 3 per cent of the order.

### Sec. 8–19—Additional Tests Required by Purchaser

If more or other tests than those provided in these specifications are required by the purchaser, such tests shall be specified in the invitation for bids.

### Sec. 8–20—Defective Specimens and Retests

8–20.1. If any test specimen shows defective machining or lack of continuity of metal, it may be discarded and replaced by another specimen. If any sound test specimen fails to meet the specified requirements, the purchaser may permit a retest on two additional sound specimens from pipe cast in the same period as the specimen which failed; both of the additional specimens shall meet the prescribed tests to be acceptable.

8–20.2. Test bars may be cast in pairs and at least one bar from each pair shall be tested, but the manufacturer shall have the right to test both bars, in which case the better bar shall be taken as representative.

8–20.3. If a routine test bar test fails to meet the requirements, the manufacturer shall have the right to substitute two Talbot strips cut from a pipe cast with iron represented by the failed test bar test. If both strip tests meet the requirements, the pipe for that period shall be acceptable.

### Sec. 8–21—Rejection of Pipe

If any routine chemical analysis fails to meet the chemical requirements of Sec. 8–4.2, or if any acceptance test fails to meet the requirements of Sec. 8–17.1.3, 8–17.2 and 8–20, the pipe cast in the period shall be rejected except as subject to the provisions of Sec. 8–22.

### Sec. 8–22—Limiting Rejection

The manufacturer may limit the amount of rejection by making similar additional tests of pipe of the same size as that rejected until the rejected lot is bracketed in order of manufacture by two acceptable tests. If a period is rejected, the acceptability of pipe of different sizes from that rejected may be established by making the routine acceptance tests for these sizes.

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# Appendix*

## Table of Contents



## Tables †



* This Appendix is a part of ASA A21.8—American Standard Specifications for Cast Iron Pipe Centrifugally Cast in Sand-lined Molds, for Water or Other Liquids.

† Data on thicknesses required for greater depths of cover and conditions of laying other than those assumed in the following tables will be found in Appendix B of ASA A21.1—American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe.

Users of the following tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

### Sec. 8-A1—Talbot Strip Tests

Talbot strips (Fig. 8.1) shall be machined longitudinally from each pipe specimen selected for testing by this method. These Talbot strips may be cut from a part of the ring little stressed in the ring test—i.e., near one of the elements marked *a* in the illustration of the ring test (Fig. 8.2). The strips in any case will be in cross section as indicated in Fig. 8.1—i.e., will have for their width the thickness of the pipe and for their depth, 0.50 in. Their length shall be at least $10\frac{1}{2}$ in. These strips shall be tested as beams on supports 10 in. apart with loads applied perpendicularly to the machined faces at two points $3\frac{1}{3}$ in. from the supports. The breaking load and

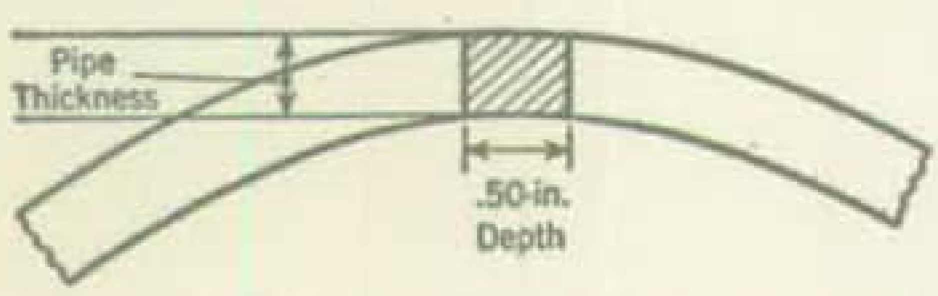



FIG. 8.1. Position From Which Talbot Strip Is Cut

the deflection shall be observed and recorded.

The strip shall be accurately calipered at the point of rupture and the modulus of rupture, *R*, shall be calculated by the usual beam formula, which for this case reduces to the expression:

$$R = \frac{10\ W}{td^2}$$

The secant modulus of elasticity, $E_s$, in pounds per square inch, shall be computed by the formula:

$$E_s = \frac{21.3R}{dy}$$

In the above formulas, *R* is the modulus of rupture (psi.), $E_s$ is the secant modulus of elasticity (psi.), *W* is the breaking load (lb.), *d* is the depth (in.) of the strip (intended to be 0.50 in.), *t* is the width (in.) of the strip (pipe thickness) and *y* is the deflection (in.) of the strip at the center at breaking load.

### Sec. 8-A2—Ring Tests

The maximum length of any ring shall not exceed 12 in.; for pipe 14 in. and larger, the minimum length shall be $10\frac{1}{2}$ in.; for pipe 12 in. and smaller, the minimum length shall be one-half the nominal diameter of the pipe. Each ring shall be tested by the three-edge bearing method as indicated in Fig. 8.2.

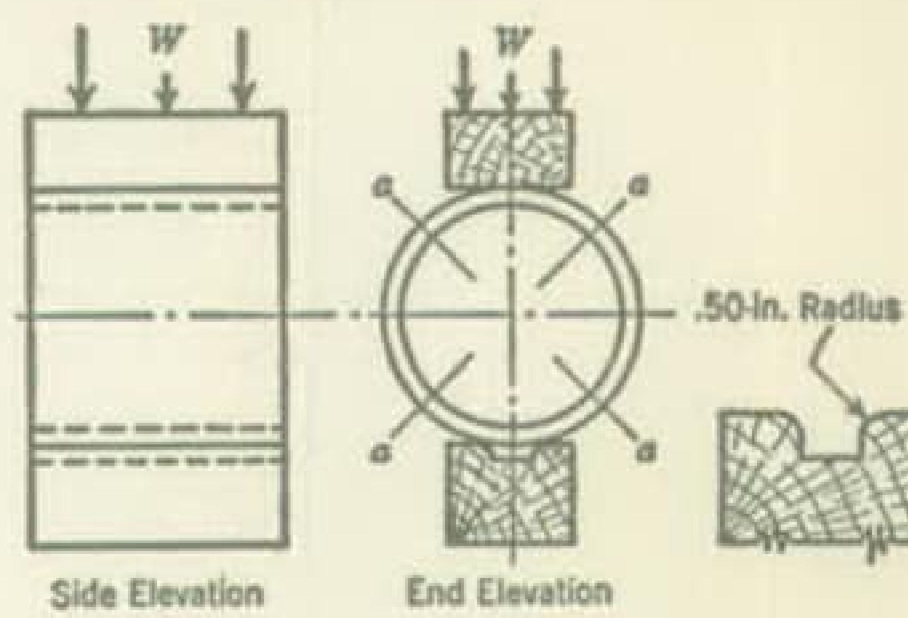



FIG. 8.2. Assembly for Ring Test

The lower bearing for the ring shall consist of two strips with vertical sides having their interior top corners rounded to a radius of approximately $\frac{1}{2}$ in. The strips shall be of hard wood or of metal. If of metal, a piece of fabric or leather approximately $\frac{1}{16}$ in. thick shall be laid over them. They shall be straight and shall be securely fastened to a rigid block, with their interior vertical faces the following distances apart:

| Nom. Pipe Diam. *in.* | Bearing Strip Spacing *in.* |
|---|---|
| 3–12 | $\frac{1}{2}$ |
| 14–24 | 1 |
| 30–48 | 2 |

The upper bearing shall be an oak block, straight and true from end to end. The upper and lower bearings shall extend the full length of the ring. The ring shall be placed symmetrically between the two bearings, and the center of application of the load shall be so placed that the vertical deformation at the two ends of the ring shall be approximately equal. If the ring is not uniform in thickness, it shall be so placed that the thick and thin portions are near the ends of the horizontal diameter.

A record of the breaking load and the vertical deformation of each ring tested shall be made. The modulus of rupture and modulus of elasticity are computed from the formulas:

$$R = 0.954 \frac{W(d+t)}{bt^2}$$

$$E = \frac{0.225W(d+t)^3}{bt^3y} = \frac{0.236R(d+t)^2}{ty}$$

in which $R$ is the modulus of rupture (psi.), $W$ is the breaking load (lb.), $d$ is the average inside diameter (in.) of the ring, $t$ is the average thickness (in.) of metal along the line of fracture, $b$ is the length (in.) of the ring, $E$ is the modulus of elasticity (psi.) and $y$ is the vertical deformation (in.) of the ring at the center.

### Sec. 8–A3—Full-Length Bursting Tests

The bursting tensile strength shall be determined by testing full-length pipe (less the amount cut off for ring and strip test specimens) to destruction by hydraulic pressure. Bells may be removed to facilitate testing. A suitable means for holding the end thrust shall be used which will not subject the pipe to endwise tension or compression, or other parasitic stresses. A calibrated pressure gage shall be used for determining the bursting pressure. This gage shall be connected to the interior of the test pipe by a separate connection from that which supplies water for the test. The unit tensile strength in bursting shall be obtained by the use of the formula:

$$S = \frac{Pd}{2t}$$

in which $S$ is the bursting tensile strength (psi.) of the iron, $P$ is the internal pressure (psi.) at bursting, $d$ is the average inside diameter (in.) of the pipe and $t$ is the minimum average thickness (in.) of the pipe along the principal line of break.

Measurements of thickness shall be taken along the principal line of break at 1-ft. intervals.

The minimum average thickness along the principal line of break shall be obtained by averaging the measurements at the thinnest section at a weight of two and at the adjacent sections on each side at a weight of one each; or, if the thinnest section is at the end of the break, by averaging this thinnest-section measurement at a weight of two and the measurements of the adjacent section and the next section at a weight of one each.

### Sec. 8–A4—Test Bars

8–A4.1. *Dimensions.* Test bars for pipe of 30-in. to 48-in. diameter shall be 2 in. in diameter and not less than 26 in. long. Individual test bars may vary as much as 3 per cent from the standard diameter.

8–A4.2. *Method of casting.* The bars shall be cast vertically in well faced, dry sand molds provided with a suitable pouring basin and mounted on a suitable refractory foundation. Metal for the bars shall be obtained by using a small heated ladle taking its metal from the main ladle from which the pipe is to be poured. The metal shall be taken after all alloys and other additional metal, except cast-iron pipe scrap for cooling, have been added to the main ladle and become melted. The bars shall not be removed from the mold before they have cooled to 500°F.

8–A4.3. *Method of testing.* The bars shall be broken as beams by placing them on supports 24 in. apart and applying the load at the center of the span. The breaking load and the corresponding deflection shall be observed and recorded.

8–A4.4. *Correcting observed breaking loads and deflections.* The bars shall be measured at the point of application of the load and the results corrected to standard dimensions by the conventional beam formula (for bars of 2-in. diameter):

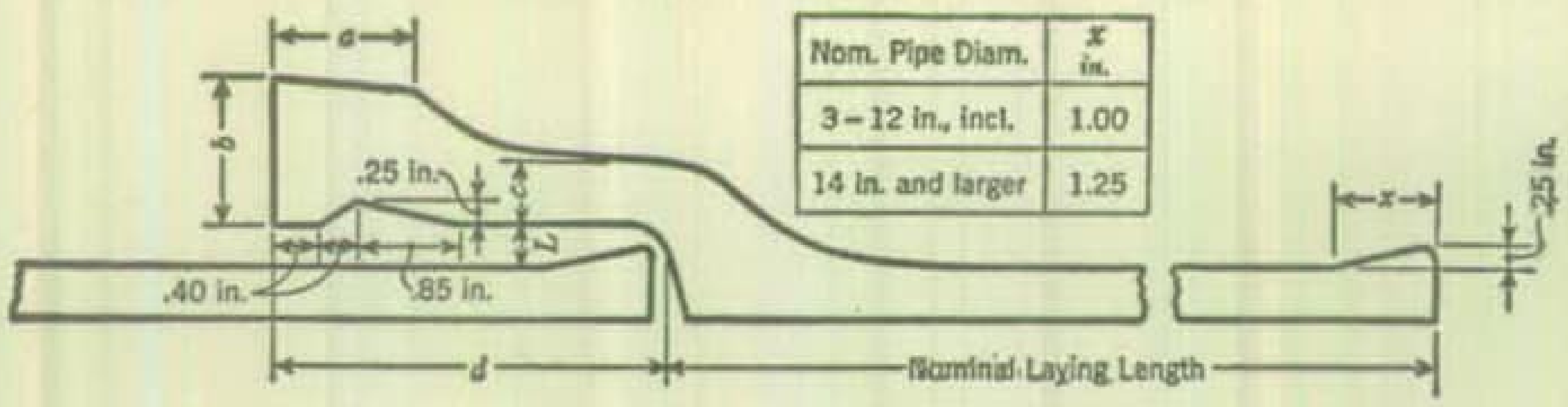
$$\text{Corrected } W = \text{Observed } W \times \frac{8}{d_h d_v^2}$$

$$\text{Corrected } y = \text{Observed } y \times \frac{d_v}{2}$$

in which $W$ is the breaking load (lb.), $d_h$ is the measured horizontal diameter (in.), $d_v$ is the measured vertical diameter (in.) and $y$ is the deflection (in.) at breaking.

## Sec. 8–A5—Deflection Measurements

All deflection measurements required by these specifications shall be that of the specimen and shall not include any compression of the supports or loading blocks, or backlash or distortion of the testing machine.




### TABLE 8.1

### STANDARD DIMENSIONS OF BELLS, SOCKETS, SPIGOT BEADS AND OUTSIDE DIAMETERS—AND WEIGHTS OF BELLS AND SPIGOT BEADS—OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. | Pipe Thickness | | Pipe Outside Diam. | Dimensions of Bells | | | | | | Weight of Bell and Spigot Bead |
|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | Socket Diam. | Thickness of Joint L | Socket Depth d | a | b | c | |
| | *in.* | | | | | | | | | *lb.* |
| 3 | 0.32 | 0.38 | 3.96 | 4.76 | 0.40 | 3.50 | 1.25 | 1.25 | 0.52 | 15 |
| 4 | 0.35 | 0.44 | 4.80 | 5.60 | 0.40 | 3.50 | 1.25 | 1.30 | 0.55 | 19 |
| | 0.35 | 0.44 | 5.00 | 5.80 | 0.40 | 3.50 | 1.25 | 1.30 | 0.55 | 20 |
| 6 | 0.38 | 0.41 | 6.90 | 7.70 | 0.40 | 3.50 | 1.38 | 1.35 | 0.48 | 26 |
| | 0.44 | 0.48 | 6.90 | 7.70 | 0.40 | 3.50 | 1.38 | 1.35 | 0.64 | 29 |
| | 0.38 | 0.41 | 7.10 | 7.90 | 0.40 | 3.50 | 1.38 | 1.35 | 0.48 | 27 |
| | 0.44 | 0.52 | 7.10 | 7.90 | 0.40 | 3.50 | 1.38 | 1.35 | 0.64 | 30 |
| 8 | 0.41 | 0.44 | 9.05 | 9.85 | 0.40 | 4.00 | 1.38 | 1.45 | 0.52 | 37 |
| | 0.48 | 0.56 | 9.05 | 9.85 | 0.40 | 4.00 | 1.38 | 1.45 | 0.68 | 43 |
| | 0.41 | 0.44 | 9.30 | 10.10 | 0.40 | 4.00 | 1.38 | 1.45 | 0.52 | 38 |
| | 0.48 | 0.60 | 9.30 | 10.10 | 0.40 | 4.00 | 1.38 | 1.45 | 0.68 | 44 |
| 10 | 0.44 | 0.48 | 11.10 | 11.90 | 0.40 | 4.00 | 1.50 | 1.55 | 0.56 | 50 |
| | 0.52 | 0.60 | 11.10 | 11.90 | 0.40 | 4.00 | 1.50 | 1.55 | 0.73 | 56 |
| | 0.44 | 0.48 | 11.40 | 12.20 | 0.40 | 4.00 | 1.50 | 1.55 | 0.56 | 51 |
| | 0.52 | 0.65 | 11.40 | 12.20 | 0.40 | 4.00 | 1.50 | 1.55 | 0.73 | 58 |
| 12 | 0.48 | 0.52 | 13.20 | 14.00 | 0.40 | 4.00 | 1.50 | 1.60 | 0.60 | 63 |
| | 0.56 | 0.65 | 13.20 | 14.00 | 0.40 | 4.00 | 1.50 | 1.60 | 0.79 | 71 |
| | 0.48 | 0.52 | 13.50 | 14.30 | 0.40 | 4.00 | 1.50 | 1.60 | 0.60 | 64 |
| | 0.56 | 0.70 | 13.50 | 14.30 | 0.40 | 4.00 | 1.50 | 1.60 | 0.79 | 73 |
| | 0.76 | | 13.50 | 14.30 | 0.40 | 4.00 | 1.50 | 1.60 | 0.95 | 81 |
| 14 | 0.48 | 0.55 | 15.30 | 16.10 | 0.40 | 4.00 | 1.50 | 1.70 | 0.64 | 79 |
| | 0.59 | 0.69 | 15.30 | 16.10 | 0.40 | 4.00 | 1.50 | 1.70 | 0.85 | 88 |
| | 0.48 | 0.55 | 15.65 | 16.45 | 0.40 | 4.00 | 1.50 | 1.70 | 0.64 | 80 |
| | 0.59 | 0.75 | 15.65 | 16.45 | 0.40 | 4.00 | 1.50 | 1.70 | 0.85 | 90 |
| | 0.81 | | 15.65 | 16.45 | 0.40 | 4.00 | 1.50 | 1.70 | 1.01 | 99 |

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

TABLE 8.1 (contd.)

STANDARD DIMENSIONS OF BELLS, SOCKETS, SPIGOT BEADS AND OUTSIDE DIAMETERS—AND WEIGHTS OF BELLS AND SPIGOT BEADS—OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. | Pipe Thickness | | Pipe Outside Diam. | Dimensions of Bells | | | | | | Weight of Bell and Spigot Bead |
|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | | Socket Diam. | Thickness of Joint $L$ | Socket Depth $d$ | $a$ | $b$ | $c$ | |
| | in. | | | | | | | | | lb. |
| 16 | 0.50 | 0.58 | 17.40 | 18.40 | 0.50 | 4.00 | 1.75 | 1.75 | 0.67 | 96 |
| | 0.63 | 0.73 | 17.40 | 18.40 | 0.50 | 4.00 | 1.75 | 1.75 | 0.89 | 108 |
| | 0.50 | 0.58 | 17.80 | 18.80 | 0.50 | 4.00 | 1.75 | 1.75 | 0.67 | 98 |
| | 0.63 | 0.79 | 17.80 | 18.80 | 0.50 | 4.00 | 1.75 | 1.75 | 0.89 | 110 |
| | 0.85 | | 17.80 | 18.80 | 0.50 | 4.00 | 1.75 | 1.75 | 1.06 | 122 |
| 18 | 0.54 | 0.63 | 19.50 | 20.50 | 0.50 | 4.00 | 1.75 | 1.80 | 0.72 | 115 |
| | 0.68 | 0.79 | 19.50 | 20.50 | 0.50 | 4.00 | 1.75 | 1.80 | 0.95 | 128 |
| | 0.54 | 0.63 | 19.92 | 20.92 | 0.50 | 4.00 | 1.75 | 1.80 | 0.72 | 117 |
| | 0.68 | 0.85 | 19.92 | 20.92 | 0.50 | 4.00 | 1.75 | 1.80 | 0.95 | 130 |
| | 0.92 | | 19.92 | 20.92 | 0.50 | 4.00 | 1.75 | 1.80 | 1.14 | 145 |
| 20 | 0.57 | 0.67 | 21.60 | 22.60 | 0.50 | 4.00 | 1.75 | 1.90 | 0.76 | 135 |
| | 0.72 | 0.84 | 21.60 | 22.60 | 0.50 | 4.00 | 1.75 | 1.90 | 1.01 | 149 |
| | 0.57 | 0.67 | 22.06 | 23.06 | 0.50 | 4.00 | 1.75 | 1.90 | 0.76 | 137 |
| | 0.72 | 0.91 | 22.06 | 23.06 | 0.50 | 4.00 | 1.75 | 1.90 | 1.01 | 152 |
| | 0.98 | | 22.06 | 23.06 | 0.50 | 4.00 | 1.75 | 1.90 | 1.21 | 171 |
| 24 | 0.63 | 0.73 | 25.80 | 26.80 | 0.50 | 4.00 | 2.00 | 2.05 | 0.85 | 171 |
| | 0.79 | 0.92 | 25.80 | 26.80 | 0.50 | 4.00 | 2.00 | 2.05 | 1.04 | 191 |
| | 0.63 | 0.73 | 26.32 | 27.32 | 0.50 | 4.00 | 2.00 | 2.05 | 0.85 | 174 |
| | 0.79 | 0.92 | 26.32 | 27.32 | 0.50 | 4.00 | 2.00 | 2.05 | 1.04 | 194 |
| | 0.99 | 1.07 | 26.32 | 27.32 | 0.50 | 4.00 | 2.00 | 2.05 | 1.29 | 221 |
| 30 | 0.73 | 0.85 | 32.00 | 33.00 | 0.50 | 4.50 | 2.00 | 2.25 | 0.97 | 254 |
| | 0.92 | 1.07 | 32.00 | 33.00 | 0.50 | 4.50 | 2.00 | 2.25 | 1.20 | 280 |
| | 1.16 | | 32.00 | 33.00 | 0.50 | 4.50 | 2.00 | 2.25 | 1.49 | 318 |
| 36 | 0.81 | 0.94 | 38.30 | 39.30 | 0.50 | 4.50 | 2.00 | 2.45 | 1.09 | 347 |
| | 1.02 | 1.19 | 38.30 | 39.30 | 0.50 | 4.50 | 2.00 | 2.45 | 1.35 | 390 |
| | 1.29 | 1.39 | 38.30 | 39.30 | 0.50 | 4.50 | 2.00 | 2.45 | 1.67 | 445 |
| 42 | 0.90 | 1.05 | 44.50 | 45.50 | 0.50 | 5.00 | 2.00 | 2.65 | 1.20 | 450 |
| | 1.13 | 1.32 | 44.50 | 45.50 | 0.50 | 5.00 | 2.00 | 2.65 | 1.48 | 510 |
| | 1.43 | 1.54 | 44.50 | 45.50 | 0.50 | 5.00 | 2.00 | 2.65 | 1.83 | 585 |
| 48 | 0.98 | 1.14 | 50.80 | 51.80 | 0.50 | 5.00 | 2.00 | 2.85 | 1.29 | 556 |
| | 1.23 | 1.44 | 50.80 | 51.80 | 0.50 | 5.00 | 2.00 | 2.85 | 1.61 | 634 |
| | 1.56 | 1.68 | 50.80 | 51.80 | 0.50 | 5.00 | 2.00 | 2.85 | 1.99 | 735 |

TABLE 8.2

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. *in.* | Thickness Class | Thickness *in.* | Outside Diam. *in.* | Inside Diam. *in.* | Weight of Barrel per Foot *lb.* | Weight of Bell and Spigot Bead *lb.* | Weight (*lb.*) Based on: 16-ft. Laying Length, Per Length* | 16-ft. Laying Length, Avg. per Foot† | 16½-ft. Laying Length, Per Length* | 16½-ft. Laying Length, Avg. per Foot† | 20-ft. Laying Length, Per Length* | 20-ft. Laying Length, Avg. per Foot† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 22 | 0.32 | 3.96 | 3.32 | 11.4 | 15 | 195 | 12.4 | 205 | 12.3 | | |
| | 23 | 0.35 | 3.96 | 3.26 | 12.4 | 15 | 215 | 13.4 | 220 | 13.3 | | |
| | 24 | 0.38 | 3.96 | 3.20 | 13.3 | 15 | 230 | 14.3 | 235 | 14.2 | | |
| 4 | 22 | 0.35 | 4.80 | 4.10 | 15.3 | 19 | 265 | 16.5 | 270 | 16.4 | | |
| | 23 | 0.38 | 4.80 | 4.04 | 16.5 | 19 | 285 | 17.7 | 290 | 17.6 | | |
| | 24 | 0.41 | 4.80 | 3.98 | 17.6 | 19 | 300 | 18.8 | 310 | 18.7 | | |
| | 25 | 0.44 | 4.80 | 3.92 | 18.8 | 19 | 320 | 20.0 | 330 | 19.9 | | |
| | 22 | 0.35 | 5.00 | 4.30 | 16.0 | 20 | 275 | 17.2 | 285 | 17.1 | | |
| | 23 | 0.38 | 5.00 | 4.24 | 17.2 | 20 | 295 | 18.5 | 305 | 18.4 | | |
| | 24 | 0.41 | 5.00 | 4.18 | 18.4 | 20 | 315 | 19.7 | 325 | 19.6 | | |
| | 25 | 0.44 | 5.00 | 4.12 | 19.7 | 20 | 335 | 21.0 | 345 | 20.9 | | |
| 6 | 22 | 0.38 | 6.90 | 6.14 | 24.3 | 26 | 415 | 25.9 | 425 | 25.8 | | |
| | 23 | 0.41 | 6.90 | 6.08 | 26.1 | 26 | 445 | 27.7 | 455 | 27.6 | | |
| | 24 | 0.44 | 6.90 | 6.02 | 27.9 | 29 | 475 | 29.7 | 490 | 29.6 | | |
| | 25 | 0.48 | 6.90 | 5.94 | 30.2 | 29 | 510 | 32.0 | 525 | 31.9 | | |
| | 22 | 0.38 | 7.10 | 6.34 | 25.0 | 27 | 425 | 26.7 | 440 | 26.6 | | |
| | 23 | 0.41 | 7.10 | 6.28 | 26.9 | 27 | 455 | 28.5 | 470 | 28.4 | | |
| | 24 | 0.44 | 7.10 | 6.22 | 28.7 | 30 | 490 | 30.6 | 505 | 30.5 | | |
| | 25 | 0.48 | 7.10 | 6.14 | 31.1 | 30 | 530 | 33.0 | 545 | 32.9 | | |
| | 26 | 0.52 | 7.10 | 6.06 | 33.5 | 30 | 565 | 35.4 | 585 | 35.3 | | |
| 8 | 22 | 0.41 | 9.05 | 8.23 | 34.7 | 37 | 590 | 37.0 | 610 | 36.9 | | |
| | 23 | 0.44 | 9.05 | 8.17 | 37.1 | 37 | 630 | 39.5 | 650 | 39.4 | | |
| | 24 | 0.48 | 9.05 | 8.09 | 40.3 | 43 | 690 | 43.0 | 710 | 42.9 | | |
| | 25 | 0.52 | 9.05 | 8.01 | 43.5 | 43 | 740 | 46.2 | 760 | 46.1 | | |
| | 26 | 0.56 | 9.05 | 7.93 | 46.6 | 43 | 790 | 49.3 | 810 | 49.2 | | |
| | 22 | 0.41 | 9.30 | 8.48 | 35.7 | 38 | 610 | 38.1 | 625 | 38.0 | | |
| | 23 | 0.44 | 9.30 | 8.42 | 38.2 | 38 | 650 | 40.6 | 670 | 40.5 | | |
| | 24 | 0.48 | 9.30 | 8.34 | 41.5 | 44 | 710 | 44.3 | 730 | 44.2 | | |
| | 25 | 0.52 | 9.30 | 8.26 | 44.8 | 44 | 760 | 47.6 | 785 | 47.5 | | |
| | 26 | 0.56 | 9.30 | 8.18 | 48.0 | 44 | 810 | 50.7 | 835 | 50.6 | | |
| | 27 | 0.60 | 9.30 | 8.10 | 51.2 | 44 | 865 | 54.0 | 890 | 53.9 | | |

* Including bell and spigot bead. Calculated weight of pipe rounded off to nearest 5 lb.
† Average weight per foot based on calculated weight of pipe before rounding.

TABLE 8.2 (contd.)

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. *in.* | Thickness Class | Thickness *in.* | Outside Diam. *in.* | Inside Diam. *in.* | Weight of Barrel per Foot *lb.* | Weight of Bell and Spigot Bead *lb.* | Weight (*lb.*) Based on 16-ft. Laying Length | | 16½-ft. Laying Length | | 20-ft. Laying Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length* | Avg. per Foot† | Per Length* | Avg. per Foot† | Per Length* | Avg. per Foot† |
| 10 | 22 | 0.44 | 11.10 | 10.22 | 46.0 | 50 | 785 | 49.1 | 810 | 49.0 | | |
| | 23 | 0.48 | 11.10 | 10.14 | 50.0 | 50 | 850 | 53.1 | 875 | 53.0 | | |
| | 24 | 0.52 | 11.10 | 10.06 | 53.9 | 56 | 920 | 57.4 | 945 | 57.3 | | |
| | 25 | 0.56 | 11.10 | 9.98 | 57.9 | 56 | 980 | 61.4 | 1,010 | 61.3 | | |
| | 26 | 0.60 | 11.10 | 9.90 | 61.8 | 56 | 1,045 | 65.3 | 1,075 | 65.2 | | |
| | 22 | 0.44 | 11.40 | 10.52 | 47.3 | 51 | 810 | 50.5 | 830 | 50.4 | | |
| | 23 | 0.48 | 11.40 | 10.44 | 51.4 | 51 | 875 | 54.6 | 900 | 54.5 | | |
| | 24 | 0.52 | 11.40 | 10.36 | 55.5 | 58 | 945 | 59.1 | 975 | 59.0 | | |
| | 25 | 0.56 | 11.40 | 10.28 | 59.5 | 58 | 1,010 | 63.1 | 1,040 | 63.0 | | |
| | 26 | 0.60 | 11.40 | 10.20 | 63.5 | 58 | 1,075 | 67.1 | 1,105 | 67.0 | | |
| | 27 | 0.65 | 11.40 | 10.10 | 68.5 | 58 | 1,155 | 72.1 | 1,190 | 72.0 | | |
| 12 | 22 | 0.48 | 13.20 | 12.24 | 59.8 | 63 | 1,020 | 63.7 | 1,050 | 63.6 | 1,260 | 63.0 |
| | 23 | 0.52 | 13.20 | 12.16 | 64.6 | 63 | 1,095 | 68.5 | 1,130 | 68.4 | 1,355 | 67.8 |
| | 24 | 0.56 | 13.20 | 12.08 | 69.4 | 71 | 1,180 | 73.8 | 1,215 | 73.7 | 1,460 | 73.0 |
| | 25 | 0.60 | 13.20 | 12.00 | 74.1 | 71 | 1,255 | 78.5 | 1,295 | 78.4 | 1,555 | 77.7 |
| | 26 | 0.65 | 13.20 | 11.90 | 80.0 | 71 | 1,350 | 84.4 | 1,390 | 84.3 | 1,670 | 83.6 |
| | 22 | 0.48 | 13.50 | 12.54 | 61.3 | 64 | 1,045 | 65.3 | 1,075 | 65.2 | 1,290 | 64.5 |
| | 23 | 0.52 | 13.50 | 12.46 | 66.2 | 64 | 1,125 | 70.2 | 1,155 | 70.1 | 1,390 | 69.4 |
| | 24 | 0.56 | 13.50 | 12.38 | 71.0 | 73 | 1,210 | 75.6 | 1,245 | 75.4 | 1,495 | 74.7 |
| | 25 | 0.60 | 13.50 | 12.30 | 75.9 | 73 | 1,285 | 80.4 | 1,325 | 80.3 | 1,590 | 79.6 |
| | 26 | 0.65 | 13.50 | 12.20 | 81.9 | 73 | 1,385 | 86.5 | 1,425 | 86.3 | 1,710 | 85.6 |
| | 27 | 0.70 | 13.50 | 12.10 | 87.8 | 73 | 1,480 | 92.4 | 1,520 | 92.2 | 1,830 | 91.4 |
| | 28 | 0.76 | 13.50 | 11.98 | 94.9 | 81 | 1,600 | 100.0 | 1,645 | 99.8 | 1,980 | 99.0 |
| 14 | 21 | 0.48 | 15.30 | 14.34 | 69.7 | 79 | 1,195 | 74.6 | 1,230 | 74.5 | 1,475 | 73.7 |
| | 22 | 0.51 | 15.30 | 14.28 | 73.9 | 79 | 1,260 | 78.8 | 1,300 | 78.7 | 1,555 | 77.8 |
| | 23 | 0.55 | 15.30 | 14.20 | 79.5 | 79 | 1,350 | 84.4 | 1,390 | 84.3 | 1,670 | 83.4 |
| | 24 | 0.59 | 15.30 | 14.12 | 85.1 | 88 | 1,450 | 90.6 | 1,490 | 90.4 | 1,790 | 89.4 |
| | 25 | 0.64 | 15.30 | 14.02 | 92.0 | 88 | 1,560 | 97.5 | 1,605 | 97.3 | 1,930 | 96.4 |
| | 26 | 0.69 | 15.30 | 13.92 | 98.8 | 88 | 1,670 | 104.3 | 1,720 | 104.1 | 2,065 | 103.2 |
| | 21 | 0.48 | 15.65 | 14.69 | 71.4 | 80 | 1,220 | 76.4 | 1,260 | 76.3 | 1,510 | 75.4 |
| | 22 | 0.51 | 15.65 | 14.63 | 75.7 | 80 | 1,290 | 80.7 | 1,330 | 80.5 | 1,595 | 79.7 |
| | 23 | 0.55 | 15.65 | 14.55 | 81.4 | 80 | 1,380 | 86.4 | 1,425 | 86.3 | 1,710 | 85.4 |
| | 24 | 0.59 | 15.65 | 14.47 | 87.1 | 90 | 1,485 | 92.7 | 1,525 | 92.5 | 1,830 | 91.5 |
| | 25 | 0.64 | 15.65 | 14.37 | 94.2 | 90 | 1,595 | 99.8 | 1,645 | 99.7 | 1,975 | 98.7 |
| | 26 | 0.69 | 15.65 | 14.27 | 101.2 | 90 | 1,710 | 106.8 | 1,760 | 106.7 | 2,115 | 105.7 |
| | 27 | 0.75 | 15.65 | 14.15 | 109.5 | 90 | 1,840 | 115.1 | 1,895 | 114.9 | 2,280 | 114.0 |
| | 28 | 0.81 | 15.65 | 14.03 | 117.8 | 99 | 1,985 | 124.0 | 2,045 | 123.8 | 2,455 | 122.8 |

* Including bell and spigot bead. Calculated weight of pipe rounded off to nearest 5 lb.
† Average weight per foot based on calculated weight of pipe before rounding.

TABLE 8.2 (contd.)

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. *in.* | Thickness Class | Thickness *in.* | Outside Diam. *in.* | Inside Diam. *in.* | Weight of Barrel per Foot *lb.* | Weight of Bell and Spigot Bead *lb.* | Weight (*lb.*) Based on: 16-ft. Laying Length, Per Length* | 16-ft. Laying Length, Avg. per Foot† | 16½-ft. Laying Length, Per Length* | 16½-ft. Laying Length, Avg. per Foot† | 20-ft. Laying Length, Per Length* | 20-ft. Laying Length, Avg. per Foot† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 21 | 0.50 | 17.40 | 16.40 | 82.8 | 96 | 1,420 | 88.8 | 1,460 | 88.6 | 1,750 | 87.6 |
| | 22 | 0.54 | 17.40 | 16.32 | 89.2 | 96 | 1,525 | 95.2 | 1,570 | 95.0 | 1,880 | 94.0 |
| | 23 | 0.58 | 17.40 | 16.24 | 95.6 | 96 | 1,625 | 101.6 | 1,675 | 101.4 | 2,010 | 100.4 |
| | 24 | 0.63 | 17.40 | 16.14 | 103.6 | 108 | 1,765 | 110.4 | 1,815 | 110.1 | 2,180 | 108.9 |
| | 25 | 0.68 | 17.40 | 16.04 | 111.4 | 108 | 1,890 | 118.2 | 1,945 | 117.9 | 2,335 | 116.7 |
| | 26 | 0.73 | 17.40 | 15.94 | 119.3 | 108 | 2,015 | 126.0 | 2,075 | 125.8 | 2,495 | 124.7 |
| | 21 | 0.50 | 17.80 | 16.80 | 84.8 | 98 | 1,455 | 90.9 | 1,495 | 90.7 | 1,795 | 89.7 |
| | 22 | 0.54 | 17.80 | 16.72 | 91.4 | 98 | 1,560 | 97.5 | 1,605 | 97.3 | 1,925 | 96.3 |
| | 23 | 0.58 | 17.80 | 16.64 | 97.9 | 98 | 1,665 | 104.0 | 1,715 | 103.8 | 2,055 | 102.8 |
| | 24 | 0.63 | 17.80 | 16.54 | 106.0 | 110 | 1,805 | 112.9 | 1,860 | 112.7 | 2,230 | 111.4 |
| | 25 | 0.68 | 17.80 | 16.44 | 114.1 | 110 | 1,935 | 121.0 | 1,995 | 120.8 | 2,390 | 119.4 |
| | 26 | 0.73 | 17.80 | 16.34 | 122.1 | 110 | 2,065 | 129.0 | 2,125 | 128.8 | 2,550 | 127.6 |
| | 27 | 0.79 | 17.80 | 16.22 | 131.7 | 110 | 2,215 | 138.5 | 2,285 | 138.4 | 2,745 | 137.2 |
| | 28 | 0.85 | 17.80 | 16.10 | 141.2 | 122 | 2,380 | 148.8 | 2,450 | 148.6 | 2,945 | 147.3 |
| 18 | 21 | 0.54 | 19.50 | 18.42 | 100.4 | 115 | 1,720 | 107.6 | 1,770 | 107.4 | 2,125 | 106.2 |
| | 22 | 0.58 | 19.50 | 18.34 | 107.6 | 115 | 1,835 | 114.8 | 1,890 | 114.6 | 2,265 | 113.3 |
| | 23 | 0.63 | 19.50 | 18.24 | 116.5 | 115 | 1,980 | 123.7 | 2,035 | 123.4 | 2,445 | 122.2 |
| | 24 | 0.68 | 19.50 | 18.14 | 125.4 | 128 | 2,135 | 133.4 | 2,195 | 133.1 | 2,635 | 131.7 |
| | 25 | 0.73 | 19.50 | 18.04 | 134.3 | 128 | 2,275 | 142.3 | 2,345 | 142.1 | 2,815 | 140.7 |
| | 26 | 0.79 | 19.50 | 17.92 | 144.9 | 128 | 2,445 | 152.9 | 2,520 | 152.7 | 3,025 | 151.3 |
| | 21 | 0.54 | 19.92 | 18.84 | 102.6 | 117 | 1,760 | 109.9 | 1,810 | 109.7 | 2,170 | 108.4 |
| | 22 | 0.58 | 19.92 | 18.76 | 109.9 | 117 | 1,875 | 117.2 | 1,930 | 117.0 | 2,315 | 115.8 |
| | 23 | 0.63 | 19.92 | 18.66 | 119.1 | 117 | 2,025 | 126.5 | 2,080 | 126.2 | 2,500 | 125.0 |
| | 24 | 0.68 | 19.92 | 18.56 | 128.2 | 130 | 2,180 | 136.3 | 2,245 | 136.1 | 2,695 | 134.7 |
| | 25 | 0.73 | 19.92 | 18.46 | 137.3 | 130 | 2,325 | 145.4 | 2,395 | 145.2 | 2,875 | 143.7 |
| | 26 | 0.79 | 19.92 | 18.34 | 148.1 | 130 | 2,500 | 156.2 | 2,575 | 156.1 | 3,090 | 154.6 |
| | 27 | 0.85 | 19.92 | 18.22 | 158.9 | 130 | 2,670 | 167.0 | 2,750 | 166.8 | 3,310 | 165.4 |
| | 28 | 0.92 | 19.92 | 18.08 | 171.3 | 145 | 2,885 | 180.4 | 2,970 | 180.1 | 3,570 | 178.6 |
| 20 | 21 | 0.57 | 21.60 | 20.46 | 117.5 | 135 | 2,015 | 125.9 | 2,075 | 125.7 | 2,485 | 124.2 |
| | 22 | 0.62 | 21.60 | 20.36 | 127.5 | 135 | 2,175 | 135.9 | 2,240 | 135.7 | 2,685 | 134.2 |
| | 23 | 0.67 | 21.60 | 20.26 | 137.5 | 135 | 2,335 | 145.9 | 2,405 | 145.7 | 2,885 | 144.2 |
| | 24 | 0.72 | 21.60 | 20.16 | 147.4 | 149 | 2,505 | 156.7 | 2,580 | 156.4 | 3,095 | 154.7 |
| | 25 | 0.78 | 21.60 | 20.04 | 159.2 | 149 | 2,695 | 168.5 | 2,775 | 168.2 | 3,335 | 166.7 |
| | 26 | 0.84 | 21.60 | 19.92 | 170.9 | 149 | 2,885 | 180.2 | 2,970 | 179.9 | 3,565 | 178.3 |

* Including bell and spigot bead. Calculated weight of pipe rounded off to nearest 5 lb.

† Average weight per foot based on calculated weight of pipe before rounding.

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

TABLE 8.2 (contd.)

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. *in.* | Thickness Class | Thickness *in.* | Outside Diam. *in.* | Inside Diam. *in.* | Weight of Barrel per Foot *lb.* | Weight of Bell and Spigot Bead *lb.* | Weight (*lb.*) Based on: 16-ft. Laying Length | | 16½-ft. Laying Length | | 20-ft. Laying Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length* | Avg. per Foot† | Per Length* | Avg. per Foot† | Per Length* | Avg. per Foot† |
| 20 | 21 | 0.57 | 22.06 | 20.92 | 120.1 | 137 | 2,060 | 128.7 | 2,120 | 128.4 | 2,540 | 127.0 |
| | 22 | 0.62 | 22.06 | 20.82 | 130.3 | 137 | 2,220 | 138.9 | 2,285 | 138.6 | 2,745 | 137.2 |
| | 23 | 0.67 | 22.06 | 20.72 | 140.5 | 137 | 2,385 | 149.1 | 2,455 | 148.8 | 2,945 | 147.3 |
| | 24 | 0.72 | 22.06 | 20.62 | 150.6 | 152 | 2,560 | 160.1 | 2,635 | 159.8 | 3,165 | 158.2 |
| | 25 | 0.78 | 22.06 | 20.50 | 162.7 | 152 | 2,755 | 172.2 | 2,835 | 171.9 | 3,405 | 170.3 |
| | 26 | 0.84 | 22.06 | 20.38 | 174.7 | 152 | 2,945 | 184.2 | 3,035 | 184.0 | 3,645 | 182.3 |
| | 27 | 0.91 | 22.06 | 20.24 | 188.7 | 152 | 3,170 | 198.2 | 3,265 | 198.0 | 3,925 | 196.3 |
| | 28 | 0.98 | 22.06 | 20.10 | 202.5 | 171 | 3,410 | 213.2 | 3,510 | 212.8 | 4,220 | 211.0 |
| 24 | 21 | 0.63 | 25.80 | 24.54 | 155.4 | 171 | 2,655 | 166.0 | 2,735 | 165.8 | 3,280 | 164.0 |
| | 22 | 0.68 | 25.80 | 24.44 | 167.4 | 171 | 2,850 | 178.1 | 2,935 | 177.8 | 3,520 | 176.0 |
| | 23 | 0.73 | 25.80 | 24.34 | 179.4 | 171 | 3,040 | 190.1 | 3,130 | 189.8 | 3,760 | 188.0 |
| | 24 | 0.79 | 25.80 | 24.22 | 193.7 | 191 | 3,290 | 205.6 | 3,385 | 205.3 | 4,065 | 203.2 |
| | 25 | 0.85 | 25.80 | 24.10 | 207.9 | 191 | 3,515 | 219.8 | 3,620 | 219.5 | 4,350 | 217.4 |
| | 26 | 0.92 | 25.80 | 23.96 | 224.4 | 191 | 3,780 | 236.3 | 3,895 | 236.0 | 4,680 | 234.0 |
| | 21 | 0.63 | 26.32 | 25.06 | 158.6 | 174 | 2,710 | 169.5 | 2,790 | 169.1 | 3,345 | 167.3 |
| | 22 | 0.68 | 26.32 | 24.96 | 170.9 | 174 | 2,910 | 181.8 | 2,995 | 181.4 | 3,590 | 179.6 |
| | 23 | 0.73 | 26.32 | 24.86 | 183.1 | 174 | 3,105 | 194.0 | 3,195 | 193.6 | 3,835 | 191.8 |
| | 24 | 0.79 | 26.32 | 24.74 | 197.7 | 194 | 3,355 | 209.8 | 3,455 | 209.5 | 4,150 | 207.4 |
| | 25 | 0.85 | 26.32 | 24.62 | 212.2 | 194 | 3,590 | 224.3 | 3,695 | 224.0 | 4,440 | 221.9 |
| | 26 | 0.92 | 26.32 | 24.48 | 229.0 | 194 | 3,860 | 241.1 | 3,970 | 240.7 | 4,775 | 238.7 |
| | 27 | 0.99 | 26.32 | 24.34 | 245.8 | 221 | 4,155 | 259.6 | 4,275 | 259.2 | 5,135 | 256.8 |
| | 28 | 1.07 | 26.32 | 24.18 | 264.8 | 221 | 4,460 | 278.6 | 4,590 | 278.2 | 5,515 | 275.8 |
| 30 | 21 | 0.73 | 32.00 | 30.54 | 223.7 | 254 | 3,835 | 239.6 | 3,945 | 239.1 | 4,730 | 236.4 |
| | 22 | 0.79 | 32.00 | 30.42 | 241.7 | 254 | 4,120 | 257.6 | 4,240 | 257.1 | 5,090 | 254.4 |
| | 23 | 0.85 | 32.00 | 30.30 | 259.5 | 254 | 4,405 | 275.4 | 4,535 | 274.9 | 5,445 | 272.2 |
| | 24 | 0.92 | 32.00 | 30.16 | 280.3 | 280 | 4,765 | 297.8 | 4,905 | 297.3 | 5,885 | 294.3 |
| | 25 | 0.99 | 32.00 | 30.02 | 300.9 | 280 | 5,095 | 318.4 | 5,245 | 317.9 | 6,300 | 314.9 |
| | 26 | 1.07 | 32.00 | 29.86 | 324.4 | 280 | 5,470 | 341.9 | 5,635 | 341.4 | 6,770 | 338.4 |
| | 27 | 1.16 | 32.00 | 29.68 | 350.7 | 318 | 5,930 | 370.6 | 6,105 | 370.0 | 7,330 | 366.6 |

* Including bell and spigot bead. Calculated weight of pipe rounded off to nearest 5 lb.
† Average weight per foot based on calculated weight of pipe before rounding.

TABLE 8.2 (contd.)

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

| Nom. Diam. *in.* | Thickness Class | Thickness *in.* | Outside Diam. *in.* | Inside Diam. *in.* | Weight of Barrel per Foot *lb.* | Weight of Bell and Spigot Bead *lb.* | Weight (*lb.*) Based on: 16-ft. Laying Length, Per Length* | 16-ft. Laying Length, Avg. per Foot† | 16½-ft. Laying Length, Per Length* | 16½-ft. Laying Length, Avg. per Foot† | 20-ft. Laying Length, Per Length* | 20-ft. Laying Length, Avg. per Foot† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 21 | 0.81 | 38.30 | 36.68 | 297.7 | 347 | 5,110 | 319.4 | | | | |
| | 22 | 0.87 | 38.30 | 36.56 | 319.2 | 347 | 5,455 | 340.9 | | | | |
| | 23 | 0.94 | 38.30 | 36.42 | 344.2 | 347 | 5,855 | 365.9 | | | | |
| | 24 | 1.02 | 38.30 | 36.26 | 372.7 | 390 | 6,355 | 397.1 | | | | |
| | 25 | 1.10 | 38.30 | 36.10 | 401.1 | 390 | 6,810 | 425.5 | | | | |
| | 26 | 1.19 | 38.30 | 35.92 | 432.9 | 390 | 7,315 | 457.3 | | | | |
| | 27 | 1.29 | 38.30 | 35.72 | 468.0 | 445 | 7,935 | 495.8 | | | | |
| | 28 | 1.39 | 38.30 | 35.52 | 502.9 | 445 | 8,490 | 530.7 | | | | |
| 42 | 21 | 0.90 | 44.50 | 42.70 | 384.6 | 450 | 6,605 | 412.7 | | | | |
| | 22 | 0.97 | 44.50 | 42.56 | 413.9 | 450 | 7,070 | 442.0 | | | | |
| | 23 | 1.05 | 44.50 | 42.40 | 447.2 | 450 | 7,605 | 475.3 | | | | |
| | 24 | 1.13 | 44.50 | 42.24 | 480.4 | 510 | 8,195 | 512.3 | | | | |
| | 25 | 1.22 | 44.50 | 42.06 | 517.6 | 510 | 8,790 | 549.5 | | | | |
| | 26 | 1.32 | 44.50 | 41.86 | 558.7 | 510 | 9,450 | 590.6 | | | | |
| | 27 | 1.43 | 44.50 | 41.64 | 603.7 | 585 | 10,245 | 640.3 | | | | |
| | 28 | 1.54 | 44.50 | 41.42 | 648.5 | 585 | 10,960 | 685.1 | | | | |
| 48 | 21 | 0.98 | 50.80 | 48.84 | 478.6 | 556 | 8,215 | 513.4 | | | | |
| | 22 | 1.06 | 50.80 | 48.68 | 516.8 | 556 | 8,825 | 551.6 | | | | |
| | 23 | 1.14 | 50.80 | 48.52 | 554.9 | 556 | 9,435 | 589.6 | | | | |
| | 24 | 1.23 | 50.80 | 48.34 | 597.6 | 634 | 10,195 | 637.2 | | | | |
| | 25 | 1.33 | 50.80 | 48.14 | 644.9 | 634 | 10,950 | 684.5 | | | | |
| | 26 | 1.44 | 50.80 | 47.92 | 696.7 | 634 | 11,780 | 736.3 | | | | |
| | 27 | 1.56 | 50.80 | 47.68 | 752.9 | 735 | 12,780 | 798.8 | | | | |
| | 28 | 1.68 | 50.80 | 47.44 | 808.9 | 735 | 13,675 | 854.8 | | | | |

* Including bell and spigot bead. Calculated weight of pipe rounded off to nearest 5 lb.
† Average weight per foot based on calculated weight of pipe before rounding.

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

TABLE 8.3.

STANDARD THICKNESSES AND WEIGHTS OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS*

| Size *in.* | Thickness *in.* | Outside Diam. *in.* | Weight (*lb.*) Based on | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 16-ft. Laying Length | | 16½-ft. Laying Length | | 20-ft. Laying Length | |
| | | | Avg. per Foot† | Per Length‡ | Avg. per Foot† | Per Length‡ | Avg. per Foot† | Per Length‡ |
| Class 50—50-psi. Pressure—115-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.44 | 11.10 | 49.1 | 785 | 49.0 | 810 | | |
| 12 | 0.48 | 13.20 | 63.7 | 1,020 | 63.6 | 1,050 | 63.0 | 1,260 |
| 14 | 0.48 | 15.30 | 74.6 | 1,195 | 74.5 | 1,230 | 73.7 | 1,475 |
| 16 | 0.54 | 17.40 | 95.2 | 1,525 | 95.0 | 1,570 | 94.0 | 1,880 |
| 18 | 0.54 | 19.50 | 107.6 | 1,720 | 107.4 | 1,770 | 106.2 | 2,125 |
| 20 | 0.57 | 21.60 | 125.9 | 2,015 | 125.7 | 2,075 | 124.2 | 2,485 |
| 24 | 0.63 | 25.80 | 166.0 | 2,655 | 165.8 | 2,735 | 164.0 | 3,280 |
| 30 | 0.79 | 32.00 | 257.6 | 4,120 | 257.1 | 4,240 | 254.4 | 5,090 |
| 36 | 0.87 | 38.30 | 340.9 | 5,455 | | | | |
| 42 | 0.97 | 44.50 | 442.0 | 7,070 | | | | |
| 48 | 1.06 | 50.80 | 551.6 | 8,825 | | | | |
| Class 100—100-psi. Pressure—231-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.44 | 11.10 | 49.1 | 785 | 49.0 | 810 | | |
| 12 | 0.48 | 13.20 | 63.7 | 1,020 | 63.6 | 1,050 | 63.0 | 1,260 |
| 14 | 0.51 | 15.30 | 78.8 | 1,260 | 78.7 | 1,300 | 77.8 | 1,555 |
| 16 | 0.54 | 17.40 | 95.2 | 1,525 | 95.0 | 1,570 | 94.0 | 1,880 |
| 18 | 0.58 | 19.50 | 114.8 | 1,835 | 114.6 | 1,890 | 113.3 | 2,265 |
| 20 | 0.62 | 21.60 | 135.9 | 2,175 | 135.7 | 2,240 | 134.2 | 2,685 |
| 24 | 0.68 | 25.80 | 178.1 | 2,850 | 177.8 | 2,935 | 176.0 | 3,520 |
| 30 | 0.79 | 32.00 | 257.6 | 4,120 | 257.1 | 4,240 | 254.4 | 5,090 |
| 36 | 0.87 | 38.30 | 340.9 | 5,455 | | | | |
| 42 | 0.97 | 44.50 | 442.0 | 7,070 | | | | |
| 48 | 1.06 | 50.80 | 551.6 | 8,825 | | | | |
| Class 150—150-psi. Pressure—346-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.44 | 11.10 | 49.1 | 785 | 49.0 | 810 | | |
| 12 | 0.48 | 13.20 | 63.7 | 1,020 | 63.6 | 1,050 | 63.0 | 1,260 |
| 14 | 0.51 | 15.65 | 80.7 | 1,290 | 80.5 | 1,330 | 79.7 | 1,595 |
| 16 | 0.54 | 17.80 | 97.5 | 1,560 | 97.3 | 1,605 | 96.3 | 1,925 |
| 18 | 0.58 | 19.92 | 117.2 | 1,875 | 117.0 | 1,930 | 115.8 | 2,315 |
| 20 | 0.62 | 22.06 | 138.9 | 2,220 | 138.6 | 2,285 | 137.2 | 2,745 |
| 24 | 0.73 | 26.32 | 194.0 | 3,105 | 193.6 | 3,195 | 191.8 | 3,835 |
| 30 | 0.85 | 32.00 | 275.4 | 4,405 | 274.9 | 4,535 | 272.2 | 5,445 |
| 36 | 0.94 | 38.30 | 365.9 | 5,855 | | | | |
| 42 | 1.05 | 44.50 | 475.3 | 7,605 | | | | |
| 48 | 1.14 | 50.80 | 589.6 | 9,435 | | | | |

* These thicknesses and weights are for pipe laid without blocks, on flat-bottom trench, with tamped backfill, under 5 ft. of cover. For other conditions see Tables 8.2 and 8.4 hereof and ASA A21.1, "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

† Average weight per foot based on calculated weight of pipe before rounding.

‡ Including bell and spigot bead. Calculated weight of pipe rounded off to nearest 5 lb.

TABLE 8.3 (contd.)—STANDARD THICKNESSES AND WEIGHTS*

| Size *in.* | Thickness *in.* | Outside Diam. *in.* | Weight (*lb.*) Based on: 16-ft. Laying Length, Avg. per Foot† | 16-ft. Laying Length, Per Length‡ | 16½-ft. Laying Length, Avg. per Foot† | 16½-ft. Laying Length, Per Length‡ | 20-ft. Laying Length, Avg. per Foot† | 20-ft. Laying Length, Per Length‡ |
|---|---|---|---|---|---|---|---|---|
| Class 200—200-psi. Pressure—462-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.44 | 11.10 | 49.1 | 785 | 49.0 | 810 | | |
| 12 | 0.48 | 13.20 | 63.7 | 1,020 | 63.6 | 1,050 | 63.0 | 1,260 |
| 14 | 0.55 | 15.65 | 86.4 | 1,380 | 86.3 | 1,425 | 85.4 | 1,710 |
| 16 | 0.58 | 17.80 | 104.0 | 1,665 | 103.8 | 1,715 | 102.8 | 2,055 |
| 18 | 0.63 | 19.92 | 126.5 | 2,025 | 126.2 | 2,080 | 125.0 | 2,500 |
| 20 | 0.67 | 22.06 | 149.1 | 2,385 | 148.8 | 2,455 | 147.3 | 2,945 |
| 24 | 0.79 | 26.32 | 209.8 | 3,355 | 209.5 | 3,455 | 207.4 | 4,150 |
| 30 | 0.92 | 32.00 | 297.8 | 4,765 | 297.3 | 4,905 | 294.3 | 5,885 |
| 36 | 1.02 | 38.30 | 397.1 | 6,355 | | | | |
| 42 | 1.13 | 44.50 | 512.3 | 8,195 | | | | |
| 48 | 1.23 | 50.80 | 637.2 | 10,195 | | | | |
| Class 250—250-psi. Pressure—577-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.44 | 11.10 | 49.1 | 785 | 49.0 | 810 | | |
| 12 | 0.52 | 13.20 | 68.5 | 1,095 | 68.4 | 1,130 | 67.8 | 1,355 |
| 14 | 0.59 | 15.65 | 92.7 | 1,485 | 92.5 | 1,525 | 91.5 | 1,830 |
| 16 | 0.63 | 17.80 | 112.9 | 1,805 | 112.7 | 1,860 | 111.4 | 2,230 |
| 18 | 0.68 | 19.92 | 136.3 | 2,180 | 136.1 | 2,245 | 134.7 | 2,695 |
| 20 | 0.72 | 22.06 | 160.1 | 2,560 | 159.8 | 2,635 | 158.2 | 3,165 |
| 24 | 0.79 | 26.32 | 209.8 | 3,355 | 209.5 | 3,455 | 207.4 | 4,150 |
| 30 | 0.99 | 32.00 | 318.4 | 5,095 | 317.9 | 5,245 | 314.9 | 6,300 |
| 36 | 1.10 | 38.30 | 425.5 | 6,810 | | | | |
| 42 | 1.22 | 44.50 | 549.5 | 8,790 | | | | |
| 48 | 1.33 | 50.80 | 684.5 | 10,950 | | | | |
| Class 300—300-psi. Pressure—693-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.48 | 11.10 | 53.1 | 850 | 53.0 | 875 | | |
| 12 | 0.52 | 13.20 | 68.5 | 1,095 | 68.4 | 1,130 | 67.8 | 1,355 |
| 14 | 0.59 | 15.65 | 92.7 | 1,485 | 92.5 | 1,525 | 91.5 | 1,830 |
| 16 | 0.68 | 17.80 | 121.0 | 1,935 | 120.8 | 1,995 | 119.4 | 2,390 |
| 18 | 0.73 | 19.92 | 145.4 | 2,325 | 145.2 | 2,395 | 143.7 | 2,875 |
| 20 | 0.78 | 22.06 | 172.2 | 2,755 | 171.9 | 2,835 | 170.3 | 3,405 |
| 24 | 0.85 | 26.32 | 224.3 | 3,590 | 224.0 | 3,695 | 221.9 | 4,440 |
| Class 350—350-psi. Pressure—808-ft. Head | | | | | | | | |
| 3 | 0.32 | 3.96 | 12.4 | 195 | 12.3 | 205 | | |
| 4 | 0.35 | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| 6 | 0.38 | 6.90 | 25.9 | 415 | 25.8 | 425 | | |
| 8 | 0.41 | 9.05 | 37.0 | 590 | 36.9 | 610 | | |
| 10 | 0.52 | 11.10 | 57.4 | 920 | 57.3 | 945 | | |
| 12 | 0.56 | 13.20 | 73.8 | 1,180 | 73.7 | 1,215 | 73.0 | 1,460 |
| 14 | 0.64 | 15.65 | 99.8 | 1,595 | 99.7 | 1,645 | 98.7 | 1,975 |
| 16 | 0.68 | 17.80 | 121.0 | 1,935 | 120.8 | 1,995 | 119.4 | 2,390 |
| 18 | 0.79 | 19.92 | 156.2 | 2,500 | 156.1 | 2,575 | 154.6 | 3,090 |
| 20 | 0.84 | 22.06 | 184.2 | 2,945 | 184.0 | 3,035 | 182.3 | 3,645 |
| 24 | 0.92 | 26.32 | 241.1 | 3,860 | 240.7 | 3,970 | 238.7 | 4,775 |

*†‡ See footnotes on preceding page.

PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

TABLE 8.4

STANDARD THICKNESSES* OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

Laying Condition A—Flat-bottom trench, without blocks, untamped backfill
Laying Condition B—Flat-bottom trench, without blocks, tamped backfill
Laying Condition C—Pipe laid on blocks, untamped backfill
Laying Condition D—Pipe laid on blocks, tamped backfill

| Size *in.* | Working Pressure *psi.* | 3½-ft. Cover | | | | 5-ft. Cover | | | | 8-ft. Cover | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Laying Condition | | | | Laying Condition | | | | Laying Condition | | | |
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| | | Thickness—*in.* | | | | | | | | | | | |
| 3 | 50 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 100 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 150 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 200 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 250 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 300 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| | 350 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 | 0.32 | 0.38 | 0.32 |
| 4 | 50 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.41 | 0.35 |
| | 100 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.41 | 0.35 |
| | 150 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.41 | 0.35 |
| | 200 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| | 250 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| | 300 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| | 350 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.38 | 0.35 | 0.35 | 0.35 | 0.44 | 0.35 |
| 6 | 50 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 |
| | 100 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 |
| | 150 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 |
| | 200 | 0.38 | 0.38 | 0.41 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| | 250 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| | 300 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| | 350 | 0.38 | 0.38 | 0.44 | 0.38 | 0.38 | 0.38 | 0.48 | 0.38 | 0.38 | 0.38 | 0.52 | 0.38 |
| 8 | 50 | 0.41 | 0.41 | 0.44 | 0.41 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 |
| | 100 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.56 | 0.41 |
| | 150 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.56 | 0.41 |
| | 200 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 | 0.41 | 0.41 | 0.56 | 0.44 |
| | 250 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 | 0.44 | 0.41 | 0.56 | 0.44 |
| | 300 | 0.41 | 0.41 | 0.48 | 0.41 | 0.41 | 0.41 | 0.52 | 0.41 | 0.44 | 0.44 | 0.60 | 0.44 |
| | 350 | 0.41 | 0.41 | 0.52 | 0.41 | 0.44 | 0.41 | 0.52 | 0.44 | 0.48 | 0.44 | 0.60 | 0.48 |
| 10 | 50 | 0.44 | 0.44 | 0.48 | 0.44 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.60 | 0.48 |
| | 100 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.52 | 0.44 | 0.48 | 0.44 | 0.60 | 0.48 |
| | 150 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.56 | 0.44 | 0.48 | 0.44 | 0.60 | 0.48 |
| | 200 | 0.44 | 0.44 | 0.52 | 0.44 | 0.44 | 0.44 | 0.56 | 0.44 | 0.48 | 0.48 | 0.60 | 0.52 |
| | 250 | 0.44 | 0.44 | 0.56 | 0.44 | 0.48 | 0.44 | 0.56 | 0.48 | 0.52 | 0.48 | 0.65 | 0.52 |
| | 300 | 0.48 | 0.44 | 0.56 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.52 | 0.65 | 0.56 |
| | 350 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.52 | 0.60 | 0.52 | 0.56 | 0.52 | 0.65 | 0.56 |
| 12 | 50 | 0.48 | 0.48 | 0.52 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.48 | 0.65 | 0.52 |
| | 100 | 0.48 | 0.48 | 0.56 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.48 | 0.65 | 0.52 |
| | 150 | 0.48 | 0.48 | 0.56 | 0.48 | 0.48 | 0.48 | 0.56 | 0.48 | 0.52 | 0.52 | 0.65 | 0.56 |
| | 200 | 0.48 | 0.48 | 0.56 | 0.48 | 0.48 | 0.48 | 0.60 | 0.52 | 0.56 | 0.52 | 0.65 | 0.56 |
| | 250 | 0.52 | 0.48 | 0.60 | 0.52 | 0.52 | 0.52 | 0.60 | 0.52 | 0.56 | 0.56 | 0.70 | 0.60 |
| | 300 | 0.52 | 0.52 | 0.60 | 0.52 | 0.56 | 0.52 | 0.60 | 0.56 | 0.60 | 0.56 | 0.70 | 0.60 |
| | 350 | 0.56 | 0.56 | 0.60 | 0.56 | 0.56 | 0.56 | 0.65 | 0.60 | 0.60 | 0.60 | 0.76 | 0.65 |
| 14 | 50 | 0.51 | 0.48 | 0.59 | 0.51 | 0.51 | 0.48 | 0.59 | 0.55 | 0.59 | 0.55 | 0.69 | 0.59 |
| | 100 | 0.51 | 0.48 | 0.59 | 0.55 | 0.55 | 0.51 | 0.64 | 0.55 | 0.59 | 0.55 | 0.69 | 0.64 |
| | 150 | 0.55 | 0.51 | 0.59 | 0.55 | 0.55 | 0.51 | 0.64 | 0.59 | 0.64 | 0.59 | 0.75 | 0.64 |
| | 200 | 0.55 | 0.51 | 0.64 | 0.59 | 0.55 | 0.55 | 0.64 | 0.59 | 0.64 | 0.59 | 0.75 | 0.69 |
| | 250 | 0.59 | 0.55 | 0.64 | 0.59 | 0.59 | 0.59 | 0.69 | 0.59 | 0.64 | 0.64 | 0.75 | 0.69 |
| | 300 | 0.59 | 0.59 | 0.69 | 0.59 | 0.64 | 0.59 | 0.69 | 0.64 | 0.69 | 0.64 | 0.81 | 0.69 |
| | 350 | 0.64 | 0.64 | 0.69 | 0.64 | 0.64 | 0.64 | 0.75 | 0.69 | 0.75 | 0.69 | 0.81 | 0.75 |

* Thicknesses include allowances for foundry practice, corrosion, and either water hammer or truck load.

TABLE 8.4 (contd.)

STANDARD THICKNESSES* OF PIPE CENTRIFUGALLY CAST IN SAND-LINED MOLDS

Laying Condition A—Flat-bottom trench, without blocks, untamped backfill
Laying Condition B—Flat-bottom trench, without blocks, tamped backfill
Laying Condition C—Pipe laid on blocks, untamped backfill
Laying Condition D—Pipe laid on blocks, tamped backfill

| Size *in.* | Working Pressure *psi.* | 3½-ft. Cover — Laying Condition | | | | 5-ft. Cover — Laying Condition | | | | 8-ft. Cover — Laying Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| | | Thickness—*in.* | | | | | | | | | | | |
| 16 | 50 | 0.54 | 0.50 | 0.63 | 0.58 | 0.58 | 0.54 | 0.63 | 0.58 | 0.63 | 0.58 | 0.73 | 0.63 |
| | 100 | 0.54 | 0.54 | 0.63 | 0.58 | 0.58 | 0.54 | 0.68 | 0.58 | 0.63 | 0.58 | 0.73 | 0.68 |
| | 150 | 0.58 | 0.54 | 0.63 | 0.58 | 0.58 | 0.54 | 0.68 | 0.63 | 0.68 | 0.63 | 0.79 | 0.68 |
| | 200 | 0.58 | 0.58 | 0.68 | 0.63 | 0.63 | 0.58 | 0.68 | 0.63 | 0.68 | 0.63 | 0.79 | 0.73 |
| | 250 | 0.63 | 0.58 | 0.68 | 0.63 | 0.63 | 0.63 | 0.73 | 0.68 | 0.73 | 0.68 | 0.79 | 0.73 |
| | 300 | 0.63 | 0.63 | 0.73 | 0.68 | 0.68 | 0.68 | 0.73 | 0.68 | 0.73 | 0.73 | 0.85 | 0.79 |
| | 350 | 0.68 | 0.68 | 0.73 | 0.68 | 0.73 | 0.68 | 0.79 | 0.73 | 0.79 | 0.73 | 0.85 | 0.79 |
| 18 | 50 | 0.58 | 0.54 | 0.63 | 0.58 | 0.58 | 0.54 | 0.68 | 0.63 | 0.68 | 0.63 | 0.79 | 0.68 |
| | 100 | 0.58 | 0.54 | 0.68 | 0.63 | 0.63 | 0.58 | 0.73 | 0.63 | 0.68 | 0.63 | 0.79 | 0.73 |
| | 150 | 0.63 | 0.58 | 0.68 | 0.63 | 0.63 | 0.58 | 0.73 | 0.68 | 0.73 | 0.68 | 0.79 | 0.73 |
| | 200 | 0.63 | 0.58 | 0.73 | 0.68 | 0.68 | 0.63 | 0.73 | 0.68 | 0.73 | 0.68 | 0.85 | 0.79 |
| | 250 | 0.68 | 0.63 | 0.73 | 0.68 | 0.68 | 0.68 | 0.79 | 0.73 | 0.79 | 0.73 | 0.85 | 0.79 |
| | 300 | 0.68 | 0.68 | 0.79 | 0.73 | 0.73 | 0.73 | 0.79 | 0.79 | 0.79 | 0.79 | 0.92 | 0.85 |
| | 350 | 0.79 | 0.73 | 0.79 | 0.79 | 0.79 | 0.79 | 0.85 | 0.79 | 0.85 | 0.85 | 0.92 | 0.85 |
| 20 | 50 | 0.62 | 0.57 | 0.72 | 0.62 | 0.67 | 0.57 | 0.72 | 0.67 | 0.72 | 0.67 | 0.78 | 0.72 |
| | 100 | 0.62 | 0.57 | 0.72 | 0.67 | 0.67 | 0.62 | 0.78 | 0.67 | 0.72 | 0.67 | 0.84 | 0.78 |
| | 150 | 0.67 | 0.62 | 0.72 | 0.67 | 0.67 | 0.62 | 0.78 | 0.72 | 0.78 | 0.72 | 0.84 | 0.78 |
| | 200 | 0.67 | 0.62 | 0.78 | 0.72 | 0.72 | 0.67 | 0.78 | 0.72 | 0.78 | 0.72 | 0.91 | 0.84 |
| | 250 | 0.72 | 0.67 | 0.78 | 0.72 | 0.78 | 0.72 | 0.84 | 0.78 | 0.84 | 0.78 | 0.91 | 0.84 |
| | 300 | 0.78 | 0.72 | 0.84 | 0.78 | 0.78 | 0.78 | 0.84 | 0.84 | 0.84 | 0.84 | 0.98 | 0.91 |
| | 350 | 0.84 | 0.78 | 0.84 | 0.84 | 0.84 | 0.84 | 0.91 | 0.84 | 0.91 | 0.84 | 0.98 | 0.91 |
| 24 | 50 | 0.68 | 0.63 | 0.79 | 0.68 | 0.73 | 0.63 | 0.79 | 0.73 | 0.79 | 0.73 | 0.85 | 0.79 |
| | 100 | 0.73 | 0.63 | 0.79 | 0.73 | 0.73 | 0.68 | 0.85 | 0.79 | 0.85 | 0.73 | 0.92 | 0.85 |
| | 150 | 0.73 | 0.68 | 0.79 | 0.79 | 0.79 | 0.73 | 0.85 | 0.79 | 0.85 | 0.79 | 0.92 | 0.85 |
| | 200 | 0.79 | 0.73 | 0.85 | 0.79 | 0.79 | 0.79 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.92 |
| | 250 | 0.79 | 0.79 | 0.85 | 0.85 | 0.85 | 0.79 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.99 |
| | 300 | 0.85 | 0.85 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.92 | 0.99 | 0.92 | 1.07 | 0.99 |
| | 350 | 0.92 | 0.92 | 0.99 | 0.92 | 0.99 | 0.92 | 0.99 | 0.99 | 1.07 | 0.99 | 1.07 | 1.07 |
| 30 | 50 | 0.85 | 0.73 | 0.85 | 0.85 | 0.85 | 0.79 | 0.92 | 0.85 | 0.92 | 0.85 | 0.99 | 0.92 |
| | 100 | 0.85 | 0.79 | 0.92 | 0.85 | 0.92 | 0.79 | 0.99 | 0.92 | 0.99 | 0.85 | 1.07 | 0.99 |
| | 150 | 0.92 | 0.79 | 0.92 | 0.92 | 0.92 | 0.85 | 0.99 | 0.92 | 0.99 | 0.92 | 1.07 | 0.99 |
| | 200 | 0.92 | 0.85 | 0.99 | 0.92 | 0.99 | 0.92 | 1.07 | 0.99 | 1.07 | 0.99 | 1.16 | 1.07 |
| | 250 | 0.99 | 0.92 | 1.07 | 0.99 | 1.07 | 0.99 | 1.07 | 1.07 | 1.16 | 1.07 | 1.16 | 1.16 |
| 36 | 50 | 0.94 | 0.81 | 1.02 | 0.94 | 1.02 | 0.87 | 1.10 | 0.94 | 1.10 | 0.94 | 1.19 | 1.02 |
| | 100 | 0.94 | 0.87 | 1.02 | 0.94 | 1.02 | 0.87 | 1.10 | 1.02 | 1.10 | 1.02 | 1.19 | 1.10 |
| | 150 | 1.02 | 0.87 | 1.10 | 1.02 | 1.10 | 0.94 | 1.10 | 1.02 | 1.19 | 1.02 | 1.19 | 1.19 |
| | 200 | 1.10 | 0.94 | 1.10 | 1.02 | 1.10 | 1.02 | 1.19 | 1.10 | 1.19 | 1.10 | 1.29 | 1.19 |
| | 250 | 1.10 | 1.02 | 1.19 | 1.10 | 1.19 | 1.10 | 1.29 | 1.19 | 1.29 | 1.19 | 1.39 | 1.29 |
| 42 | 50 | 1.05 | 0.90 | 1.13 | 1.05 | 1.13 | 0.97 | 1.13 | 1.05 | 1.22 | 1.05 | 1.32 | 1.13 |
| | 100 | 1.05 | 0.97 | 1.13 | 1.05 | 1.13 | 0.97 | 1.22 | 1.13 | 1.22 | 1.13 | 1.32 | 1.22 |
| | 150 | 1.13 | 0.97 | 1.22 | 1.13 | 1.22 | 1.05 | 1.22 | 1.13 | 1.32 | 1.13 | 1.32 | 1.32 |
| | 200 | 1.22 | 1.05 | 1.22 | 1.13 | 1.22 | 1.13 | 1.32 | 1.22 | 1.32 | 1.22 | 1.43 | 1.32 |
| | 250 | 1.32 | 1.13 | 1.32 | 1.22 | 1.32 | 1.22 | 1.43 | 1.32 | 1.43 | 1.32 | 1.54 | 1.43 |
| 48 | 50 | 1.14 | 0.98 | 1.23 | 1.14 | 1.23 | 1.06 | 1.33 | 1.14 | 1.33 | 1.14 | 1.44 | 1.33 |
| | 100 | 1.23 | 1.06 | 1.23 | 1.14 | 1.23 | 1.06 | 1.33 | 1.23 | 1.33 | 1.23 | 1.44 | 1.33 |
| | 150 | 1.23 | 1.14 | 1.33 | 1.23 | 1.33 | 1.14 | 1.44 | 1.33 | 1.44 | 1.33 | 1.56 | 1.44 |
| | 200 | 1.33 | 1.14 | 1.44 | 1.33 | 1.44 | 1.23 | 1.44 | 1.33 | 1.56 | 1.33 | 1.56 | 1.44 |
| | 250 | 1.44 | 1.33 | 1.44 | 1.33 | 1.44 | 1.33 | 1.56 | 1.44 | 1.56 | 1.44 | 1.68 | 1.56 |

* Thicknesses include allowances for foundry practice, corrosion, and either water hammer or truck load.

ASA
A21.9–1952

American Standard

# SPECIFICATIONS

*for*

# CAST IRON PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS FOR GAS

SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

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Note 1—Tables showing additional thicknesses required for greater depths of cover and other conditions of laying will be found in ASA A21.1.

Note 2—Users of these tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

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Users of this document should make reference to "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe" (ASA A21.1) for complete information concerning the conditions which various thicknesses of pipe are designed to meet. The foreword of the Manual also contains a statement regarding the history of the specifications and references to other related documents.

ASA
A21.9–1952

# AMERICAN STANDARD SPECIFICATIONS
for
# CAST IRON PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS FOR GAS

This specification covers cast iron pipe centrifugally cast in sand lined molds.

### Section 9-1—Definitions

PURCHASER. Wherever the word "Purchaser" is used herein, it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

HEAT. A heat is a period during which a cupola or furnace is operated continuously.

RUN. A run is a period of one or more shifts during which a shop is operated continuously.

MIXTURE OF IRON. Mixture of iron is a combination of pig iron, scrap, coke and other raw materials charged to a cupola or furnace to give a desired composition of iron; or a combination of molten iron from one or more sources, made in a forehearth or ladle to give a desired composition of iron.

SOURCE OF IRON. A source of iron is a cupola, furnace or forehearth from which iron is delivered to a transfer or pouring ladle.

FOREHEARTH. A forehearth is a refractory-lined receptacle for the temporary storage of molten iron from one or more cupolas or furnaces.

### Section 9-2—Description of Pipe

The pipe shall be made with bell and spigot ends with beads cast on, plain ends or such other type of ends as may be agreed upon at the time of purchase. Pipe with bell and spigot ends shall conform to the dimensions and weights given in the following tables. Pipe with other types of ends shall comply with the dimensions agreed upon, but in all other respects shall fulfill the specifications hereinafter given. Pipe shall be straight and shall be true circles in section, with their inner and outer surfaces concentric. They shall be cast at least 12 feet in nominal laying length. This type of pipe is commonly made at present (1952) in 16-, 16½- and 20-foot lengths.

### Section 9-3—Casting of Pipe

The pipe shall be centrifugally cast in sand lined molds and shall remain in the sand for a sufficient length of time to prevent unequal contraction during cooling.

### Section 9-4—Quality of Iron

(9-4.1) All pipe shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the pipe to be cast, that the iron in the pipe shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting and it shall comply with the physical specifications given in Sections 9-17 and 9-18. The metal shall be remelted in a cupola or other suitable furnace.

(9-4.2) The iron in the pipe shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulphur. Samples for chemical analyses shall be taken by drilling completely through from skin to skin either acceptance test specimens or specimens cast for this purpose but not to exceed three specimens per heat of approximately eight hours. In case of dispute, analyses will be determined on samples taken from the pipe in question.

### Section 9-5—Quality of Castings

The pipe shall be smooth, free from scales, lumps, blisters, sand holes, laps, and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

### Section 9-6—Foundry Records

A record of the results of the following tests shall be made and retained for at least one year. Upon request such record will be available to purchaser at the foundry. If written transcripts of the results of any of these tests are desired, this fact shall be noted in the order for pipe, naming tests of which transcripts are desired. The methods of testing and the dimensions of all test specimens are given in the Appendix.

(9-6.1) *Chemical Analyses*—Chemical analyses of each iron mixture used directly in the pouring of pipe, obtained as in Section 9-4.2 shall be made for silicon, sulphur, manganese, phosphorus and total carbon during the first hour and at intervals not to exceed three hours throughout the heat. If pipe are poured directly from the cupola, chemical analyses shall be made of iron from the first and from the last ladle. In case the mixture is changed one or more times during a heat in order to produce a different iron, the time of taking samples shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality.

(9-6.2) *Pouring Temperatures*—The pouring temperature of the iron shall be taken at the casting ladle for each size of pipe at least once each hour.

(9-6.3) *Talbot Strip Tests*

(See Section 9-17.1.)

(9-6.4) *Test Bar Tests*

(See Section 9-17.2.)

(9-6.5) *Periodic Ring, Strip, and Full-Length Bursting Tests*

(See Sections 9-17 and 9-18.)

**Section 9-7—Marking Pipe**

Each pipe shall have the weight and class designation conspicuously painted on it. In addition each pipe shall have cast on it the manufacturer's mark the year in which the pipe was cast and, when specified by the purchaser, initials not exceeding four in number. The letters and figures shall be on the outside surface of the pipe and cast marks shall have dimensions not less than those indicated below:

| Nominal Pipe Diameter, Inches | Height of Letter, Inches | Relief of Letter, Inches |
|---|---|---|
| 4 | ½ | $\frac{1}{16}$ |
| 6-12 | ¾ | $\frac{3}{32}$ |
| 16-20 | 1½ | ⅛ |
| 24-48 | 2 | ⅛ |

**Section 9-8—Inspection by Purchaser**

(9-8.1) *Power of Purchaser to Inspect*

The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, the pattern work, molding, casting and coating (if used) of the pipe. The forms, sizes, uniformity and conditions of all pipe herein referred to shall be subject to his inspection and approval, and he may reject, without subjection to hydrostatic test, any pipe which is not in conformity with the specifications or drawings. Any pipe rejected shall be marked as rejected and any marks pertaining to the purchaser shall be chipped or erased from such pipe.

(9-8.2) *Manufacturer to Furnish Men and Materials*

The manufacturer shall provide tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the pipe at the foundry.

(9-8.3) *Report of Purchaser's Inspection*

The purchaser shall make written report daily to the foundry office of all pipe rejected with the causes for rejection.

**Section 9-9—Inspection and Certification by Manufacturer**

Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made and met as specified. If written transcripts of any of these test results are required, including chemical tests if desired, a request for same, specifying the tests of which transcripts are desired, shall accompany the order.

**Section 9-10—Pipe to be Delivered Sound**

All the pipe shall be delivered in all respects sound and in conformity with these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this respect, and any defective pipe which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for pipe found to be damaged after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the pipe not to injure the coating (if used) and no pipe or other material of any kind shall be placed in the pipe during transportation.

**Section 9-11—Cut Pipe**

Defective spigot ends on pipe may be cut off in a manner which will produce a square end. Not more than 10 per cent of the total number of pipe of each size of a given order may be shipped as cut pipe. Such cut pipe when cut from 12-foot lengths shall have a nominal laying length of not less than 11 feet; pipe originally of 16 feet or greater length shall not be cut more than 2 feet.

**Section 9-12—Tolerances or Maximum Permitted Variations from Standard Dimensions**

(9-12.1) *Tolerances in Diameter of Pipe and Sockets*

Outside diameters of pipe barrels, spigot ends and inside diameters of sockets shall be kept as nearly as practicable to the specified dimensions. The inside diameters of the sockets and the outside diameters of the spigot ends shall be tested with circular gauges. Tolerances or maximum permitted variations from standard dimensions are listed in the following table.

| Nominal Pipe Diameter, Inches | Tolerances, Plus or Minus, Inches |
|---|---|
| 4 to 12 | .06 |
| 16 to 24 | .08 |
| 30 to 36 | .10 |
| 42 to 48 | .12 |

(9-12.2) *Tolerances in Thickness*

The minus tolerances from standard thickness of pipe and dimensions a, b, c, and d of the bell are listed in the following table.

| Nominal Pipe Diameter, Inches | Minus Tolerance, Inches |
|---|---|
| 4 to 8 | .05 |
| 10 to 12 | .06 |
| 16 to 24 | .08 |
| 30 to 48 | .10 |

*NOTE:* In pipe barrel thickness, tolerances .02 inch greater than those listed above shall be permissible over areas not exceeding 8 inches in length in any direction.

(9-12.3) *Allowable Percentage of Variation in Weight*

The weight of no single pipe shall be less than the nominal tabulated weight by more than 5% for pipe 12 inches or smaller in diameter, nor by more than 4% for pipe larger than 12 inches in diameter. The total weight of any order of 25 tons or more shall not be more than 2% under the total nominal weight. The total excess weight to be paid for on orders of 25 tons or more shall not exceed 2% of the nominal weight and on orders less than 25 tons shall not exceed 5% of the nominal weight. An order is hereby defined as including all the pipe ordered under the terms of a specific contract or purchase order or a single order placed under the terms of a standing contract. Unless otherwise stated in the contract, the ton shall be 2,000 pounds avoirdupois.

**Section 9-13—Cleaning and Inspecting**

All pipe shall have fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful inspection and a rolling test before the coating (if used) is applied.

**Section 9-14—Hydrostatic Test**

Each pipe shall be subjected to a hydrostatic proof test as follows:

TABLE OF PRESSURES FOR HYDROSTATIC TESTS

| Nominal Diameter of Pipe, Inches | Nominal Barrel Thickness, Inches | Test Pressures, Lbs. per sq. in. |
|---|---|---|
| 4 to 12 | All Thicknesses | 500 |
| 16 | .60 and less | 400 |
| 16 | .61 and over | 500 |
| 20 | .70 and less | 400 |
| 20 | .71 and over | 500 |
| 24 | .75 and less | 400 |
| 24 | .76 and over | 500 |
| 30 | .88 and less | 400 |
| 30 | .89 and over | 500 |
| 36 | .98 and less | 400 |
| 36 | .99 and over | 500 |
| 42 | 1.09 and less | 400 |
| 42 | 1.10 and over | 500 |
| 48 | 1.18 and less | 400 |
| 48 | 1.19 and over | 500 |

The pipe shall be under the test pressure for at least one-half minute. Any pipe showing defects by leaking, sweating or otherwise shall be rejected.

**Section 9-15—Weighing**

Each length of pipe shall be weighed and the weight plainly marked on the outside or inside of the bell or spigot end.

**Section 9-16—Exterior Coatings**

Any coating (if used) which is to be applied to the pipe, shall be specified in the agreement made at time of purchase.

**Section 9-17—Acceptance Tests for Physical Properties**

The standard acceptance tests for the physical characteristics of the pipe shall be as follows:

(9-17.1) *Talbot Strip Tests*

Talbot strip tests shall be used to determine acceptability of 4 inch to 24 inch pipe for modulus of rupture and secant modulus of elasticity.

(17.1.1) *Sampling.* For sampling, each run shall be divided into periods of approximately three hours each and at least one sample shall be taken during each 3-hour period. The sample for the first period of the run shall be taken during the first hour, or if casting is direct from cupola, from the first ladle. Samples shall be taken so that each size of pipe cast for two hours or longer during the run and each mixture or source of iron used for two hours or longer during the run shall be fairly represented.

(17.1.2) *Method of Testing.* The method of testing Talbot strips is given in the Appendix.

(17.1.3) *Acceptance Values.* The acceptance values for Talbot strip tests shall be as follows:

*Talbot Strips from 4-inch to 24-inch Pipe*

| | |
|---|---|
| Modulus of rupture ........... | 40,000 lbs. per sq.in. minimum |
| Secant modulus of elasticity ..... | 10,000,000 lbs. per sq.in. maximum |

If the modulus of elasticity exceeds 10,000,000, the modulus of rupture shall exceed 40,000 in at least the same proportion.

(9-17.2) *2-inch Diameter Test Bar Tests*

A.S.T.M. standard (A-48 Bar C) 2-inch diameter × 27 inch test bar tests shall be used to determine the acceptability of 30-inch to 48-inch pipe.

From each mixture of iron used to cast pipe of 30-inch to 48-inch sizes, 2-inch diameter test bars shall be cast and tested from the first ladle of iron and at intervals not to exceed three hours during the heat.

For the record, from every 200 lengths, but not less than one pipe of each size each week, one Talbot strip shall be cut and tested and shall meet the requirements of Section 9-17.1.3.

At the manufacturer's option, Talbot strips may be tested instead of test bars. If Talbot strips are tested, they shall meet the requirements of Section 9-17.1.3.

Test bars shall have the following properties:

| | |
|---|---|
| Breaking Load | 6000 lbs., minimum |
| Deflection | 0.15 inch plus 0.01 inch for each 500 lbs. that the breaking load exceeds 6000 lbs. |

These test bar values apply only to pipe of thickness classes 21 to 25 in pipe designed using 18,000 lbs. per sq.in. tensile strength in bursting and 40,000 lbs. per sq.in. in modulus of rupture of the ring.

**Section 9-18—Periodic Ring Tests and Full Length Bursting Tests**

The manufacturer shall periodically make such bursting tests and ring tests in conjunction with strip tests that he can certify the design values of modulus of rupture (40,000 lbs. per sq.in.) and tensile strength of the iron in the pipe (18,000 lbs. per sq.in.). These tests shall be made in accordance with dimensions and methods given in the Appendix.

Pipe for these periodic ring and bursting tests shall be so selected that they will be representative of the sizes and various thicknesses of each size cast. Ring tests shall not be made on 4-inch pipe.

Tests of Talbot strips cut from the ring, as provided in the Appendix, shall be made in conjunction with ring and bursting tests. At least three Talbot strips shall be tested from each burst pipe and one of these strips shall come from the ring. For pipe for which rings less than 10½ inches long are used, the Talbot strip shall come from parts other than the ring.

Tests and records shall include modulus of rupture of each strip and ring, modulus of elasticity of each strip and of each ring 12-inches and larger: also, breaking load and deflection of each test bar.

At purchaser's request, manufacturer shall furnish a written transcript of ring and bursting tests and tests on Talbot strips made in connection therewith for a period not exceeding one year and for such sizes as requested.

Unless there is a record of satisfactory tests equivalent to those hereinafter described, extending to within three months or less of the time to begin manufacture of an order for pipe of any size 30-inch to 48-inch, the producer shall test three pipe from the first day's production, and one each succeeding day for the next 4 days. If all the tests meet the specifications, test one pipe every 5 days for the next 3 weeks and if all those meet the specifications, test one pipe each month. In the case of a failure of any test, repeat the same series of tests as above specified. In the case of a lapse of more than one month in the manufacture of such pipe, the monthly test shall be made on a pipe from the first day's run. If the tests are all satisfactory, the number of pipe tested shall not exceed 3% of the order.

**Section 9-19—Additional Tests Required by the Purchaser**

If more or other tests than provided in these specifications are required by the purchaser, such tests shall be specified in the invitation for bids.

**Section 9-20—Defective Specimens and Retests**

(9-20.1) If any test specimen shows defective machining or lack of continuity of metal it may be discarded and replaced by another specimen. If any sound test specimen fails to meet the specified requirements, the purchaser may permit a retest on two additional sound specimens from pipe cast in the same period as the specimen which failed, in which case both specimens shall meet the prescribed tests to be acceptable.

(9-20.2) Test bars may be cast in pairs and at least one bar from each pair shall be tested, but the manufacturer shall have the right to test both bars in which case the better bar shall be taken as representative.

(9-20.3) If a routine test bar test fails to meet the requirements the manufacturer shall have the right to substitute two Talbot strips cut from a pipe cast with iron represented by the failed test bar test. If both strip tests meet the requirements, the pipe for that period shall be acceptable.

### Section 9-21—Rejection Due to Failure to Meet the Routine Acceptance Test Requirements

If any routine chemical analysis fails to meet the chemical requirements of Section 9-4.2 or if any acceptance test fails to meet the requirements of Sections 9-17.1.3, 9-17.2 and 9-20, the pipe cast in the period shall be rejected except subject to the provisions of Section 9-22.

### Section 9-22—Limiting the Rejection Due to Failure to Meet the Routine Acceptance Test Requirements

The manufacturer may limit the amount of rejection by making similar additional tests of pipe of the same size as that rejected until the rejected lot is bracketed in order of manufacture by two acceptable tests. If a period is rejected, the acceptability of pipe of different sizes from that rejected may be established by making the routine acceptance tests for these sizes.

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## APPENDIX*

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### Tables †



### Section 9-A1—Talbot Strip Tests

Talbot strips (Fig. 9.1) shall be machined longitudinally from each pipe specimen selected for testing by this method. These Talbot strips may be cut from a part of the ring little stressed in the ring test —i.e., near one of the elements marked *a* in the illustration of the ring test (Fig. 9.2). The strips in any case will be in cross section as indicated in Fig. 9.1—i.e., will have for their width the thickness of the pipe and for their depth, 0.50 in. Their length shall be at least 10½ in. These strips shall be tested as beams on supports 10 in. apart with loads applied perpendicularly to the machined faces at two points

* This Appendix is a part of ASA A21.9—American Standard Specifications for Cast Iron Pipe Centrifugal Cast in Sand-lined Molds, for Gas.

† Data on thicknesses required for greater depths of cover and conditions of laying other than those assumed in the following tables will be found in Appendix B of ASA A21.1—American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe.

Users of the following tables are cautioned to select fittings having proper socket dimensions and thicknesses suited to the pressures. Pipe specified in these tables have outside diameters which will chamber correctly with existing standards for pipe and fittings.

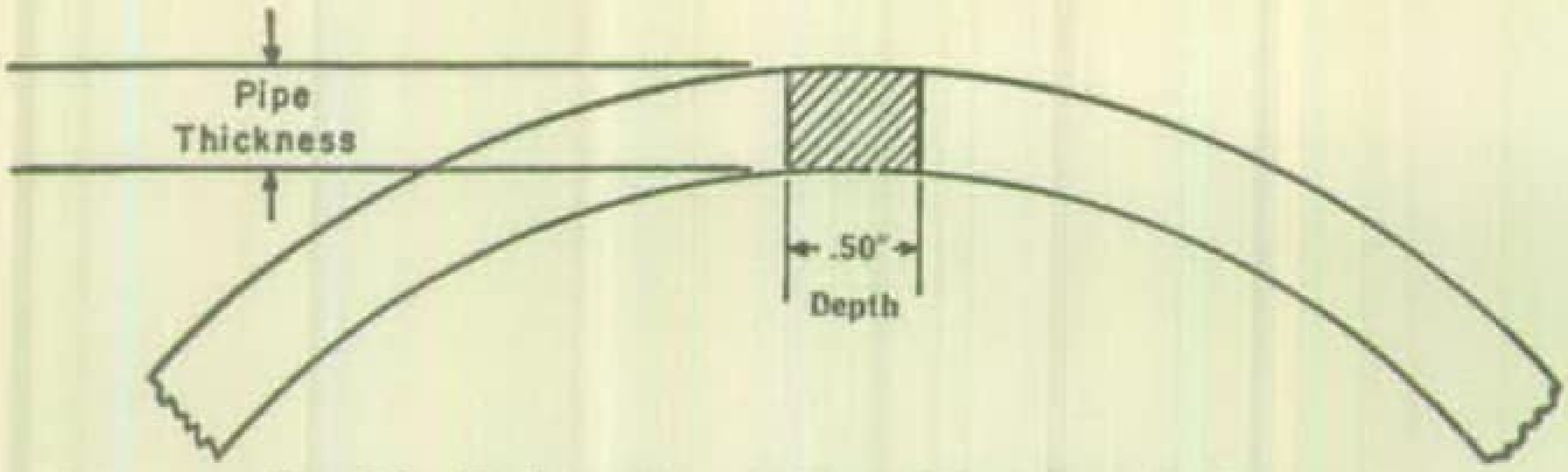



FIG. 9.1 Position From Which Talbot Strip Is Cut

3⅓ in. from the supports. The breaking load and the deflection shall be observed and recorded.

The strip shall be accurately calipered at the point of rupture and the modulus of rupture, $R$, shall be calculated by the usual beam formula, which for this case reduces to the expression:

$$R = \frac{10W}{td^2}$$

The secant modulus of elasticity, $E_s$ in pounds per square inch, shall be computed by the formula:

$$E_s = \frac{21.3R}{dy}$$

In the above formulas, $R$ is the modulus of rupture (lbs. per sq. in.), $E_s$ is the secant modulus of elasticity (lbs. per sq.in.), $W$ is the breaking load (lb.), $d$ is the depth (in.) of the strip (intended to be 0.50 in.), $t$ is the width (in.) of the strip (pipe thickness) and $y$ is the deflection (in.) of the strip at the center at breaking load.

**Section 9-A2—Ring Tests**

The maximum length of any ring shall not exceed 12 in.; for pipe 16 in. and larger, the minimum length shall be 10½ in.; for pipe 12 in. and smaller, the minimum length shall be one-half the nominal diameter of the pipe. Each ring shall be tested by the three-edge bearing method as indicated in Fig. 9.2. The lower bearing for the ring shall consist of two strips with vertical sides having their interior top corners rounded to a radius of approximately ½ in. The strips shall be of hard wood or of metal. If of metal, a piece of fabric or leather approximately $\frac{3}{16}$ in. thick shall be laid over them. They shall be

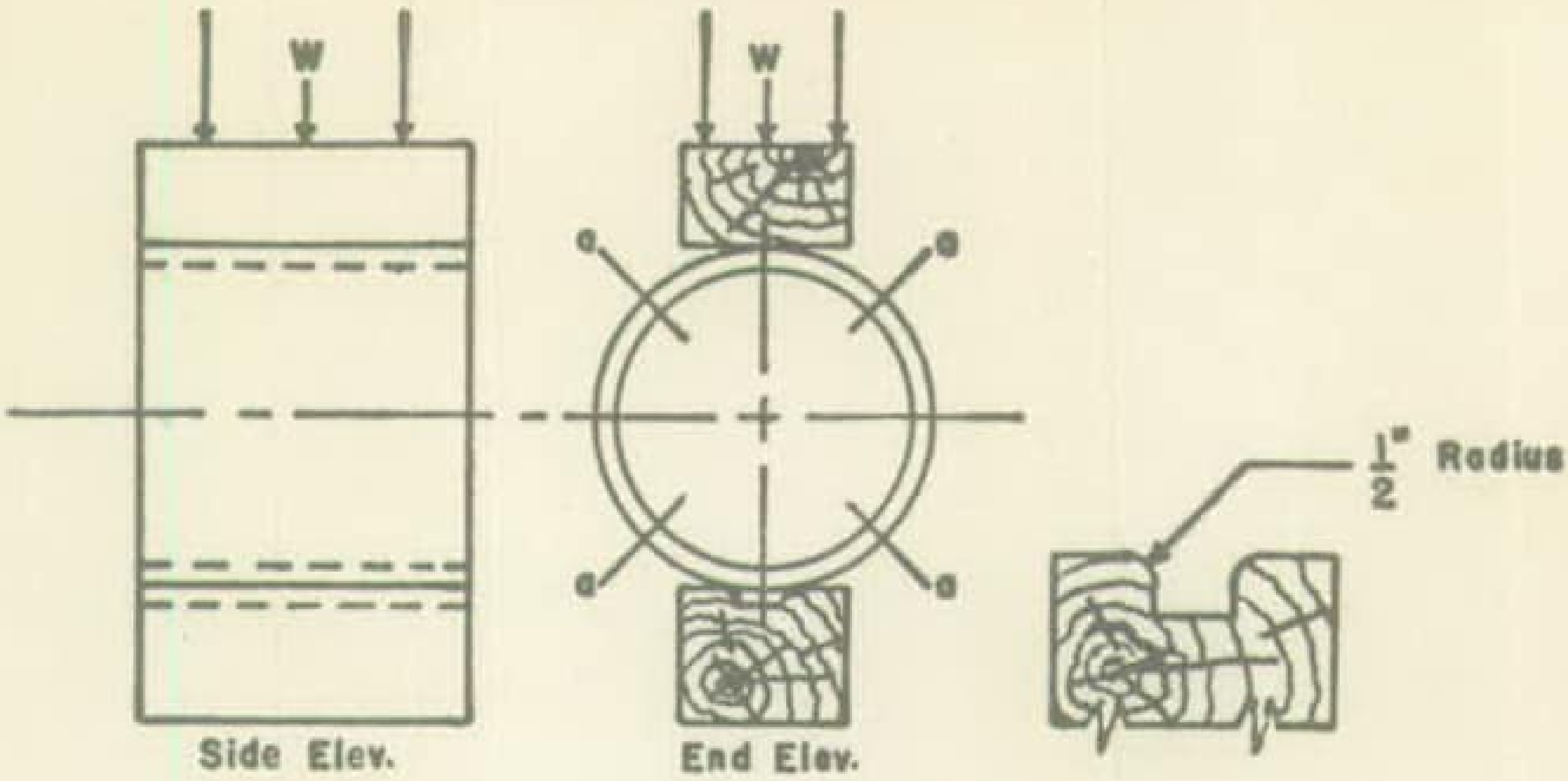



FIG. 9.2 Assembly for Ring Test

straight and shall be securely fastened to a rigid block, with their interior vertical faces the following distances apart:

| Nom. Pipe Diam. *in.* | Bearing Strip Spacing *in.* |
|---|---|
| 4–12 | ½ |
| 16–24 | 1 |
| 30–48 | 2 |

The upper bearing shall be an oak block, straight and true from end to end. The upper and lower bearings shall extend the full length of the ring. The ring shall be placed symmetrically between the two bearings, and the center of application of the load shall be so placed that the vertical deformation at the two ends of the ring shall be approximately equal. If the ring is not uniform in thickness, it shall be so placed that the thick and thin portions are near the ends of the horizontal diameter.

A record of the breaking load and the vertical deformation of each ring tested shall be made. The modulus of rupture and modulus of elasticity are computed from the formulas:

$$R = 0.954 \, \frac{W(d+t)}{bt^2}$$

$$E = \frac{0.225W(d+t)^3}{bt^3y} = \frac{0.236R(d+t)^2}{ty}$$

in which $R$ is the modulus of rupture (lbs. per sq.in.), $W$ is the breaking load (lb.), $d$ is the average inside diameter (in.) of the ring, $t$ is the average thickness (in.) of metal along the line of fracture, $b$ is the length (in.) of the ring, $E$ is the modulus of elasticity (lbs. per sq.in.) and $y$ is the vertical deformation (in.) of the ring at the center.

### Section 9-A3—Full-Length Bursting Tests

The bursting tensile strength shall be determined by testing full-length pipe (less the amount cut off for ring and strip test specimens) to destruction by hydraulic pressure. Bells may be removed to facilitate testing. A suitable means for holding the end thrust shall be used which will not subject the pipe to endwise tension or compression, or other parasitic stresses. A calibrated pressure gage shall be used for determining the bursting pressure. This gage shall be connected to the interior of the test pipe by a separate connection from that which supplies water for the test. The unit tensile strength in bursting shall be obtained by the use of the formula:

$$S = \frac{Pd}{2t}$$

in which $S$ is the bursting tensile strength (lbs. per sq.in.) of the iron, $P$ is the internal pressure (lbs. per sq.in.) at bursting, $d$ is the average inside diameter (in.) of the pipe and $t$ is the minimum average thickness (in.) of the pipe along the principal line of break.

Measurements of thickness shall be taken along the principal line of break at 1-ft. intervals.

The minimum average thickness along the principal line of break shall be obtained by averaging the measurements at the thinnest section at a weight of two and at the adjacent sections on each side at a weight of one each; or, if the thinnest section is at the end of the break, by averaging this thinnest-section measurement at a weight of two and the measurements of the adjacent section and the next section at a weight of one each.

### Section 9-A4—Test Bars

9-A4.1. *Dimensions.* Test bars for pipe of 30-in. to 48-in. diameter shall be 2 in. in diameter and not less than 26 in. long. Individual test bars may vary as much as 3 per cent from the standard diameter.

9-A4.2. *Method of casting.* The bars shall be east vertically in well faced, dry sand molds provided with a suitable pouring basin and mounted on a suitable refractory foundation. Metal for the bars shall be obtained by using a small heated ladle taking its metal from the main ladle from which the pipe is to be poured. The metal shall be taken after all alloys and other additional metal, except cast-iron pipe scrap for cooling, have been added to the main ladle and become melted. The bars shall not be removed from the mold before they have cooled to 500°F.

9-A4.3. *Method of testing.* The bars shall be broken as beams by placing them on supports 24 in. apart and applying the load at the center of the span. The breaking load and the corresponding deflection shall be observed and recorded.

9-A4.4. *Correcting observed breaking loads and deflections.* The bars shall be measured at the point of application of the load and the results corrected to standard dimensions by the conventional beam formula (for bars of 2-in. diameter):

$$\text{Corrected } W = \text{Observed } W \times \frac{8}{d_h d_v^2}$$

$$\text{Corrected } y = \text{Observed } y \times \frac{d_v}{2}$$

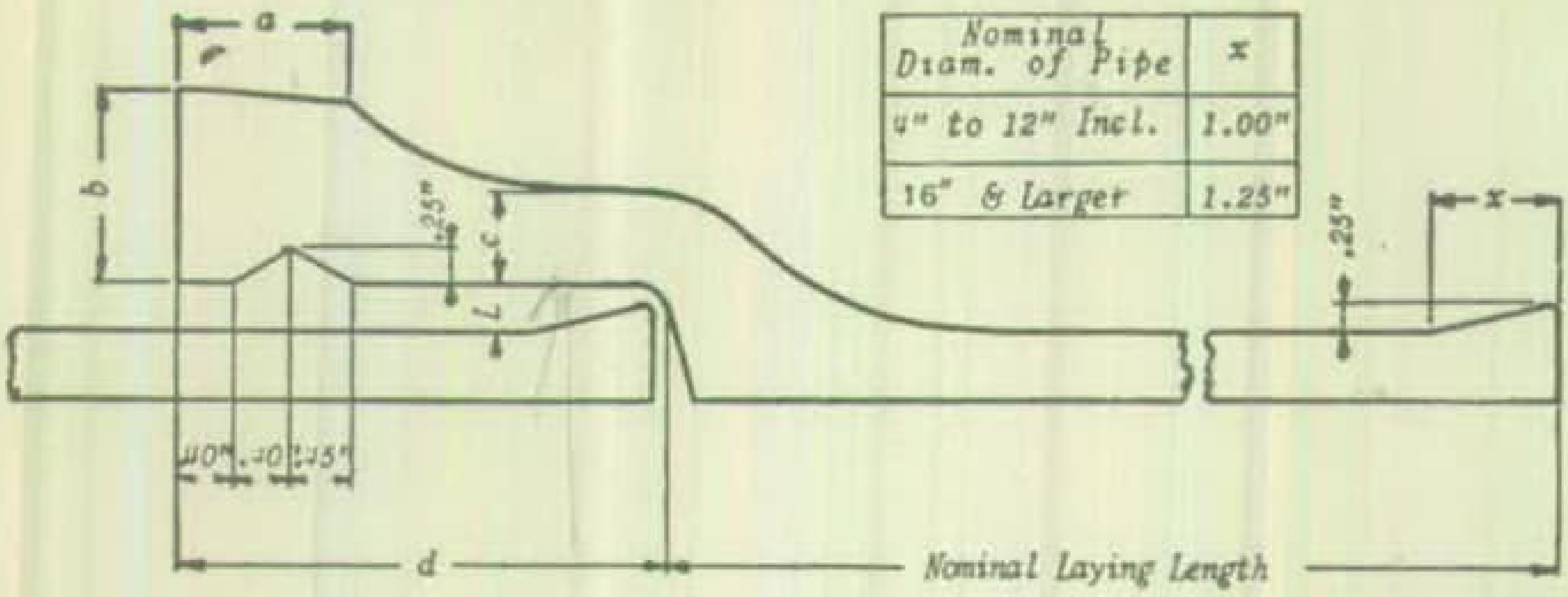
in which $W$ is the breaking load (lb.), $d_h$ is the measured horizontal diameter (in.), $d_v$ is the measured vertical diameter (in.) and $y$ is the deflection (in.) at breaking.

**Section 9-A5—Deflection Measurements**

All deflection measurements required by these specifications shall be that of the specimen and shall not include any compression of the supports or loading blocks, or backlash or distortion of the testing machine.

## Table No. 9.1

### STANDARD DIMENSIONS OF BELLS, SOCKETS, SPIGOT BEADS and OUTSIDE DIAMETERS OF GAS PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS also WEIGHTS OF BELLS AND SPIGOT BEADS




| Nominal Diam. | Thickness of Pipe From | Thickness of Pipe To | Outside Diam. of Pipe | Dimensions of Bells: Diam. of Socket | Thickness of Joint L | Depth of Socket d | a | b | c | Wt. of Bell and Spigot Bead |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | .35 | .38 | 4.80 | 5.80 | .50 | 3.50 | 1.25 | 1.20 | .45 | 18 |
| | .41 | | 4.80 | 5.80 | .50 | 3.50 | 1.25 | 1.20 | .60 | 20 |
| 6 | .38 | .44 | 6.90 | 7.90 | .50 | 3.50 | 1.38 | 1.25 | .54 | 27 |
| | .48 | | 6.90 | 7.90 | .50 | 3.50 | 1.38 | 1.25 | .66 | 30 |
| 8 | .41 | .48 | 9.05 | 10.05 | .50 | 4.00 | 1.38 | 1.35 | .58 | 40 |
| | .52 | .56 | 9.05 | 10.05 | .50 | 4.00 | 1.38 | 1.35 | .72 | 45 |
| 10 | .44 | .52 | 11.10 | 12.10 | .50 | 4.00 | 1.50 | 1.45 | .63 | 52 |
| | .56 | .60 | 11.10 | 12.10 | .50 | 4.00 | 1.50 | 1.45 | .78 | 59 |
| 12 | .48 | .56 | 13.20 | 14.20 | .50 | 4.00 | 1.50 | 1.50 | .69 | 67 |
| | .60 | .65 | 13.20 | 14.20 | .50 | 4.00 | 1.50 | 1.50 | .85 | 75 |
| 16 | .50 | .63 | 17.40 | 18.66 | .63 | 4.00 | 1.75 | 1.62 | .76 | 101 |
| | .68 | .73 | 17.40 | 18.66 | .63 | 4.00 | 1.75 | 1.62 | .93 | 113 |
| 20 | .57 | .72 | 21.60 | 22.86 | .63 | 4.00 | 1.75 | 1.77 | .88 | 140 |
| | .78 | .84 | 21.60 | 22.86 | .63 | 4.00 | 1.75 | 1.77 | 1.08 | 159 |
| 24 | .63 | .79 | 25.80 | 27.06 | .63 | 4.00 | 2.00 | 1.92 | .91 | 180 |
| | .85 | .92 | 25.80 | 27.06 | .63 | 4.00 | 2.00 | 1.92 | 1.16 | 207 |
| 30 | .73 | .92 | 32.00 | 33.26 | .63 | 4.50 | 2.00 | 2.12 | 1.07 | 264 |
| | .99 | | 32.00 | 33.26 | .63 | 4.50 | 2.00 | 2.12 | 1.36 | 302 |
| 36 | .81 | 1.02 | 38.30 | 39.56 | .63 | 4.50 | 2.00 | 2.32 | 1.22 | 371 |
| | 1.10 | 1.19 | 38.30 | 39.56 | .63 | 4.50 | 2.00 | 2.32 | 1.54 | 426 |
| 42 | .90 | 1.13 | 44.50 | 45.76 | .63 | 5.00 | 2.00 | 2.52 | 1.35 | 486 |
| | 1.22 | 1.32 | 44.50 | 45.76 | .63 | 5.00 | 2.00 | 2.52 | 1.70 | 561 |
| 48 | .98 | 1.23 | 50.80 | 52.06 | .63 | 5.00 | 2.00 | 2.72 | 1.48 | 607 |
| | 1.33 | 1.44 | 50.80 | 52.06 | .63 | 5.00 | 2.00 | 2.72 | 1.86 | 708 |

All dimensions given in inches. All weights given in pounds.

Table No. 9.2

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF GAS PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS

Dimensions in Inches — Weights in Pounds

| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Foot | Wt. of Bell and Bead | Wt. Based On 16 Foot Length | | Wt. Based On 16½ Foot Length | | Wt. Based On 20 Foot Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length* | †Average Per Foot | Per Length* | †Average Per Foot | Per Length* | †Average Per Foot |
| 4 | 22 | .35 | 4.80 | 4.10 | 15.3 | 18 | 265 | 16.5 | 270 | 16.4 | | |
| | 23 | .38 | 4.80 | 4.04 | 16.5 | 18 | 280 | 17.6 | 290 | 17.5 | | |
| | 24 | .41 | 4.80 | 3.98 | 17.6 | 20 | 300 | 18.9 | 310 | 18.8 | | |
| 6 | 22 | .38 | 6.90 | 6.14 | 24.3 | 27 | 415 | 26.0 | 430 | 25.9 | | |
| | 23 | .41 | 6.90 | 6.08 | 26.1 | 27 | 445 | 27.9 | 460 | 27.8 | | |
| | 24 | .44 | 6.90 | 6.02 | 27.9 | 27 | 475 | 29.6 | 485 | 29.5 | | |
| | 25 | .48 | 6.90 | 5.94 | 30.2 | 30 | 515 | 32.1 | 530 | 32.0 | | |
| 8 | 22 | .41 | 9.05 | 8.23 | 34.7 | 40 | 595 | 37.3 | 615 | 37.2 | | |
| | 23 | .44 | 9.05 | 8.17 | 37.1 | 40 | 635 | 39.6 | 650 | 39.5 | | |
| | 24 | .48 | 9.05 | 8.09 | 40.3 | 40 | 685 | 42.8 | 705 | 42.7 | | |
| | 25 | .52 | 9.05 | 8.01 | 43.5 | 45 | 740 | 46.4 | 765 | 46.3 | | |
| | 26 | .56 | 9.05 | 7.93 | 46.6 | 45 | 790 | 49.4 | 815 | 49.3 | | |
| 10 | 22 | .44 | 11.10 | 10.22 | 46.0 | 52 | 790 | 49.3 | 810 | 49.2 | | |
| | 23 | .48 | 11.10 | 10.14 | 50.0 | 52 | 850 | 53.2 | 875 | 53.1 | | |
| | 24 | .52 | 11.10 | 10.06 | 53.9 | 52 | 915 | 57.2 | 940 | 57.1 | | |
| | 25 | .56 | 11.10 | 9.98 | 57.9 | 59 | 985 | 61.6 | 1015 | 61.5 | | |
| | 26 | .60 | 11.10 | 9.90 | 61.8 | 59 | 1050 | 65.5 | 1080 | 65.4 | | |
| 12 | 22 | .48 | 13.20 | 12.24 | 59.8 | 67 | 1025 | 64.0 | 1055 | 63.9 | 1265 | 63.2 |
| | 23 | .52 | 13.20 | 12.16 | 64.6 | 67 | 1100 | 68.8 | 1135 | 68.7 | 1360 | 68.0 |
| | 24 | .56 | 13.20 | 12.08 | 69.4 | 67 | 1175 | 73.5 | 1210 | 73.4 | 1455 | 72.8 |
| | 25 | .60 | 13.20 | 12.00 | 74.1 | 75 | 1260 | 78.8 | 1300 | 78.7 | 1555 | 77.8 |
| | 26 | .65 | 13.20 | 11.90 | 80.0 | 75 | 1355 | 84.7 | 1395 | 84.5 | 1675 | 83.8 |
| 16 | 21 | .50 | 17.40 | 16.40 | 82.8 | 101 | 1425 | 89.1 | 1465 | 88.9 | 1755 | 87.8 |
| | 22 | .54 | 17.40 | 16.32 | 89.2 | 101 | 1530 | 95.5 | 1575 | 95.4 | 1885 | 94.2 |
| | 23 | .58 | 17.40 | 16.24 | 95.6 | 101 | 1630 | 101.9 | 1680 | 101.7 | 2015 | 100.7 |
| | 24 | .63 | 17.40 | 16.14 | 103.6 | 101 | 1760 | 109.9 | 1810 | 109.7 | 2175 | 108.7 |
| | 25 | .68 | 17.40 | 16.04 | 111.4 | 113 | 1895 | 118.5 | 1950 | 118.2 | 2340 | 117.0 |
| | 26 | .73 | 17.40 | 15.94 | 119.3 | 113 | 2020 | 126.4 | 2080 | 126.1 | 2500 | 125.0 |

*Including Bell and Spigot Bead. Calculated weight of pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.

10.05
1.35
1.35
17.75

Table No. 9.2 (continued)

STANDARD THICKNESSES, DIAMETERS AND WEIGHTS OF GAS PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS

Dimensions in Inches — Weights in Pounds

| Nominal Diam. | Thickness Class | Thickness | Outside Diam. | Inside Diam. | Wt. of Barrel Per Foot | Wt. of Bell and Bead | Wt. Based On 16 Foot Length | | Wt. Based On 16½ Foot Length | | Wt. Based On 20 Foot Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Per Length* | †Average Per Foot | Per Length* | †Average Per Foot | Per Length* | †Average Per Foot |
| 20 | 21 | .57 | 21.60 | 20.46 | 117.5 | 140 | 2020 | 126.2 | 2080 | 126.0 | 2490 | 124.5 |
| | 22 | .62 | 21.60 | 20.36 | 127.5 | 140 | 2180 | 136.2 | 2245 | 136.0 | 2690 | 134.5 |
| | 23 | .67 | 21.60 | 20.26 | 137.5 | 140 | 2340 | 146.2 | 2410 | 146.0 | 2890 | 144.5 |
| | 24 | .72 | 21.60 | 20.16 | 147.4 | 140 | 2500 | 156.2 | 2570 | 155.9 | 3090 | 154.4 |
| | 25 | .78 | 21.60 | 20.04 | 159.2 | 159 | 2705 | 169.1 | 2785 | 168.8 | 3345 | 167.2 |
| | 26 | .84 | 21.60 | 19.92 | 170.9 | 159 | 2895 | 180.8 | 2980 | 180.5 | 3575 | 178.8 |
| 24 | 21 | .63 | 25.80 | 24.54 | 155.4 | 180 | 2665 | 166.6 | 2745 | 166.3 | 3290 | 164.4 |
| | 22 | .68 | 25.80 | 24.44 | 167.4 | 180 | 2860 | 178.6 | 2940 | 178.3 | 3530 | 176.4 |
| | 23 | .73 | 25.80 | 24.34 | 179.4 | 180 | 3050 | 190.6 | 3140 | 190.3 | 3770 | 188.4 |
| | 24 | .79 | 25.80 | 24.22 | 193.7 | 180 | 3280 | 205.0 | 3375 | 204.6 | 4055 | 202.7 |
| | 25 | .85 | 25.80 | 24.10 | 207.9 | 207 | 3535 | 220.8 | 3635 | 220.4 | 4365 | 218.2 |
| | 26 | .92 | 25.80 | 23.96 | 224.4 | 207 | 3795 | 237.3 | 3910 | 236.9 | 4695 | 234.8 |
| 30 | 21 | .73 | 32.00 | 30.54 | 223.7 | 264 | 3845 | 240.2 | 3955 | 239.7 | 4740 | 236.9 |
| | 22 | .79 | 32.00 | 30.42 | 241.7 | 264 | 4130 | 258.2 | 4250 | 257.7 | 5100 | 254.9 |
| | 23 | .85 | 32.00 | 30.30 | 259.5 | 264 | 4415 | 276.0 | 4545 | 275.5 | 5455 | 272.7 |
| | 24 | .92 | 32.00 | 30.16 | 280.3 | 264 | 4750 | 296.8 | 4890 | 296.3 | 5870 | 293.5 |
| | 25 | .99 | 32.00 | 30.02 | 300.9 | 302 | 5115 | 319.8 | 5265 | 319.2 | 6320 | 316.0 |
| 36 | 21 | .81 | 38.30 | 36.68 | 297.7 | 371 | 5135 | 320.9 | | | | |
| | 22 | .87 | 38.30 | 36.56 | 319.2 | 371 | 5480 | 342.4 | | | | |
| | 23 | .94 | 38.30 | 36.42 | 344.2 | 371 | 5880 | 367.4 | | | | |
| | 24 | 1.02 | 38.30 | 36.26 | 372.7 | 371 | 6335 | 395.9 | | | | |
| | 25 | 1.10 | 38.30 | 36.10 | 401.1 | 426 | 6845 | 427.7 | | | | |
| | 26 | 1.19 | 38.30 | 35.92 | 432.9 | 426 | 7350 | 459.5 | | | | |
| 42 | 21 | .90 | 44.50 | 42.70 | 384.6 | 486 | 6640 | 415.0 | | | | |
| | 22 | .97 | 44.50 | 42.56 | 413.9 | 486 | 7110 | 444.3 | | | | |
| | 23 | 1.05 | 44.50 | 42.40 | 447.2 | 486 | 7640 | 477.6 | | | | |
| | 24 | 1.13 | 44.50 | 42.24 | 480.4 | 486 | 8170 | 510.7 | | | | |
| | 25 | 1.22 | 44.50 | 42.06 | 517.6 | 561 | 8845 | 552.7 | | | | |
| | 26 | 1.32 | 44.50 | 41.86 | 558.7 | 561 | 9500 | 593.8 | | | | |
| 48 | 21 | .98 | 50.80 | 48.84 | 478.6 | 607 | 8265 | 516.5 | | | | |
| | 22 | 1.06 | 50.80 | 48.68 | 516.8 | 607 | 8875 | 554.7 | | | | |
| | 23 | 1.14 | 50.80 | 48.52 | 554.9 | 607 | 9485 | 592.8 | | | | |
| | 24 | 1.23 | 50.80 | 48.34 | 597.6 | 607 | 10170 | 635.5 | | | | |
| | 25 | 1.33 | 50.80 | 48.14 | 644.9 | 708 | 11025 | 689.2 | | | | |
| | 26 | 1.44 | 50.80 | 47.92 | 696.7 | 708 | 11855 | 741.0 | | | | |

*Including Bell and Spigot Bead. Calculated weight of pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.

## Table No. 9.3

### STANDARD THICKNESSES AND WEIGHTS OF CAST IRON GAS PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS

NOTE: These thicknesses and weights are for pipe laid without blocks, on flat bottom trench with tamped backfill, under 5 feet of cover. For other conditions see tables 9.2 and 9.4 hereof and the Manual.

| Size Inches | CLASS 10 — 10 Lb. Pressure | | | | | | | | CLASS 50 — 50 Lb. Pressure | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Weight Based On | | | | | | | | Weight Based On | | | | | |
| | | | 16 Ft. Length | | 16½ Ft. Length | | 20 Ft. Length | | | | 16 Ft. Length | | 16½ Ft. Length | | 20 Ft. Length | |
| | Thickness Inches | Outside Dia. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Thickness Inches | Outside Dia. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* |
| 4 | .35[1] | 4.80 | 16.5 | 265 | 16.4 | 270 | | | .35[1] | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| | or .38[2] | 4.80 | 17.6 | 280 | 17.5 | 290 | | | or .38[2] | 4.80 | 17.6 | 280 | 17.5 | 290 | | |
| 6 | .38[1] | 6.90 | 26.0 | 415 | 25.9 | 430 | | | .38[1] | 6.90 | 26.0 | 415 | 25.9 | 430 | | |
| | or .41[2] | 6.90 | 27.9 | 445 | 27.8 | 460 | | | or .41[2] | 6.90 | 27.9 | 445 | 27.8 | 460 | | |
| 8 | .41 | 9.05 | 37.3 | 595 | 37.2 | 615 | | | .41 | 9.05 | 37.3 | 595 | 37.2 | 615 | | |
| 10 | .44 | 11.10 | 49.3 | 790 | 49.2 | 810 | | | .44 | 11.10 | 49.3 | 790 | 49.2 | 810 | | |
| 12 | .48 | 13.20 | 61.0 | 1025 | 63.9 | 1055 | 63.2 | 1265 | .48 | 13.20 | 64.0 | 1025 | 63.9 | 1055 | 63.2 | 1265 |
| 16 | .50 | 17.40 | 89.1 | 1425 | 88.9 | 1465 | 87.8 | 1755 | .50 | 17.40 | 89.1 | 1425 | 88.9 | 1465 | 87.8 | 1755 |
| 20 | .57 | 21.60 | 126.2 | 2020 | 126.0 | 2080 | 124.5 | 2490 | .57 | 21.60 | 126.2 | 2020 | 126.0 | 2080 | 124.5 | 2490 |
| 24 | .63 | 25.80 | 166 6 | 2665 | 166.3 | 2745 | 164.4 | 3290 | .63 | 25.80 | 166.6 | 2665 | 166.3 | 2745 | 164.4 | 3290 |
| 30 | .73 | 32.00 | 240.2 | 3845 | 239.7 | 3955 | 236.9 | 4740 | .79 | 32.00 | 258.2 | 4130 | 257.7 | 4250 | 254.9 | 5100 |
| 36 | .81 | 38.30 | 320.9 | 5135 | | | | | .87 | 38.30 | 342.4 | 5480 | | | | |
| 42 | .90 | 44.50 | 415.0 | 6640 | | | | | .97 | 44.50 | 444.3 | 7110 | | | | |
| 48 | .98 | 50.80 | 516.5 | 8265 | | | | | 1.06 | 50.80 | 554.7 | 8875 | | | | |

*Including Bell and Spigot Bead. Calculated weight of pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.
[1]Class 22 thickness.
[2]Class 23 thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

## Table No. 9.3 (continued)

### STANDARD THICKNESSES AND WEIGHTS OF CAST IRON GAS PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS

NOTE: These thicknesses and weights are for pipe laid without blocks, on flat bottom trench with tamped backfill, under 5 feet of cover. For other conditions see tables 9.2 and 9.4 hereof and the Manual.

| | CLASS 100 | | | | | | | | CLASS 150 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100 Lb. Pressure | | | | | | | | 150 Lb. Pressure | | | | | | | |
| | | | Weight Based On | | | | | | | | Weight Based On | | | | | |
| | | | 16 Ft. Length | | 16½ Ft. Length | | 20 Ft. Length | | | | 16 Ft. Length | | 16½ Ft. Length | | 20 Ft. Length | |
| Size Inches | Thickness Inches | Outside Dia. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Thickness Inches | Outside Dia. Inches | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* | Avg. Per Foot† | Per Length* |
| 4 | .35[1] | 4.80 | 16.5 | 265 | 16.4 | 270 | | | .35[1] | 4.80 | 16.5 | 265 | 16.4 | 270 | | |
| | or .38[2] | 4.80 | 17.6 | 280 | 17.5 | 290 | | | or. .38[2] | 4.80 | 17.6 | 280 | 17.5 | 290 | | |
| 6 | .38[1] | 6.90 | 26.0 | 415 | 25.9 | 430 | | | .38[1] | 6.90 | 26.0 | 415 | 25.9 | 430 | | |
| | or .41[2] | 6.90 | 27.9 | 445 | 27.8 | 460 | | | or .41[2] | 6.90 | 27.9 | 445 | 27.8 | 460 | | |
| 8 | .41 | 9.05 | 37.3 | 595 | 37.2 | 615 | | | .41 | 9.05 | 37.3 | 595 | 37.2 | 615 | | |
| 10 | .44 | 11.10 | 49.3 | 790 | 49.2 | 810 | | | .44 | 11.10 | 49.3 | 790 | 49.2 | 810 | | |
| 12 | .48 | 13.20 | 64.0 | 1025 | 63.9 | 1055 | 63.2 | 1265 | .48 | 13.20 | 64.0 | 1025 | 63.9 | 1055 | 63.2 | 1265 |
| 16 | .54 | 17.40 | 95.5 | 1530 | 95.4 | 1575 | 94.2 | 1885 | | | | | | | | |
| 20 | .62 | 21.60 | 136.2 | 2180 | 136.0 | 2245 | 134.5 | 2690 | | | | | | | | |
| 24 | .68 | 25.80 | 178.6 | 2860 | 178.3 | 2940 | 176.4 | 3530 | | | | | | | | |

*Including Bell and Spigot Bead. Calculated weight of pipe rounded off to nearest 5 pounds.
†Average weight per foot based on calculated weight of pipe before rounding.
[1]Class 22 thickness.
[2]Class 23 thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

## Table No. 9.4

### STANDARD THICKNESSES OF CAST IRON GAS PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS

**Thickness in Inches. Working Pressure in Pounds per Square Inch.**
**Thicknesses Include Allowances for Foundry Practice and Corrosion**

Laying Condition A—Flat Bottom Trench, Without Blocks, Untamped Backfill
Laying Condition B—Flat Bottom Trench, Without Blocks, Tamped Backfill
Laying Condition C—Pipe Laid on Blocks, Untamped Backfill
Laying Condition D—Pipe Laid on Blocks, Tamped Backfill

| Size Inches | Working Pressure | 3½ FEET OF COVER Laying Condition | | | | 5 FEET OF COVER Laying Condition | | | | 8 FEET OF COVER Laying Condition | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D | A | B | C | D |
| 4 | 10 | [1].35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| | 50 | [1].35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| | 100 | [1].35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| | 150 | [1].35 | .35 | .35 | .35 | .35 | .35 | .38 | .35 | .35 | .35 | .41 | .35 |
| | | [2].38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .41 | .38 |
| 6 | 10 | [1].38 | .38 | .41 | .38 | .38 | .38 | .41 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .48 | .41 |
| | 50 | [1].38 | .38 | .41 | .38 | .38 | .38 | .41 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .48 | .41 |
| | 100 | [1].38 | .38 | .41 | .38 | .38 | .38 | .44 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 |
| | 150 | [1].38 | .38 | .41 | .38 | .38 | .38 | .44 | .38 | .38 | .38 | .48 | .38 |
| | | [2].41 | .41 | .41 | .41 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 |
| 8 | 10 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .52 | .41 |
| | 50 | .41 | .41 | .44 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .52 | .41 |
| | 100 | .41 | .41 | .48 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .56 | .41 |
| | 150 | .41 | .41 | .48 | .41 | .41 | .41 | .48 | .41 | .41 | .41 | .56 | .41 |
| 10 | 10 | .44 | .44 | .48 | .44 | .44 | .44 | .52 | .44 | .44 | .44 | .60 | .44 |
| | 50 | .44 | .44 | .48 | .44 | .44 | .44 | .52 | .44 | .44 | .44 | .60 | .44 |
| | 100 | .44 | .44 | .52 | .44 | .44 | .44 | .52 | .44 | .44 | .44 | .60 | .48 |
| | 150 | .44 | .44 | .52 | .44 | .44 | .44 | .56 | .44 | .48 | .44 | .60 | .48 |
| 12 | 10 | .48 | .48 | .52 | .48 | .48 | .48 | .56 | .48 | .48 | .48 | .60 | .52 |
| | 50 | .48 | .48 | .52 | .48 | .48 | .48 | .56 | .48 | .48 | .48 | .60 | .52 |
| | 100 | .48 | .48 | .56 | .48 | .48 | .48 | .56 | .48 | .52 | .48 | .65 | .52 |
| | 150 | .48 | .48 | .56 | .48 | .48 | .48 | .56 | .48 | .52 | .48 | .65 | .52 |
| 16 | 10 | .54 | .50 | .58 | .54 | .54 | .50 | .63 | .58 | .58 | .54 | .73 | .63 |
| | 50 | .54 | .50 | .63 | .54 | .54 | .50 | .63 | .58 | .63 | .58 | .73 | .63 |
| | 100 | .54 | .54 | .63 | .58 | .58 | .54 | .68 | .58 | .63 | .58 | .73 | .68 |
| 20 | 10 | .62 | .57 | .67 | .62 | .62 | .57 | .72 | .67 | .67 | .62 | .78 | .72 |
| | 50 | .62 | .57 | .72 | .62 | .67 | .57 | .72 | .67 | .72 | .62 | .78 | .72 |
| | 100 | .62 | .57 | .72 | .67 | .67 | .62 | .78 | .67 | .72 | .67 | .84 | .78 |
| 24 | 10 | .68 | .63 | .73 | .68 | .73 | .63 | .79 | .73 | .79 | .68 | .85 | .79 |
| | 50 | .68 | .63 | .79 | .68 | .73 | .63 | .79 | .73 | .79 | .73 | .85 | .79 |
| | 100 | .73 | .63 | .79 | .73 | .73 | .68 | .85 | .79 | .79 | .73 | .92 | .85 |
| 30 | 10 | .79 | .73 | .85 | .79 | .85 | .73 | .92 | .85 | .92 | .79 | .99 | .92 |
| | 50 | .85 | .73 | .85 | .85 | .85 | .79 | .92 | .85 | .92 | .85 | .99 | .92 |
| 36 | 10 | .87 | .81 | .94 | .87 | .94 | .81 | 1.02 | .94 | 1.02 | .87 | 1.10 | 1.02 |
| | 50 | .94 | .81 | 1.02 | .94 | 1.02 | .87 | 1.10 | .94 | 1.10 | .94 | 1.19 | 1.02 |
| 42 | 10 | 1.05 | .90 | 1.05 | .97 | 1.05 | .90 | 1.13 | 1.05 | 1.13 | .97 | 1.22 | 1.13 |
| | 50 | 1.05 | .90 | 1.13 | 1.05 | 1.13 | .97 | 1.13 | 1.05 | 1.22 | 1.05 | 1.32 | 1.13 |
| 48 | 10 | 1.14 | .98 | 1.14 | 1.06 | 1.14 | .98 | 1.23 | 1.14 | 1.33 | 1.06 | 1.33 | 1.23 |
| | 50 | 1.14 | .98 | 1.23 | 1.14 | 1.23 | 1.06 | 1.33 | 1.14 | 1.33 | 1.14 | 1.44 | 1.33 |

[1]Class 22 Thickness.
[2]Class 23 Thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

ASA
A21.10–1951

# American Standard Specifications

*for*

# SHORT-BODY CAST-IRON FITTINGS, 3 INCH TO 12 INCH, FOR 250-PSI. WATER PRESSURE PLUS WATER HAMMER

SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

## Foreword

For a brief history of the development of standard specications for cast-iron pipe and fittings for water, for the organization and program of the Sectional Committee (A21) on Specifications for Cast Iron Pipe and Fittings which developed the specifications contained herein, and for a description of the other specifications issued or in preparation by this sectional committee, reference should be made to the Foreword of the "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe (ASA A21.1)."

The short-body fittings described in the specifications which follow were developed to meet a growing demand for lighter, cheaper and more compact fittings than those of earlier standard specifications for bell-and-spigot fittings for water, fittings better adapted to use in distribution work in city streets congested with other utility structures. This need for more compact fittings had led to a variety of special designs by different municipalities and manufacturers.

The radical change in design raised questions of strength and hydraulic properties which were studied exhaustively by Committee A21. Strength was investigated, with numerous bursting tests in each case, by Dean M. L. Enger and Prof. W. M. Lansford of the Dept. of Theoretical and Applied Mechanics, University of Illinois (unpublished), and by the American Cast Iron Pipe Co. representing the Cast Iron Pressure Pipe Institute of the manufacturers (unpublished). Hydraulic losses, in comparison with losses in fittings of the current A.W.W.A. long-body patterns, were measured at the Cornell University Engineering Experiment Station by Prof. Ernest W. Schoder and Prof. Arthur N. Vanderlip; and an economic comparison of the short-body and the A.W.W.A. types, as they would be used in a typical distribution system, was made by Allen T. Ricketts and Thomas H. Wiggin. Both of these studies of hydraulic losses were published in Cornell University Engineering Experiment Station Bulletin No. 20, September 1935 (102 pages, $1.25). These studies, for 12-in. and smaller fittings, demonstrated not only the strength of the short-body designs, but also that these short fittings are slightly superior economically in distribution systems, considering friction losses, the cost of power for pumping, and installation costs. Longer-radius bends show somewhat smaller losses of head, but the difference is so small for usual distribution velocities, and the use of bends in distribution systems, except where space is limited, is so infrequent, that this difference may be disregarded.

Since cast iron tees and crosses, especially those with equal outlets, defy accurate stress analysis, the designs were developed on the basis of numerous bursting tests, with allowances for water hammer, for foundry tolerance and for a loss in thickness of 0.08 in. by corrosion. These fittings are of one class only, for a static working water pressure of 250 psi. plus water hammer, with or without ordinary earth loads, and with a factor of safety of about 2½.

The designs contemplate all bell fittings. The spigots shown in Fig. 1 (*see* p. 6) will be substituted for one or more bells as ordered. Fittings of the same body dimensions and laying lengths, with flange ends or ends for mechanical joints, may also be ordered under these specifications.

ASA
A21.10-1951

*American Standard Specifications for*

# Short-Body Cast-Iron Fittings, 3 Inch to 12 Inch, for 250-psi. Water Pressure Plus Water Hammer

*This specification covers 3-in. to 12-in. short-body cast-iron fittings for water pressure of 250 psi. plus water hammer as specified in the "American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe" (ASA A21.1).*

**Sec. 10-1—Description of Fittings**

Fittings shall be made with all bell ends or such other type of ends as may be agreed upon at the time of purchase. Fittings with all bell ends or with spigot ends shall accurately conform to the dimensions given in the tables accompanying and forming a part of these specifications. Fittings with other types of ends shall comply with the dimensions agreed upon but in all other respects shall fulfill the specifications hereinafter given.

**Sec. 10-2—Casting of Fittings**

Fittings shall be molded from accurate patterns. They shall not be stripped while sufficiently hot to be injured by subsequent cooling.

**Sec. 10-3—Quality of Iron**

10-3.1. All fittings shall be made of cast iron of good quality, and of such character and so adapted in chemical composition to the thickness of the fittings to be cast that the iron in the fittings shall be strong, tough, resilient, of even grain and soft enough for satisfactory drilling and cutting and it shall comply with the physical specifications given in Sec. 10-14 and 10-15. The metal shall be remelted in a cupola or other suitable furnace.

10-3.2. The iron in the fittings shall not contain more than 0.90 per cent of phosphorus nor more than 0.12 per cent of sulfur. Samples for chemical analysis shall be taken by drilling completely through from skin to skin each of the acceptance test specimens; but not to exceed three specimens per heat.

**Sec. 10-4—Quality of Castings**

The fittings shall be smooth and free from scales, lumps, blisters, sand holes and defects of every nature which unfit them for the use for which they are intended. No plugging, filling, burning-in or welding will be allowed except as permitted by the purchaser.

**Sec. 10-5—Foundry Records**

10-5.1. *Casting.* A record of the melting and pouring temperatures of the iron shall be furnished the purchaser if requested.

10-5.2. *Chemical analyses.* Chemical analyses shall be made by the manufacturer from each heat to determine total carbon, manganese, phosphorus, sulfur and silicon; duplicate copies of test reports shall be furnished the purchaser on request.

### Sec. 10-6—Marking of Fittings

Every fitting shall have distinctly cast upon it the initials of the maker's name, and, if requested by the purchaser, figures showing the year in which it was cast. Nominal diameters of openings shall be cast on all fittings and the fraction of the circle on all bends; also any initials, not exceeding four, which may be required by the purchaser. The letters and figures shall be cast on the outside and have dimensions not less than those indicated below:

| Fitting Diam. *in.* | Height of Letters *in.* | Relief *in.* |
|---|---|---|
| 3–10 | $\frac{3}{4}$ | $\frac{3}{32}$ |
| 12 | $1\frac{1}{4}$ | $\frac{3}{32}$ |

The weight and the class shall be conspicuously painted in white on the inside or outside of each fitting after the coating has become hard.

### Sec. 10-7—Inspection by Purchaser

10-7.1. *Definition of "Purchaser."* Wherever the word "Purchaser" is used herein it shall be understood to mean the actual purchaser of the fittings or his authorized agents acting within the scope of the duties entrusted to them.

10-7.2. *Power of purchaser to inspect.* The purchaser shall have free access at all times to all parts of any manufacturing plant which concern the manufacture of articles to be made for him. He may inspect the material, pattern work, molding, casting, coating and lining of the fittings. The forms, sizes, uniformity and conditions of all fittings herein referred to shall be subject to his inspection and approval, and he may reject any fitting which is not in conformity with the specifications or drawings. Any fitting rejected shall be marked "rejected," and any marks pertaining to the purchaser shall be chipped or erased from such fitting.

10-7.3. *Manufacturer to furnish men and materials.* The manufacturer shall provide all tools, testing equipment, materials, labor and facilities necessary for the required testing, inspection and weighing of the fittings at the foundry.

10-7.4. *Report of purchaser's inspection.* The purchaser shall make written report daily at the foundry office of all fittings rejected, noting causes for rejection.

### Sec. 10-8—Inspection and Certification by Manufacturer

Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made as specified, this statement to contain the results of all specified tests.

### Sec. 10-9—Fittings to Be Delivered Sound

All the fittings must be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the manufacturer of any of his obligations in this regard, and any defective fitting which may have passed the purchaser at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for fittings found to be cracked after they have been accepted at the agreed point of delivery, unless there shall be unmistakable evidence that the casting was originally defective or damaged before acceptance. Care shall be taken in handling the fittings not to injure the coating or lining, and no material of any kind shall be placed in the fittings during transportation or at any other time after they have received the coating or lining.

**Sec. 10–10—Tolerances or Maximum Permitted Variations From Standard**

10–10.1. *Tolerances in diameter.* All sockets and spigots shall be tested by circular gages. All fittings shall be rejected which are defective in joint room, or which vary more than 0.12 in. from standard dimensions in the diameters of the sockets and the outside diameters of spigots.

10–10.2. *Tolerances in thickness.* No variations below the standard thickness shall be permitted for 10-in. by 10-in., 12-in. by 12-in. and 12-in. by 10-in. tees and crosses. For other fittings, variations below the standard thickness shall not be greater than those shown in the following table and note:

| Nom. Diameter *in.* | Minus Tolerance *in.* |
|---|---|
| 3, 4 and 6 | 0.10 |
| 8, 10 and 12 | 0.12 |

Note: Variations from the standard thickness of 0.02 in. in excess of the allowances above given shall be permitted for spaces not exceeding 8 in. in length in any direction.

10–10.3. *Allowable percentage of variation in weight.* No fitting shall be accepted the weight of which shall be less than the standard weight by more than 10 per cent, and no excess above the standard weight of more than 10 per cent will be paid for.

**Sec. 10–11—Cleaning and Inspecting**

All fittings shall have gates, fins and other roughnesses chipped or ground off and shall be thoroughly cleaned, checked as to dimensions and also subjected to a careful surface inspection and a hammer test before being coated or lined.

**Sec. 10–12—Weighing**

Each fitting shall be weighed and the weight and class conspicuously painted on the outside or inside of the bell or spigot end. Fittings which are to be lined with cement mortar or coated on the inside or outside, or both, with bituminous enamel or other special material shall be weighed before the application of such a lining or coating. If desired by the purchaser, fittings not lined or coated with cement mortar, bituminous enamel or other special material shall be weighed after delivery and the weights so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weighmaster. Unless otherwise stated in the contract, a ton shall be 2,000 lb. avoirdupois.

**Sec. 10–13—Linings and Exterior Coatings**

Any particular lining or coating which is to be applied to the fittings shall be specified in the agreement made at the time of purchase. Separate specifications for a cement-mortar lining have been provided in connection with these specifications for fittings. (*See* specification ASA A21.4–1952.)

No pipe or specials for waterworks service shall be furnished without protective coating unless specifically ordered by the purchaser.

**Sec. 10–14—Test of Material**

The acceptability of the iron used in the fittings shall be determined by testing bars cast from the same iron as the fittings. The observations and the computed results hereinafter required shall be recorded, and, if requested, reported to the purchaser.

**Sec. 10–15—Test Bars**

10–15.1. *Dimensions.* Test bars shall be 2 in. wide, 1 in. thick and not less than 26 in. long. Individual test bars may vary as much as 2 per cent from the standard width or standard thickness, or both, but the patterns and molding practice shall be such that the errors shall in general not exceed 1 per cent.

10–15.2. *Methods of casting.* The bars shall be cast vertically in well faced, dry sand molds provided with a suitable pouring basin and mounted on a suitable refractory foundation. Metal for the bars shall be obtained by using a small, heated ladle taking its metal from the main ladle from which the fittings are to be poured and after all alloys and other additional metal, except cast iron for cooling, have been added to the main ladle and become melted. The bars shall not be removed from the mold before they have cooled to 500°F.

10–15.3. *When cast and to what fittings applicable.* Except as hereinafter provided for special cases, one pair of test bars of the metal used shall be cast with iron from the first ladle, another pair with iron from the approximately middle ladle and a third pair with iron from the last ladle of iron taken during a day's run or heat, from the cupola in which the iron for the fittings is melted. If the heat lasts for more than six hours, then additional pairs of bars shall be cast at approximately uniform intervals so as to give an extra pair of bars for each three hours during which the heat lasts in excess of six hours. In case the charging of the cupola is to be changed for one or more times during the day's run or heat in order to produce a different iron, the time of taking test bars shall be varied in such a way as to obtain representative tests of the iron at least at the beginning and end of each period during which the iron is intended to be constant in quality; and in case such period exceeds four hours, additional pairs of bars shall be taken at such times as will provide a pair of bars for each two hours during which this special mixture is used. At least one bar from each pair shall be broken, but the manufacturer shall have the right to break both bars, in which case the better bar shall be taken as representative. Bars showing flaws in fracture may be disregarded.

10–15.4. *Test bar requirements to indicate acceptable iron.* In order that the iron shall be acceptable, the average results from the single bars representing the respective pairs of bars cast during the heat or period shall comply with the requirements hereinafter specified, and, in addition, no representative bar shall be more than 5 per cent below the minimum requirements in either corrected breaking load or corrected deflection.

10–15.5. *Method of testing.* The bars shall be broken as beams by placing them flatwise on supports 24 in. apart and applying the load at the center of the span. The breaking load and the corresponding deflection shall be observed and recorded.

10–15.6. *Correcting observed breaking loads and deflections.* The bars shall be measured at the point of application of the load and the results corrected to standard 2-in. by 1-in. cross section by the conventional beam formula as follows:

SHORT-BODY CAST-IRON FITTINGS

Corrected breaking load

$$= \text{Observed breaking load} \times \frac{2}{bd^2}$$

Corrected deflection at breaking

$$= \text{Observed deflection at breaking} \times d$$

where $b$ is the measured width and $d$ is the measured depth of the bar at the point of application of the load. In the formulas above, the deflection and all dimensions are in inches.

10–15.7. *Requirements on strength and deflection of 2-in. by 1-in. bars.* In order to indicate acceptable metal, the corrected breaking loads and deflections of the representative 2-in. by 1-in. test bars for a given heat or period, interpreted as provided in Sec. 10–15.4 above, shall comply with the following requirements:

Minimum center breaking load:

2,300 lb.

Minimum center deflection at breaking:

0.30 + 0.0001 (breaking load − 2,300) in.

TABLE 1

*Weights of Short-Body Fittings*

**Tees and Crosses**

| Nom. Diam. *in.* Run | Branch | Weight *lb.* Tee | Cross |
|---|---|---|---|
| 3 | 3 | 80 | 105 |
| 4 | 3 | 100 | 125 |
| 4 | 4 | 105 | 140 |
| 6 | 3 | 140 | 165 |
| 6 | 4 | 150 | 180 |
| 6 | 6 | 160 | 210 |
| 8 | 3 | 200 | 225 |
| 8 | 4 | 210 | 240 |
| 8 | 6 | 220 | 265 |
| 8 | 8 | 240 | 305 |
| 10 | 3 | 280 | 305 |
| 10 | 4 | 290 | 320 |
| 10 | 6 | 300 | 350 |
| 10 | 8 | 320 | 390 |
| 10 | 10 | 370 | 465 |
| 12 | 3 | 365 | 390 |
| 12 | 4 | 375 | 405 |
| 12 | 6 | 385 | 435 |
| 12 | 8 | 405 | 475 |
| 12 | 10 | 460 | 555 |
| 12 | 12 | 485 | 600 |

**Bends**

| Nom. Diam. *in.* | Weight—*lb.* 90° | 45° | 22½° | 11¼° |
|---|---|---|---|---|
| 3 | 55 | 50 | 50 | 50 |
| 4 | 70 | 65 | 65 | 65 |
| 6 | 110 | 100 | 100 | 100 |
| 8 | 165 | 145 | 145 | 145 |
| 10 | 230 | 200 | 200 | 200 |
| 12 | 305 | 270 | 270 | 270 |

**Reducers**

| Nom. Diam.—*in.* Large | Small | Weight *lb.* |
|---|---|---|
| 4 | 3 | 55 |
| 6 | 3 | 75 |
| 6 | 4 | 80 |
| 8 | 3 | 100 |
| 8 | 4 | 110 |
| 8 | 6 | 125 |
| 10 | 3 | 125 |
| 10 | 4 | 135 |
| 10 | 6 | 150 |
| 10 | 8 | 170 |
| 12 | 3 | 160 |
| 12 | 4 | 165 |
| 12 | 6 | 185 |
| 12 | 8 | 210 |
| 12 | 10 | 235 |

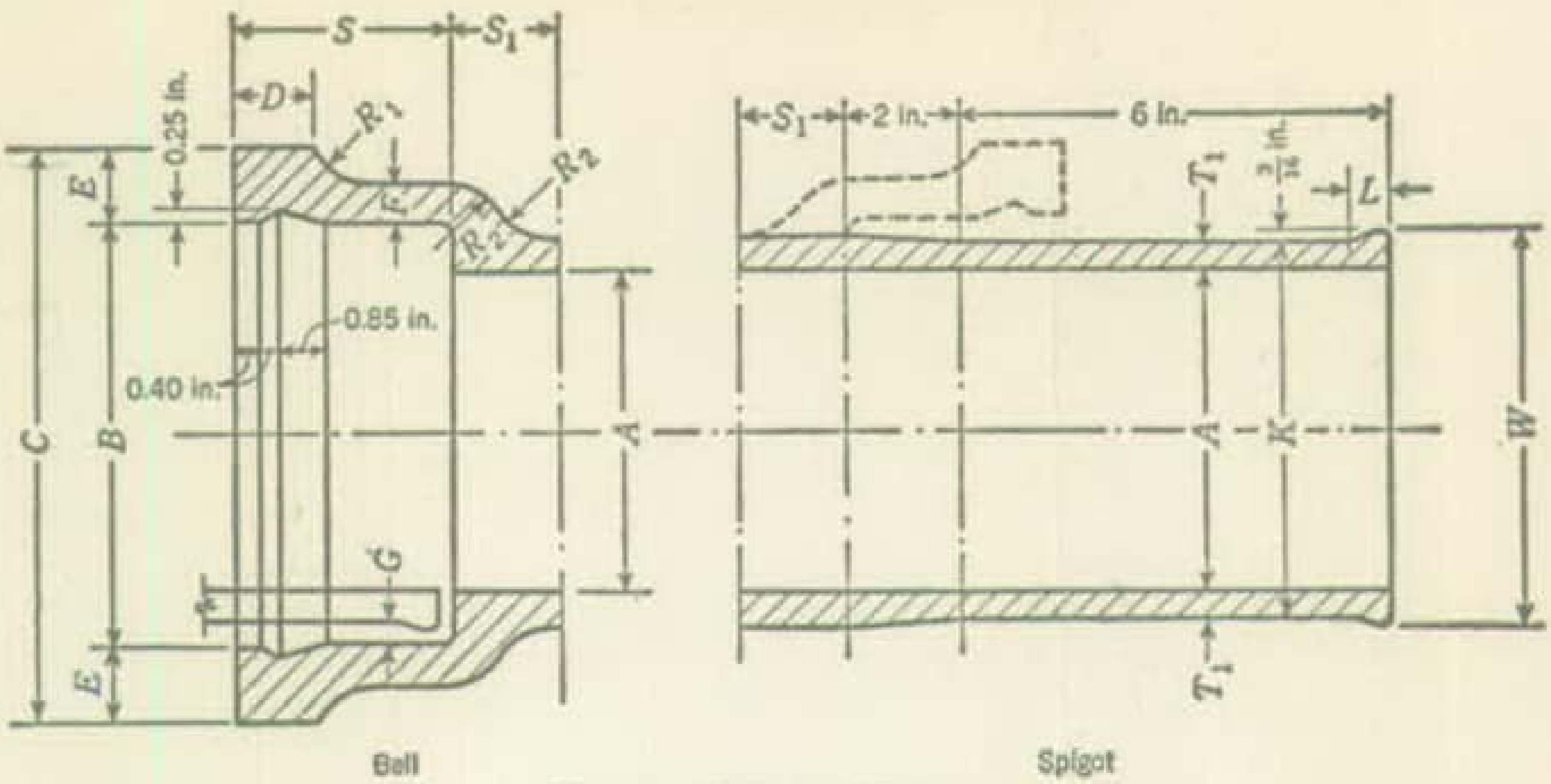



FIG. 1. Bells and Spigots

*Bell and Spigot Dimensions*

| Nom. Diam. *in.* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | $S_1$ | *K* | *L* | $R_1$* | $R_2$† | *S* | $T_1$ | *W*‡ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 3.00 | 4.66 | 7.26 | 1.25 | 1.30 | 0.65 | 0.35 | 1.50 | 3.96 | 0.75 | 0.98 | 1.00 | 3.50 | 0.48 | 4.34 |
| 4 | 3.96 | 5.70 | 8.30 | 1.50 | 1.30 | 0.65 | 0.40 | 2.00 | 4.90 | 0.75 | 0.98 | 1.05 | 4.00 | 0.47 | 5.28 |
| 6 | 6.00 | 7.80 | 10.60 | 1.50 | 1.40 | 0.70 | 0.40 | 2.00 | 7.00 | 0.75 | 1.05 | 1.10 | 4.00 | 0.50 | 7.38 |
| 8 | 8.10 | 10.00 | 13.00 | 1.50 | 1.50 | 0.75 | 0.41 | 2.00 | 9.18 | 1.00 | 1.12 | 1.16 | 4.00 | 0.54 | 9.56 |
| 10 | 10.04 | 12.10 | 15.30 | 1.50 | 1.60 | 0.80 | 0.42 | 2.00 | 11.25 | 1.00 | 1.20 | 1.22 | 4.00 | 0.60 | 11.63 |
| 12 | 12.00 | 14.20 | 17.60 | 1.50 | 1.70 | 0.85 | 0.42 | 2 00 | 13.35 | 1.00 | 1.28 | 1.27 | 4.00 | 0.68 | 13.73 |

* $R_1 = 1.5(E - F)$. † $R_2 = F + G$. ‡ $W = K + 0.38$.

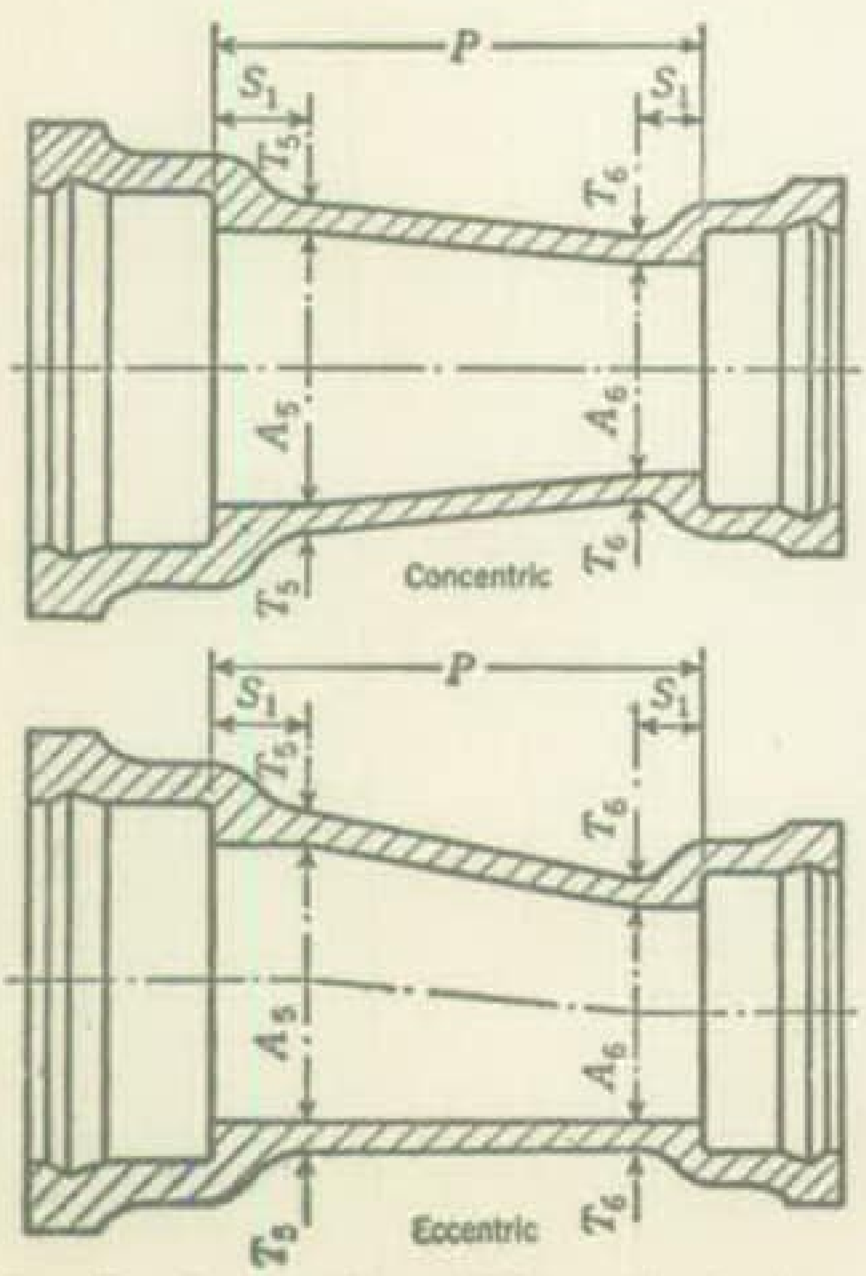



FIG. 2. Concentric and Eccentric Reducers

*Standard Short-Body Reducers**

| Size *in.* | $A_5$ | $A_6$ | $T_5$ | $T_6$ | *P* |
|---|---|---|---|---|---|
| 4×3 | 3.96 | 3.00 | 0.52 | 0.48 | 7.00 |
| 6×3 | 6.00 | 3.00 | 0.55 | 0.48 | 9.00 |
| 6×4 | 6.00 | 3.96 | 0.55 | 0.52 | 9.00 |
| 8×3 | 8.10 | 3.00 | 0.60 | 0.48 | 11.00 |
| 8×4 | 8.10 | 3.96 | 0.60 | 0.52 | 11.00 |
| 8×6 | 8.10 | 6.00 | 0.60 | 0.55 | 11.00 |
| 10×3 | 10.04 | 3.00 | 0.68 | 0.48 | 12.00 |
| 10×4 | 10.04 | 3.96 | 0.68 | 0.52 | 12.00 |
| 10×6 | 10.04 | 6.00 | 0.68 | 0.55 | 12.00 |
| 10×8 | 10.04 | 8.10 | 0.68 | 0.60 | 12.00 |
| 12×3 | 12.00 | 3.00 | 0.75 | 0.48 | 14.00 |
| 12×4 | 12.00 | 3.96 | 0.75 | 0 52 | 14.00 |
| 12×6 | 12.00 | 6.00 | 0.75 | 0.55 | 14.00 |
| 12×8 | 12.00 | 8.10 | 0.75 | 0.60 | 14.00 |
| 12×10 | 12.00 | 10.04 | 0.75 | 0.68 | 14.00 |

* $S_1$ equals 1.5 in. for 3-in. size; $S_1$ equals 2.0 in. for 4-in. through 12-in. size. For bell and spigot dimensions, see Fig. 1.

## SHORT-BODY CAST-IRON FITTINGS

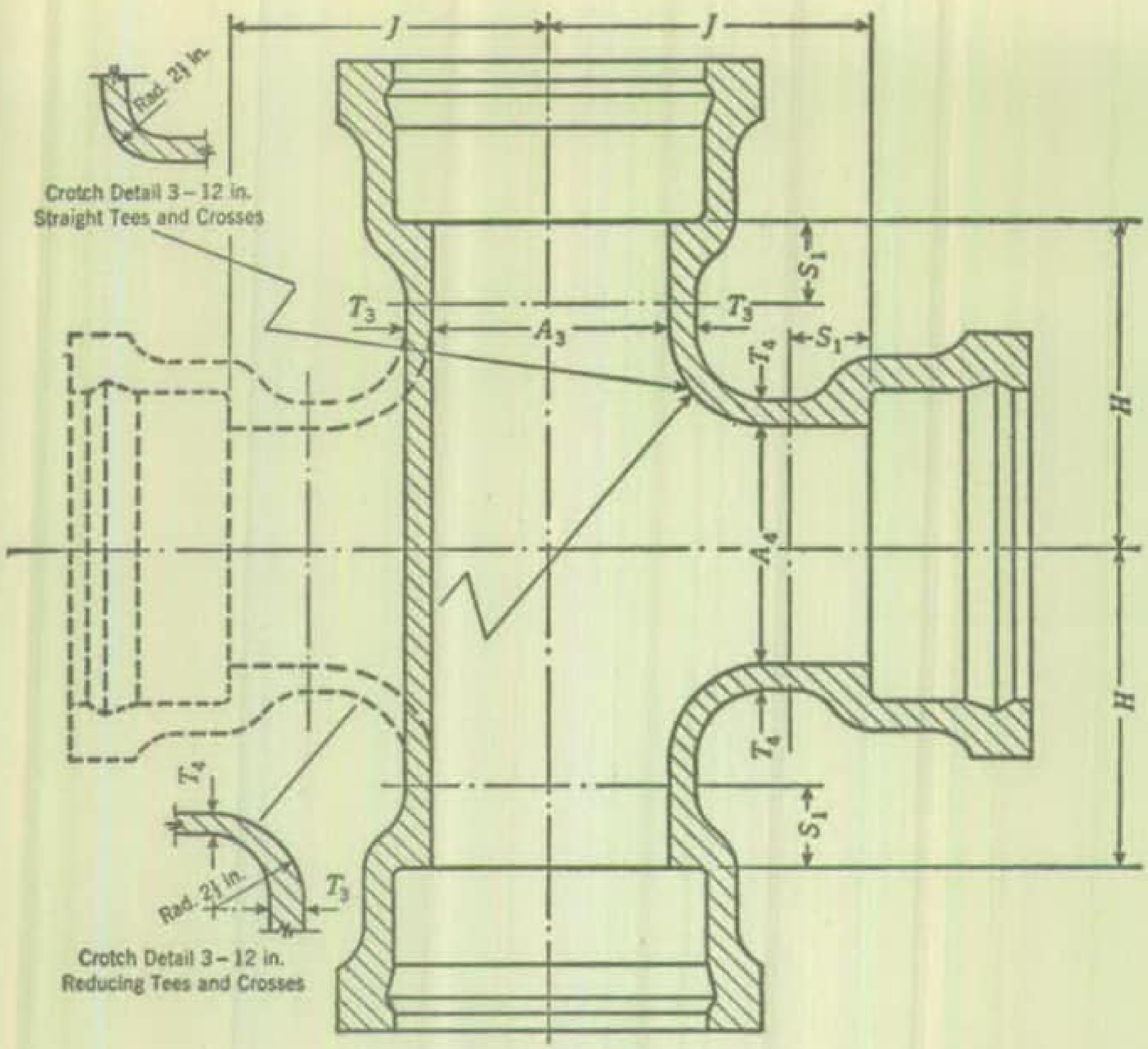



FIG. 3. Tees and Crosses

*Standard Short-Body Tees and Crosses**

| Size in. | $A_3$ | $A_4$ | $H$ | $J$ | $T_3$ | $T_4$ | Size in. | $A_3$ | $A_4$ | $H$ | $J$ | $T_3$ | $T_4$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3×3 | 3.00 | 3.00 | 5.5 | 5.5 | 0.48 | 0.48 | 10×4 | 10.04 | 3.96 | 11.00 | 11.00 | 0.68 | 0.52 |
| 4×3 | 3.96 | 3.00 | 6.5 | 6.5 | 0.52 | 0.48 | 10×6 | 10.04 | 6.00 | 11.00 | 11.00 | 0.68 | 0.55 |
| 4×4 | 3.96 | 3.96 | 6.5 | 6.5 | 0.52 | 0.52 | 10×8 | 10.04 | 8.10 | 11.00 | 11.00 | 0.68 | 0.60 |
| 6×3 | 6.00 | 3.00 | 8.0 | 8.0 | 0.55 | 0.48 | 10×10 | 10.04 | 10.04 | 11.00 | 11.00 | 0.80 | 0.80 |
| 6×4 | 6.00 | 3.96 | 8.0 | 8.0 | 0.55 | 0.52 | 12×3 | 12.00 | 3.00 | 12.00 | 12.00 | 0.75 | 0.48 |
| 6×6 | 6.00 | 6.00 | 8.0 | 8.0 | 0.55 | 0.55 | 12×4 | 12.00 | 3.96 | 12.00 | 12.00 | 0.75 | 0.52 |
| 8×3 | 8.10 | 3.00 | 9.0 | 9.0 | 0.60 | 0.48 | 12×6 | 12.00 | 6.00 | 12.00 | 12.00 | 0.75 | 0.55 |
| 8×4 | 8.10 | 3.96 | 9.0 | 9.0 | 0.60 | 0.52 | 12×8 | 12.00 | 8.10 | 12.00 | 12.00 | 0.75 | 0.60 |
| 8×6 | 8.10 | 6.00 | 9.0 | 9.0 | 0.60 | 0.55 | 12×10 | 12.00 | 10.04 | 12.00 | 12.00 | 0.87 | 0.80 |
| 8×8 | 8.10 | 8.10 | 9.0 | 9.0 | 0.60 | 0.60 | 12×12 | 12.00 | 12.00 | 12.00 | 12.00 | 0.87 | 0.87 |
| 10×3 | 10.04 | 3.00 | 11.00 | 11.00 | 0.68 | 0.48 | | | | | | | |

* $S_1$ equals 1.5 in. for 3-in. size; $S_1$ equals 2.0 in. for 4-in. through 12-in. size. For bell and spigot dimensions, see Fig. 1.

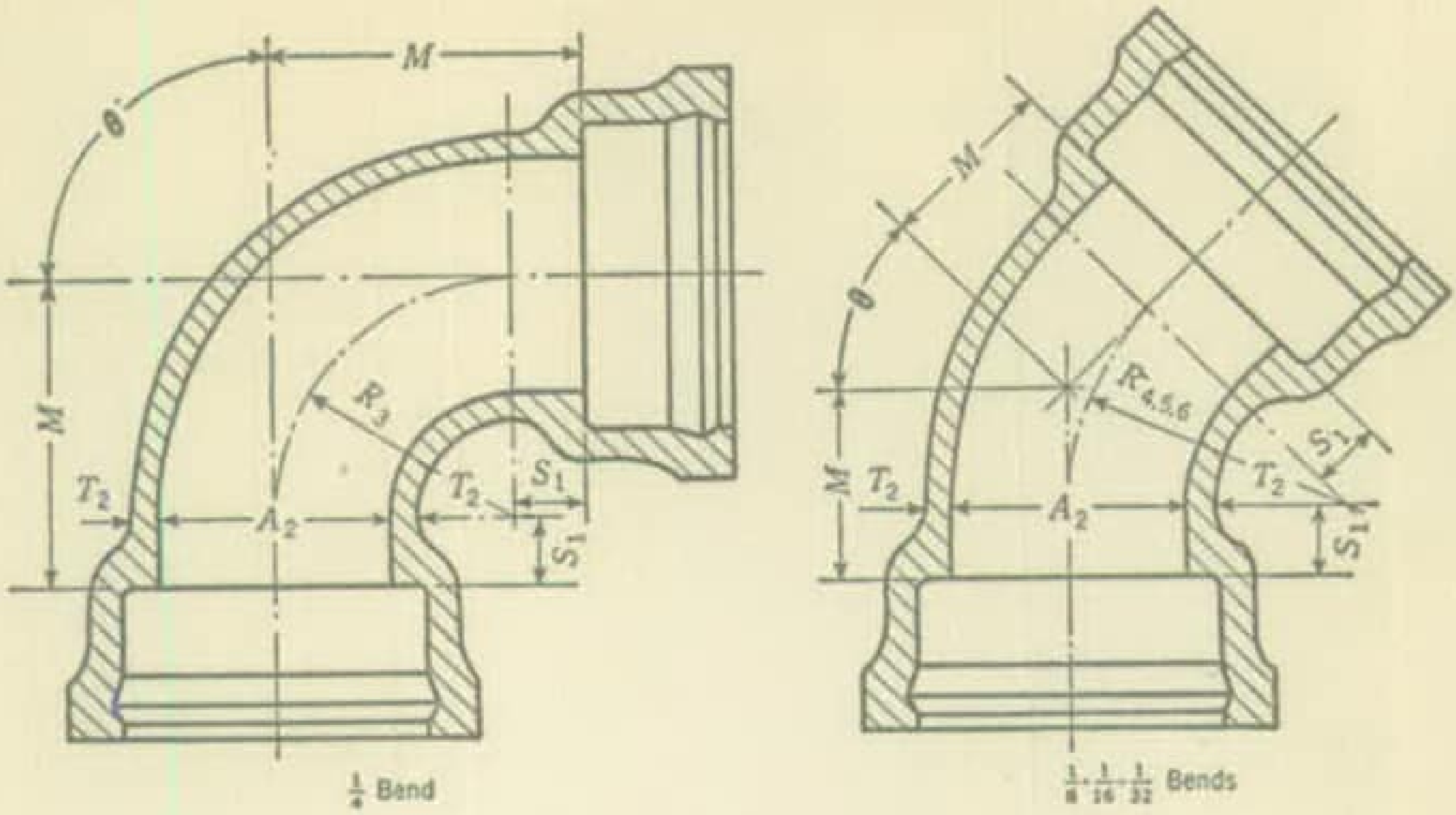



FIG. 4. Short-Body Bends

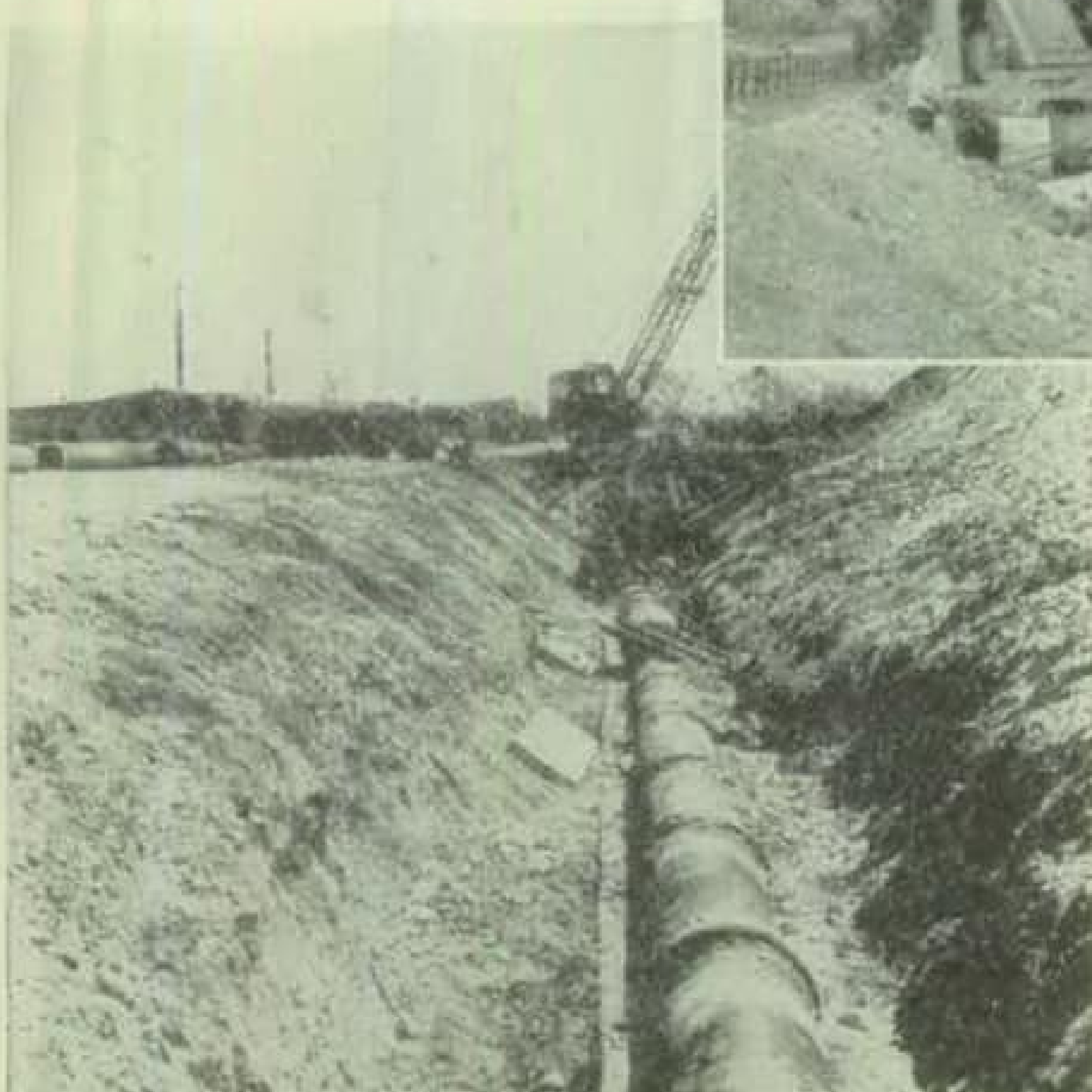
*Standard Short-Body Bends**

| Size in. | All Bends | | 1/4 Bend θ = 90° | | 1/8 Bend θ = 45° | | 1/16 Bend θ = 22½° | | 1/32 Bend θ = 11¼° | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $A_2$ | $T_2$ | $M$ | $R_3$ | $M$ | $R_4$ | $M$ | $R_5$ | $M$ | $R_6$ |
| 3 | 3.00 | 0.48 | 5.50 | 4.00 | 3.00 | 3.62 | 3.00 | 7.56 | 3.00 | 15.25 |
| 4 | 3.96 | 0.52 | 6.50 | 4.50 | 4.00 | 4.81 | 4.00 | 10.06 | 4.00 | 20.31 |
| 6 | 6.00 | 0.55 | 8.00 | 6.00 | 5.00 | 7.25 | 5.00 | 15.06 | 5.00 | 30.50 |
| 8 | 8.10 | 0.60 | 9.00 | 7.00 | 5.50 | 8.44 | 5.50 | 17.63 | 5.50 | 35.50 |
| 10 | 10.04 | 0.68 | 11.00 | 9.00 | 6.50 | 10.88 | 6.50 | 22.62 | 6.50 | 45.69 |
| 12 | 12.00 | 0.75 | 12.00 | 10.00 | 7.50 | 13.25 | 7.50 | 27.62 | 7.50 | 55.81 |

* $S_1$ equals 1.5 in. for 3-in. size; $S_1$ equals 2.0 in. for 4-in. through 12-in. size. For bell and spigot dimensions see Fig. 1.

**Installing mechanical joint cast iron pipe for gas distribution main.**

**Laying mechanical joint cast iron pipe for a water feeder main.**



**Mechanical joint cast iron pipe being installed for a deep sewer line.**

ASA
A21.11-1952

# AMERICAN STANDARD SPECIFICATIONS

*for*

# A MECHANICAL JOINT

*for*

# CAST IRON PRESSURE PIPE AND FITTINGS

SPONSORS

American Gas Association
American Society for Testing Materials
American Water Works Association
New England Water Works Association

ASA
A21.11–1952

# AMERICAN STANDARD SPECIFICATIONS

*for*

# A MECHANICAL JOINT

*for*

# CAST IRON PRESSURE PIPE AND FITTINGS

These specifications cover a mechanical joint, in sizes 3-inch to 48-inch, for cast iron pressure pipe made by pit cast or by centrifugal methods and cast iron pressure fittings, for gas, water, and other liquids.

## Sec. 11–1—Definitions

Purchaser. Wherever the word "purchaser" is used herein, it shall be understood to mean the actual purchaser of the pipe or his authorized agents acting within the scope of the duties entrusted to them.

Manufacturer. The word "manufacturer" means the producer who is making the pipe or fittings and who assumes the responsibility for the fulfillment of these specifications. Accessories, including glands and bolts, may be sublet to other manufacturers. Gaskets will in general be made by other manufacturers who are not expected to permit inspection of manufacturing processes without special arrangements.

## Sec. 11–2—Description of Joint

The mechanical joint is a bolted joint of the stuffing box type, as shown in Section 11–4A. Each joint shall consist of (1) a bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting; (2) a pipe or fitting spigot; (3) a sealing gasket; (4) a separate cast iron follower gland having cored or drilled bolt holes; and (5) cast iron tee-head bolts and hexagon nuts.

The joint is designed to permit normal expansion, contraction, and deflection of the pipe line.

## Sec. 11–3—Pipe and Fittings to Which Mechanical Joint Is Applicable

The mechanical joint made under these specifications is intended for use on cast iron pressure pipe and fittings made in accordance with the following

Standard ASA Specifications and shall be suitable for leakproof assembly therewith.

| | |
|---|---|
| ASA A21.2 | Specifications for Cast Iron Pit Cast Pipe for Water and Other Liquids |
| ASA A21.3 | Specifications for Cast Iron Pit Cast Pipe for Gas |
| ASA A21.6 | Specifications for Cast Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids |
| ASA A21.7 | Specifications for Cast Iron Pipe Centrifugally Cast in Metal Molds for Gas |
| ASA A21.8 | Specifications for Cast Iron Pipe Centrifugally Cast in Sand Lined Molds for Water or Other Liquids |
| ASA A21.9 | Specifications for Cast Iron Pipe Centrifugally Cast in Sand Lined Molds for Gas |
| ASA A21.10 | Specifications for Cast Iron Short-Body Pressure Fittings |

The mechanical joint shall meet all applicable requirements of the above listed specifications and shall have the same pressure rating as the pipe or fitting of which it is a part.

Mechanical joints for pipe or fittings beyond the scope of such standard specifications shall be subject to agreement between the manufacturer and the purchaser.

### Sec. 11–4—Dimensions and Tolerances

The joint and accessories shall meet the following dimensions and the tolerances shown above them.

### Sec. 11–5—Bell and Socket

The bell shall be cast integrally with the pipe or fitting and shall meet the applicable requirements of the specification under which the pipe or fitting is produced.

The surfaces of the bell and socket shall be smooth, free from holes, laps and defects of every nature which unfit them for the use for which they are intended. The bell and socket shall be subject to suitable joint tests for leakage. Such tests shall be made at sufficiently frequent intervals to assure that the joints shall be tight when properly assembled.

The annular recesses of the socket, the bolt circle, and the bell flange shall be concentric within the tolerances of Section 11–4A. The dimensions of the bell and socket, the bolt circle and the spacing of the bolt holes shall be gaged in accordance with Section 11–4A, at sufficiently frequent intervals to assure dimensional control.

### Sec. 11–6—Glands

The iron in the glands shall meet the requirements of Class 25 of the Standard Specification for Gray Iron Castings ASA G25.1 (ASTM A48). The preferred acceptance test under this specification shall be the transverse test, although the tension test may be used for qualification. The minimum strengths under this specification are shown in the following table.

| | 1.2 in. dia. bar 18 in. supports Load at center | 2 in. dia. bar 24 in. supports Load at center |
|---|---|---|
| Minimum Transverse Breaking Loads | 2000 pounds | 6800 pounds |
| Minimum Tensile Strength | 25,000 p.s.i. | |

The annular surfaces of the gland lip and the bolt circle shall be concentric. Their accuracy within the tolerances of Section 11–4A shall be checked by gaging at sufficiently frequent intervals to assure dimensional control.

The surfaces of the gland shall be smooth and free from defects of every nature which would unfit them for the use intended.

Glands shall be coated with a bituminous dip or paint unless otherwise specified.

## Sec. 11–7—Bolt Holes

Bolt holes for pipe and fittings may be drilled or cored. All bolt holes shall be free of sand or projections of iron that would interfere with the fit of the bolts. Drilled holes shall be gaged as to location, at sufficiently frequent intervals to assure dimensional control. All cored holes shall be gaged for diameter of bolt circle, location and size of holes and concentricity with the socket or gland lip.

## Sec. 11–8—Gaskets

*Manufacture*

The gaskets shall be made of a vulcanized crude rubber compound and unless otherwise specified the rubber shall be first grade plantation rubber. All surfaces of the gaskets shall be smooth except for the specified marking, and free from imperfections and the gaskets shall be free from any porosity. Tips or backs, if specified for special conditions shall be applied as shown in Section 11–4B and shall be well bonded to the rubber.

*Service*

Plain rubber gaskets are standard for joints in water service or other service where the gas or liquid being conveyed or the temperature is not deteriorating to the gaskets. Tips of duck, Thiokol impregnated duck, synthetic rubber of various kinds, lead and other materials can be applied for special services. Duck or other reinforcing material also may be applied to the back of the gaskets. Gaskets other than plain rubber shall be specified on the purchase order.

*Physical Properties and Tests*

The following tests shall be made by the gasket manufacturer in accordance with Federal Specification ZZ–R–601a or the equivalent ASTM specification.

> The test specimen for all tests except hardness shall be die-cut from routine production gaskets. It shall have a gage length of 2″ with a width of 0.25″ and a thickness of 0.10″. The gaskets selected for testing shall be such as to represent the full range of quality of the lot from which the order is to be filled. For each 5000 gaskets produced or for any week's production of less than 5000 gaskets, at least one set of tests shall be made.

1. Ultimate tensile strength.
2. Ultimate elongation.
3. Elongation at 1000 p.s.i. stress—Limits: 110% to 190%.

4. Permanent Set. The sample shall be clamped for 10 minutes at the elongation produced by 1000 p.s.i. stress, relieved of load and measured after 10 minutes' rest. The permanent set expressed as percentage of the original gage length shall not exceed 5%.
5. Hardness. Hardness tests shall be made on each batch of production gaskets. This test shall be made with a type A durometer. The preferred hardness is 70 to 75 durometer.

### Sec. 11-9—Bolts and Nuts

High strength, heat-treated cast iron tee-head bolts with hexagon nuts shall be the standard bolts; they shall be in accordance with Section 11-4C and meet the requirements hereinafter specified. If special types of bolts are required by the purchaser, agreement as to such shall be made at time of placing the order.

Standard bolts and nuts shall be manufactured under close metallurgical control and the finished bolt and nut assemblies shall be subject to proof testing with the load applied between the head and the nut in a suitable test machine. Proof tests shall be made at sufficiently frequent intervals to assure conformance with the proof test loads. The following proof test loads shall be applicable and shall not permanently stretch the bolt.

| Size, Inches | Proof Test Load, Pounds |
|---|---|
| ⅝ | 10,000 |
| ¾ | 15,000 |
| 1 | 24,500 |
| 1¼ | 40,000 |

The bearing surface of the cast nut shall be smooth and the nut shall be tapped at right angles to this surface to insure axial loading.

Bolts and nuts shall be coated with a rust-preventing lubricant after threading or tapping. They shall be packed in suitable containers, which shall be marked with the number of bolts, the size and type of bolts, and the net weight.

### Sec. 11-10—Foundry Records

A record of the specified tests, including those of glands, bolts, and gaskets, shall be made and retained for at least one year. Upon request, such records will be available to the purchaser at the foundry. If written transcripts of the results of any tests are desired, this fact shall be noted in the order for the material.

### Sec. 11-11—Inspection by Purchaser

(a) The purchaser shall have access at all times to those parts of the manufacturer's plant which concern the manufacture of articles being made for him. If the purchaser desires to inspect the manufacture of glands, bolts and gaskets which may be made by sub-contractors, special arrangements must be made therefor at the time of placing the order. He may inspect the joint materials and may reject any of the material which is not in conformity with the specification.

(b) The manufacturer shall provide all tools, testing equipment, materials, labor, and facilities necessary for the required testing and inspection of the joint at the foundry.

(c) The purchaser shall make written report daily to the foundry office of all material rejected, with the causes for rejection.

### Sec. 11-12—Inspection and Certification by Manufacturer

Should the purchaser have no inspector at the works, the manufacturer shall, if required by the purchaser, furnish a sworn statement that the inspection and all of the tests have been made and met as specified.

## NOTES ON METHOD OF INSTALLATION

(These notes are not parts of the Standard, but are given for information only.)

The successful operation of the mechanical joint specified requires that the spigot be centrally located in the bell and that adequate anchorage shall be provided where abrupt changes in direction and dead ends occur.

The rubber gasket seals most effectively (particularly when sealing gas) if the surfaces with which it comes in contact are brushed thoroughly with a wire brush just prior to assembly. This thorough brushing removes all loose rust or foreign material which may be present and provides clean surfaces which should be brushed with soapy water just prior to slipping the gasket over the spigot end and into the bell. Soapy water brushed over the gasket prior to installation also removes loose dirt and lubricates the gasket as it is forced into its retaining space.

For water and gas service, the normal range of bolt torques to be applied to Standard Cast Iron Bolts in a joint are:

| Size, Inches | Range of Torque, Ft. Pounds |
|---|---|
| 5/8 | 40– 60 |
| 3/4 | 60– 90 |
| 1 | 70–100 |
| 1 1/4 | 90–120 |

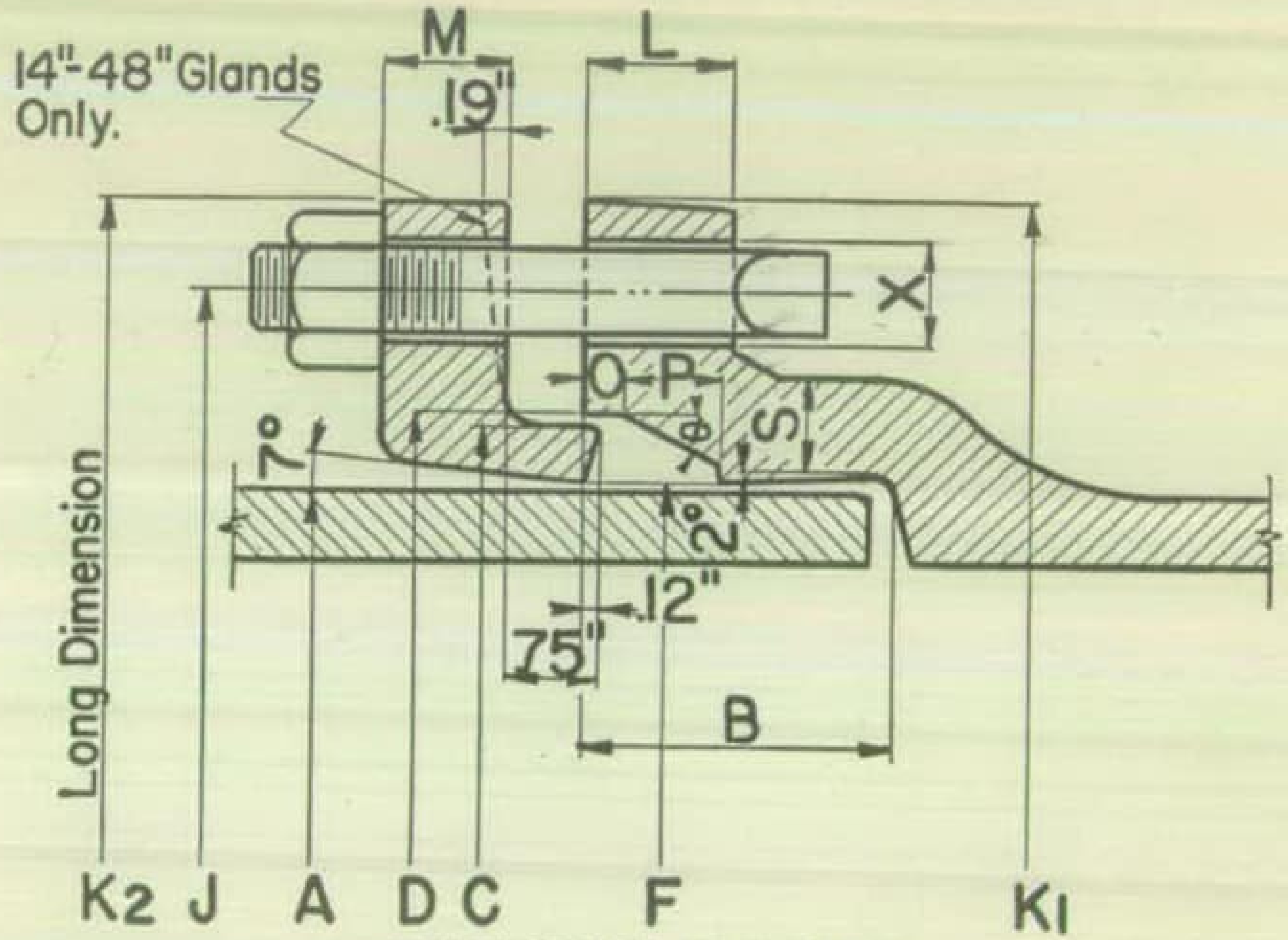
The above torque loads may be applied with torque measuring or indicating wrenches. Torque wrenches may be used to check the application of approximate torque loads applied by men trained to give an average pull on a definite length of regular socket wrench. The following lengths of wrenches should satisfactorily produce the above ranges of torques when used by the average man:

| Size, Inches | Length of Wrench, Inches |
|---|---|
| 5/8 | 8 |
| 3/4 | 10 |
| 1 | 12 |
| 1 1/4 | 14 |

When tightening bolts, it is essential that the gland be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This may be done by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side, and last, the remaining bolts. Repeat this cycle until all bolts are within the above range of torques. If effective sealing is not attained at the maximum torque indicated above, the joint should be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation practice is to be avoided.

SECTION 11–4A

3″–48″ STD. MECHANICAL JOINT DIMENSIONS




DIMENSIONS IN INCHES

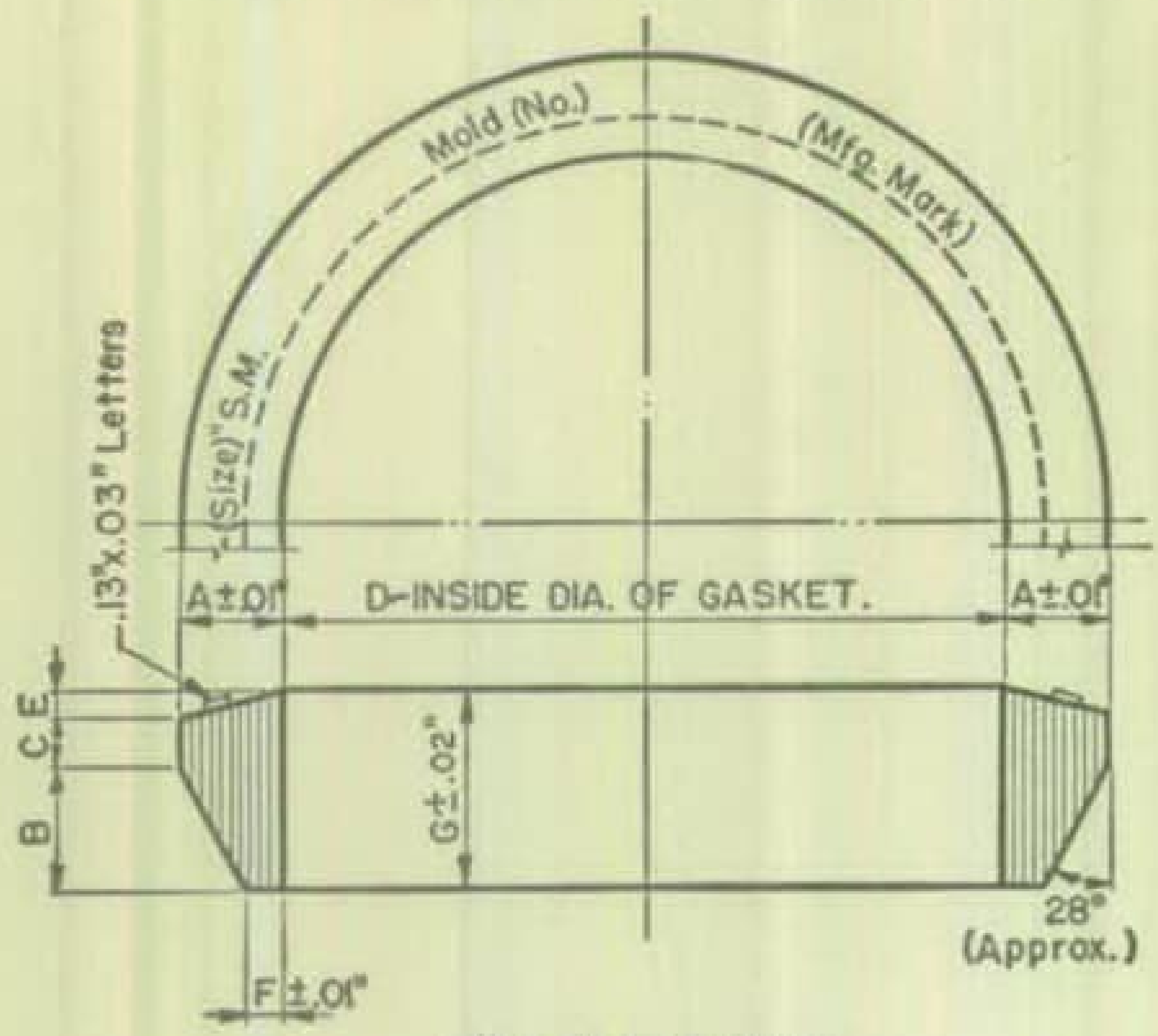
NOTES:

1. The thickness of the bell, S, shall in all cases be equal to and generally exceeds by at least 10% the nominal wall thickness of the pipe or fitting of which it is a part.
2. Cored holes may be tapered an additional 0.06″ in diameter.
3. In case of ovalness of the spigot O.D., the mean diameter measured by a circumferential tape shall not be less than the minimum diameter shown in the table. The minor axis shall not be less than the above minimum diameter plus an additional minus tolerance of .04″ for sizes 8″ through 12″, and .07″ for sizes 14″ through 24″.
4. $K_2$ is O.D. of glands across bolt holes, outside of gland may be polygon shape.
5. Dimensions of 30″—48″ sizes are tentative.

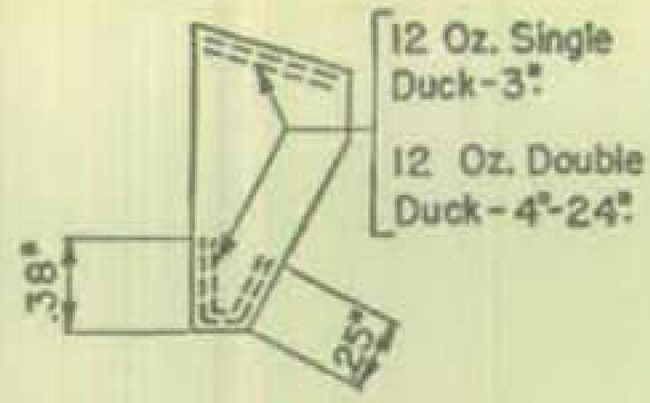
DIMENSIONS IN INCHES

| SIZE | A | B | C | D | F | φ | X | J | K₁ Cent. Pipe | K₁ Pit Cast Pipe and Fittings | K₂ | L | M | O | P | S Cent. Pipe | S Pit Cast Pipe and Fittings | BOLTS No. | BOLTS Size | BOLTS Lgth. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | ±.06 3.96 | 2.50 | ±.04 4.84 | +.06 −.04 4.94 | +.07 −.03 4.06 | 28° | +.06 −.0 ¾ | ±.06 6.19 | −.06 7.62 | −.12 7.69 | −.12 7.69 | −.06 .94 | −.06 .62 | .31 | .63 | −.05 .47 | −.10 .52 | 4 | ⅝ | 3 |
| 4 | ±.06 4.80 | 2.50 | ±.04 5.92 | +.06 −.04 6.02 | +.07 −.03 4.90 | 28° | +.06 −.0 ⅞ | ±.06 7.50 | −.06 9.06 | −.12 9.12 | −.12 9.12 | −.06 1.00 | −.06 .75 | .31 | .75 | −.05 .55 | −.10 .65 | 4 | ¾ | 3½ |
| 6 | ±.06 6.90 | 2.50 | ±.04 8.02 | +.06 −.04 8.12 | +.07 −.03 7.00 | 28° | +.06 −.0 ⅞ | ±.06 9.50 | −.06 11.06 | −.12 11.12 | −.12 11.12 | −.06 1.06 | −.06 .88 | .31 | .75 | −.05 .60 | −.10 .70 | 6 | ¾ | 3½ |
| 8 | ±.06 9.05 | 2.50 | ±.04 10.17 | +.06 −.04 10.27 | +.07 −.03 9.15 | 28° | +.06 −.0 ⅞ | ±.06 11.75 | −.06 13.31 | −.12 13.37 | −.12 13.37 | −.08 1.12 | −.08 1.00 | .31 | .75 | −.05 .66 | −.12 .75 | 6 | ¾ | 4 |
| 10 | ±.06 11.10 | 2.50 | +.06 −.04 12.22 | +.06 −.04 12.34 | +.07 −.03 11.20 | 28° | +.06 −.0 ⅞ | ±.06 14.00 | −.06 15.62 | −.12 15.69 | −.12 15.62 | −.08 1.19 | −.08 1.00 | .31 | .75 | −.06 .72 | −.12 .80 | 8 | ¾ | 4 |
| 12 | ±.06 13.20 | 2.50 | +.06 −.04 14.32 | +.06 −.04 14.44 | +.07 −.03 13.30 | 28° | +.06 −.0 ⅞ | ±.06 16.25 | −.06 17.88 | −.12 17.94 | −.12 17.88 | −.08 1.25 | −.08 1.00 | .31 | .75 | −.06 .79 | −.12 .85 | 8 | ¾ | 4 |
| 14 | +.05 −.08 15.30 | 3.50 | +.07 −.05 16.40 | +.07 −.05 16.54 | +.06 −.07 15.44 | 28° | +.06 −.0 ⅞ | ±.06 18.75 | −.08 20.25 | −.12 20.31 | −.12 20.25 | −.12 1.31 | −.12 1.25 | .31 | .75 | −.08 .85 | −.12 .89 | 10 | ¾ | 4 |
| 16 | +.05 −.08 17.40 | 3.50 | +.07 −.05 18.50 | +.07 −.05 18.64 | +.06 −.07 17.54 | 28° | +.06 −.0 ⅞ | ±.06 21.00 | −.08 22.50 | −.12 22.56 | −.12 22.50 | −.12 1.38 | −.12 1.31 | .31 | .75 | −.08 .91 | −.12 .97 | 12 | ¾ | 4½ |
| 18 | +.05 −.08 19.50 | 3.50 | +.07 −.05 20.60 | +.07 −.05 20.74 | +.06 −.07 19.64 | 28° | +.06 −.0 ⅞ | ±.06 23.25 | −.08 24.75 | −.15 24.83 | −.15 24.75 | −.12 1.44 | −.12 1.38 | .31 | .75 | −.08 .97 | −.15 1.05 | 12 | ¾ | 4½ |
| 20 | +.05 −.08 21.60 | 3.50 | +.07 −.05 22.70 | +.07 −.05 22.84 | +.06 −.07 21.74 | 28° | +.06 −.0 ⅞ | ±.06 25.50 | −.08 27.00 | −.15 27.08 | −.15 27.00 | −.12 1.50 | −.12 1.44 | .31 | .75 | −.08 1.03 | −.15 1.12 | 14 | ¾ | 4½ |
| 24 | +.05 −.08 25.80 | 3.50 | +.07 −.05 26.90 | +.07 −.05 27.04 | +.06 −.07 25.94 | 28° | +.06 −.0 ⅞ | ±.06 30.00 | −.08 31.50 | −.15 31.58 | −.15 31.50 | −.12 1.62 | −.12 1.56 | .31 | .75 | −.08 1.08 | −.15 1.22 | 16 | ¾ | 5 |
| 30 | 32.00 | 4.00 | 33.29 | 33.46 | 32.17 | 20° | 1⅛ | 36.88 | 39.12 | 39.12 | 39.12 | 1.81 | 2.00 | .38 | 1.00 | 1.20 | 1.50 | 20 | 1 | 5½ |
| 36 | 38.30 | 4.00 | 39.59 | 39.76 | 38.47 | 20° | 1⅛ | 43.75 | 46.00 | 46.00 | 46.00 | 2.00 | 2.00 | .38 | 1.00 | 1.35 | 1.80 | 24 | 1 | 5½ |
| 42 | 44.50 | 4.00 | 45.79 | 45.96 | 44.67 | 20° | 1¼ | 50.62 | 53.12 | 53.12 | 53.12 | 2.00 | 2.00 | .38 | 1.00 | 1.48 | 1.95 | 28 | 1¼ | 6 |
| 48 | 50.80 | 4.00 | 52.09 | 52.26 | 50.97 | 20° | 1⅜ | 57.50 | 60.00 | 60.00 | 60.00 | 2.00 | 2.00 | .38 | 1.00 | 1.61 | 2.20 | 32 | 1¼ | 6 |

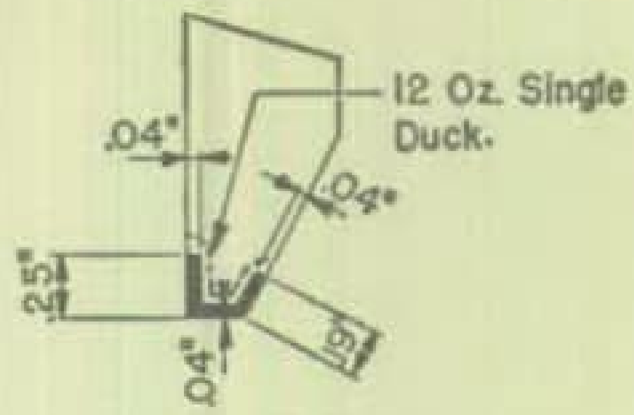
# SECTION 11-4B
## 3"–24" MECHANICAL JOINT GASKETS



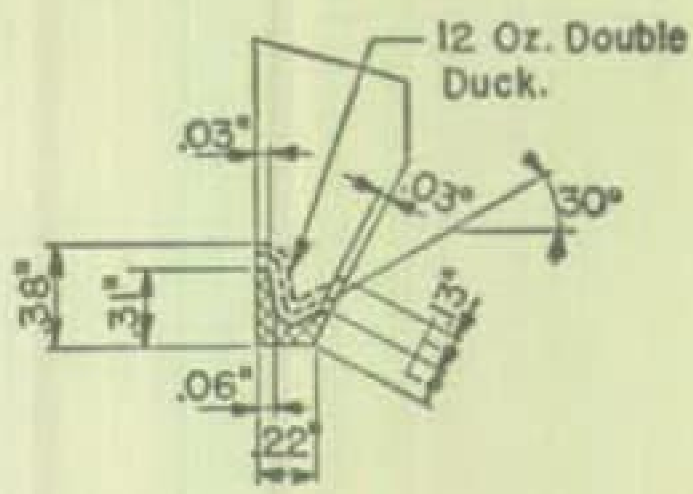

3"-24" GASKETS



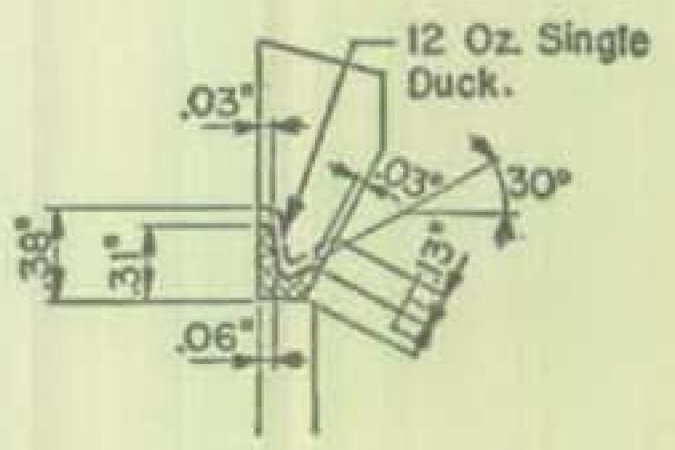

DUCK BACK or TIP-ALL SIZES




THIOKOL TIP-ALL SIZES




4"-24"-LEAD TIP




3"-LEAD TIP

CHART OF SIZES (in Inches)

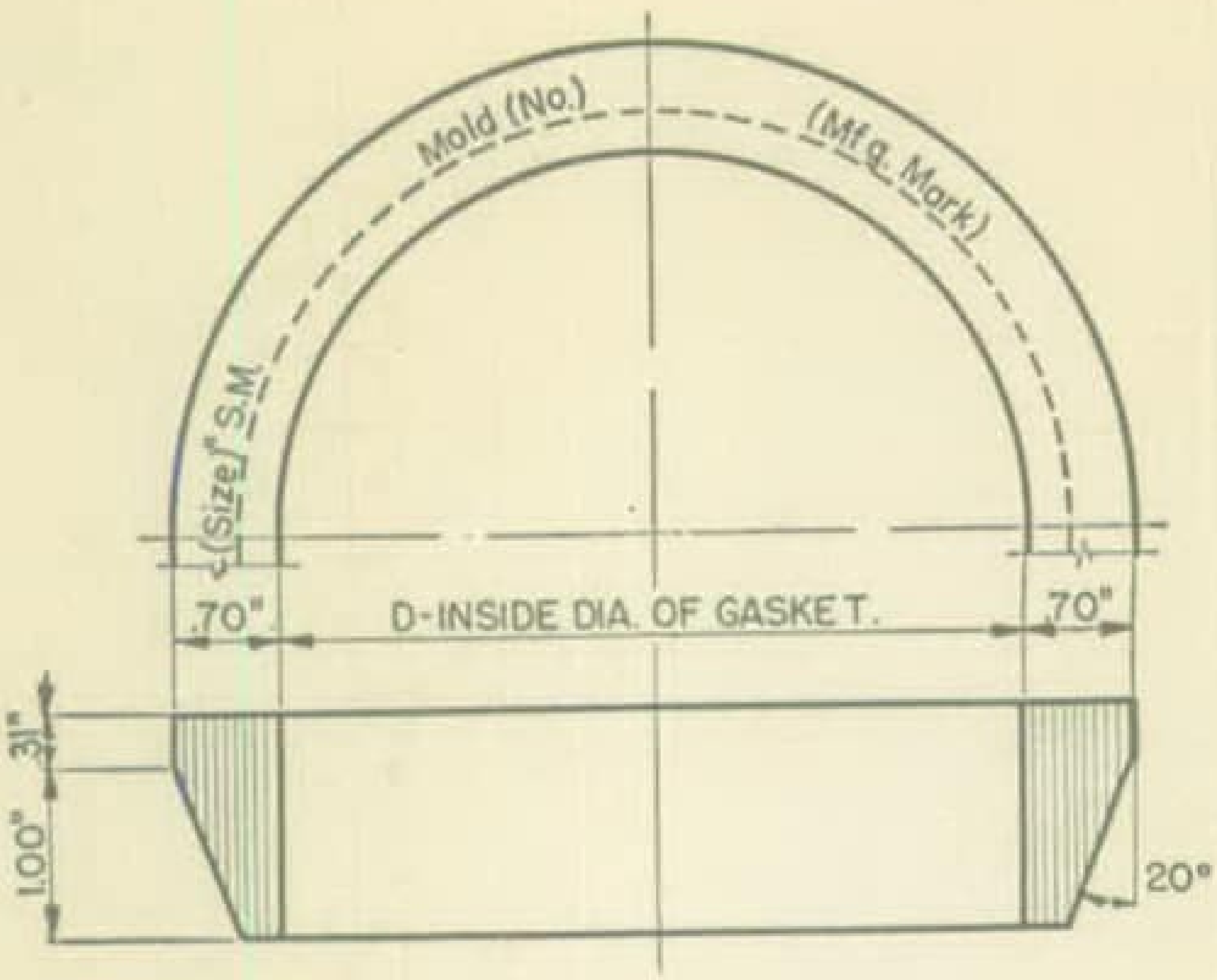
| Pipe Size | O.D. of Pipe | Dimensions of Plain Rubber Gaskets | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A ±.01" | B | C | D +0−1% | E | F ±.01" | G ±.02" |
| 3 | 3.96 | .48 | .62 | .31 | 3.90 | .12 | .15 | 1.05 |
| 4 | 4.80 | .62 | .75 | .31 | 4.73 | .16 | .22 | 1.22 |
| 6 | 6.90 | .62 | .75 | .31 | 6.80 | .16 | .22 | 1.22 |
| 8 | 9.05 | .62 | .75 | .31 | 8.91 | .16 | .22 | 1.22 |
| 10 | 11.10 | .62 | .75 | .31 | 10.93 | .16 | .22 | 1.22 |
| 12 | 13.20 | .62 | .75 | .31 | 13.00 | .16 | .22 | 1.22 |
| 14 | 15.30 | .62 | .75 | .31 | 15.07 | .16 | .22 | 1.22 |
| 16 | 17.40 | .62 | .75 | .31 | 17.14 | .16 | .22 | 1.22 |
| 18 | 19.50 | .62 | .75 | .31 | 19.21 | .16 | .22 | 1.22 |
| 20 | 21.60 | .62 | .75 | .31 | 21.28 | .16 | .22 | 1.22 |
| 24 | 25.80 | .62 | .75 | .31 | 25.41 | .16 | .22 | 1.22 |

NOTE:

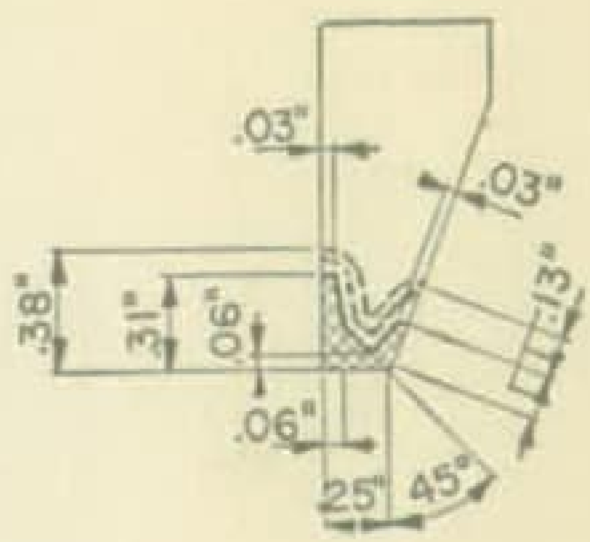
Duck backing can be omitted from lead tipped gaskets provided sufficient bonding of the lead to the rubber is obtained.

Tipped or backed gaskets may be made in the same mold as plain rubber gaskets but the inside diameter of such reinforced portions shall not exceed the "O.D. of Pipe."

## SECTION 11–4B
## 30″–48″ STD. MECHANICAL JOINT GASKETS




30"-48" GASKETS




LEAD TIP

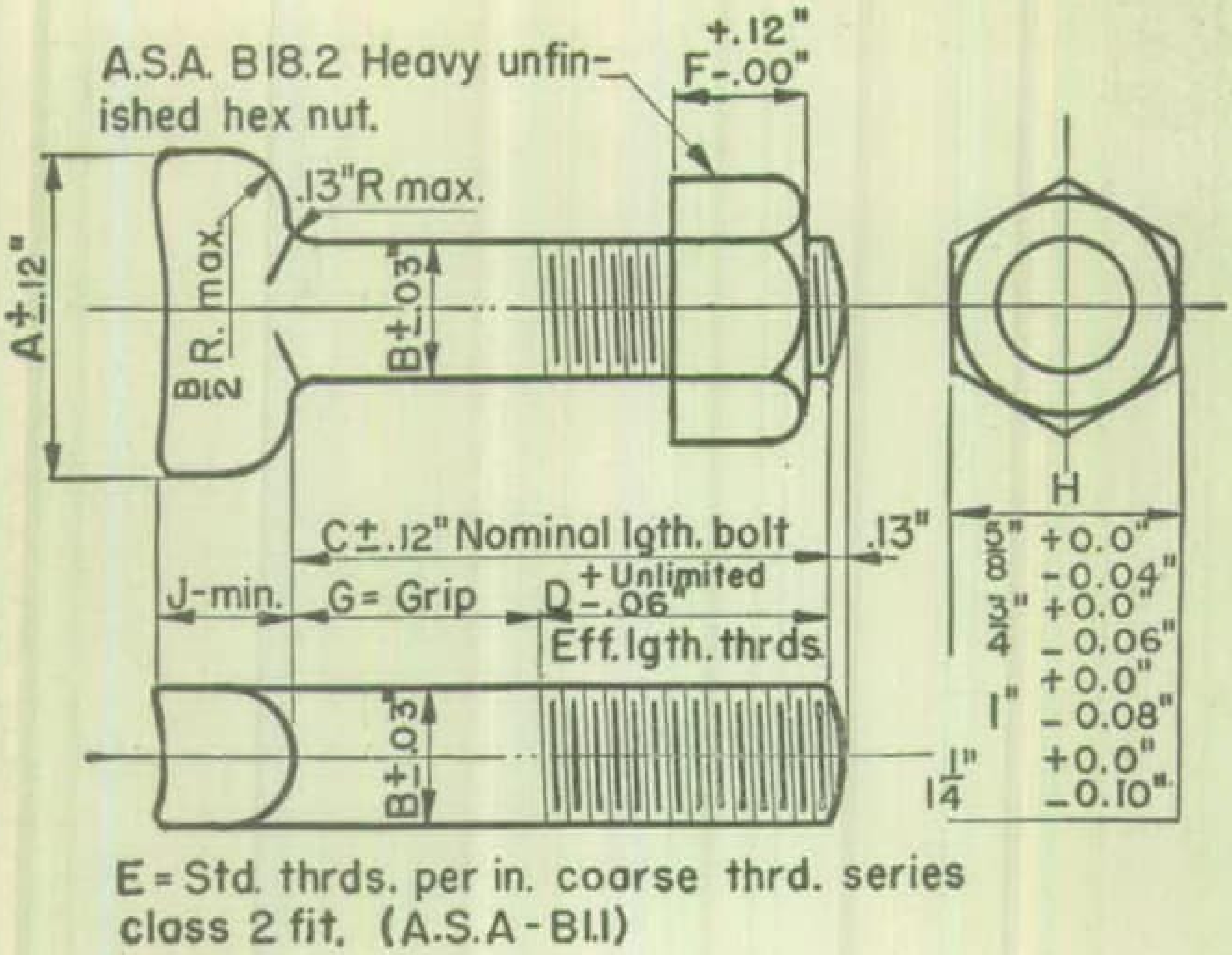
**DIMENSIONS IN INCHES**

| Pipe Size | Pipe O.D. | D |
|---|---|---|
| 30 | 32.00 | 31.50 |
| 36 | 38.30 | 37.62 |
| 42 | 44.50 | 43.67 |
| 48 | 50.80 | 49.80 |

*NOTE: Dimensions of 30″–48″ sizes are tentative.*

## SECTION 11–4C

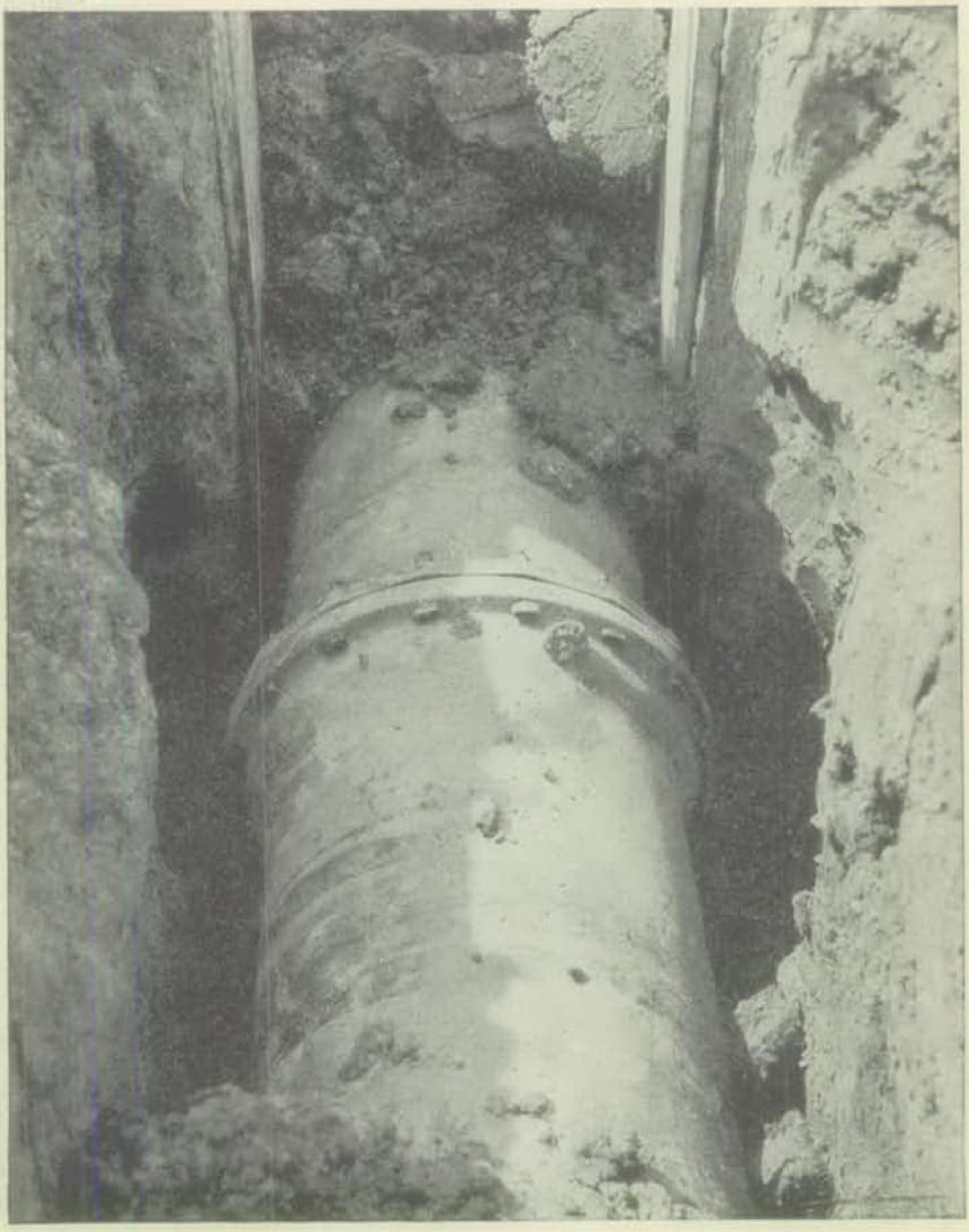
## MECHANICAL JOINT BOLTS AND NUTS




| Nom. Size | A | B | C | D | E | F | G | H | J | Wt.-Lbs./ 100 Bolts & Nuts |
|---|---|---|---|---|---|---|---|---|---|---|
| ⅝ x 3 | 1.50 | .625 | 3.00 | 1.50 | 11 | .625 | 1.50 | 1.062 | .625 | 47 |
| ¾ x 3½ | 1.75 | .75 | 3.50 | 2.00 | 10 | .75 | 1.50 | 1.25 | .75 | 77 |
| ¾ x 4 | 1.75 | .75 | 4.00 | 2.00 | 10 | .75 | 2.00 | 1.25 | .75 | 82 |
| ¾ x 4½ | 1.75 | .75 | 4.50 | 2.00 | 10 | .75 | 2.50 | 1.25 | .75 | 87 |
| ¾ x 5 | 1.75 | .75 | 5.00 | 2.00 | 10 | .75 | 3.00 | 1.25 | .75 | 93 |
| 1 x 5½ | 2.25 | 1.00 | 5.50 | 2.50 | 8 | 1.00 | 3.00 | 1.625 | 1.00 | 192 |
| 1¼ x 6 | 2.50 | 1.25 | 6.00 | 2.50 | 7 | 1.25 | 3.50 | 2.00 | 1.25 | 334 |

# SECTION 10

## Mechanical Joint Cast Iron Pipe and Fittings for Gas and Water Service



# SECTION 10

## Mechanical Joint Cast Iron Pipe and Fittings for Gas and Water Service

MECHANICAL joint cast iron pipe was developed in the early 1920's primarily to meet the needs of the Gas Industry occasioned by the growing use of dry, natural and mixed gas distributed under low, intermediate, or high pressures. However, it soon commended itself to water works engineers because of its tight joints and time-saving advantages in installation.

### A TIME-TRIED PRINCIPLE

The mechanical joint is an adaption of the stuffing-box principle. It consists of a *socket*, or special bell, provided with a flange cast integral with it; a cast iron *gland*, or follower ring; a rubber gasket, and necessary bolts and nuts. (See cross-sectional drawing.)

The stuffing-box principle is long-established and well known to the engineering profession. Its invention is credited to an Englishman, Samuel Moreland, who obtained in 1675 a patent on a plunger pump incorporating a gland and stuffing-box through which the plunger operated.

The rubber gasket also has a successful history. Rubber ring joints have been used in Europe for upwards of a century. Thorough-going tests by an English engineer proved the utility and durability of rubber as a jointing material for underground mains. These tests demonstrated that, when a rubber ring is sealed in a joint, its life is rendered indefinitely long because the rubber is compressed in a space free from air, not exposed to light, and relatively cool, and consequently, not subject to deterioration. Present-day mechanical joints are so designed as to expose little or none of the rubber gasket to the gas or water being carried in the line.

### ADVANTAGES ARE MANY

Mechanical joint cast iron pipe offers many advantages in addition to providing a bottle-tight joint for all working pressures. It permits considerable deflection as well as longitudinal expansion and contraction in line without causing leakage. It is a time-saver: The joint assembly is simple, rapid and practically fool-proof. It does not require a skilled crew. An ordinary ratchet wrench is the only tool required.

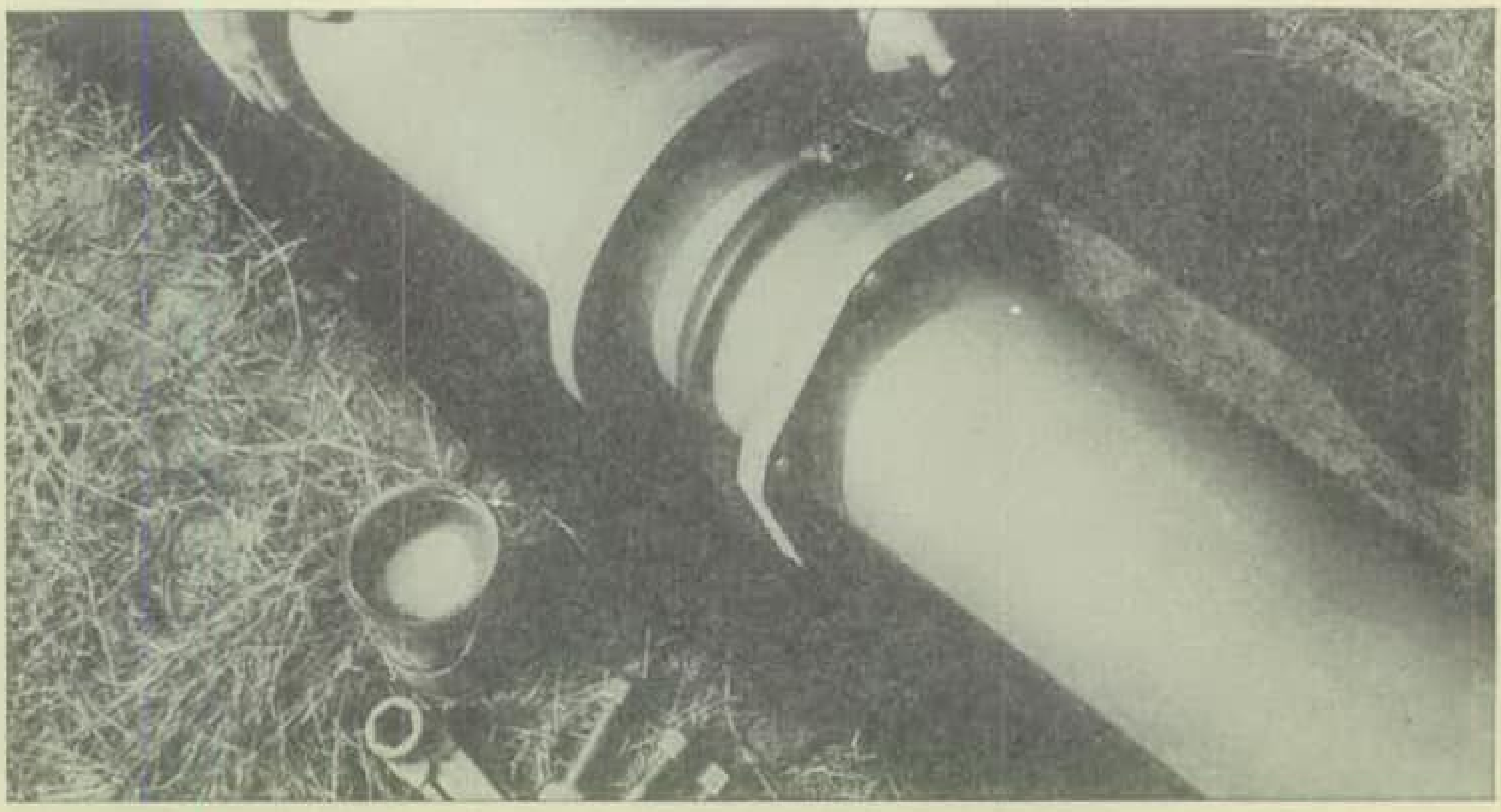
In the event of a flooded trench, an important advantage of the mechanical joint is that the pipe can be jointed on the bank in sections and lowered into the trench, saving costly delays.

### HOW TO ASSEMBLE THE JOINT

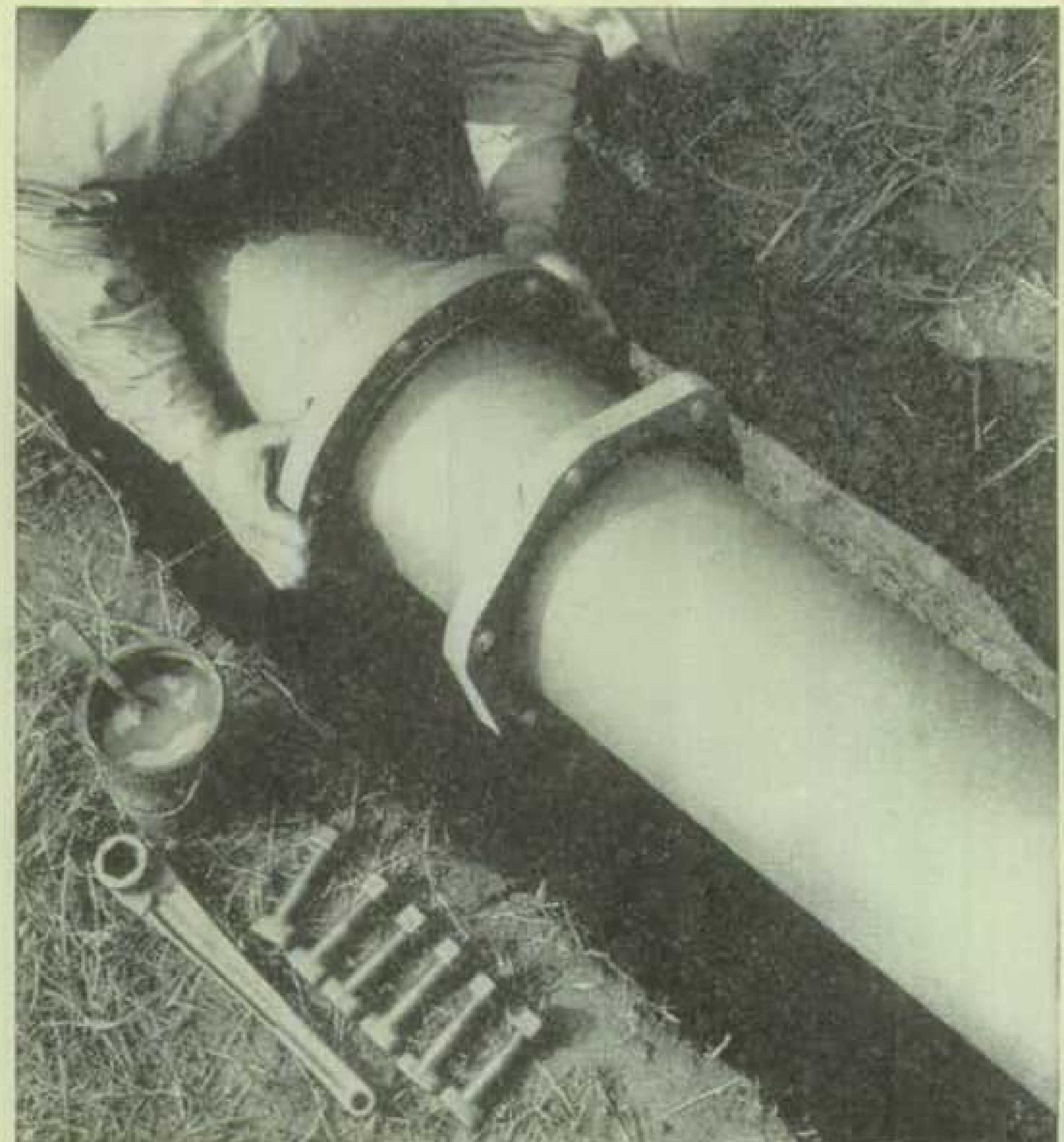
Assembling the mechanical joint is simplicity itself (see cuts). The gland, followed by the rubber gasket, is placed over the plain end of the pipe which is inserted into the socket. The gasket is then pushed into position so that it is evenly seated in the socket. The gland is moved into position against the face of the gasket. Bolts are inserted and made finger-tight. Then, with an ordinary ratchet wrench, the bolts are tightened up, and the joint is completed.

### STANDARDIZATION AND INTERCHANGEABILITY

Standardization added the final touch of convenience, economy and simplicity to mechanical joint cast iron pipe. Its chief advantage is *complete interchangeability* with respect to pipe, fittings, glands, gaskets and bolts furnished by all manufacturers of mechanical joint cast iron pipe. This makes it unnecessary to stock parts for each make of pipe purchased, and removes the risk of delays on jobs through delivery of wrong parts. The standardized mechanical joint incorporates the best features of the various designs previously made by members of the Cast Iron Pipe Research Association. (See A.S.A. A21.11 for complete specifications for mechanical joint.)



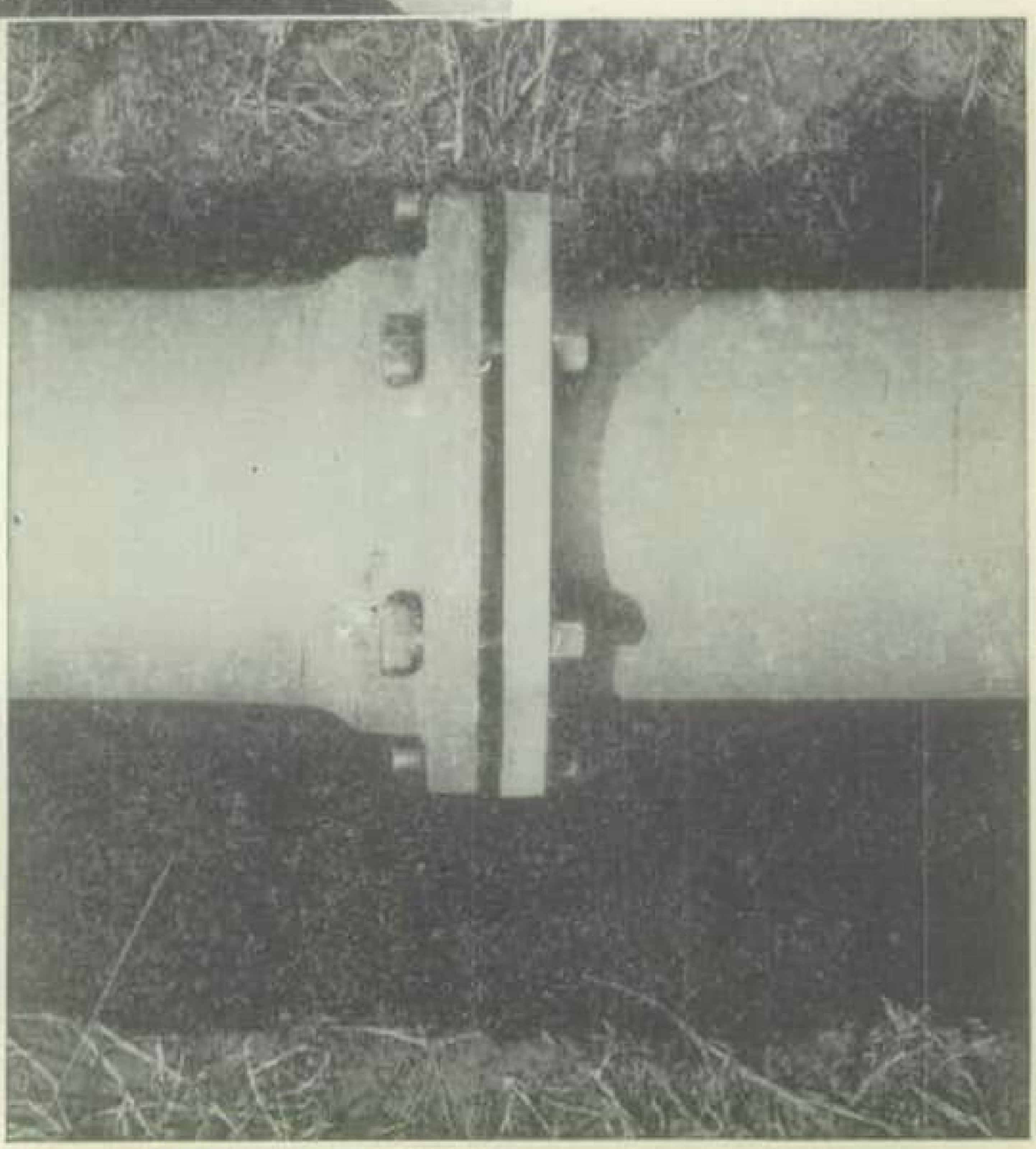
*Wash socket and plain end with soapy water, then slip gland and gasket over plain end. Small side of gasket and lip side of gland, face the socket. Paint gasket with soapy water.*



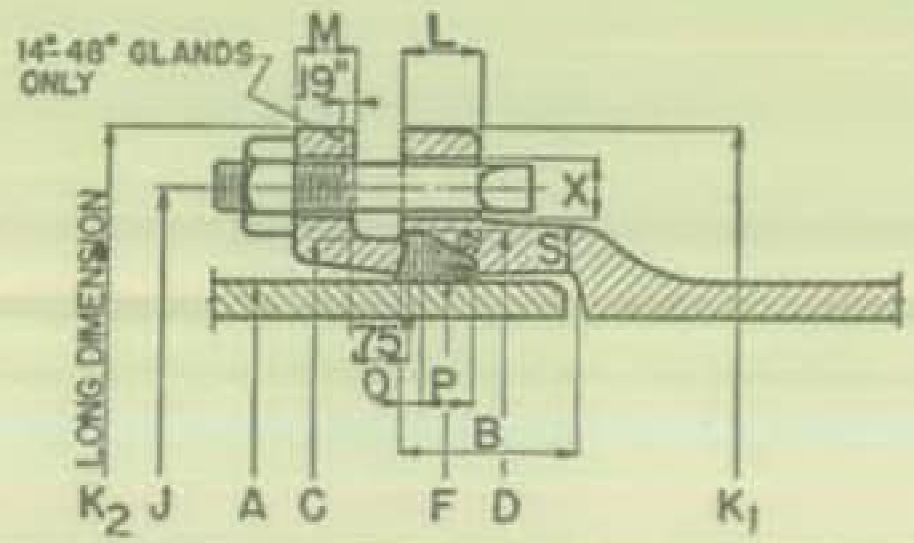
*Insert plain end into socket. Push gasket into position with fingers, making sure it is evenly seated.*

*Slide gland into position, insert bolts and tighten nuts by hand.*

With ordinary ratchet wrench, tighten up bolts alternately (bottom, then top, and so on, all around).



The completed standardized mechanical joint — bottle-tight under all working pressures, flexible, time-saving.




# Dimensions

## *of mechanical joint cast iron pipe and fittings*

DIMENSIONS IN INCHES

| Size | A | B | C | D | F | φ | X | J | K1 | | K2 | L | M | O | P | S | | Bolts | | | ★ Weight of Bell, lb. | | Weight of Gland, Bolts and Gasket, lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Cent. Pipe | Pit Cast Pipe and Fittings | | | | | | Cent. Pipe | Pit Cast Pipe and Fittings | No. | Size | Lgth. | Cent. Pipe | Pit Cast Pipe and Fittings | |
| 3 | ±.06 3.96 | 2.50 | ±.04 4.84 | +.06 −.04 4.94 | +.07 −.03 4.06 | 28° | +.06 −.0 ¾ | ±.06 6.19 | −.06 7.62 | −.12 7.69 | −.12 7.69 | −.06 .94 | −.05 .62 | .31 | .63 | −.05 .47 | −.10 .52 | 4 | ⅝ | 3 | 11 | 11 | 7 |
| 4 | ±.06 4.80 | 2.50 | ±.04 5.92 | +.06 −.04 6.02 | +.07 −.03 4.90 | 28° | +.06 −.0 ⅞ | ±.06 7.50 | −.06 9.06 | −.12 9.12 | −.12 9.12 | −.06 1.00 | −.06 .75 | .31 | .75 | −.05 .55 | −.10 .65 | 4 | ¾ | 3½ | 16 | 16 | 10 |
| 6 | ±.06 6.90 | 2.50 | ±.04 8.02 | +.06 −.04 8.12 | +.07 −.03 7.00 | 28° | +.06 −.0 ⅞ | ±.06 9.50 | −.06 11.06 | −.12 11.12 | −.12 11.12 | −.06 1.06 | −.06 .88 | .31 | .75 | −.05 .60 | −.10 .70 | 6 | ¾ | 3½ | 22 | 23 | 16 |
| 8 | ±.06 9.05 | 2.50 | ±.04 10.17 | +.06 −.04 10.27 | +.07 −.03 9.15 | 28° | +.06 −.0 ⅞ | ±.06 11.75 | −.06 13.31 | −.12 13.37 | −.12 13.37 | −.08 1.12 | −.08 1.00 | .31 | .75 | −.05 .66 | −.12 .75 | 6 | ¾ | 4 | 30 | 31 | 25 |
| 10 | ±.06 11.10 | 2.50 | +.06 −.04 12.22 | +.06 −.04 12.34 | +.07 −.03 11.20 | 28° | +.06 −.0 ⅞ | ±.06 14.00 | −.06 15.62 | −.12 15.69 | −.12 15.62 | −.08 1.19 | −.08 1.00 | .31 | .75 | −.06 .72 | −.12 .80 | 8 | ¾ | 4 | 40 | 41 | 30 |
| 12 | ±.06 13.20 | 2.50 | +.06 −.04 14.32 | +.06 −.04 14.44 | +.07 −.03 13.30 | 28° | +.06 −.0 ⅞ | ±.06 16.25 | −.06 17.88 | −.12 17.94 | −.12 17.88 | −.08 1.25 | −.08 1.00 | .31 | .75 | −.06 .79 | −.12 .85 | 8 | ¾ | 4 | 50 | 51 | 40 |
| 14 | +.05 −.08 15.30 | 3.50 | +.07 −.05 16.40 | +.07 −.05 16.54 | +.06 −.07 15.44 | 28° | +.06 −.0 ⅞ | ±.06 18.75 | −.08 20.25 | −.12 20.31 | −.12 20.25 | −.12 1.31 | −.12 1.25 | .31 | .75 | −.08 .85 | −.12 .89 | 10 | ¾ | 4 | 78 | 79 | 45 |
| 16 | +.05 −.08 17.40 | 3.50 | +.07 −.05 18.50 | +.07 −.05 18.64 | +.06 −.07 17.54 | 28° | +.06 −.0 ⅞ | ±.06 21.00 | −.08 22.50 | −.12 22.56 | −.12 22.50 | −.12 1.38 | −.12 1.31 | .31 | .75 | −.08 .91 | −.12 .97 | 12 | ¾ | 4½ | 95 | 97 | 55 |
| 18 | +.05 −.08 19.50 | 3.50 | +.07 −.05 20.60 | +.07 −.05 20.74 | +.06 −.07 19.64 | 28° | +.06 −.0 ⅞ | ±.06 23.25 | −.08 24.75 | −.15 24.83 | −.15 24.75 | −.12 1.44 | −.12 1.38 | .31 | .75 | −.08 .97 | −.15 1.05 | 12 | ¾ | 4½ | 113 | 117 | 65 |
| 20 | +.05 −.08 21.60 | 3.50 | +.07 −.05 22.70 | +.07 −.05 22.84 | +.06 −.07 21.74 | 28° | +.06 −.0 ⅞ | ±.06 25.50 | −.08 27.00 | −.15 27.08 | −.15 27.00 | −.12 1.50 | −.12 1.44 | .31 | .75 | −.08 1.03 | −.15 1.12 | 14 | ¾ | 4½ | 134 | 140 | 85 |
| 24 | +.05 −.08 25.80 | 3.50 | +.07 −.05 26.90 | +.07 −.05 27.04 | +.06 −.07 25.94 | 28° | +.06 −.0 ⅞ | ±.06 30.00 | −.08 31.50 | −.15 31.58 | −.15 31.50 | −.12 1.62 | −.12 1.56 | .31 | .75 | −.08 1.08 | −.15 1.22 | 16 | ¾ | 5 | 177 | 185 | 105 |
| 30 | 32.00 | 4.00 | 33.29 | 33.46 | 32.17 | 20° | 1⅛ | 36.88 | 39.12 | 39.12 | 39.12 | 1.81 | 2.00 | .38 | 1.00 | 1.20 | 1.50 | 20 | 1 | 5½ | 285 | 315 | 220 |
| 36 | 38.30 | 4.00 | 39.59 | 39.76 | 38.47 | 20° | 1⅛ | 43.75 | 46.00 | 46.00 | 46.00 | 2.00 | 2.00 | .38 | 1.00 | 1.35 | 1.80 | 24 | 1 | 5½ | 395 | 445 | 285 |
| 42 | 44.50 | 4.00 | 45.79 | 45.96 | 44.67 | 20° | 1⅜ | 50.62 | 53.12 | 53.12 | 53.12 | 2.00 | 2.00 | .38 | 1.00 | 1.48 | 1.95 | 28 | 1¼ | 6 | 510 | 570 | 400 |
| 48 | 50.80 | 4.00 | 52.09 | 52.26 | 50.97 | 20° | 1⅜ | 57.50 | 60.00 | 60.00 | 60.00 | 2.00 | 2.00 | .38 | 1.00 | 1.61 | 2.20 | 32 | 1¼ | 6 | 645 | 725 | 475 |

NOTES: 1. Cored holes may be tapered an additional 0.06" in diameter. . . . 2. In case of ovalness of the spigot O. D., the mean diameter measured by a circumferential tape shall not be less than the minimum diameter shown in the table. The minor axis shall not be less than the above minimum diameter plus an additional minus tolerance of .04" for sizes 8" through 12", and .07" for sizes 14" through 24". . . . 3. K2 is O. D. of glands across bolt holes, outside of gland may be polygon shape. . . . 4. Dimensions of 30"—48" sizes are tentative, consult the manufacturer. . . . 5. This joint conforms to A.S.A. Specification A-21.11.

★Weights not part of specifications—for information only.

# WEIGHTS OF MECHANICAL JOINT PIPE FOR WATER

## STANDARD THICKNESSES AND WEIGHTS OF CAST IRON MECHANICAL JOINT PIPE CENTRIFUGALLY CAST IN METAL AND SAND LINED MOLDS FOR WATER AND OTHER LIQUIDS

Note: Thicknesses in accordance with A.S.A. Specifications, 18,000 psi full length bursting tensile, 40,000 psi ring modulus of rupture. For pipe laid without blocks on flat bottom trench with tamped backfill under 5 feet of cover. For other conditions consult the manufacturer.

| Size ins. | Thickness ins. | Outside Diam. ins. | Weight Based On: 12 ft. Lgth.* Avg. per ft. | 12 ft. Lgth.* per Lgth. | 16 ft. Lgth.* Avg. per ft. | 16 ft. Lgth.* per Lgth. | 16½ ft. Lgth.* Avg. per ft. | 16½ ft. Lgth.* per Lgth. | 18 ft. Lgth.* Avg. per ft. | 18 ft. Lgth.* per Lgth. | 20 ft. Lgth.* Avg. per ft. | 20 ft. Lgth.* per Lgth. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class 50—50 Lb. Pressure—115 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 14 | .48 | 15.30 | 76.2 | 915 | 74.6 | 1195 | 74.4 | 1230 | 74.1 | 1335 | 73.6 | 1470 |
| 16 | .54 | 17.40 | 97.1 | 1165 | 95.0 | 1520 | 94.9 | 1565 | 94.5 | 1700 | 94.0 | 1880 |
| 18 | .54 | 19.50 | 109.8 | 1320 | 107.5 | 1720 | 107.2 | 1770 | 106.7 | 1920 | 106.0 | 2120 |
| 20 | .57 | 21.60 | 128.7 | 1545 | 125.9 | 2015 | 125.7 | 2075 | 124.9 | 2250 | 124.2 | 2485 |
| 24 | .63 | 25.80 | 170.2 | 2040 | 166.5 | 2665 | 166.1 | 2740 | 165.2 | 2975 | 164.2 | 3285 |
| 30 | .79 | 32.00 | | | 259.5 | 4150 | 259.0 | 4275 | | | 256.0 | 5120 |
| 36 | .87 | 38.30 | | | 343.9 | 5500 | | | | | | |
| 42 | .97 | 44.50 | | | 445.7 | 7130 | | | | | | |
| 48 | 1.06 | 50.80 | | | 557.1 | 8915 | | | | | | |
| Class 100—100 Lb. Pressure—231 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 14 | .51 | 15.30 | 80.4 | 965 | 78.8 | 1260 | 78.6 | 1295 | 78.2 | 1410 | 77.8 | 1555 |
| 16 | .54 | 17.40 | 97.1 | 1165 | 95.0 | 1520 | 94.9 | 1565 | 94.5 | 1700 | 94.0 | 1880 |
| 18 | .58 | 19.50 | 117.0 | 1405 | 114.7 | 1835 | 114.4 | 1890 | 113.9 | 2050 | 113.2 | 2265 |
| 20 | .62 | 21.60 | 138.7 | 1665 | 135.9 | 2175 | 135.7 | 2240 | 134.9 | 2430 | 134.2 | 2685 |
| 24 | .68 | 25.80 | 182.2 | 2185 | 178.5 | 2855 | 178.1 | 2940 | 177.2 | 3190 | 176.2 | 3525 |
| 30 | .79 | 32.00 | | | 259.5 | 4150 | 259.0 | 4275 | | | 256.0 | 5120 |
| 36 | .87 | 38.30 | | | 343.9 | 5500 | | | | | | |
| 42 | .97 | 44.50 | | | 445.7 | 7130 | | | | | | |
| 48 | 1.06 | 50.80 | | | 557.1 | 8915 | | | | | | |
| Class 150—150 Lb. Pressure—346 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 14 | .51 | 15.30 | 80.4 | 965 | 78.8 | 1260 | 78.6 | 1295 | 78.2 | 1410 | 77.8 | 1555 |
| 16 | .54 | 17.40 | 97.1 | 1165 | 95.0 | 1520 | 94.9 | 1565 | 94.5 | 1700 | 94.0 | 1880 |
| 18 | .58 | 19.50 | 117.0 | 1405 | 114.7 | 1835 | 114.4 | 1890 | 113.9 | 2050 | 113.2 | 2265 |
| 20 | .62 | 21.60 | 138.7 | 1665 | 135.9 | 2175 | 135.7 | 2240 | 134.9 | 2430 | 134.2 | 2685 |
| 24 | .73 | 25.80 | 194.2 | 2330 | 190.4 | 3045 | 190.1 | 3135 | 189.2 | 3405 | 188.2 | 3765 |
| 30 | .85 | 32.00 | | | 277.3 | 4435 | 276.8 | 4565 | | | 273.8 | 5475 |
| 36 | .94 | 38.30 | | | 368.9 | 5900 | | | | | | |
| 42 | 1.05 | 44.50 | | | 479.1 | 7665 | | | | | | |
| 48 | 1.14 | 50.80 | | | 595.2 | 9525 | | | | | | |

* Including Bell. Calculated weight of pipe rounded off to nearest 5 pounds.

References: A.S.A.—A-21.6—pipes cast in metal molds. A.S.A.—A-21.8—pipe cast in sand lined molds. A.S.A.—21.11—mechanical joints.

## WEIGHTS OF MECHANICAL JOINT PIPE FOR WATER (Continued)

| Size ins. | Thickness ins. | Outside Diam. ins. | Weight Based On: 12 ft. Lgth.* Avg. per ft. | 12 ft. Lgth.* per Lgth. | 16 ft. Lgth.* Avg. per ft. | 16 ft. Lgth.* per Lgth. | 16½ ft. Lgth.* Avg. per ft. | 16½ ft. Lgth.* per Lgth. | 18 ft. Lgth.* Avg. per ft. | 18 ft. Lgth.* per Lgth. | 20 ft. Lgth.* Avg. per ft. | 20 ft. Lgth.* per Lgth. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class 200—200 Lb. Pressure—462 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 14 | .55 | 15.30 | 86.0 | 1030 | 84.4 | 1350 | 84.2 | 1390 | 83.8 | 1510 | 83.4 | 1670 |
| 16 | .58 | 17.40 | 103.5 | 1240 | 101.5 | 1625 | 101.3 | 1670 | 100.9 | 1815 | 100.3 | 2005 |
| 18 | .63 | 19.50 | 125.9 | 1510 | 123.5 | 1975 | 123.3 | 2035 | 122.8 | 2210 | 122.2 | 2445 |
| 20 | .67 | 21.60 | 148.7 | 1785 | 145.9 | 2335 | 145.7 | 2405 | 144.9 | 2610 | 144.2 | 2885 |
| 24 | .79 | 25.80 | 208.4 | 2500 | 204.8 | 3275 | 204.4 | 3375 | 203.5 | 3665 | 202.6 | 4050 |
| 30 | .92 | 32.00 | | | 298.1 | 4770 | 297.6 | 4910 | | | 294.6 | 5890 |
| 36 | 1.02 | 38.30 | | | 397.4 | 6360 | | | | | | |
| 42 | 1.13 | 44.50 | | | 512.3 | 8195 | | | | | | |
| 48 | 1.23 | 50.80 | | | 637.9 | 10205 | | | | | | |
| Class 250—250 Lb. Pressure—577 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .52 | 13.20 | 68.8 | 825 | 67.7 | 1085 | 67.6 | 1115 | 67.4 | 1215 | 67.1 | 1340 |
| 14 | .59 | 15.30 | 91.6 | 1100 | 90.0 | 1440 | 89.8 | 1480 | 89.4 | 1610 | 89.0 | 1780 |
| 16 | .63 | 17.40 | 111.5 | 1340 | 109.6 | 1755 | 109.4 | 1805 | 108.9 | 1960 | 108.3 | 2165 |
| 18 | .68 | 19.50 | 134.8 | 1620 | 132.5 | 2120 | 132.2 | 2180 | 131.7 | 2370 | 131.0 | 2620 |
| 20 | .72 | 21.60 | 158.6 | 1905 | 155.7 | 2490 | 155.5 | 2565 | 154.8 | 2785 | 154.1 | 3080 |
| 24 | .79 | 25.80 | 208.4 | 2500 | 204.8 | 3275 | 204.4 | 3375 | 203.5 | 3665 | 202.6 | 4050 |
| 30 | .99 | 32.00 | | | 318.7 | 5100 | 318.2 | 5250 | | | 315.2 | 6305 |
| 36 | 1.10 | 38.30 | | | 425.8 | 6815 | | | | | | |
| 42 | 1.22 | 44.50 | | | 549.5 | 8790 | | | | | | |
| 48 | 1.33 | 50.80 | | | 685.2 | 10965 | | | | | | |
| Class 300—300 Lb. Pressure—693 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .48 | 11.10 | 53.3 | 640 | 52.5 | 840 | 52.4 | 865 | 52.2 | 940 | | |
| 12 | .52 | 13.20 | 68.8 | 825 | 67.7 | 1085 | 67.6 | 1115 | 67.4 | 1215 | 67.1 | 1340 |
| 14 | .59 | 15.30 | 91.6 | 1100 | 90.0 | 1440 | 89.8 | 1480 | 89.4 | 1610 | 89.0 | 1780 |
| 16 | .68 | 17.40 | 119.3 | 1430 | 117.3 | 1875 | 117.2 | 1935 | 116.7 | 2100 | 116.2 | 2325 |
| 18 | .73 | 19.50 | 143.7 | 1725 | 141.4 | 2260 | 141.1 | 2330 | 140.6 | 2530 | 140.0 | 2800 |
| 20 | .78 | 21.60 | 170.4 | 2045 | 167.6 | 2680 | 167.3 | 2760 | 166.6 | 3000 | 165.9 | 3320 |
| 24 | .85 | 25.80 | 222.6 | 2670 | 219.0 | 3505 | 218.6 | 3605 | 217.7 | 3920 | 216.8 | 4335 |
| Class 350—350 Lb. Pressure—808 Foot Head | | | | | | | | | | | | |
| 3 | .32 | 3.96 | 12.3 | 150 | 12.2 | 195 | 12.1 | 200 | 12.0 | 215 | | |
| 4 | .35 | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| 6 | .38 | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .52 | 11.10 | 57.2 | 685 | 56.4 | 900 | 56.3 | 930 | 56.1 | 1010 | | |
| 12 | .56 | 13.20 | 73.6 | 885 | 72.5 | 1160 | 72.4 | 1195 | 72.2 | 1300 | 71.9 | 1440 |
| 14 | .64 | 15.30 | 98.5 | 1180 | 96.9 | 1550 | 96.7 | 1595 | 96.3 | 1735 | 95.9 | 1920 |
| 16 | .68 | 17.40 | 119.3 | 1430 | 117.3 | 1875 | 117.2 | 1935 | 116.7 | 2100 | 116.2 | 2325 |
| 18 | .79 | 19.50 | 154.3 | 1850 | 152.0 | 2430 | 151.7 | 2505 | 151.2 | 2720 | 150.6 | 3010 |
| 20 | .84 | 21.60 | 182.1 | 2185 | 179.3 | 2870 | 179.0 | 2955 | 178.3 | 3210 | 177.6 | 3550 |
| 24 | .92 | 25.80 | 239.2 | 2870 | 235.4 | 3765 | 235.1 | 3880 | 234.2 | 4215 | 233.2 | 4665 |

*Including Bell. Calculated weight of pipe rounded off to nearest 5 pounds.

# WEIGHTS OF MECHANICAL JOINT PIPE FOR GAS

## STANDARD THICKNESSES AND WEIGHTS OF CAST IRON MECHANICAL JOINT PIPE CENTRIFUGALLY CAST IN METAL AND SAND LINED MOLDS FOR GAS

Note: Thicknesses in accordance with A.S.A. Specifications, 18,000 psi full length bursting tensile, 40,000 psi ring modulus of rupture. For pipe laid without blocks on flat bottom trench with tamped backfill under 5 feet of cover. For other conditions consult the manufacturer.

| Size ins. | Thickness ins. | Outside Diam. ins. | Weight Based On 12 ft. Lgth.* Avg. per ft. | 12 ft. Lgth.* per Lgth. | 16 ft. Lgth.* Avg. per ft. | 16 ft. Lgth.* per Lgth. | 16½ ft. Lgth.* Avg. per ft. | 16½ ft. Lgth.* per Lgth. | 18 ft. Lgth.* Avg. per ft. | 18 ft. Lgth.* per Lgth. | 20 ft. Lgth.* Avg. per ft. | 20 ft. Lgth.* per Lgth. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Class 10—10 Lb. Pressure** | | | | | | | | | |
| 4 | .35[1] | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| | or .38[2] | 4.80 | 17.8 | 215 | 17.6 | 280 | 17.5 | 290 | 17.4 | 315 | | |
| 6 | .38[1] | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| | or .41[2] | 6.90 | 27.9 | 335 | 27.6 | 440 | 27.5 | 455 | 27.3 | 490 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 16 | .50 | 17.40 | 90.7 | 1090 | 88.7 | 1420 | 88.6 | 1460 | 88.1 | 1585 | 87.6 | 1750 |
| 20 | .57 | 21.60 | 128.7 | 1545 | 125.9 | 2015 | 125.7 | 2075 | 124.9 | 2250 | 124.2 | 2485 |
| 24 | .63 | 25.80 | 170.2 | 2040 | 166.5 | 2665 | 166.1 | 2740 | 165.2 | 2975 | 164.2 | 3285 |
| 30 | .73 | 32.00 | | | 241.5 | 3865 | 241.0 | 3975 | | | 238.0 | 4760 |
| 36 | .81 | 38.30 | | | 322.4 | 5160 | | | | | | |
| 42 | .90 | 44.50 | | | 416.5 | 6665 | | | | | | |
| 48 | .98 | 50.80 | | | 519.0 | 8305 | | | | | | |
| | | | **Class 50—50 Lb. Pressure** | | | | | | | | | |
| 4 | .35[1] | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| | or .38[2] | 4.80 | 17.8 | 215 | 17.6 | 280 | 17.5 | 290 | 17.4 | 315 | | |
| 6 | .38[1] | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| | or .41[2] | 6.90 | 27.9 | 335 | 27.6 | 440 | 27.5 | 455 | 27.3 | 490 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 16 | .50 | 17.40 | 90.7 | 1090 | 88.7 | 1420 | 88.6 | 1460 | 88.1 | 1585 | 87.6 | 1750 |
| 20 | .57 | 21.60 | 128.7 | 1545 | 125.9 | 2015 | 125.7 | 2075 | 124.9 | 2250 | 124.2 | 2485 |
| 24 | .63 | 25.80 | 170.2 | 2040 | 166.5 | 2665 | 166.1 | 2740 | 165.2 | 2975 | 164.2 | 3285 |
| 30 | .79 | 32.00 | | | 259.5 | 4150 | 259.0 | 4275 | | | 256.0 | 5120 |
| 36 | .87 | 38.30 | | | 343.9 | 5500 | | | | | | |
| 42 | .97 | 44.50 | | | 445.7 | 7130 | | | | | | |
| 48 | 1.06 | 50.80 | | | 557.1 | 8915 | | | | | | |
| | | | **Class 100—100 Lb. Pressure** | | | | | | | | | |
| 4 | .35[1] | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| | or .38[2] | 4.80 | 17.8 | 215 | 17.6 | 280 | 17.5 | 290 | 17.4 | 315 | | |
| 6 | .38[1] | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| | or .41[2] | 6.90 | 27.9 | 335 | 27.6 | 440 | 27.5 | 455 | 27.3 | 490 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |
| 16 | .54 | 17.40 | 97.1 | 1165 | 95.0 | 1520 | 94.9 | 1565 | 94.5 | 1700 | 94.0 | 1880 |
| 20 | .62 | 21.60 | 138.7 | 1665 | 135.9 | 2175 | 135.7 | 2240 | 134.9 | 2430 | 134.2 | 2685 |
| 24 | .68 | 25.80 | 182.2 | 2185 | 178.5 | 2855 | 178.1 | 2940 | 177.2 | 3190 | 176.2 | 3525 |
| | | | **Class 150—150 Lb. Pressure** | | | | | | | | | |
| 4 | .35[1] | 4.80 | 16.6 | 200 | 16.4 | 260 | 16.3 | 270 | 16.2 | 290 | | |
| | or .38[2] | 4.80 | 17.8 | 215 | 17.6 | 280 | 17.5 | 290 | 17.4 | 315 | | |
| 6 | .38[1] | 6.90 | 26.1 | 315 | 25.7 | 410 | 25.6 | 420 | 25.5 | 460 | | |
| | or .41[2] | 6.90 | 27.9 | 335 | 27.6 | 440 | 27.5 | 455 | 27.3 | 490 | | |
| 8 | .41 | 9.05 | 37.2 | 445 | 36.7 | 585 | 36.6 | 605 | 36.4 | 655 | | |
| 10 | .44 | 11.10 | 49.3 | 590 | 48.5 | 775 | 48.4 | 800 | 48.2 | 870 | | |
| 12 | .48 | 13.20 | 64.0 | 770 | 62.9 | 1005 | 62.8 | 1035 | 62.6 | 1125 | 62.3 | 1245 |

* Including Bell. Calculated weight of pipe rounded off to nearest 5 pounds.

(1) Class 22 thickness.

(2) Class 23 thickness offers increased factor of safety and is recommended for use in areas of dense population and heavy traffic.

References: A.S.A.—A-21.7—pipe cast in metal molds. A.S.A.—A-21.9—pipe cast in sand lined molds. A.S.A.—A-21.11—mechanical joints.

# WEIGHTS OF MECHANICAL JOINT PIPE FOR WATER

STANDARD THICKNESSES AND WEIGHTS OF CAST IRON MECHANICAL JOINT PIT CAST PIPE FOR WATER AND OTHER LIQUIDS

Note: Thicknesses in accordance with A.S.A. Specifications, 11,000 psi full length bursting tensile, 31,000 psi ring modulus of rupture. For pipe laid without blocks on flat bottom trench with tampered backfill under 5 feet of cover. For other conditions consult the manufacturer.

| | | Class 50<br>50 lb. Pressure<br>115 ft. Head | | | Class 100<br>100 lb. Pressure<br>231 ft. Head | | | Class 150<br>150 lb. Pressure<br>346 ft. Head | | | Class 200<br>200 lb. Pressure<br>462 ft. Head | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Weight Based on 12 ft. Length* | | | Weight Based on 12 ft. Length* | | | Weight Based on 12 ft. Length* | | | Weight Based on 12 ft. Length* | |
| Size ins. | Out-side Diam. ins. | Thick-ness ins. | Avg. per ft. | per Length | Thick-ness ins. | Avg. per ft. | per Length | Thick-ness ins. | Avg. per ft. | per Length | Thick-ness ins. | Avg. per ft. | per Length |
| 3 | 3.96 | .37 | 13.9 | 165 | .37 | 13.9 | 165 | .37 | 13.9 | 165 | .37 | 13.9 | 165 |
| 4 | 4.80 | .40 | 18.6 | 225 | .40 | 18.6 | 225 | .40 | 18.6 | 225 | .40 | 18.6 | 225 |
| 6 | 6.90 | .43 | 29.2 | 350 | .43 | 29.2 | 350 | .43 | 29.2 | 350 | .43 | 29.2 | 350 |
| 8 | 9.05 | .46 | 41.3 | 495 | .46 | 41.3 | 495 | .46 | 41.3 | 495 | .46 | 41.3 | 495 |
| 10 | 11.10 | .50 | 55.4 | 665 | .50 | 55.4 | 665 | .54 | 59.3 | 710 | .58 | 63.2 | 760 |
| 12 | 13.20 | .54 | 71.2 | 855 | .54 | 71.2 | 855 | .58 | 76.0 | 910 | .63 | 81.8 | 980 |
| 14 | 15.30 | .54 | 84.7 | 1015 | .58 | 90.3 | 1085 | .63 | 97.2 | 1165 | .68 | 104.0 | 1250 |
| 16 | 17.40 | .58 | 103.7 | 1245 | .63 | 111.7 | 1340 | .68 | 119.5 | 1435 | .79 | 136.7 | 1640 |
| 18 | 19.50 | .63 | 126.2 | 1515 | .68 | 135.2 | 1620 | .79 | 154.6 | 1855 | .85 | 165.2 | 1980 |
| 20 | 21.60 | .66 | 147.2 | 1765 | .71 | 157.1 | 1885 | .83 | 180.7 | 2170 | .90 | 194.3 | 2330 |
| 24 | 25.80 | .74 | 197.2 | 2365 | .80 | 211.4 | 2535 | .93 | 242.1 | 2905 | 1.00 | 258.5 | 3100 |
| 30 | 32.00 | .87 | 291.8 | 3500 | .94 | 312.4 | 3750 | 1.10 | 359.4 | 4315 | 1.19 | 385.7 | 4630 |
| 36 | 38.30 | .97 | 392.0 | 4705 | 1.13 | 448.8 | 5385 | 1.22 | 480.5 | 5765 | 1.43 | 553.9 | 6645 |
| 42 | 44.50 | 1.07 | 503.0 | 6035 | 1.16 | 540.3 | 6485 | 1.35 | 618.5 | 7420 | 1.58 | 712.2 | 8545 |
| 48 | 50.80 | 1.18 | 634.3 | 7610 | 1.37 | 724.2 | 8690 | 1.48 | 775.9 | 9310 | 1.73 | 892.5 | 10710 |

| | | Class 250<br>250 lb. Pressure<br>577 ft. Head | | | Class 300<br>300 lb. Pressure<br>693 ft. Head | | | Class 350<br>350 lb. Pressure<br>808 ft. Head | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Weight Based on 12 ft. Length* | | | Weight based on 12 ft. Length* | | | Weight Based on 12 ft. Length* | |
| Size ins. | Out-side Diam. ins. | Thick-ness ins. | Avg. per ft. | per Length | Thick-ness ins. | Avg. per ft. | per Length | Thick-ness ins. | Avg. per ft. | per Length |
| 3 | 3.96 | .37 | 13.9 | 165 | .37 | 13.9 | 165 | .37 | 13.9 | 165 |
| 4 | 4.80 | .40 | 18.6 | 225 | .40 | 18.6 | 225 | .40 | 18.6 | 225 |
| 6 | 6.90 | .43 | 29.2 | 350 | .46 | 30.9 | 370 | .50 | 33.3 | 400 |
| 8 | 9.05 | .50 | 44.5 | 535 | .54 | 47.6 | 570 | .58 | 50.8 | 610 |
| 10 | 11.10 | .63 | 68.1 | 815 | .68 | 72.9 | 875 | .73 | 77.6 | 930 |
| 12 | 13.20 | .68 | 87.6 | 1050 | .73 | 93.4 | 1120 | .79 | 100.4 | 1205 |
| 14 | 15.30 | .79 | 119.0 | 1430 | .85 | 127.0 | 1525 | .92 | 136.3 | 1635 |
| 16 | 17.40 | .85 | 146.0 | 1750 | .92 | 156.7 | 1880 | .99 | 167.2 | 2005 |
| 18 | 19.50 | .92 | 177.2 | 2125 | .99 | 189.3 | 2270 | 1.07 | 203.0 | 2435 |
| 20 | 21.60 | .97 | 207.8 | 2495 | 1.05 | 223.2 | 2680 | 1.22 | 255.4 | 3065 |
| 24 | 25.80 | 1.17 | 297.9 | 3575 | 1.26 | 318.5 | 3820 | 1.36 | 341.2 | 4095 |
| 30 | 32.00 | 1.39 | 443.2 | 5320 | 1.50 | 474.6 | 5695 | 1.62 | 508.6 | 6105 |
| 36 | 38.30 | 1.54 | 592.0 | 7105 | 1.79 | 677.7 | 8130 | 1.93 | 725.1 | 8700 |
| 42 | 44.50 | 1.71 | 764.7 | 9175 | | | | | | |
| 48 | 50.80 | 2.02 | 1026.2 | 12315 | | | | | | |

* Including Bell. Calculated weight of pipe rounded off to nearest 5 pounds.
References: Thicknesses—A.S.A.—A-21.2. Mechanical joint A.S.A.—A-21.11.

# WEIGHTS OF MECHANICAL JOINT PIPE FOR GAS

STANDARD THICKNESSES AND WEIGHTS OF CAST IRON
MECHANICAL JOINT PIT CAST PIPE FOR GAS

Note: Thicknesses in accordance with A.S.A. Specifications, 11,000 psi full length bursting tensile, 31,000 psi ring modulus of rupture. For pipe laid without blocks on flat bottom trench with tamped backfill under 5 feet of cover. For other conditions consult the manufacturer.

| | | Class 10 10 lb. Pressure | | | Class 50 50 lb. Pressure | | | Class 100 100 lb. Pressure | | | Class 150 150 lb. Pressure | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Weight Based on 12 ft. Lgth.* | | | Weight Based on 12 ft. Lgth.* | | | Weight Based on 12 ft. Lgth.* | | | Weight Based on 12 ft. Lgth.* | |
| Size ins. | Out-side Diam. ins. | Thick-ness ins. | Avg. per ft. | per Lgth. | Thick-ness ins. | Avg. per ft. | per Lgth. | Thick-ness ins. | Avg. per ft. | per Lgth. | Thick-ness ins. | Avg. per ft. | per Lgth. |
| 4 | 4.80 | .40 | 18.6 | 225 | .40 | 18.6 | 225 | .40 | 18.6 | 225 | .40 | 18.6 | 225 |
| 6 | 6.90 | .43 | 29.2 | 350 | .43 | 29.2 | 350 | .43 | 29.2 | 350 | .43 | 29.2 | 350 |
| 8 | 9.05 | .46 | 41.3 | 495 | .46 | 41.3 | 495 | .46 | 41.3 | 495 | .46 | 41.3 | 495 |
| 10 | 11.10 | .50 | 55.4 | 665 | .50 | 55.4 | 665 | .50 | 55.4 | 665 | .50 | 55.4 | 665 |
| 12 | 13.20 | .54 | 71.2 | 855 | .54 | 71.2 | 855 | .54 | 71.2 | 855 | .54 | 71.2 | 855 |
| 16 | 17.40 | .58 | 103.7 | 1245 | .58 | 103.7 | 1245 | .58 | 103.7 | 1245 | | | |
| 20 | 21.60 | .66 | 147.2 | 1765 | .66 | 147.2 | 1765 | .71 | 157.1 | 1885 | | | |
| 24 | 25.80 | .74 | 197.2 | 2365 | .74 | 197.2 | 2365 | .80 | 211.4 | 2535 | | | |
| 30 | 32.00 | .87 | 291.8 | 3500 | .87 | 291.8 | 3500 | | | | | | |
| 36 | 38.30 | .97 | 392.0 | 4705 | .97 | 392.0 | 4705 | | | | | | |
| 42 | 44.50 | 1.07 | 503.0 | 6035 | 1.07 | 503.0 | 6035 | | | | | | |
| 48 | 50.80 | 1.18 | 634.3 | 7610 | 1.18 | 634.3 | 7610 | | | | | | |

* Including Bell. Calculated weight of pipe rounded off to nearest 5 pounds.
References: Thicknesses—A.S.A.—A-21.3—pit cast for gas. Mechanical joint—A.S.A.—A-21.11.

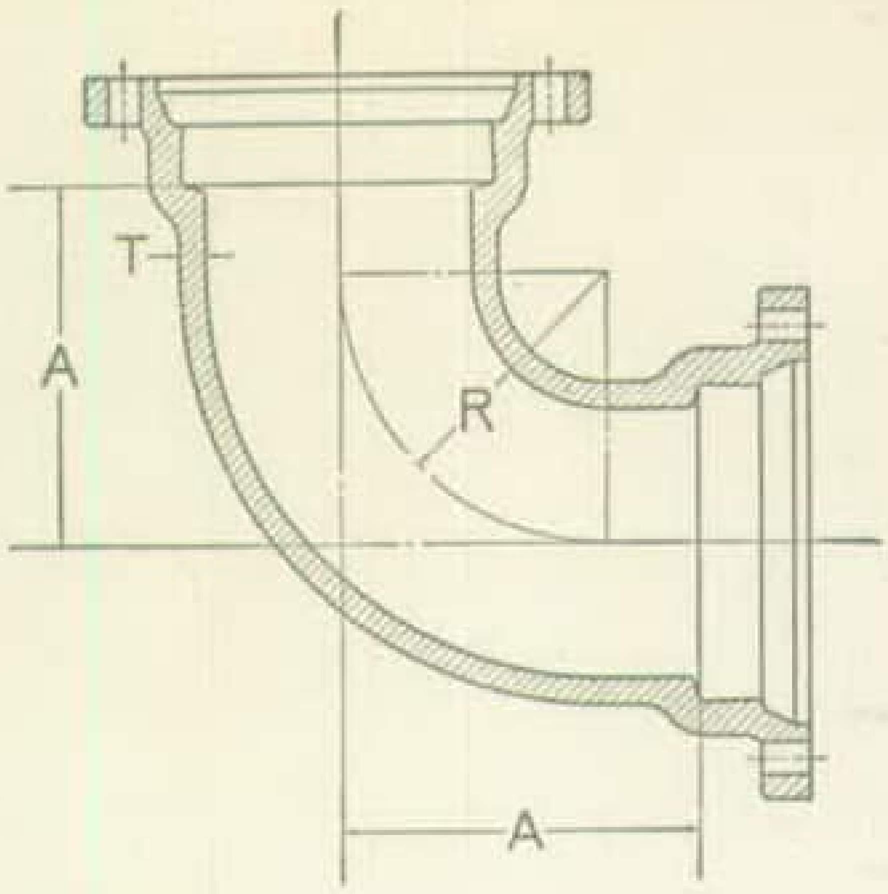
# Thicknesses and Weights of Cast Iron Mechanical Joint Pipe Based on Federal Specifications, WW-P-421

| Size | O.D. | Thickness | Class or Working Pressure in Psi. | Weights in Pounds: 12 Ft. Length | | 16 Ft. Length | | 16½ Ft. Length | | 18 Ft. Length | | 20 Ft. Length | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Per Foot Incl. Bell | Per 12 Ft. Lgth. | Per Foot Incl. Bell | Per 16 Ft. Lgth. | Per Foot Incl. Bell | Per 16½ Ft. Lgth. | Per Foot Incl. Bell | Per 18 Ft. Lgth. | Per Foot Incl. Bell | Per 20 Ft. Lgth. |
| 4 | 4.80 | 0.34 | 150 | 16.2 | 195 | 15.9 | 255 | 15.9 | 260 | 15.8 | 285 | ..... | ..... |
| 4 | 4.80 | 0.38 | 250 | 17.8 | 215 | 17.6 | 280 | 17.5 | 290 | 17.4 | 315 | ..... | ..... |
| 6 | 6.90 | 0.37 | 150 | 25.5 | 305 | 25.1 | 400 | 25.0 | 415 | 24.9 | 450 | ..... | ..... |
| 6 | 6.90 | 0.43 | 250 | 29.1 | 350 | 28.7 | 460 | 28.6 | 470 | 28.5 | 515 | ..... | ..... |
| 8 | 9.05 | 0.42 | 150 | 38.0 | 460 | 37.4 | 600 | 37.3 | 615 | 37.2 | 670 | ..... | ..... |
| 8 | 9.05 | 0.46 | 200 | 41.2 | 495 | 40.6 | 650 | 40.5 | 670 | 40.4 | 725 | ..... | ..... |
| 8 | 9.05 | 0.50 | 250 | 44.4 | 530 | 43.8 | 700 | 43.7 | 720 | 43.6 | 785 | ..... | ..... |
| 10 | 11.10 | 0.47 | 150 | 52.3 | 630 | 51.5 | 825 | 51.4 | 850 | 51.2 | 920 | ..... | ..... |
| 10 | 11.10 | 0.52 | 200 | 57.2 | 685 | 56.4 | 900 | 56.3 | 930 | 56.1 | 1010 | ..... | ..... |
| 10 | 11.10 | 0.57 | 250 | 62.1 | 745 | 61.3 | 980 | 61.2 | 1010 | 61.0 | 1100 | ..... | ..... |
| 12 | 13.20 | 0.50 | 150 | 66.4 | 795 | 65.3 | 1045 | 65.2 | 1075 | 65.0 | 1170 | 64.7 | 1295 |
| 12 | 13.20 | 0.57 | 200 | 74.8 | 895 | 73.7 | 1180 | 73.6 | 1215 | 73.4 | 1320 | 73.1 | 1460 |
| 12 | 13.20 | 0.62 | 250 | 80.7 | 970 | 79.6 | 1275 | 79.5 | 1310 | 79.3 | 1430 | 79.0 | 1580 |
| 14 | 15.30 | 0.48 | 100 | 76.2 | 915 | 74.6 | 1195 | ..... | ..... | 74.0 | 1335 | ..... | ..... |
| 14 | 15.30 | 0.55 | 150 | 86.0 | 1030 | 84.4 | 1350 | ..... | ..... | 83.8 | 1510 | ..... | ..... |
| 14 | 15.30 | 0.62 | 200 | 95.7 | 1150 | 94.1 | 1505 | ..... | ..... | 93.5 | 1685 | ..... | ..... |
| 14 | 15.30 | 0.69 | 250 | 105.3 | 1265 | 103.7 | 1660 | ..... | ..... | 103.1 | 1855 | ..... | ..... |
| 16 | 17.40 | 0.52 | 100 | 93.9 | 1125 | 91.9 | 1470 | 91.8 | 1515 | 91.3 | 1645 | 90.8 | 1815 |
| 16 | 17.40 | 0.60 | 150 | 106.7 | 1280 | 104.7 | 1675 | 104.5 | 1725 | 104.1 | 1875 | 103.6 | 2070 |
| 16 | 17.40 | 0.68 | 200 | 119.3 | 1430 | 117.3 | 1875 | 117.2 | 1935 | 116.7 | 2100 | 116.2 | 2325 |
| 16 | 17.40 | 0.75 | 250 | 130.3 | 1565 | 128.3 | 2055 | 128.2 | 2115 | 127.7 | 2300 | 127.2 | 2545 |
| 18 | 19.50 | 0.56 | 100 | 113.4 | 1360 | 111.0 | 1775 | ..... | ..... | 110.3 | 1985 | ..... | ..... |
| 18 | 19.50 | 0.65 | 150 | 129.5 | 1555 | 127.2 | 2035 | ..... | ..... | 126.4 | 2280 | ..... | ..... |
| 18 | 19.50 | 0.74 | 200 | 145.5 | 1745 | 143.2 | 2290 | ..... | ..... | 142.4 | 2565 | ..... | ..... |
| 18 | 19.50 | 0.83 | 250 | 161.3 | 1935 | 159.0 | 2545 | ..... | ..... | 158.2 | 2845 | ..... | ..... |
| 20 | 21.60 | 0.58 | 100 | 130.7 | 1570 | 127.9 | 2045 | 127.6 | 2105 | 126.9 | 2285 | 126.2 | 2525 |
| 20 | 21.60 | 0.68 | 150 | 150.6 | 1805 | 147.8 | 2365 | 147.5 | 2435 | 146.8 | 2640 | 146.1 | 2920 |
| 20 | 21.60 | 0.78 | 200 | 170.4 | 2045 | 167.6 | 2680 | 167.3 | 2760 | 166.6 | 3000 | 165.9 | 3320 |
| 20 | 21.60 | 0.88 | 250 | 189.9 | 2280 | 187.1 | 2995 | 186.8 | 3085 | 186.1 | 3350 | 185.4 | 3710 |
| 24 | 25.80 | 0.64 | 100 | 172.6 | 2070 | 168.9 | 2700 | 168.5 | 2780 | 167.6 | 3015 | 166.7 | 3335 |
| 24 | 25.80 | 0.76 | 150 | 201.3 | 2415 | 197.6 | 3160 | 197.2 | 3255 | 196.3 | 3535 | 195.4 | 3905 |
| 24 | 25.80 | 0.88 | 200 | 229.7 | 2755 | 226.0 | 3615 | 225.6 | 3725 | 224.7 | 4045 | 223.8 | 4475 |
| 24 | 25.80 | 1.00 | 250 | 257.9 | 3095 | 254.2 | 4065 | 253.8 | 4190 | 252.9 | 4555 | 252.0 | 5040 |

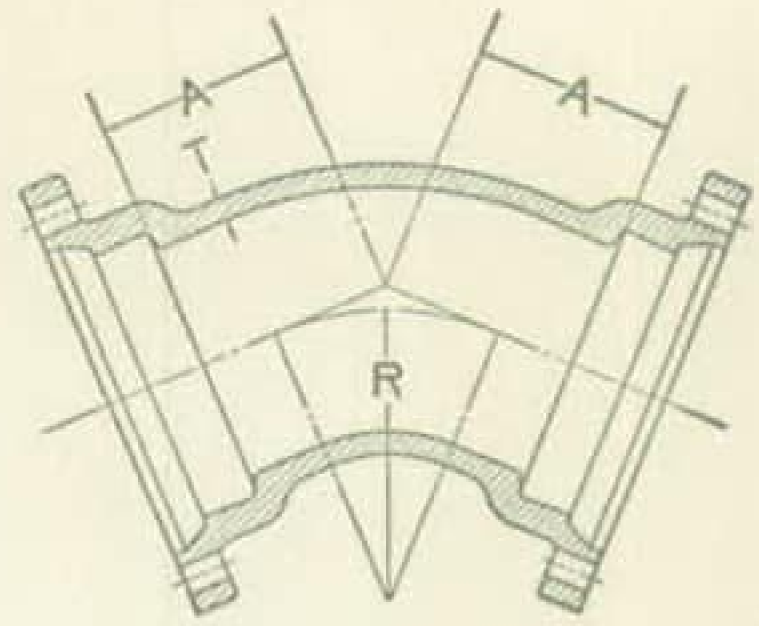
*Note:* Thicknesses for sizes and classes of pipe not included in the WW-P-421 specifications are calculated by the Revised Fairchild Formula which is the formula used to calculate the federal specification thicknesses for Class 150 and Class 250.

Dimensions in inches.

**For dimensions of Mechanical Joint, see page 242.**



90°

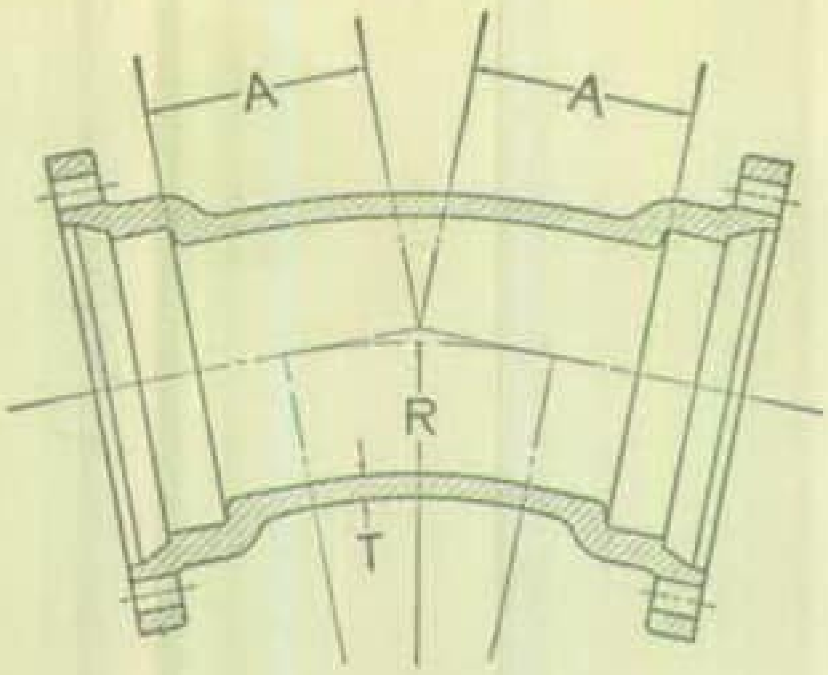


45°

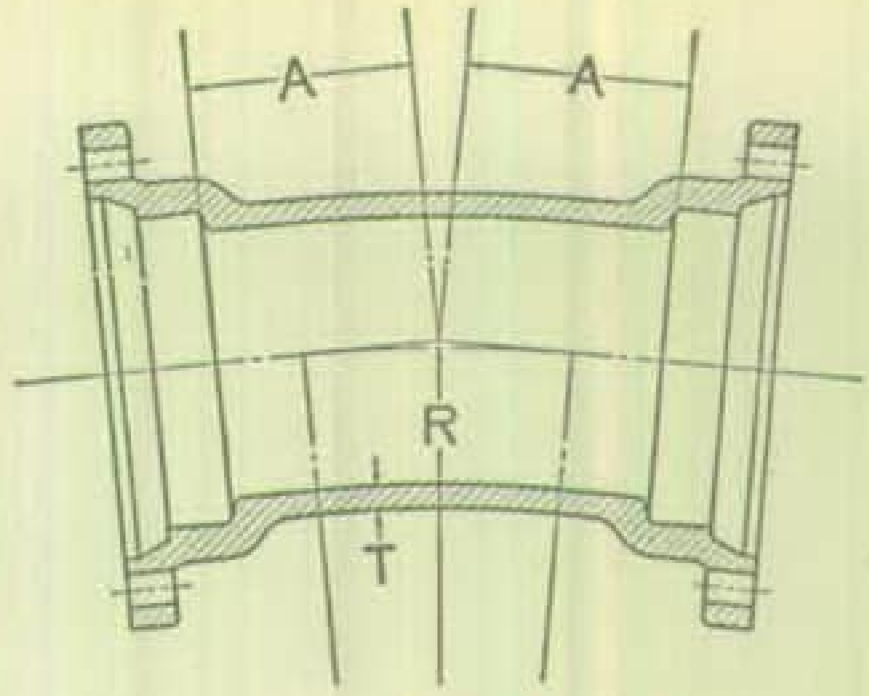
# Bends

| TABLE OF DIMENSIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Diam. | Outside Diam. | 90° Bends | | | | 45° Bends | | | Max. Working Pressure |
| | | T | A | R | Weights | A | R | Weights | |
| 3 | 3.96 | .48 | 5.5 | 4.0 | 35 | 3.0 | 3.62 | 30 | 250 |
| 4 | 5.00 | .52 | 6.5 | 4.5 | 55 | 4.0 | 4.81 | 50 | 250 |
| 6 | 7.10 | .55 | 8.0 | 6.0 | 85 | 5.0 | 7.25 | 75 | 250 |
| 8 | 9.30 | .60 | 9.0 | 7.0 | 125 | 5.5 | 8.44 | 110 | 250 |
| 10 | 11.40 | .68 | 11.0 | 9.0 | 190 | 6.5 | 10.88 | 155 | 250 |
| 12 | 13.50 | .75 | 12.0 | 10.0 | 255 | 7.5 | 13.25 | 215 | 250 |
| 14 | 15.30 | .66 | 14.0 | 11.5 | 340 | 7.5 | 12.06 | 270 | 150 |
| 16 | 17.40 | .70 | 15.0 | 12.5 | 430 | 8.0 | 13.25 | 340 | 150 |
| 18 | 19.50 | .75 | 16.5 | 14.0 | 545 | 8.5 | 14.50 | 420 | 150 |
| 20 | 21.60 | .80 | 18.0 | 15.5 | 680 | 9.5 | 16.88 | 530 | 150 |
| 24 | 25.80 | .89 | 22.0 | 18.5 | 1025 | 11.0 | 18.12 | 755 | 150 |
| 30 | 32.00 | 1.03 | 36.0 | 32.5 | 2145 | 15.0 | 27.75 | 1380 | 150 |
| 36 | 38.30 | 1.15 | 48.0 | 44.5 | 3575 | 18.0 | 35.00 | 2095 | 150 |
| 42 | 44.50 | 1.28 | 48.0 | 44.5 | 4615 | 21.0 | 42.25 | 2955 | 150 |
| 48 | 50.80 | 1.42 | 54.0 | 50.5 | 6395 | 24.0 | 49.50 | 4080 | 150 |

All weights are approximate and do not include joint accessories.
See page 242 for joint dimensions and weight of joint accessories.
Three to twelve-inch fittings conform to A.S.A. Specification—A-21.10—for short body fittings.




22½°




11¼°

# Bends

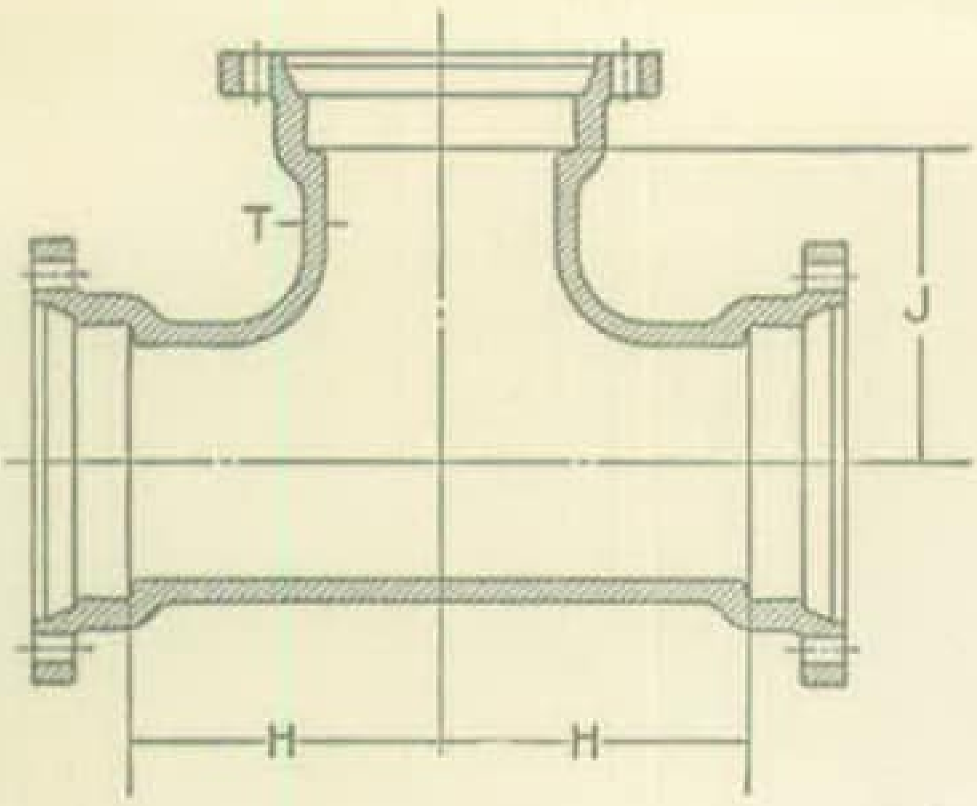
TABLE OF DIMENSIONS

| Nominal Diam. | Outside Diam. | 22½° Bends | | | | 11¼° Bends | | | Max. Working Pressure |
|---|---|---|---|---|---|---|---|---|---|
| | | T | A | R | Weights | A | R | Weights | |
| 3 | 3.96 | .48 | 3.0 | 7.56 | 30 | 3.0 | 15.25 | 30 | 250 |
| 4 | 5.00 | .52 | 4.0 | 10.06 | 50 | 4.0 | 20.31 | 50 | 250 |
| 6 | 7.10 | .55 | 5.0 | 15.06 | 75 | 5.0 | 30.50 | 75 | 250 |
| 8 | 9.30 | .60 | 5.5 | 17.62 | 110 | 5.5 | 35.50 | 110 | 250 |
| 10 | 11.40 | .68 | 6.5 | 22.62 | 160 | 6.5 | 45.69 | 160 | 250 |
| 12 | 13.50 | .75 | 7.5 | 27.62 | 220 | 7.5 | 55.81 | 220 | 250 |
| 14 | 15.30 | .66 | 7.5 | 25.12 | 275 | 7.5 | 50.75 | 275 | 150 |
| 16 | 17.40 | .70 | 8.0 | 27.62 | 345 | 8.0 | 55.81 | 345 | 150 |
| 18 | 19.50 | .75 | 8.5 | 30.19 | 430 | 8.5 | 60.94 | 430 | 150 |
| 20 | 21.60 | .80 | 9.5 | 35.19 | 535 | 9.5 | 71.06 | 540 | 150 |
| 24 | 25.80 | .89 | 11.0 | 37.69 | 765 | 11.0 | 76.12 | 770 | 150 |
| 30 | 32.00 | 1.03 | 15.0 | 57.81 | 1400 | 15.0 | 116.75 | 1410 | 150 |
| 36 | 38.30 | 1.15 | 18.0 | 72.88 | 2135 | 18.0 | 147.25 | 2145 | 150 |
| 42 | 44.50 | 1.28 | 21.0 | 88.00 | 3020 | 21.0 | 177.69 | 3035 | 150 |
| 48 | 50.80 | 1.42 | 24.0 | 103.06 | 4170 | 24.0 | 208.12 | 4190 | 150 |

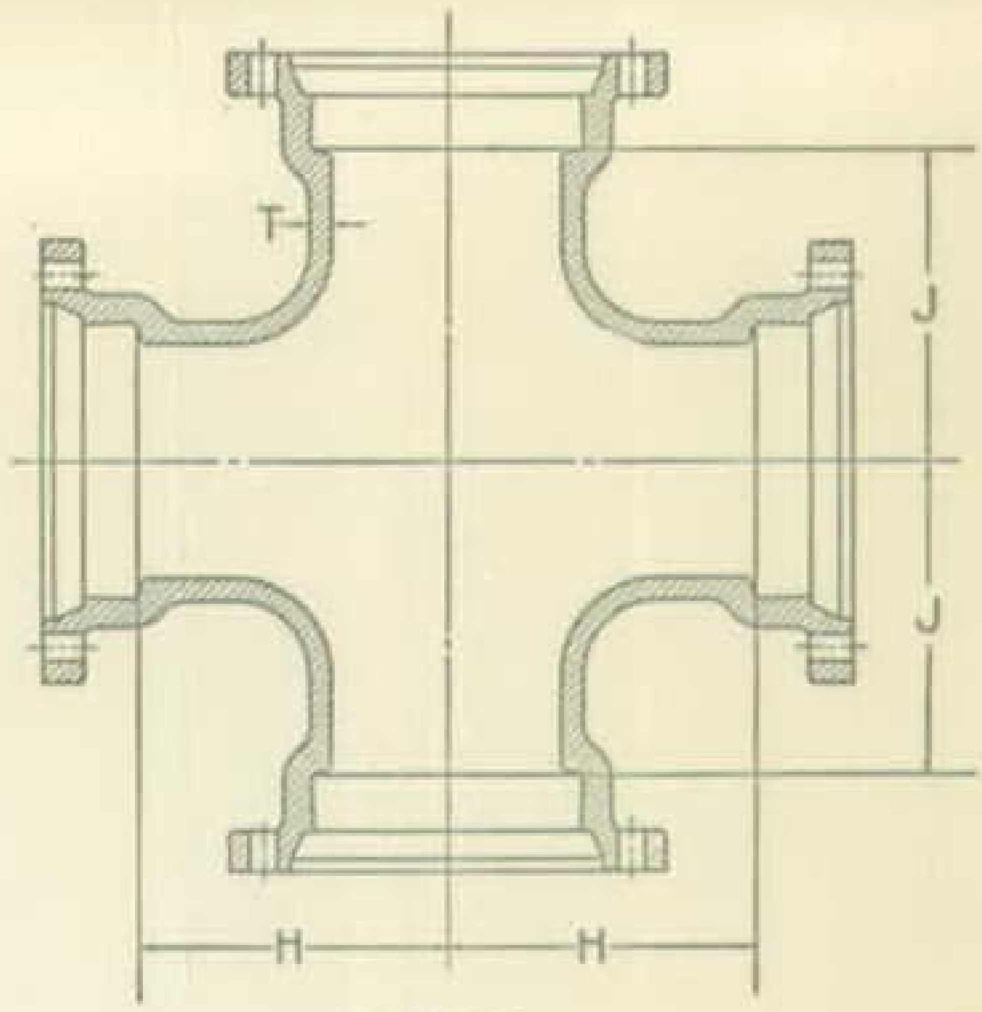
All weights are approximate and do not include joint accessories.

See page 242 for joint dimensions and weight of joint accessories.

Three to twelve-inch fittings conform to A.S.A. Specification—A-21.10—for short body fittings.




TEE




CROSS

# Tees and Crosses

TABLE OF DIMENSIONS

| Nominal Diam. | | Outside Diam. | | T | | | | Tee | Cross | Max. Working Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| Run | Branch | Run | Branch | Run | Branch | H | J | Weight | Weight | |
| 3 | 3 | 3.96 | 3.96 | .48 | .48 | 5.5 | 5.5 | 55 | 70 | 250 |
| 4 | 3 | 5.00 | 3.96 | .52 | .48 | 6.5 | 6.5 | 75 | 90 | 250 |
| 4 | 4 | 5.00 | 5.00 | .52 | .52 | 6.5 | 6.5 | 80 | 105 | 250 |
| 6 | 3 | 7.10 | 3.96 | .55 | .48 | 8.0 | 8.0 | 110 | 125 | 250 |
| 6 | 4 | 7.10 | 5.00 | .55 | .52 | 8.0 | 8.0 | 115 | 140 | 250 |
| 6 | 6 | 7.10 | 7.10 | .55 | .55 | 8.0 | 8.0 | 125 | 160 | 250 |
| 8 | 4 | 9.30 | 5.00 | .60 | .52 | 9.0 | 9.0 | 165 | 185 | 250 |
| 8 | 6 | 9.30 | 7.10 | .60 | .55 | 9.0 | 9.0 | 175 | 205 | 250 |
| 8 | 8 | 9.30 | 9.30 | .60 | .60 | 9.0 | 9.0 | 185 | 235 | 250 |
| 10 | 4 | 11.40 | 5.00 | .68 | .52 | 11.0 | 11.0 | 235 | 260 | 250 |
| 10 | 6 | 11.40 | 7.10 | .68 | .55 | 11.0 | 11.0 | 250 | 285 | 250 |
| 10 | 8 | 11.40 | 9.30 | .68 | .60 | 11.0 | 11.0 | 260 | 310 | 250 |
| 10 | 10 | 11.64 | 11.64 | .80 | .80 | 11.0 | 11.0 | 310 | 380 | 250 |
| 12 | 4 | 13.50 | 5.00 | .75 | .52 | 12.0 | 12.0 | 315 | 340 | 250 |
| 12 | 6 | 13.50 | 7.10 | .75 | .55 | 12.0 | 12.0 | 325 | 360 | 250 |
| 12 | 8 | 13.50 | 9.30 | .75 | .60 | 12.0 | 12.0 | 340 | 385 | 250 |
| 12 | 10 | 13.74 | 11.64 | .87 | .80 | 12.0 | 12.0 | 390 | 460 | 250 |
| 12 | 12 | 13.74 | 13.74 | .87 | .87 | 12.0 | 12.0 | 410 | 495 | 250 |
| 14 | 6 | 15.30 | 7.10 | .66 | .55 | 14.0 | 14.0 | 435 | 475 | 150 |
| 14 | 8 | 15.30 | 9.30 | .66 | .60 | 14.0 | 14.0 | 450 | 500 | 150 |
| 14 | 10 | 15.30 | 11.40 | .66 | .68 | 14.0 | 14.0 | 465 | 540 | 150 |
| 14 | 12 | 15.65 | 13.50 | .82 | .75 | 14.0 | 14.0 | 540 | 630 | 150 |
| 14 | 14 | 15.65 | 15.65 | .82 | .82 | 14.0 | 14.0 | 585 | 710 | 150 |
| 16 | 6 | 17.40 | 7.10 | .70 | .55 | 15.0 | 15.0 | 540 | 575 | 150 |
| 16 | 8 | 17.40 | 9.30 | .70 | .60 | 15.0 | 15.0 | 550 | 605 | 150 |
| 16 | 10 | 17.40 | 11.40 | .70 | .68 | 15.0 | 15.0 | 570 | 645 | 150 |
| 16 | 12 | 17.40 | 13.50 | .70 | .75 | 15.0 | 15.0 | 590 | 685 | 150 |
| 16 | 14 | 17.80 | 15.65 | .89 | .82 | 15.0 | 15.0 | 710 | 830 | 150 |
| 16 | 16 | 17.80 | 17.80 | .89 | .89 | 15.0 | 15.0 | 740 | 895 | 150 |

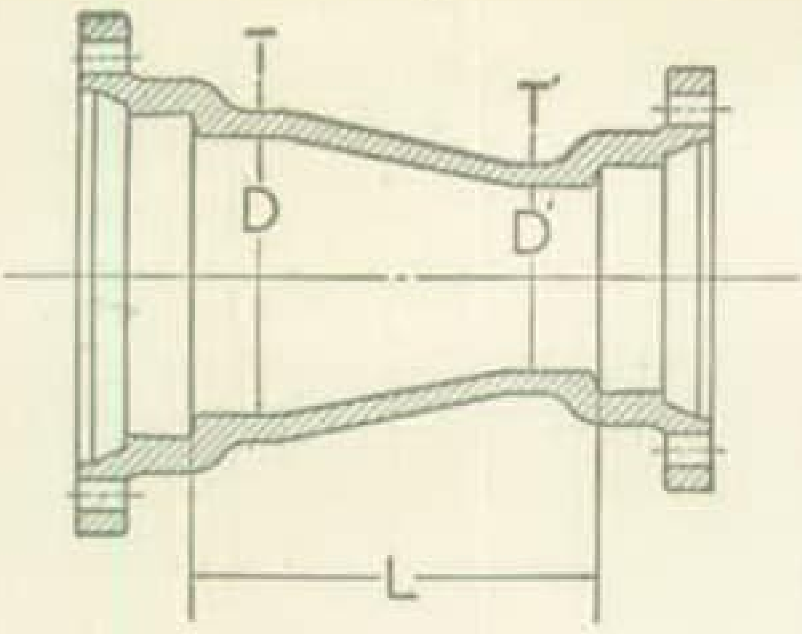
All weights are approximate and do not include joint accessories.
See page 242 for joint dimensions and weight of joint accessories.
Three to twelve-inch fittings conform to A.S.A. Specification—A-21.10—for short body fittings.

# Tees and Crosses
## Continued

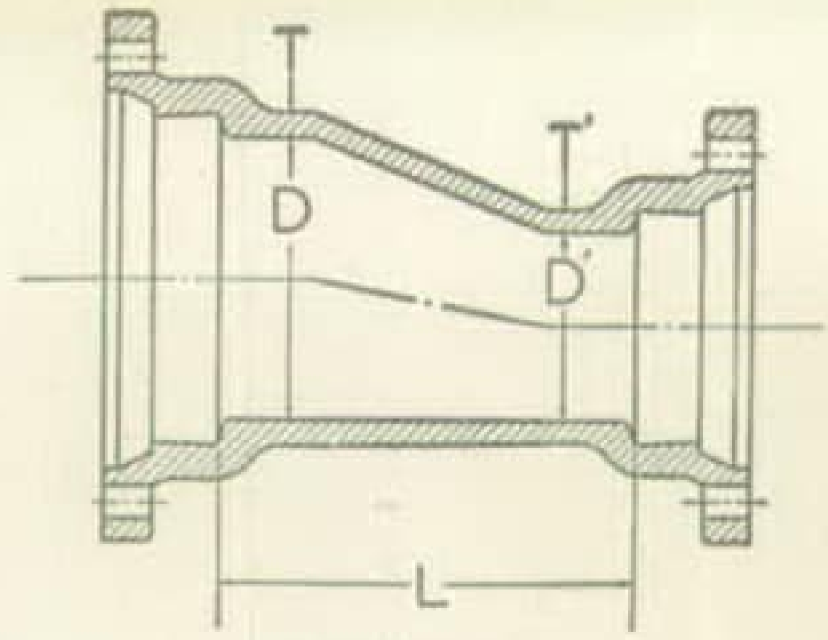
TABLE OF DIMENSIONS

| Nominal Diam. | | Outside Diam. | | T | | | | Tee | Cross | Max. Working Pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| Run | Branch | Run | Branch | Run | Branch | H | J | Weight | Weight | |
| 18 | 6 | 19.50 | 7.10 | .75 | .55 | 13.0 | 15.5 | 590 | 625 | 150 |
| 18 | 8 | 19.50 | 9.30 | .75 | .60 | 13.0 | 15.5 | 605 | 655 | 150 |
| 18 | 10 | 19.50 | 11.40 | .75 | .68 | 13.0 | 15.5 | 620 | 685 | 150 |
| 18 | 12 | 19.50 | 13.50 | .75 | .75 | 13.0 | 15.5 | 640 | 725 | 150 |
| 18 | 14 | 19.50 | 15.30 | .75 | .66 | 16.5 | 16.5 | 755 | 870 | 150 |
| 18 | 16 | 19.92 | 17.80 | .96 | .89 | 16.5 | 16.5 | 905 | 1060 | 150 |
| 18 | 18 | 19.92 | 19.92 | .96 | .96 | 16.5 | 16.5 | 945 | 1130 | 150 |
| 20 | 6 | 21.60 | 7.10 | .80 | .55 | 14.0 | 17.0 | 725 | 760 | 150 |
| 20 | 8 | 21.60 | 9.30 | .80 | .60 | 14.0 | 17.0 | 735 | 790 | 150 |
| 20 | 10 | 21.60 | 11.40 | .80 | .68 | 14.0 | 17.0 | 755 | 820 | 150 |
| 20 | 12 | 21.60 | 13.50 | .80 | .75 | 14.0 | 17.0 | 775 | 860 | 150 |
| 20 | 14 | 21.60 | 15.30 | .80 | .66 | 14.0 | 17.0 | 795 | 905 | 150 |
| 20 | 16 | 21.60 | 17.40 | .80 | .70 | 18.0 | 18.0 | 945 | 1085 | 150 |
| 20 | 18 | 22.06 | 19.92 | 1.03 | .96 | 18.0 | 18.0 | 1140 | 1330 | 150 |
| 20 | 20 | 22.06 | 22.06 | 1.03 | 1.03 | 18.0 | 18.0 | 1185 | 1415 | 150 |
| 24 | 6 | 25.80 | 7.10 | .89 | .55 | 15.0 | 19.0 | 985 | 1025 | 150 |
| 24 | 8 | 25.80 | 9.30 | .89 | .60 | 15.0 | 19.0 | 1000 | 1045 | 150 |
| 24 | 10 | 25.80 | 11.40 | .89 | .68 | 15.0 | 19.0 | 1020 | 1085 | 150 |
| 24 | 12 | 25.80 | 13.50 | .89 | .75 | 15.0 | 19.0 | 1030 | 1110 | 150 |
| 24 | 14 | 25.80 | 15.30 | .89 | .66 | 15.0 | 19.0 | 1055 | 1155 | 150 |
| 24 | 16 | 25.80 | 17.40 | .89 | .70 | 15.0 | 19.0 | 1075 | 1200 | 150 |
| 24 | 18 | 25.80 | 19.50 | .89 | .75 | 22.0 | 22.0 | 1400 | 1590 | 150 |
| 24 | 20 | 26.32 | 22.06 | 1.16 | 1.03 | 22.0 | 22.0 | 1720 | 1965. | 150 |
| 24 | 24 | 26.32 | 26.32 | 1.16 | 1.16 | 22.0 | 22.0 | 1815 | 2155 | 150 |
| 30 | 6 | 32.00 | 7.10 | 1.03 | .55 | 18.0 | 23.0 | 1730 | 1770 | 150 |
| 30 | 8 | 32.00 | 9.30 | 1.03 | .60 | 18.0 | 23.0 | 1745 | 1795 | 150 |
| 30 | 10 | 32.00 | 11.40 | 1.03 | .68 | 18.0 | 23.0 | 1760 | 1830 | 150 |
| 30 | 12 | 32.00 | 13.50 | 1.03 | .75 | 18.0 | 23.0 | 1780 | 1865 | 150 |
| 30 | 14 | 32.00 | 15.30 | 1.03 | .66 | 18.0 | 23.0 | 1800 | 1905 | 150 |
| 30 | 16 | 32.00 | 17.40 | 1.03 | .70 | 18.0 | 23.0 | 1820 | 1950 | 150 |
| 30 | 18 | 32.00 | 19.50 | 1.03 | .75 | 18.0 | 23.0 | 1845 | 2000 | 150 |
| 30 | 20 | 32.00 | 21.60 | 1.03 | .80 | 18.0 | 23.0 | 1875 | 2060 | 150 |
| 30 | 24 | 32.74 | 26.32 | 1.37 | 1.16 | 25.0 | 25.0 | 2880 | 3180 | 150 |
| 30 | 30 | 32.74 | 32.74 | 1.37 | 1.37 | 25.0 | 25.0 | 3105 | 3640 | 150 |
| 36 | 8 | 38.30 | 9.30 | 1.15 | .60 | 20.0 | 26.0 | 2520 | 2565 | 150 |
| 36 | 10 | 38.30 | 11.40 | 1.15 | .68 | 20.0 | 26.0 | 2535 | 2600 | 150 |
| 36 | 12 | 38.30 | 13.50 | 1.15 | .75 | 20.0 | 26.0 | 2550 | 2630 | 150 |
| 36 | 14 | 38.30 | 15.30 | 1.15 | .66 | 20.0 | 26.0 | 2570 | 2665 | 150 |
| 36 | 16 | 38.30 | 17.40 | 1.15 | .70 | 20.0 | 26.0 | 2585 | 2705 | 150 |
| 36 | 18 | 38.30 | 19.50 | 1.15 | .75 | 20.0 | 26.0 | 2610 | 2750 | 150 |
| 36 | 20 | 38.30 | 21.60 | 1.15 | .80 | 20.0 | 26.0 | 2635 | 2805 | 150 |
| 36 | 24 | 38.30 | 25.80 | 1.15 | .89 | 20.0 | 26.0 | 2690 | 2910 | 150 |
| 36 | 30 | 39.16 | 32.74 | 1.58 | 1.37 | 28.0 | 28.0 | 4345 | 4790 | 150 |
| 36 | 36 | 39.16 | 39.16 | 1.58 | 1.58 | 28.0 | 28.0 | 4590 | 5280 | 150 |
| 42 | 12 | 44.50 | 13.50 | 1.28 | .75 | 23.0 | 30.0 | 3555 | 3640 | 150 |
| 42 | 14 | 44.50 | 15.30 | 1.28 | .66 | 23.0 | 30.0 | 3575 | 3675 | 150 |
| 42 | 16 | 44.50 | 17.40 | 1.28 | .70 | 23.0 | 30.0 | 3595 | 3715 | 150 |
| 42 | 18 | 44.50 | 19.50 | 1.28 | .75 | 23.0 | 30.0 | 3615 | 3755 | 150 |
| 42 | 20 | 44.50 | 21.60 | 1.28 | .80 | 23.0 | 30.0 | 3640 | 3810 | 150 |
| 42 | 24 | 44.50 | 25.80 | 1.28 | .89 | 23.0 | 30.0 | 3690 | 3910 | 150 |
| 42 | 30 | 44.50 | 32.00 | 1.28 | 1.03 | 31.0 | 31.0 | 4650 | 5040 | 150 |
| 42 | 36 | 45.58 | 39.16 | 1.78 | 1.58 | 31.0 | 31.0 | 6075 | 6655 | 150 |
| 42 | 42 | 45.58 | 45.58 | 1.78 | 1.78 | 31.0 | 31.0 | 6320 | 7145 | 150 |
| 48 | 12 | 50.80 | 13.50 | 1.42 | .75 | 26.0 | 34.0 | 4870 | 4955 | 150 |
| 48 | 14 | 50.80 | 15.30 | 1.42 | .66 | 26.0 | 34.0 | 4885 | 4985 | 150 |
| 48 | 16 | 50.80 | 17.40 | 1.42 | .70 | 26.0 | 34.0 | 4905 | 5025 | 150 |
| 48 | 18 | 50.80 | 19.50 | 1.42 | .75 | 26.0 | 34.0 | 4925 | 5065 | 150 |
| 48 | 20 | 50.80 | 21.60 | 1.42 | .80 | 26.0 | 34.0 | 4950 | 5115 | 150 |
| 48 | 24 | 50.80 | 25.80 | 1.42 | .89 | 26.0 | 34.0 | 4995 | 5210 | 150 |
| 48 | 30 | 50.80 | 32.00 | 1.42 | 1.03 | 26.0 | 34.0 | 5140 | 5495 | 150 |
| 48 | 36 | 50.80 | 38.30 | 1.42 | 1.15 | 34.0 | 34.0 | 6280 | 6790 | 150 |
| 48 | 42 | 51.98 | 45.58 | 1.96 | 1.78 | 34.0 | 34.0 | 8130 | 8815 | 150 |
| 48 | 48 | 51.98 | 51.98 | 1.96 | 1.96 | 34.0 | 34.0 | 8420 | 9380 | 150 |

All weights are approximate and do not include joint accessories.
See page 242 for joint dimensions and weight of joint accessories.




CONCENTRIC



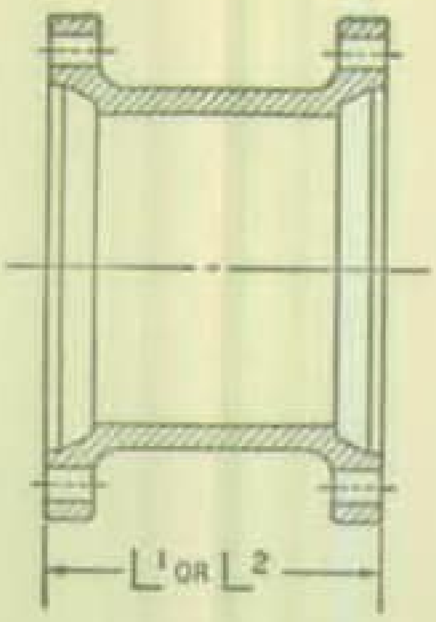

ECCENTRIC

# Reducers

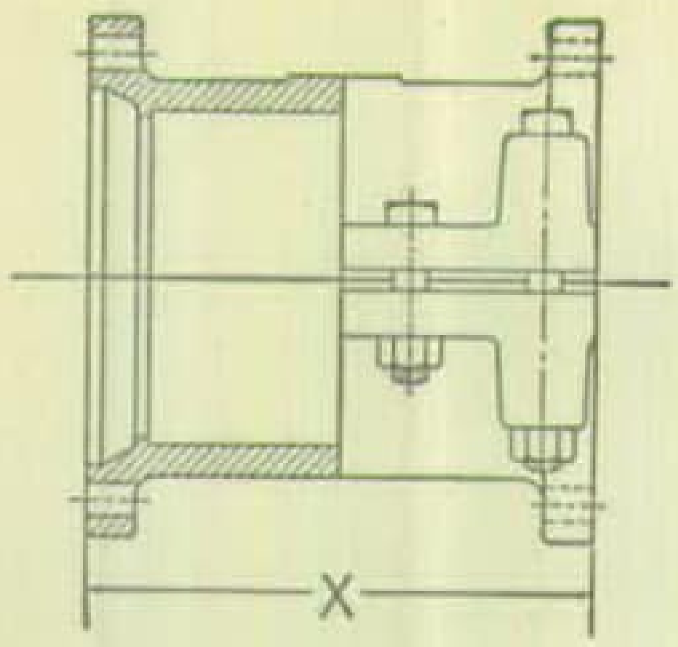
TABLE OF DIMENSIONS

| Nominal Diam. | | Outside Diam. | | Metal Thickness | | Bell & Bell | | Large End Bell | | Small End Bell | | Max. Working Pressure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | D' | Large | Small | T | T' | L | Weight | L | Weight | L | Weight | |
| 4 | 3 | 5.00 | 3.96 | .52 | .48 | 7 | 40 | 15 | 40 | 15 | 35 | 250 |
| 6 | 3 | 7.10 | 3.96 | .55 | .48 | 9 | 55 | 17 | 55 | 17 | 50 | 250 |
| 6 | 4 | 7.10 | 5.00 | .55 | .52 | 9 | 60 | 17 | 60 | 17 | 60 | 250 |
| 8 | 4 | 9.30 | 5.00 | .60 | .52 | 11 | 80 | 19 | 80 | 19 | 80 | 250 |
| 8 | 6 | 9.30 | 7.10 | .60 | .55 | 11 | 95 | 19 | 90 | 19 | 90 | 250 |
| 10 | 4 | 11.40 | 5.00 | .68 | .52 | 12 | 105 | 20 | 100 | 20 | 100 | 250 |
| 10 | 6 | 11.40 | 7.10 | .68 | .55 | 12 | 115 | 20 | 115 | 20 | 115 | 250 |
| 10 | 8 | 11.40 | 9.30 | .68 | .60 | 12 | 135 | 20 | 130 | 20 | 130 | 250 |
| 12 | 4 | 13.50 | 5.00 | .75 | .52 | 14 | 135 | 22 | 130 | 22 | 130 | 250 |
| 12 | 6 | 13.50 | 7.10 | .75 | .55 | 14 | 150 | 22 | 145 | 22 | 150 | 250 |
| 12 | 8 | 13.50 | 9.30 | .75 | .60 | 14 | 165 | 22 | 165 | 22 | 165 | 250 |
| 12 | 10 | 13.50 | 11.40 | .75 | .68 | 14 | 190 | 22 | 185 | 22 | 190 | 250 |
| 14 | 6 | 15.30 | 7.10 | .66 | .55 | 16 | 190 | 24 | 185 | 24 | 175 | 150 |
| 14 | 8 | 15.30 | 9.30 | .66 | .60 | 16 | 210 | 24 | 205 | 24 | 190 | 150 |
| 14 | 10 | 15.30 | 11.40 | .66 | .68 | 16 | 230 | 24 | 230 | 24 | 215 | 150 |
| 14 | 12 | 15.30 | 13.50 | .66 | .75 | 16 | 255 | 24 | 255 | 24 | 240 | 150 |
| 16 | 6 | 17.40 | 7.10 | .70 | .55 | 18 | 230 | 26 | 230 | 26 | 210 | 150 |
| 16 | 8 | 17.40 | 9.30 | .70 | .60 | 18 | 250 | 26 | 250 | 26 | 230 | 150 |
| 16 | 10 | 17.40 | 11.40 | .70 | .68 | 18 | 280 | 26 | 275 | 26 | 255 | 150 |
| 16 | 12 | 17.40 | 13.50 | .70 | .75 | 18 | 305 | 26 | 305 | 26 | 285 | 150 |
| 16 | 14 | 17.40 | 15.30 | .70 | .66 | 18 | 335 | 26 | 315 | 26 | 310 | 150 |
| 18 | 8 | 19.50 | 9.30 | .75 | .60 | 19 | 295 | 27 | 295 | 27 | 270 | 150 |
| 18 | 10 | 19.50 | 11.40 | .75 | .68 | 19 | 325 | 27 | 320 | 27 | 300 | 150 |
| 18 | 12 | 19.50 | 13.50 | .75 | .75 | 19 | 350 | 27 | 350 | 27 | 325 | 150 |
| 18 | 14 | 19.50 | 15.30 | .75 | .66 | 19 | 380 | 27 | 365 | 27 | 355 | 150 |
| 18 | 16 | 19.50 | 17.40 | .75 | .70 | 19 | 415 | 27 | 395 | 27 | 390 | 150 |
| 20 | 10 | 21.60 | 11.40 | .80 | .68 | 20 | 375 | 28 | 375 | 28 | 345 | 150 |
| 20 | 12 | 21.60 | 13.50 | .80 | .75 | 20 | 405 | 28 | 405 | 28 | 375 | 150 |
| 20 | 14 | 21.60 | 15.30 | .80 | .66 | 20 | 430 | 28 | 415 | 28 | 400 | 150 |
| 20 | 16 | 21.60 | 17.40 | .80 | .70 | 20 | 470 | 28 | 445 | 28 | 435 | 150 |
| 20 | 18 | 21.60 | 19.50 | .80 | .75 | 20 | 510 | 28 | 485 | 28 | 475 | 150 |
| 24 | 12 | 25.80 | 13.50 | .89 | .75 | 24 | 550 | 32 | 550 | 32 | 510 | 150 |
| 24 | 14 | 25.80 | 15.30 | .89 | .66 | 24 | 575 | 32 | 560 | 32 | 535 | 150 |
| 24 | 16 | 25.80 | 17.40 | .89 | .70 | 24 | 615 | 32 | 595 | 32 | 575 | 150 |
| 24 | 18 | 25.80 | 19.50 | .89 | .75 | 24 | 660 | 32 | 635 | 32 | 620 | 150 |
| 24 | 20 | 25.80 | 21.60 | .89 | .80 | 24 | 705 | 32 | 675 | 32 | 665 | 150 |
| 30 | 18 | 32.00 | 19.50 | 1.03 | .75 | 30 | 990 | 38 | 965 | 38 | 885 | 150 |
| 30 | 20 | 32.00 | 21.60 | 1.03 | .80 | 30 | 1050 | 38 | 1020 | 38 | 945 | 150 |
| 30 | 24 | 32.00 | 25.80 | 1.03 | .89 | 30 | 1165 | 38 | 1125 | 38 | 1060 | 150 |
| 36 | 20 | 38.30 | 21.60 | 1.15 | .80 | 36 | 1450 | 44 | 1420 | 44 | 1285 | 150 |
| 36 | 24 | 38.30 | 25.80 | 1.15 | .89 | 36 | 1580 | 44 | 1535 | 44 | 1410 | 150 |
| 36 | 30 | 38.30 | 32.00 | 1.15 | 1.03 | 36 | 1855 | 44 | 1750 | 44 | 1690 | 150 |
| 42 | 20 | 44.50 | 21.60 | 1.28 | .80 | 42 | 1915 | 50 | 1880 | 50 | 1705 | 150 |
| 42 | 24 | 44.50 | 25.80 | 1.28 | .89 | 42 | 2060 | 50 | 2020 | 50 | 1855 | 150 |
| 42 | 30 | 44.50 | 32.00 | 1.28 | 1.03 | 42 | 2370 | 50 | 2265 | 50 | 2165 | 150 |
| 42 | 36 | 44.50 | 38.30 | 1.28 | 1.15 | 42 | 2695 | 50 | 2530 | 50 | 2485 | 150 |
| 48 | 30 | 50.80 | 32.00 | 1.42 | 1.03 | 48 | 3005 | 56 | 2900 | 56 | 2740 | 150 |
| 48 | 36 | 50.80 | 38.30 | 1.42 | 1.15 | 48 | 3370 | 56 | 3205 | 56 | 3100 | 150 |
| 48 | 42 | 50.80 | 44.50 | 1.42 | 1.28 | 48 | 3750 | 56 | 3540 | 56 | 3480 | 150 |

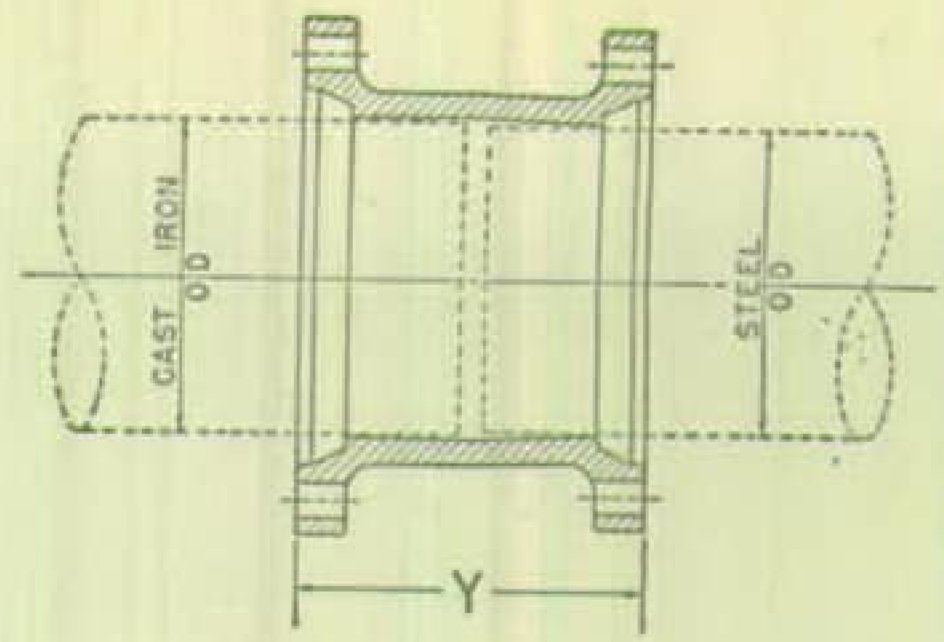
All weights are approximate and do not include joint accessories.
See page 242 for joint dimensions and weight of joint accessories.
Three to twelve-inch fittings conform to A.S.A. Specification—A-21.10—for short body fittings.




SOLID SLEEVE




SPLIT SLEEVE*




TRANSITION SLEEVE**

# Sleeves

TABLE OF DIMENSIONS

| Nominal Diam. | T | Fits O. D. C. I. Pipe | Solid Sleeves L¹ | Solid Sleeves Weight | Solid Sleeves L² | Solid Sleeves Weight | Split Sleeves X Min. | Transition Sleeves Fits O. D. Steel Pipe | Transition Sleeves Y | Transition Sleeves Weight | Max. Working Pressure |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | .48 | 3.96 | 7.5 | 25 | 12 | 30 | 10 | 3.50 | 7.50 | 25 | 250 |
| 4 | .52 | 4.80 | 7.5 | 35 | 12 | 45 | 10 | 4.50 | 7.50 | 35 | 250 |
| 6 | .55 | 6.90 | 7.5 | 45 | 12 | 65 | 10 | 6.62 | 7.50 | 45 | 250 |
| 8 | .60 | 9.05 | 7.5 | 65 | 12 | 85 | 10 | 8.62 | 7.50 | 65 | 250 |
| 10 | .68 | 11.10 | 7.5 | 85 | 12 | 115 | 10 | 10.75 | 7.50 | 85 | 250 |
| 12 | .75 | 13.20 | 7.5 | 110 | 12 | 145 | 10 | 12.75 | 7.50 | 110 | 250 |
| 14 | .82 | 15.30 | 9.5 | 165 | 15 | 225 | 11 | | | | 150 |
| 16 | .89 | 17.40 | 9.5 | 200 | 15 | 275 | 11 | | | | 150 |
| 18 | .96 | 19.50 | 9.5 | 240 | 15 | 330 | 11 | | | | 150 |
| 20 | 1.03 | 21.60 | 9.5 | 275 | 15 | 380 | 11 | | | | 150 |
| 24 | 1.16 | 25.80 | 9.5 | 360 | 15 | 505 | 11 | | | | 150 |
| 30 | 1.37 | 32.00 | 15.0 | 745 | 24 | 1085 | 15 | | | | 150 |
| 36 | 1.58 | 38.30 | 15.0 | 1030 | 24 | 1495 | 15 | | | | 150 |
| 42 | 1.78 | 44.50 | 15.0 | 1330 | 24 | 1940 | 15 | | | | 150 |
| 48 | 1.96 | 50.80 | 15.0 | 1645 | 24 | 2405 | 15 | | | | 150 |

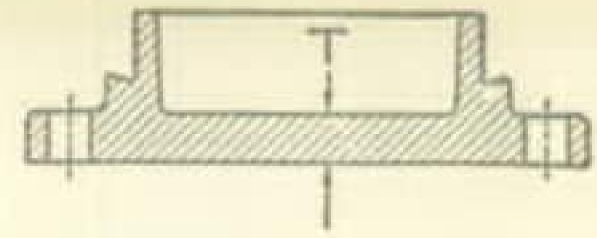
* This split sleeve can be furnished with boss and tap for service connection.

** Transition sleeves are furnished with one end designed for standard steel outside diameter pipe and the other to fit mechanical joint cast iron pipe.

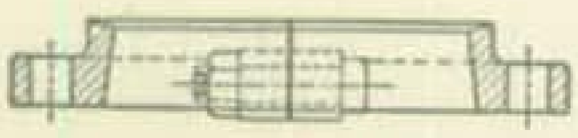
All weights are approximate and do not include joint accessories.

See page 242 for joint dimensions and weight of joint accessories.

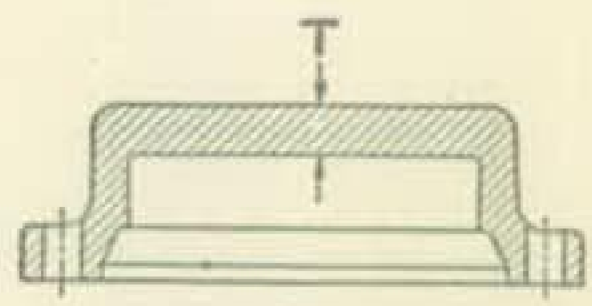
GLAND




PLUG



SPLIT GLAND




CAP

# Glands, Plugs and Caps

| TABLE OF DIMENSIONS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Weights | | | | Weights | | Max. Working Pressure |
| Nominal Diam. | Solid Glands | Split Glands | Design | T | Plugs | Caps | |
| 3 | 5 | 9 | Flat | .75 | 14 | 13 | 250 |
| 4 | 6 | 14 | Flat | .75 | 20 | 20 | 250 |
| 6 | 11 | 18 | Flat | .75 | 30 | 30 | 250 |
| 8 | 18 | 20 | Flat | .75 | 50 | 45 | 250 |
| 10 | 20 | 30 | Flat | .75 | 65 | 55 | 250 |
| 12 | 30 | 35 | Flat | .75 | 85 | 75 | 250 |
| 14 | 35 | 60 | Dished | .82 | 115 | 120 | 150 |
| 16 | 45 | 70 | Dished | .89 | 150 | 155 | 150 |
| 18 | 55 | 85 | Dished | .96 | 195 | 190 | 150 |
| 20 | 70 | 100 | Dished | 1.03 | 225 | 240 | 150 |
| 24 | 90 | 130 | Dished | 1.16 | 330 | 345 | 150 |
| 30 | 180 | 205 | Dished & Ribbed | 1.37 | 590 | 660 | 150 |
| 36 | 235 | 265 | Dished & Ribbed | 1.58 | 880 | 960 | 150 |
| 42 | 300 | 330 | Dished & Ribbed | 1.78 | 1250 | 1355 | 150 |
| 48 | 365 | 400 | Dished & Ribbed | 1.96 | 1670 | 1830 | 150 |

All weights are approximate.
See page 242 for joint dimensions and weight of joint accessories.

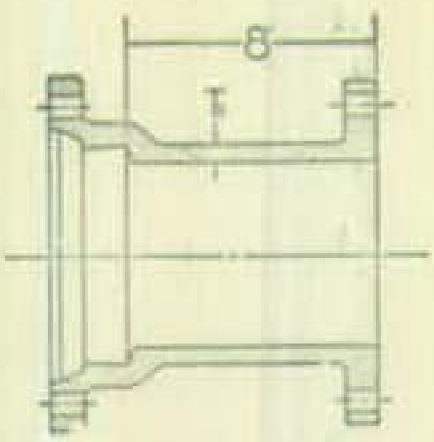



Figure A

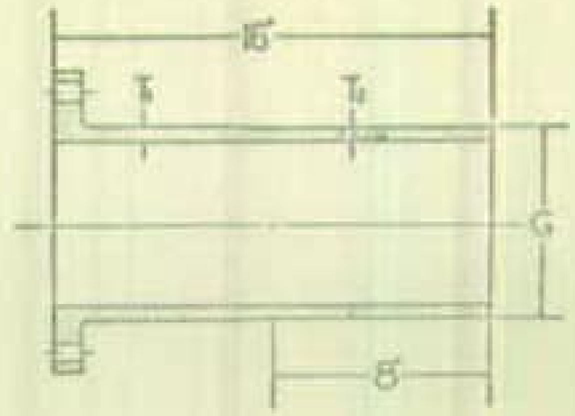



Figure B

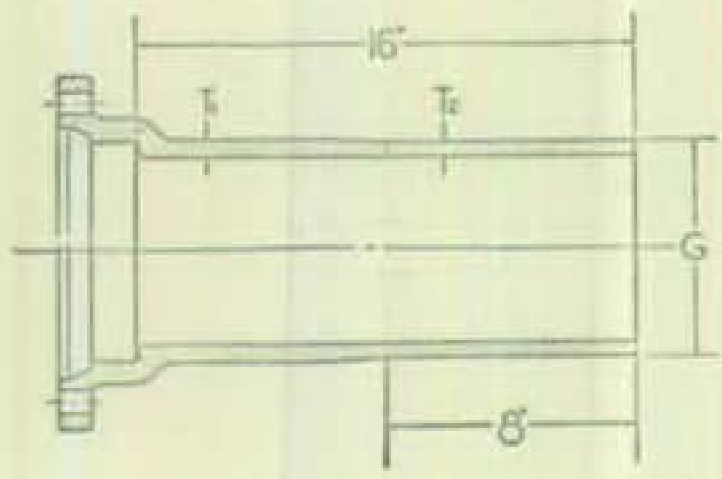



Figure C

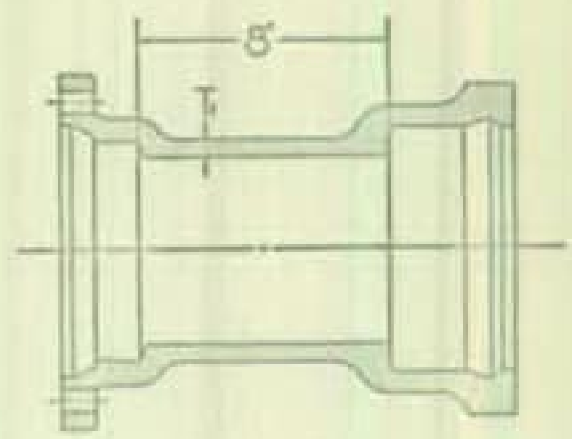



Figure D

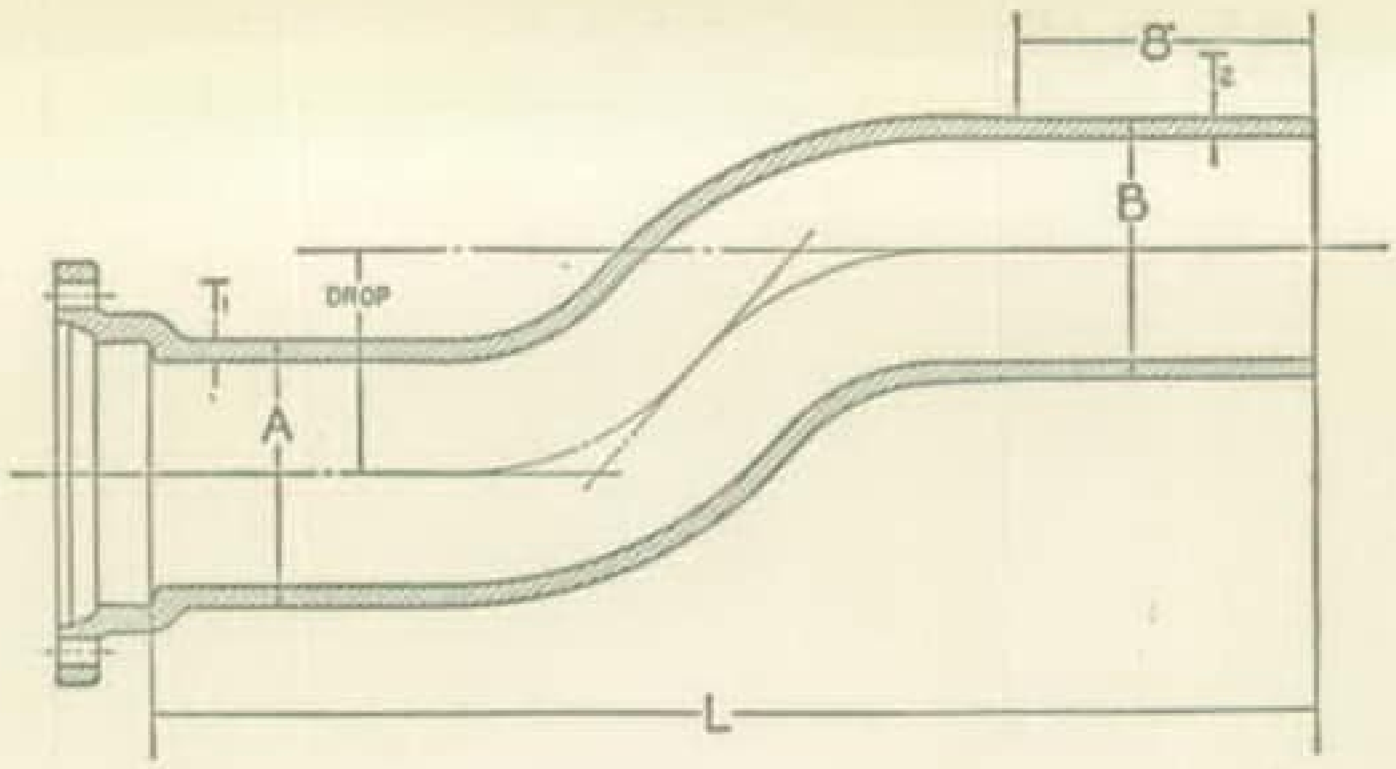
*All flanges are American 125 standard unless otherwise specified.*

# Connecting Pieces

TABLE OF DIMENSIONS

| | | | | | A | B | C | D | E* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Diam. | Body O. D. | $T_1$ | P. E. Diam. "G" | $T_2$ | MJ & Flg Weight | Flg. & PE Weight | MJ & PE Weight | MJ & B Weight | MJ & MJ Weight | Max. Working Pressure |
| 3 | 3.96 | .48 | 3.96 | .48 | 30 | 30 | 35 | 40 | 35 | 250 |
| 4 | 5.00 | .52 | 4.80 | .45 | 40 | 40 | 45 | 55 | 45 | 250 |
| 6 | 7.10 | .55 | 6.90 | .48 | 60 | 55 | 65 | 80 | 70 | 250 |
| 8 | 9.30 | .60 | 9.05 | .51 | 85 | 85 | 95 | 115 | 95 | 250 |
| 10 | 11.40 | .68 | 11.10 | .57 | 115 | 115 | 125 | 150 | 130 | 250 |
| 12 | 13.50 | .75 | 13.20 | .62 | 155 | 155 | 165 | 190 | 165 | 250 |
| 14 | 15.30 | .66 | 15.30 | .66 | 195 | 180 | 205 | 230 | 220 | 150 |
| 16 | 17.40 | .70 | 17.40 | .70 | 240 | 220 | 250 | 290 | 270 | 150 |
| 18 | 19.50 | .75 | 19.50 | .75 | 280 | 255 | 300 | 340 | 325 | 150 |
| 20 | 21.60 | .80 | 21.60 | .80 | 340 | 305 | 360 | 405 | 390 | 150 |
| 24 | 25.80 | .89 | 25.80 | .89 | 455 | 415 | 475 | 530 | 515 | 150 |
| 30 | 32.00 | 1.03 | 32.00 | 1.03 | 710 | 600 | 730 | 820 | 840 | 150 |
| 36 | 38.30 | 1.15 | 38.30 | 1.15 | 1000 | 830 | 1005 | 1170 | 1170 | 150 |
| 42 | 44.50 | 1.28 | 44.50 | 1.28 | 1325 | 1115 | 1295 | 1515 | 1500 | 150 |
| 48 | 50.80 | 1.42 | 50.80 | 1.42 | 1655 | 1390 | 1640 | 1930 | 1910 | 150 |

Fittings shown in Fig. B and C may be furnished from centrifugally cast pipe.
*Figure E is a mechanical joint-to-mechanical joint connecting piece having laying length of 8".
All weights are approximate.
See page 242 for joint dimensions and weight of joint accessories.

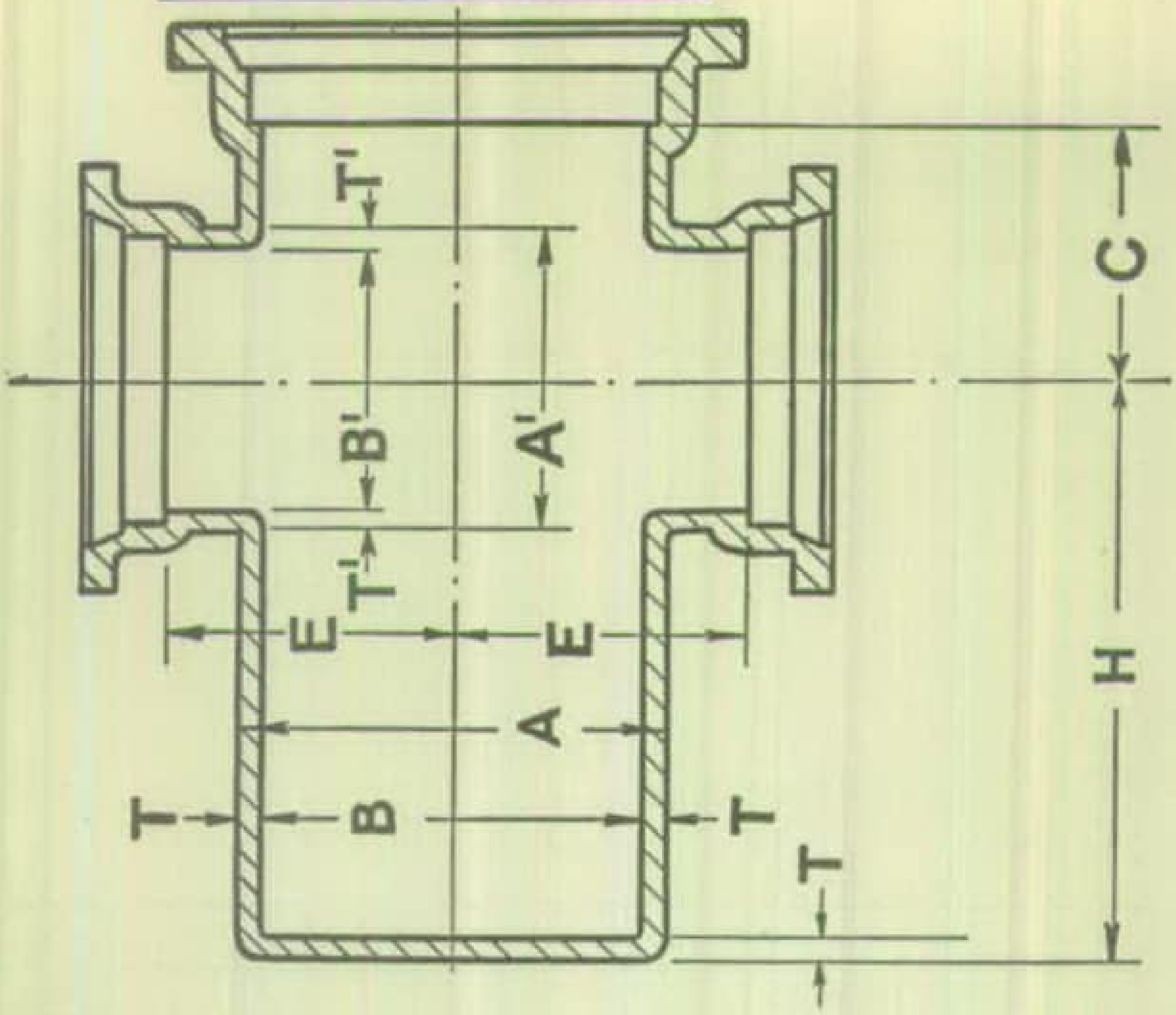



# Offsets

| TABLE OF DIMENSIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nominal Diam. | Plain End Diam. | Outside Diam. A | Drop | L | $T_1$ | $T_2$ | Weight | Max. Working Pressure |
| 3 | 3.96 | 3.96 | 6 | 27 | .48 | .48 | 50 | 250 |
| 3 | 3.96 | 3.96 | 12 | 30 | .48 | .48 | 60 | 250 |
| 3 | 3.96 | 3.96 | 18 | 38 | .48 | .48 | 75 | 250 |
| 4 | 4.80 | 5.00 | 6 | 27 | .52 | .45 | 70 | 250 |
| 4 | 4.80 | 5.00 | 12 | 30 | .52 | .45 | 80 | 250 |
| 4 | 4.80 | 5.00 | 18 | 38 | .52 | .45 | 100 | 250 |
| 6 | 6.90 | 7.10 | 6 | 28 | .55 | .48 | 105 | 250 |
| 6 | 6.90 | 7.10 | 12 | 34 | .55 | .48 | 130 | 250 |
| 6 | 6.90 | 7.10 | 18 | 41 | .55 | .48 | 160 | 250 |
| 8 | 9.05 | 9.30 | 6 | 29 | .60 | .51 | 155 | 250 |
| 8 | 9.05 | 9.30 | 12 | 36 | .60 | .51 | 195 | 250 |
| 8 | 9.05 | 9.30 | 18 | 43 | .60 | .51 | 240 | 250 |
| 10 | 11.10 | 11.40 | 6 | 30 | .68 | .57 | 220 | 250 |
| 10 | 11.10 | 11.40 | 12 | 38 | .68 | .57 | 280 | 250 |
| 10 | 11.10 | 11.40 | 18 | 46 | .68 | .57 | 340 | 250 |
| 12 | 13.20 | 13.50 | 6 | 34 | .75 | .62 | 320 | 250 |
| 12 | 13.20 | 13.50 | 12 | 45 | .75 | .62 | 420 | 250 |
| 12 | 13.20 | 13.50 | 18 | 56 | .75 | .62 | 520 | 250 |

All weights are approximate.
See page 242 for joint dimensions and weight of joint accessories.

# 3"- 24" DRIP POTS




## Drip Pots

| DIMENSIONS IN INCHES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | A' | A | B' | B | C | E | H | T' | T | Plug Size | Cap., qts. | Wts., lbs. |
| 4 | 5.00 | 15.30 | 3.96 | 13.98 | 6.00 | 10.75 | 14.75<br>26.75 | .52 | .66 | 14 | 32<br>64 | 435<br>530 |
| 6 | 7.10 | 15.30 | 6.00 | 13.98 | 7.12 | 10.75 | 15.75<br>27.75 | .55 | .66 | 14 | 32<br>64 | 465<br>560 |
| 8 | 9.30 | 15.30 | 8.10 | 13.98 | 8.25 | 10.75 | 28.75<br>40.88 | .60 | .66 | 14 | 64<br>96 | 595<br>695 |
| 10 | 11.40 | 15.30 | 10.04 | 13.98 | 9.25 | 10.75 | 29.75<br>41.88 | .68 | .66 | 14 | 64<br>96 | 645<br>740 |
| 12 | 13.50 | 17.40 | 12.00 | 16.00 | 10.25 | 11.75 | 30.88<br>42.88 | .75 | .70 | 16 | 84<br>126 | 815<br>930 |
| 16 | 17.40 | 21.60 | 16.00 | 20.00 | 12.25 | 14.38 | 34.12<br>45.88 | .70 | .80 | 20 | 138<br>208 | 1285<br>1460 |
| 20 | 21.60 | 25.80 | 20.00 | 24.02 | 15.38 | 16.50 | 36.75<br>49.62 | .80 | .89 | 24 | 203<br>304 | 1875<br>2110 |
| 24 | 25.80 | 32.00 | 24.02 | 29.94 | 17.50 | 20.50 | 36.12<br>47.62 | .89 | 1.03 | 30 | 280<br>420 | 2895<br>3195 |

All weights are approximate and do not include joint accessories.
See page 242 for joint dimensions and weight of joint accessories.
Three to twelve-inch fittings conform to A.S.A. Specification—A-21.10—for short body fittings.

# SECTION 11

## Federal Specifications—WW-P-421

# Federal Specification WW-P-421, July 21, 1931
# (with Amendment 3, April 1940)
# for
# Pipe; Water, Cast Iron (Bell and Spigot)*

**For details of the above Specification, see Section IV (Part 5) of Federal Standard Stock Catalogue, available for sale by the Superintendent of Documents, Washington, D. C.**

**The WW-P-421 Specification has been in general use for centrifugally Cast Cast-Iron Pressure Pipe for Water or Other Liquids, not only by the departments and independent establishments of the Government but also by most other consumers and manufacturers, prior to the issuance of A.S.A. Specifications A.S.A. A21.6 and A.S.A. A21.8.**

**For the convenience of the users of the Handbook, listed below are the more important requirements, dimensions and weights.**

E. DETAIL REQUIREMENTS.

E-1. Tolerances in thickness.—

E-1a. The tolerances in thickness of pipe, plus or minus, shall not exceed those listed below.

| Nominal diameter in inches: | Tolerance, plus or minus (inch) |
|---|---|
| 4 | 0.04 |
| 6 | 0.045 |
| 8 | 0.05 |
| 10 | 0.055 |
| 12 | 0.06 |
| 14, 16, 18, 20, 24 | 0.08 |

E-1b. For all sizes of pipe, tolerances not exceeding 0.02 inch additional to above will be allowed for spaces not exceeding 8 inches in length in any direction.

E-2. Tolerance in weight.—The weight of no single pipe shall be less than the nominal tabulated weight by more than 5 per cent. The total weight of any order shall be not more than 2 per cent under nominal weight.

*For weights of Federal Specification Pipe (WW-P-421) see pages 262 to 269.

**E-3. Type I—Centrifugally cast in metal contact molds in 12-foot and 18-foot lengths.**

E-3a. Type I pipe shall be of the bell and spigot type, centrifugally cast in metal contact molds with plain spigot end, and with lead groove and self-centering shoulder in the bell.

E-3b. Annealing.—Type I pipe, after withdrawing from machines, shall be annealed to meet the hardness limits specified in paragraph F-6.

E-3c. Physical requirements.—Type I pipe shall have a secant modulus of elasticity (see par. F-4b) not to exceed 12,000,000 pounds per square inch with a corresponding modulus of rupture not less than 40,000 pounds per square inch.

E-3d. Tolerances in diameter.—The inside diameters of the bells and the outside diameters of the spigot ends of Type I pipe shall not vary plus or minus from the tabulated dimensions by more than 0.06 inch for pipe 12 inches and less in nominal diameter and 0.08 inch for pipe 14 inches and larger.

E-3e. Dimensions and weights.—Type I pipe shall conform to the dimensions and weights given in Figure 1 and Tables I and II for the respective classes and subject to the tolerances given in paragraphs E-1a, E-1b, E-2, and E-3d.

**E-4. Type II.—Centrifugally cast in sand-lined molds in 16-foot, 16½-foot, and 20-foot lengths.**

E-4a. Type II pipe shall be of the bell and spigot type, centrifugally cast in sand-lined molds; with bead cast on spigot end; and with lead groove in the bell.

E-4b. Physical Requirements.—Type II pipe shall have a secant modulus of elasticity (see par. F-4b) not to exceed 10,000,000 pounds per square inch, with a corresponding modulus of rupture not less than 40,000 pounds per square inch. Where the modulus of elasticity exceeds 10,000,000 pounds the modulus of rupture shall exceed 40,000 pounds by at least the same percentage.

E-4c. Tolerances in diameter.—The inside diameters of the bells and the outside diameters of the spigot ends (exclusive of bead) of type II pipe shall not vary plus or minus from the tabulated dimensions by more than 0.06 inch for pipe 12 inches and less in nominal diameter, and 0.08 inch for pipe 14 inches and larger.

E-4d. Dimensions and weights.—Type II pipe shall conform to the dimensions and weights given in Figure 2 and Tables III and IV for the respective classes and subject to the tolerances given in paragraphs E-1a, E-1b, E-2, and E-4c.

## Dimensions of Type I Pipe (inches)

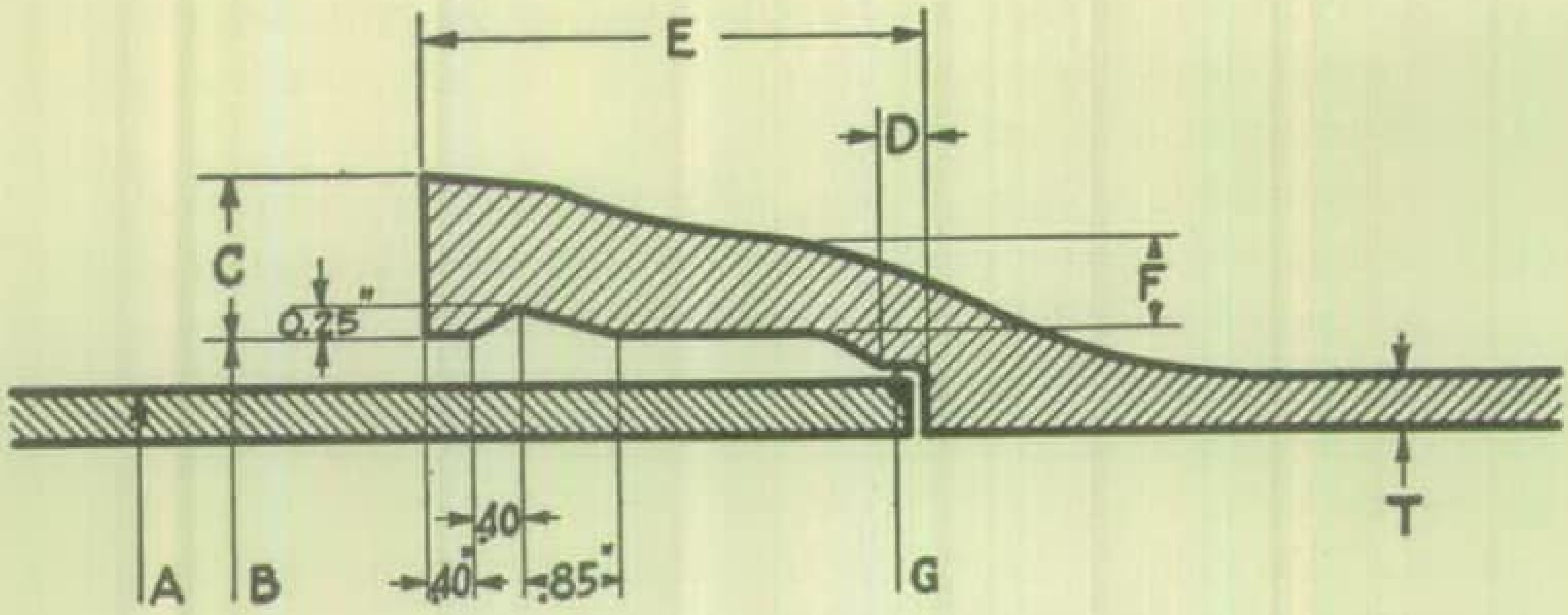



*FIGURE 1—TYPE I PIPE, END DETAILS*

TABLE I

| Nominal Inside Diameter | Outside Diameter of Pipe | Inside Diameter of Bells | Total Depth of Bells | Depth of Centering Shoulder | Inside Diameter of Centering Shoulder | Class 150, 150 Pounds Working Pressure, 346-Foot Head | | | Class 250, 250 Pounds Working Pressure, 576-Foot Head | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Thickness of Pipe | Thickness of Bells | | Thickness of Pipe | Thickness of Bells | |
| | | | | | | | At End | At Shoulder | | At End | At Shoulder |
| | A | B | E | D | G | T | C | F | T | C | F |
| 4 | 4.80 | 5.60 | 3.30 | 0.30 | 4.94 | 0.34 | 1.06 | 0.48 | 0.38 | 1.06 | 0.48 |
| 6 | 6.90 | 7.70 | 3.88 | 0.38 | 7.06 | 0.37 | 1.13 | 0.52 | 0.43 | 1.13 | 0.52 |
| 8 | 9.05 | 9.85 | 4.38 | 0.38 | 9.21 | 0.42 | 1.18 | 0.57 | 0.50 | 1.18 | 0.57 |
| 10 | 11.10 | 11.90 | 4.38 | 0.38 | 11.28 | 0.47 | 1.23 | 0.63 | 0.57 | 1.23 | 0.63 |
| 12 | 13.20 | 14.00 | 4.38 | 0.38 | 13.38 | 0.50 | 1.28 | 0.69 | 0.62 | 1.28 | 0.69 |
| 14 | 15.65 | 16.45 | 4.50 | 0.50 | 15.87 | 0.55 | 1.35 | 0.73 | 0.69 | 1.56 | 0.93 |
| 16 | 17.80 | 18.80 | 4.50 | 0.50 | 18.02 | 0.60 | 1.43 | 0.77 | 0.75 | 1.63 | 1.00 |
| 18 | 19.92 | 20.92 | 4.50 | 0.50 | 20.14 | 0.65 | 1.53 | 0.82 | 0.83 | 1.68 | 1.09 |
| 20 | 22.06 | 23.06 | 4.50 | 0.50 | 22.28 | 0.68 | 1.63 | 0.87 | 0.88 | 1.75 | 1.18 |
| 24 | 26.32 | 27.32 | 4.50 | 0.50 | 26.54 | 0.76 | 1.83 | 1.03 | 1.00 | 2.00 | 1.38 |

## Nominal weights of Type 1 pipe (pounds)

TABLE II

| Nominal Inside Diameter | Class 150, 150 Pounds Working Pressure, 346-Foot Head | | | | Class 250, 250 Pounds Working Pressure, 576-Foot Head | | | |
|---|---|---|---|---|---|---|---|---|
| | 12-Foot Nominal Laying Length | | 18-Foot Nominal Laying Length | | 12-Foot Nominal Laying Length | | 18-Foot Nominal Laying Length | |
| | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell |
| 4 | 195 | 16.4 | 285 | 15.9 | 220 | 18.4 | 325 | 17.9 |
| 6 | 315 | 26.3 | 460 | 25.5 | 350 | 29.3 | 515 | 28.5 |
| 8 | 475 | 39.4 | 690 | 38.3 | 545 | 45.5 | 800 | 44.3 |
| 10 | 640 | 53.3 | 935 | 51.8 | 760 | 63.3 | 1,115 | 61.9 |
| 12 | 810 | 67.4 | 1,180 | 65.6 | 990 | 82.5 | 1,450 | 80.7 |
| 14 | 1,060 | 88.5 | 1,555 | 86.3 | 1,320 | 110.0 | 1,930 | 107.3 |
| 16 | 1,320 | 110.2 | 1,935 | 107.4 | 1,635 | 136.1 | 2,390 | 132.7 |
| 18 | 1,595 | 132.8 | 2,330 | 129.6 | 2,015 | 168.0 | 2,950 | 163.9 |
| 20 | 1,860 | 155.0 | 2,720 | 151.0 | 2,365 | 197.1 | 3,465 | 192.4 |
| 24 | 2,480 | 206.8 | 3,630 | 201.6 | 3,200 | 266.8 | 4,690 | 260.6 |

NOTE: Calculated weight of pipe has been rounded off to nearest 5 pounds. Weight per foot is based on weight of pipe computed to nearest pound.

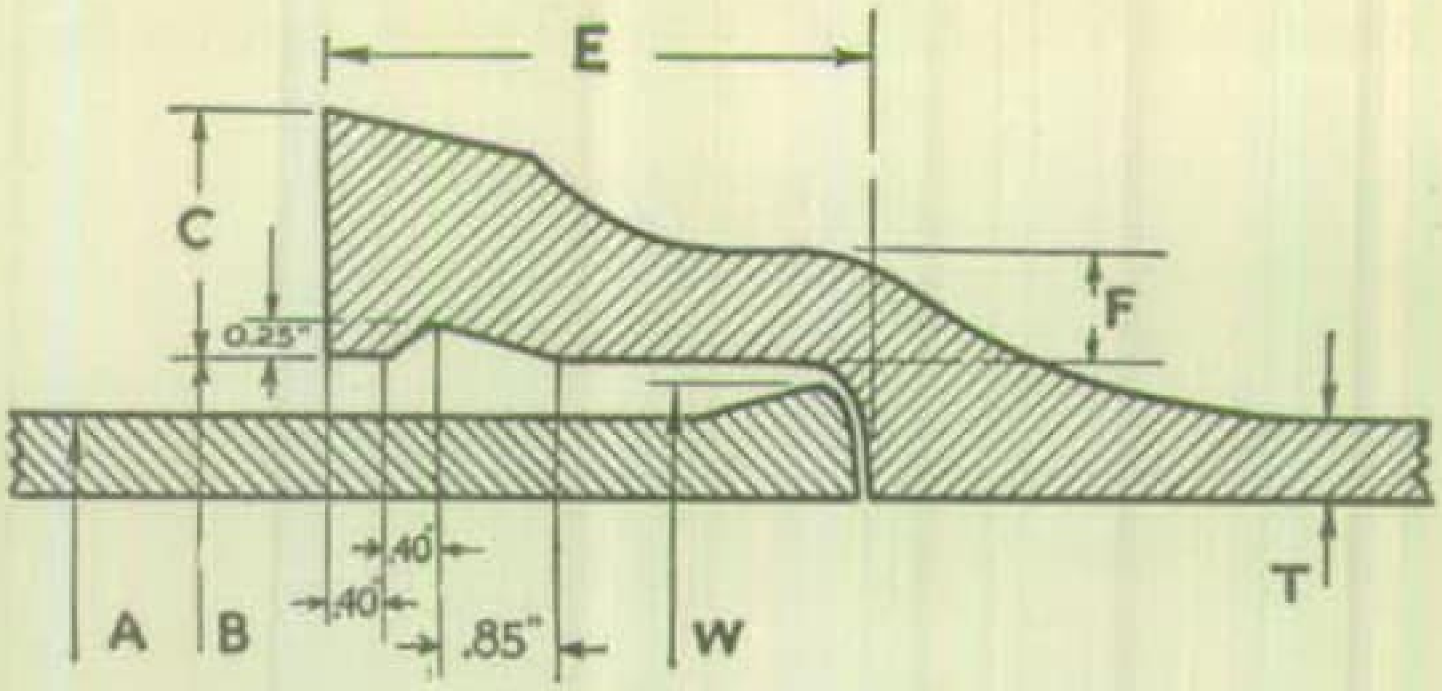



*FIGURE 2 —TYPE II PIPE, END DETAILS*

## Dimensions of Type II pipe (inches)

TABLE III

| Nominal Inside Diameter | Outside Diameter of Pipe | Outside Diameter of Spigot End, Maximum | Inside Diameter of Bells | Depth of Bells | Class 150, 150 Pounds Working Pressure, 346-Foot Head: Thickness of Pipe | Class 150: Thickness of Bells, At End, Minimum | Class 150: Thickness of Bells, At Shoulder, Minimum | Class 250, 250 Pounds Working Pressure, 576-Foot Head: Thickness of Pipe | Class 250: Thickness of Bells, At End, Minimum | Class 250: Thickness of Bells, At Shoulder, Minimum |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | W | B | E | T | C | F | T | C | F |
| 4 | 4.80 | 5.36 | 5.60 | 3.50 | 0.34 | 1.28 | 0.44 | 0.38 | 1.28 | 0.44 |
| 6 | 6.90 | 7.46 | 7.70 | 3.50 | 0.37 | 1.39 | 0.48 | 0.43 | 1.39 | 0.48 |
| 8 | 9.05 | 9.61 | 9.85 | 4.00 | 0.42 | 1.47 | 0.52 | 0.50 | 1.47 | 0.62 |
| 10 | 11.10 | 11.66 | 11.90 | 4.00 | 0.47 | 1.59 | 0.57 | 0.57 | 1.59 | 0.69 |
| 12 | 13.20 | 13.76 | 14.00 | 4.00 | 0.50 | 1.75 | 0.62 | 0.62 | 1.75 | 0.74 |
| 14 | 15.65 | 16.23 | 16.45 | 4.00 | 0.55 | 1.47 | 0.62 | 0.69 | 1.62 | 0.77 |
| 16 | 17.80 | 18.38 | 18.80 | 4.00 | 0.60 | 1.52 | 0.67 | 0.75 | 1.72 | 0.82 |
| 18 | 19.92 | 20.50 | 20.92 | 4.00 | 0.65 | 1.62 | 0.72 | 0.83 | 1.82 | 0.87 |
| 20 | 22.06 | 22.64 | 23.06 | 4.00 | 0.68 | 1.77 | 0.77 | 0.88 | 1.92 | 0.92 |
| 24 | 26.32 | 26.90 | 27.32 | 4.00 | 0.76 | 1.92 | 0.82 | 1.00 | 2.02 | 0.97 |

## Nominal weights of Type II pipe (pounds)

TABLE IV

| Nominal inside Diameter | Class 150, 150 Pounds Working Pressure, 346-Foot Head | | | | | | Class 250, 250 Pounds Working Pressure, 576-Foot Head | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16-Foot Nominal Laying Length | | 16½-Foot Nominal Laying Length | | 20-Foot Nominal Laying Length | | 16-Foot Nominal Laying Length | | 16½-Foot Nominal Laying Length | | 20-Foot Nominal Laying Length | |
| | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell |
| 4 | 255 | 16.1 | 265 | 16.0 | ...... | ...... | 290 | 18.1 | 300 | 18.0 | ...... | ...... |
| 6 | 410 | 25.7 | 425 | 25.6 | ...... | ...... | 460 | 28.7 | 475 | 28.6 | ...... | ...... |
| 8 | 615 | 38.6 | 635 | 38.5 | ...... | ...... | 715 | 44.6 | 735 | 44.5 | ...... | ...... |
| 10 | 835 | 52.2 | 860 | 52.1 | ...... | ...... | 995 | 62.3 | 1,025 | 62.2 | ...... | ...... |
| 12 | 1,055 | 66.1 | 1,090 | 65.9 | ...... | ...... | 1,300 | 81.1 | 1,335 | 81.0 | ...... | ...... |
| 14 | 1,390 | 86.9 | 1,430 | 86.7 | ...... | ...... | 1,730 | 108.0 | 1,780 | 107.8 | ...... | ...... |
| 16 | 1,730 | 108.1 | 1,780 | 107.9 | 2,140 | 106.9 | 2,135 | 133.6 | 2,200 | 133.3 | 2,640 | 132.1 |
| 18 | 2,085 | 130.4 | 2,150 | 130.2 | 2,580 | 128.9 | 2,640 | 164.9 | 2,715 | 164.7 | 3,265 | 163.2 |
| 20 | 2,430 | 152.0 | 2,505 | 151.7 | 3,005 | 150.2 | 3,095 | 193.6 | 3,190 | 193.2 | 3,830 | 191.5 |
| 24 | 3,245 | 202.9 | 3,340 | 202.5 | 4,010 | 200.5 | 4,195 | 262.1 | 4,320 | 261.7 | 5,185 | 259.3 |

NOTE: Calculated weight of pipe has been rounded off to nearest 5 pounds. Weight per foot is based on weight of pipe computed to nearest pound.

**Class 100 pipe and Class 200 pipe shown in the following tables are not included in the WW-P-421 Specification, however they are manufactured to meet all the requirements of WW-P-421. The thicknesses are calculated by the Revised Fairchild Formula which is the same formula used to calculate the Federal Specification thicknesses for Class 150 and Class 250.**

TYPE I PIPE—Class 100, 100 Pounds Working Pressure, 231-Foot Head

| Nominal Inside Diameter | Dimensions in Inches: Outside Diameter of Pipe A | Inside Diameter of Bells B | Total Depth of Bells E | Depth of Centering Shoulder D | Inside Diameter of Centering Shoulder G | Thickness of Pipe T | Weights in Pounds: 12-Foot Nominal Laying Length: Weight of Pipe | 12-Foot: Weight per Foot with Bell | 18-Foot Nominal Laying Length: Weight of Pipe | 18-Foot: Weight per Foot with Bell |
|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 15.30 | 16.10 | 4.50 | 0.50 | 15.52 | 0.48 | 920 | 76.5 | 1340 | 74.3 |
| 16 | 17.40 | 18.40 | 4.50 | 0.50 | 17.62 | 0.52 | 1130 | 94.2 | 1645 | 91.4 |
| 18 | 19.50 | 20.50 | 4.50 | 0.50 | 19.72 | 0.56 | 1365 | 113.8 | 1990 | 110.6 |
| 20 | 21.60 | 22.60 | 4.50 | 0.50 | 21.82 | 0.58 | 1585 | 132.0 | 2305 | 128.0 |
| 24 | 25.80 | 26.80 | 4.50 | 0.50 | 26.02 | 0.64 | 2085 | 173.8 | 3035 | 168.6 |

TYPE I PIPE—Class 200, 200 Pounds Working Pressure, 462-Foot Head

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 9.05 | 9.85 | 4.38 | 0.38 | 9.21 | 0.46 | 510 | 42.4 | 745 | 41.3 |
| 10 | 11.10 | 11.90 | 4.38 | 0.38 | 11.28 | 0.52 | 700 | 58.3 | 1025 | 56.8 |
| 12 | 13.20 | 14.00 | 4.38 | 0.38 | 13.38 | 0.57 | 905 | 75.4 | 1325 | 73.7 |
| 14 | 15.65 | 16.45 | 4.50 | 0.50 | 15.87 | 0.62 | 1190 | 99.0 | 1735 | 96.3 |
| 16 | 17.80 | 18.80 | 4.50 | 0.50 | 18.02 | 0.68 | 1490 | 124.1 | 2175 | 120.7 |
| 18 | 19.92 | 20.92 | 4.50 | 0.50 | 20.14 | 0.74 | 1810 | 150.9 | 2645 | 146.9 |
| 20 | 22.06 | 23.06 | 4.50 | 0.50 | 22.28 | 0.78 | 2125 | 177.1 | 3105 | 172.4 |
| 24 | 26.32 | 27.32 | 4.50 | 0.50 | 26.54 | 0.88 | 2855 | 237.8 | 4170 | 231.6 |

In diameters 14″–24″ Class 100 pipe are made for use with A.W.W.A. Class "B" fittings.

Class 200 pipe are made for use with A.W.W.A. Class "D" fittings.

Standard WW-P-421 pipe Classes 150 and 250 are made for use with A.W.W.A. Class "D" fittings.

**Special Class 150 pipe shown in the following table is made for use with Class "B" fittings to meet the requirements of those who desire to use a pipe having Standard Class 150 thickness and still use A.W.W.A. Class "B" fittings.**

TYPE I PIPE—Special Class 150, 150 Pounds Working Pressure, 346-Foot Head

| Nominal Inside Diameter | Dimensions in Inches | | | | | | Weights in Pounds | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Outside Diameter of Pipe | Inside Diameter of Bells | Total Depth of Bells | Depth of Centering Shoulder | Inside Diameter of Centering Shoulder | Thickness of Pipe | 12-Foot Nominal Laying Length | | 18-Foot Nominal Laying Length | |
| | A | B | E | D | G | T | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell |
| 14 | 15.30 | 16.10 | 4.50 | 0.50 | 15.52 | 0.55 | 1040 | 86.5 | 1520 | 84.3 |
| 16 | 17.40 | 18.40 | 4.50 | 0.50 | 17.62 | 0.60 | 1285 | 107.2 | 1880 | 104.4 |
| 18 | 19.50 | 20.50 | 4.50 | 0.50 | 19.72 | 0.65 | 1560 | 129.8 | 2280 | 126.6 |
| 20 | 21.60 | 22.60 | 4.50 | 0.50 | 21.82 | 0.68 | 1810 | 151.0 | 2645 | 147.0 |
| 24 | 25.80 | 26.80 | 4.50 | 0.50 | 26.02 | 0.76 | 2435 | 202.8 | 3555 | 197.6 |

**Class 100 pipe and Class 200 pipe shown in the following tables are not included in the WW-P-421 Specification, however they are manufactured to meet all the requirements of WW-P-421. The thicknesses are calculated by the Revised Fairchild Formula which is the same formula used to calculate the Federal Specification thicknesses for Class 150 and Class 250.**

TYPE II PIPE—Class 100, 100 Pounds Working Pressure, 231-Foot Head

| Nominal Inside Diameter | Dimensions in Inches | | | | | Weights in Pounds | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Outside Diameter of Pipe | Outside Diameter of Spigot End, Max. | Inside Diameter of Bells | Depth of Bells | Thickness of Pipe | 16-Foot Nominal Laying Length | | 16½-Foot Nominal Laying Length | | 20-Foot Nominal Laying Length | |
| | A | W | B | E | T | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell |
| 14 | 15.30 | 15.88 | 16.10 | 4.00 | 0.48 | 1195 | 74.6 | 1230 | 74.5 | 1475 | 73.7 |
| 16 | 17.40 | 17.98 | 18.40 | 4.00 | 0.52 | 1470 | 92.0 | 1515 | 91.8 | 1815 | 90.8 |
| 18 | 19.50 | 20.08 | 20.50 | 4.00 | 0.56 | 1780 | 111.2 | 1830 | 111.0 | 2195 | 109.8 |
| 20 | 21.60 | 22.18 | 22.60 | 4.00 | 0.58 | 2045 | 127.9 | 2105 | 127.7 | 2525 | 126.2 |
| 24 | 25.80 | 26.38 | 26.80 | 4.00 | 0.64 | 2695 | 168.5 | 2775 | 168.2 | 3325 | 166.4 |

TYPE II PIPE—Class 200, 200 Pounds Working Pressure, 462-Foot Head

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 9.05 | 9.61 | 9.85 | 4.00 | 0.46 | 655 | 41.0 | 675 | 40.9 | ...... | ...... |
| 10 | 11.10 | 11.66 | 11.90 | 4.00 | 0.52 | 920 | 57.4 | 945 | 57.3 | ...... | ...... |
| 12 | 13.20 | 13.76 | 14.00 | 4.00 | 0.57 | 1200 | 75.0 | 1235 | 74.9 | 1485 | 74.2 |
| 14 | 15.65 | 16.23 | 16.45 | 4.00 | 0.62 | 1550 | 96.9 | 1595 | 96.8 | 1915 | 95.8 |
| 16 | 17.80 | 18.38 | 18.80 | 4.00 | 0.68 | 1935 | 121.0 | 1995 | 120.8 | 2390 | 119.4 |
| 18 | 19.92 | 20.50 | 20.92 | 4.00 | 0.74 | 2355 | 147.2 | 2425 | 147.0 | 2910 | 145.6 |
| 20 | 22.06 | 22.64 | 23.06 | 4.00 | 0.78 | 2755 | 172.2 | 2835 | 171.9 | 3405 | 170.3 |
| 24 | 26.32 | 26.90 | 27.32 | 4.00 | 0.88 | 3705 | 231.5 | 3815 | 231.2 | 4580 | 229.1 |

In diameters 14″–24″ Class 100 pipe are made for use with A.W.W.A. Class "B" fittings.

Class 200 pipe are made for use with A.W.W.A. Class "D" fittings.

Standard WW-P-421 pipe Classes 150 and 250 are made for use with A.W.W.A. Class "D" fittings.

**Special Class 150 pipe shown in the following table is made for use with Class "B" fittings to meet the requirements of those who desire to use a pipe having Standard Class 150 thickness and still use A.W.W.A. Class "B" fittings.**

TYPE II PIPE—Special Class 150, 150 Pounds Working Pressure, 346-Foot Head

| Dimensions in Inches | | | | | | Weights in Pounds | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Inside Diameter | Outside Diameter of Pipe | Outside Diameter of Spigot End, Max. | Inside Diameter of Bells | Depth of Bells | Thickness of Pipe | 16-Foot Nominal Laying Length | | 16½-Foot Nominal Laying Length | | 20-Foot Nominal Laying Length | |
| | A | W | B | E | T | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell | Weight of Pipe | Weight per Foot with Bell |
| 14 | 15.30 | 15.88 | 16.10 | 4.00 | 0.55 | 1350 | 84.4 | 1390 | 84.3 | 1670 | 83.4 |
| 16 | 17.40 | 17.98 | 18.40 | 4.00 | 0.60 | 1675 | 104.8 | 1725 | 104.6 | 2070 | 103.6 |
| 18 | 19.50 | 20.08 | 20.50 | 4.00 | 0.65 | 2035 | 127.3 | 2095 | 127.1 | 2515 | 125.8 |
| 20 | 21.60 | 22.18 | 22.60 | 4.00 | 0.68 | 2365 | 147.8 | 2435 | 147.6 | 2925 | 146.2 |
| 24 | 25.80 | 26.38 | 26.80 | 4.00 | 0.76 | 3155 | 197.2 | 3250 | 196.9 | 3900 | 195.0 |

# SECTION 12

## A.W.W.A. Fittings Specifications

**These Specifications include ALL of the fittings shown in American Water Works Association Specification C100-08. They also include 3-inch fittings and certain sizes of other fittings NOT shown in C100-08.**

# American Water Works Association

## Standard Specifications

## For Cast Iron Pressure Fittings

WITH TABLES OF DIMENSIONS, THICKNESSES AND WEIGHTS

(In referring to the fittings tables in this specification, the data below will clarify class designations.)

| Class | Head in feet | Pounds pressure per sq. in. |
|---|---|---|
| A | 100 | 43 |
| B | 200 | 86 |
| C | 300 | 130 |
| D | 400 | 173 |

# Standard Specifications
# for
# Cast Iron Pressure Fittings

### DESCRIPTION OF FITTINGS

Section 1. The fittings shall be made with bell and spigot joints and shall conform, within the specified tolerances, to the dimensions given in the tables forming a part of these specifications.

For pipe 4″–12″, one class of fittings shall be furnished, made from Class D patterns. Spigot ends shall have reduced outside diameters as shown by Table 1 and shall taper back for a distance of 6″.

For pipe 14″–24″, two classes of fittings shall be furnished; Class B, and Class D; the former shall have cast on them the letter "B" and the latter "D". For pipe 30″–60″, four classes of fittings shall be furnished; Classes A, B, C and D; and they shall have cast on them the letter of the class to which they belong.

The flanges on all manhole castings and manhole covers shall be faced and drilled as shown in the tables. The manufacturer shall furnish mild steel bolts with square heads, hexagon nuts and gaskets.

### ALLOWABLE VARIATION IN DIAMETER OF SOCKETS AND SPIGOTS

Section 2. Sockets and spigots shall be tested with circular gages. Tolerances of fittings made from standard patterns are:

| *Size, Inches* | *Tolerance plus or minus, Inches* |
|---|---|
| 4–16 | 0.12 |
| 18–24 | 0.15 |
| 30–42 | 0.20 |
| 48–60 | 0.24 |

### ALLOWABLE VARIATION IN THICKNESS

| Section 3. | *Tolerance, Minus, Inches* |
|---|---|
| Fittings with standard wall thickness less than 1″ | 0.12 |
| Fittings with standard wall thickness 1″ or more | 0.15 |

0.03″ additional tolerance is permitted for spaces not exceeding 8″ in length in any direction.

### ALLOWABLE PERCENTAGE OF VARIATION IN WEIGHT

Section 4.

| *Size, Inches* | *Standard Weight Tolerance ±, Per cent* |
|---|---|
| 4–12 standard fittings | 10 |
| 14–60 standard fittings | 8 |
| Bends and Wyes | 12 |

No weight shall be paid for that is in excess of the amount allowed by maximum tolerance. No fitting shall be accepted that weighs less than the amount allowed by minimum tolerance.

### MARKING

Section 5. Each fitting shall have cast on the outside the initials of the maker's name and the class. As many as four special initials and the year may also be cast on when required by the customer. The weight shall be painted conspicuously on each fitting.

### QUALITY OF IRON

Section 6. All fittings shall be made of cast iron of good quality. The metal of the castings shall be strong, tough, of even grain, and soft enough to satisfactorily drill and cut. The manufacturer shall have the right to make and break three bars from each heat and report the average results of the three tests.

### TESTS OF MATERIAL

Section 7. At least one test bar of the metal used, twenty-six inches long by two inches wide and one inch thick, shall be made and tested from each heat. The bars when placed flatwise upon supports twenty-four inches apart, and loaded in the center, shall support a load of 2,000 pounds, and show a deflection of not less than 0.30 of an inch before breaking. If preferred, tensile bars shall be made which will show a breaking point of not less than 20,000 p.s.i.

#### QUALITY OF CASTINGS

Section 8. The fittings shall be smooth and free from defects of every nature which unfit them for the use for which they are intended. No plugging or filling will be allowed.

#### CLEANING AND INSPECTION

Section 9. All fittings shall be thoroughly cleaned and subjected to a careful inspection.

#### LININGS AND EXTERIOR COATINGS

Section 10. Any particular lining or coating which is to be applied to the fittings shall be specified in the agreement made at the time of purchase. Separate specifications for a cement-mortar lining have been provided in connection with these specifications for fittings. (*See* specification ASA A21.4.)

No pipe or specials for waterworks service shall be furnished without protective coating unless specifically ordered by the purchaser.

#### WEIGHING

Section 11. The fittings shall be weighed under the supervision of the engineer before the application of any lining or coating other than hot or cold bituminous dip or paint. If desired by the engineer, the fittings shall be weighed after their delivery, and the weights so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weighmaster. Bids shall be submitted and a final settlement made upon the basis of a ton of 2,000 pounds.

#### MANUFACTURER TO FURNISH MEN AND MATERIAL

Section 12. The manufacturer shall provide all tools, testing machines, and labor necessary for the required testing, inspection and weighing at the foundry. If specified on the order, the manufacturer shall furnish the test results and a sworn statement that all of the tests have been made as specified.

#### POWER OF ENGINEER TO INSPECT

Section 13. The engineer shall be at liberty at all times to inspect the material at the foundry, and the molding, casting, and coating of the fittings. All castings shall be subject to his inspection and approval, and he may reject any casting which is not in conformity with the specifications or drawings.

#### INSPECTOR TO REPORT

Section 14. The inspector at the foundry shall report daily to the foundry office all fittings rejected, with the causes for rejection.

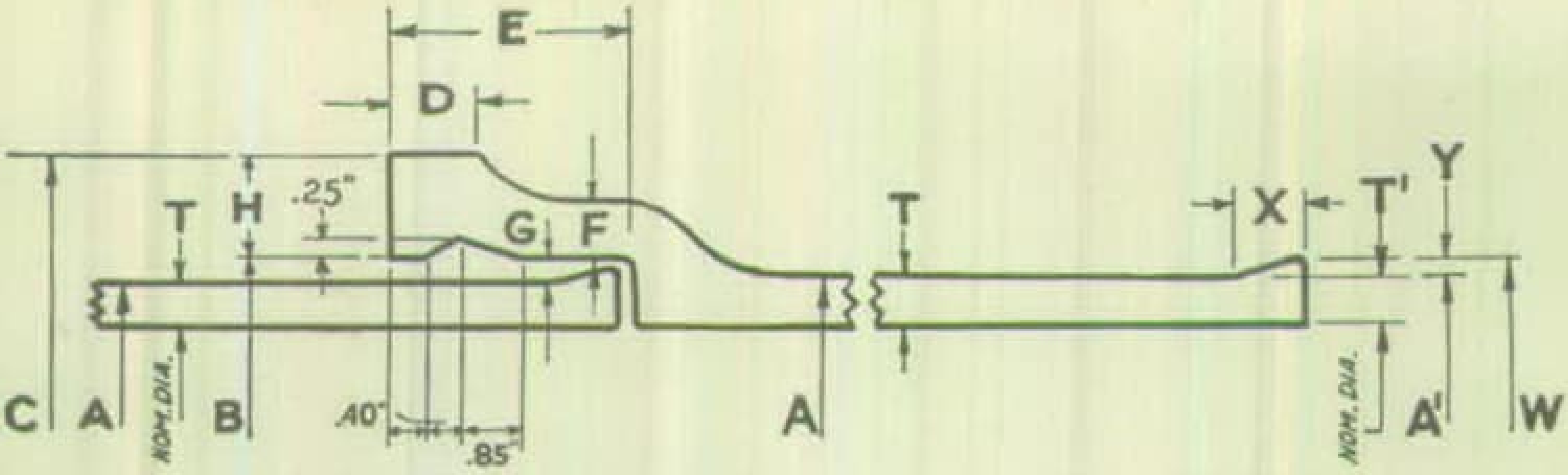
#### FITTINGS TO BE DELIVERED SOUND

Section 15. All the fittings must be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the manufacturer of his obligations in this respect, and any defective fittings which may have passed the engineer at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the manufacturer shall not be held liable for fittings found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the fittings not to injure the coating, and no material of any kind shall be placed in the fittings at any time after they have been coated.

#### DEFINITION OF THE WORD "ENGINEER"

Section 16. Wherever the word "engineer" is used herein it shall be understood to refer to the engineer or inspector acting for the purchaser and to his properly authorized agents, limited by the particular duties intrusted to them.

# Standard Dimensions of Bells and Spigots for Fittings




3" & 14" TO 60" SPIGOTS

X & Y COMMON
TO ALL SIZES

4" TO 12" SPIGOTS

X = ¾" ON 4"- 6"
Y = ½" ON 4"-12"

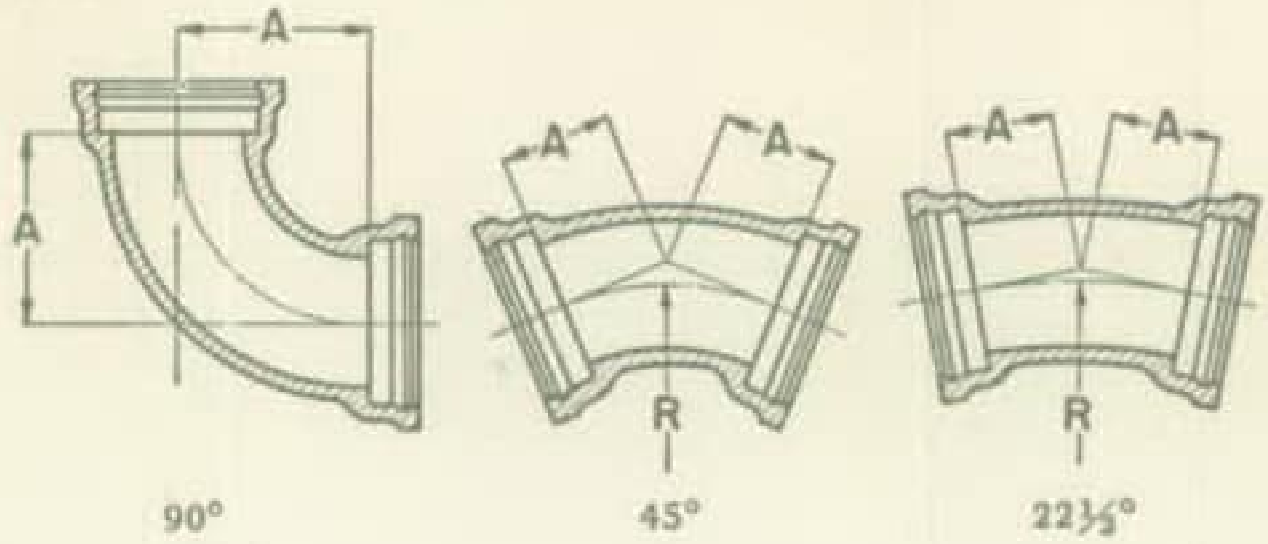
X = 1" ON 8"-60"
Y = ¼" ON 14"-60"

| Size | Class | Dimensions, Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | A¹* | B | C | D | E | F | G | H | T | T¹* | W |
| 3 | D | 3.96 | | 4.66 | 7.26 | 1.25 | 3.50 | 0.65 | 0.35 | 1.30 | 0.48 | | 4.34 |
| 4 | D | 5.00 | 4.90 | 5.70 | 8.30 | 1.50 | 4.00 | 0.65 | 0.40 | 1.30 | 0.52 | 0.47 | 5.28 |
| 6 | D | 7.10 | 7.00 | 7.80 | 10.60 | 1.50 | 4.00 | 0.70 | 0.40 | 1.40 | 0.55 | 0.50 | 7.38 |
| 8 | D | 9.30 | 9.18 | 10.00 | 13.00 | 1.50 | 4.00 | 0.75 | 0.41 | 1.50 | 0.60 | 0.54 | 9.56 |
| 10 | D | 11.40 | 11.25 | 12.10 | 15.30 | 1.50 | 4.00 | 0.80 | 0.42 | 1.60 | 0.68 | 0.60 | 11.63 |
| 12 | D | 13.50 | 13.35 | 14.20 | 17.60 | 1.50 | 4.00 | 0.85 | 0.42 | 1.70 | 0.75 | 0.68 | 13.73 |
| 14 | B | 15.30 | | 16.10 | 19.50 | 1.50 | 4.00 | 0.85 | 0.40 | 1.70 | 0.66 | | 15.80 |
| 14 | D | 15.65 | | 16.45 | 20.05 | 1.50 | 4.00 | 0.90 | 0.40 | 1.80 | 0.82 | | 16.15 |
| 16 | B | 17.40 | | 18.40 | 22.00 | 1.75 | 4.00 | 0.90 | 0.50 | 1.80 | 0.70 | | 17.90 |
| 16 | D | 17.80 | | 18.80 | 22.60 | 1.75 | 4.00 | 1.00 | 0.50 | 1.90 | 0.89 | | 18.30 |
| 18 | B | 19.50 | | 20.50 | 24.30 | 1.75 | 4.00 | 0.95 | 0.50 | 1.90 | 0.75 | | 20.00 |
| 18 | D | 19.92 | | 20.92 | 25.12 | 1.75 | 4.00 | 1.05 | 0.50 | 2.10 | 0.96 | | 20.42 |
| 20 | B | 21.60 | | 22.60 | 26.60 | 1.75 | 4.00 | 1.00 | 0.50 | 2.00 | 0.80 | | 22.10 |
| 20 | D | 22.06 | | 23.06 | 27.66 | 1.75 | 4.00 | 1.15 | 0.50 | 2.30 | 1.03 | | 22.56 |
| 24 | B | 25.80 | | 26.80 | 31.00 | 2.00 | 4.00 | 1.05 | 0.50 | 2.10 | 0.89 | | 26.30 |
| 24 | D | 26.32 | | 27.32 | 32.32 | 2.00 | 4.00 | 1.25 | 0.50 | 2.50 | 1.16 | | 26.82 |
| 30 | A | 31.74 | | 32.74 | 37.34 | 2.00 | 4.50 | 1.15 | 0.50 | 2.30 | 0.88 | | 32.24 |
| 30 | B | 32.00 | | 33.00 | 37.60 | 2.00 | 4.50 | 1.15 | 0.50 | 2.30 | 1.03 | | 32.50 |
| 30 | C | 32.40 | | 33.40 | 38.60 | 2.00 | 4.50 | 1.32 | 0.50 | 2.60 | 1.20 | | 32.90 |
| 30 | D | 32.74 | | 33.74 | 39.74 | 2.00 | 4.50 | 1.50 | 0.50 | 3.00 | 1.37 | | 33.24 |
| 36 | A | 37.96 | | 38.96 | 43.96 | 2.00 | 4.50 | 1.25 | 0.50 | 2.50 | 0.99 | | 38.46 |
| 36 | B | 38.30 | | 39.30 | 44.90 | 2.00 | 4.50 | 1.40 | 0.50 | 2.80 | 1.15 | | 38.80 |
| 36 | C | 38.70 | | 39.70 | 45.90 | 2.00 | 4.50 | 1.60 | 0.50 | 3.10 | 1.36 | | 39.20 |
| 36 | D | 39.16 | | 40.16 | 46.96 | 2.00 | 4.50 | 1.80 | 0.50 | 3.40 | 1.58 | | 39.66 |
| 42 | A | 44.20 | | 45.20 | 50.80 | 2.00 | 5.00 | 1.40 | 0.50 | 2.80 | 1.10 | | 44.70 |
| 42 | B | 44.50 | | 45.50 | 51.50 | 2.00 | 5.00 | 1.50 | 0.50 | 3.00 | 1.28 | | 45.00 |
| 42 | C | 45.10 | | 46.10 | 52.90 | 2.00 | 5.00 | 1.75 | 0.50 | 3.40 | 1.54 | | 45.60 |
| 42 | D | 45.58 | | 46.58 | 54.18 | 2.00 | 5.00 | 1.95 | 0.50 | 3.80 | 1.78 | | 46.08 |
| 48 | A | 50.50 | | 51.50 | 57.50 | 2.00 | 5.00 | 1.50 | 0.50 | 3.00 | 1.26 | | 51.00 |
| 48 | B | 50.80 | | 51.80 | 58.40 | 2.00 | 5.00 | 1.65 | 0.50 | 3.30 | 1.42 | | 51.30 |
| 48 | C | 51.40 | | 52.40 | 60.00 | 2.00 | 5.00 | 1.95 | 0.50 | 3.80 | 1.71 | | 51.90 |
| 48 | D | 51.98 | | 52.98 | 61.38 | 2.00 | 5.00 | 2.20 | 0.50 | 4.20 | 1.96 | | 52.48 |
| 54 | A | 56.66 | | 57.66 | 64.06 | 2.25 | 5.50 | 1.60 | 0.50 | 3.20 | 1.35 | | 57.16 |
| 54 | B | 57.10 | | 58.10 | 65.30 | 2.25 | 5.50 | 1.80 | 0.50 | 3.60 | 1.55 | | 57.60 |
| 54 | C | 57.80 | | 58.80 | 66.80 | 2.25 | 5.50 | 2.15 | 0.50 | 4.00 | 1.90 | | 58.30 |
| 54 | D | 58.40 | | 59.40 | 68.20 | 2.25 | 5.50 | 2.45 | 0.50 | 4.40 | 2.23 | | 58.90 |
| 60 | A | 62.80 | | 63.80 | 70.60 | 2.25 | 5.50 | 1.70 | 0.50 | 3.40 | 1.39 | | 63.30 |
| 60 | B | 63.40 | | 64.40 | 71.80 | 2.25 | 5.50 | 1.90 | 0.50 | 3.70 | 1.67 | | 63.90 |
| 60 | C | 64.20 | | 65.20 | 73.60 | 2.25 | 5.50 | 2.25 | 0.50 | 4.20 | 2.00 | | 64.70 |
| 60 | D | 64.82 | | 65.82 | 75.22 | 2.25 | 5.50 | 2.60 | 0.50 | 4.70 | 2.38 | | 65.32 |

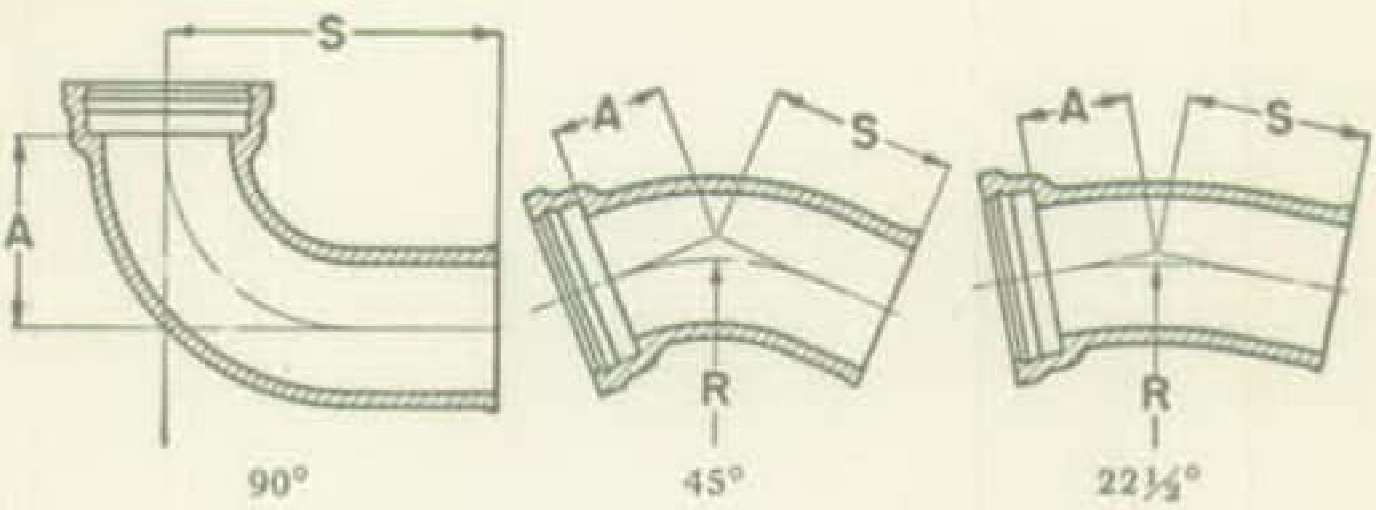
*For sizes 3" and 14"-60", A¹ = A and T¹ = T.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Bends

**Bell and Bell Bends**




**Bell and Spigot Bends**




| Size | Class | 90° Bend (¼) | | | | 45° Bend (⅛) | | | | | 22½° Bend (1/16) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dimensions | | Weights | | Dimensions | | | Weights | | Dimensions | | | Weights | |
| | | A | S | Bell and Spigot | Bell and Bell | A | S | R | Bell and Spigot | Bell and Bell | A | S | R | Bell and Spigot | Bell and Bell |
| 3 | D | 16 | 24 | 65 | 75 | 9.94 | 15.94 | 24 | 55 | 65 | 9.55 | 15.55 | 48 | 55 | 65 |
| 4 | D | 16 | 24 | 90 | 100 | 9.94 | 15.94 | 24 | 75 | 90 | 9.55 | 15.55 | 48 | 75 | 90 |
| 6 | D | 16 | 24 | 135 | 145 | 9.94 | 15.94 | 24 | 110 | 125 | 9.55 | 15.55 | 48 | 110 | 125 |
| 8 | D | 16 | 26 | 200 | 200 | 9.94 | 15.94 | 24 | 155 | 180 | 9.55 | 15.55 | 48 | 155 | 180 |
| 10 | D | 16 | 28 | 285 | 275 | 9.94 | 15.94 | 24 | 210 | 240 | 9.55 | 15.55 | 48 | 210 | 240 |
| 12 | D | 16 | 28 | 365 | 350 | 9.94 | 15.94 | 24 | 270 | 305 | 9.55 | 15.55 | 48 | 270 | 305 |
| 14 | B | 18 | 30 | 410 | 400 | 14.91 | 20.91 | 36 | 365 | 400 | 14.32 | 14.32 | 72 | 315 | 400 |
| 14 | D | 18 | 30 | 495 | 470 | 14.91 | 20.91 | 36 | 440 | 475 | 14.32 | 14.32 | 72 | 380 | 475 |
| 16 | B | 24 | 36 | 590 | 590 | 14.91 | 20.91 | 36 | 445 | 500 | 14.32 | 14.32 | 72 | 385 | 500 |
| 16 | D | 24 | 36 | 740 | 720 | 14.91 | 20.91 | 36 | 550 | 605 | 14.32 | 14.32 | 72 | 480 | 605 |
| 18 | B | 24 | 36 | 705 | 700 | 14.91 | 20.91 | 36 | 555 | 590 | 14.32 | 14.32 | 72 | 460 | 590 |
| 18 | D | 24 | 36 | 895 | 870 | 14.91 | 20.91 | 36 | 665 | 730 | 14.32 | 14.32 | 72 | 580 | 730 |

Dimensions in inches.

For bell and spigot dimensions, see page 276.

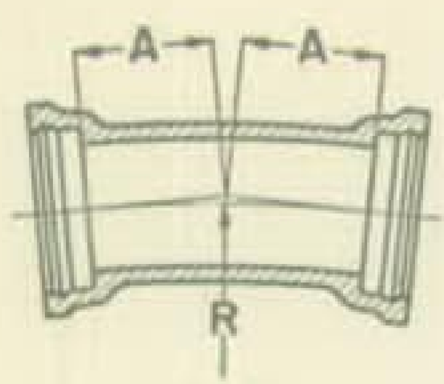
# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Bends

| Size | Class | 90° Bend (1/4) | | | | 45° Bend (1/8) | | | | | 22½° Bend (1/16) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dimensions | | Weights | | Dimensions | | | Weights | | Dimensions | | | Weights | |
| | | A | S | Bell and Spigot | Bell and Bell | A | S | R | Bell and Spigot | Bell and Bell | A | S | R | Bell and Spigot | Bell and Bell |
| 20 | B | 24 | 36 | 835 | 825 | 19.88 | 25.88 | 48 | 755 | 825 | 19.10 | 19.10 | 96 | 670 | 825 |
| 20 | D | 24 | 36 | 1070 | 1045 | 19.88 | 25.88 | 48 | 965 | 1045 | 19.10 | 19.10 | 96 | 860 | 1045 |
| 24 | B | 30 | 42 | 1275 | 1255 | 24.85 | 30.85 | 60 | 1165 | 1255 | 23.87 | 23.87 | 120 | 1055 | 1255 |
| 24 | D | 30 | 42 | 1665 | 1625 | 24.85 | 30.85 | 60 | 1520 | 1625 | 23.87 | 23.87 | 120 | 1375 | 1625 |
| 30 | A | 36 | 48 | 1820 | 1850 | 24.85 | 30.85 | 60 | 1480 | 1645 | 23.87 | 23.87 | 120 | 1345 | 1645 |
| 30 | B | 36 | 48 | 2090 | 2075 | 24.85 | 30.85 | 60 | 1690 | 1830 | 23.87 | 23.87 | 120 | 1530 | 1830 |
| 30 | C | 36 | 48 | 2450 | 2430 | 24.85 | 30.85 | 60 | 1980 | 2145 | 23.87 | 23.87 | 120 | 1795 | 2145 |
| 30 | D | 36 | 48 | 2825 | 2820 | 24.85 | 30.85 | 60 | 2285 | 2490 | 23.87 | 23.87 | 120 | 2075 | 2490 |
| 36 | A | 48 | 60 | 3000 | 3025 | 37.28 | 37.28 | 90 | 2500 | 2885 | 35.80 | 35.80 | 180 | 2500 | 2885 |
| 36 | B | 48 | 60 | 3500 | 3525 | 37.28 | 37.28 | 90 | 2920 | 3360 | 35.80 | 35.80 | 180 | 2920 | 3360 |
| 36 | C | 48 | 60 | 4145 | 4155 | 37.28 | 37.28 | 90 | 3450 | 3960 | 35.80 | 35.80 | 180 | 3450 | 3960 |
| 36 | D | 48 | 60 | 4830 | 4835 | 37.28 | 37.28 | 90 | 4020 | 4605 | 35.80 | 35.80 | 180 | 4020 | 4605 |
| 42 | A | 48 | 60 | 3930 | 4000 | 37.28 | 37.28 | 90 | 3280 | 3820 | 35.80 | 35.80 | 180 | 3280 | 3820 |
| 42 | B | 48 | 60 | 4540 | 4585 | 37.28 | 37.28 | 90 | 3785 | 4370 | 35.80 | 35.80 | 180 | 3785 | 4370 |
| 42 | C | 48 | 60 | 5495 | 5540 | 37.28 | 37.28 | 90 | 4580 | 5280 | 35.80 | 35.80 | 180 | 4580 | 5280 |
| 42 | D | 48 | 60 | 6380 | 6415 | 37.28 | 37.28 | 90 | 5315 | 6115 | 35.80 | 35.80 | 180 | 5315 | 6115 |
| 48 | A | 54 | 66 | 5575 | 5620 | 37.28 | 37.28 | 90 | 4250 | 4905 | 35.80 | 35.80 | 180 | 4250 | 4905 |
| 48 | B | 54 | 66 | 6300 | 6355 | 37.28 | 37.28 | 90 | 4800 | 5545 | 35.80 | 35.80 | 180 | 4800 | 5545 |
| 48 | C | 54 | 66 | 7630 | 7690 | 37.28 | 37.28 | 90 | 5815 | 6710 | 35.80 | 35.80 | 180 | 5815 | 6710 |
| 48 | D | 54 | 66 | 8810 | 8890 | 37.28 | 37.28 | 90 | 6715 | 7755 | 35.80 | 35.80 | 180 | 6715 | 7755 |
| 54 | A | .. | .. | 6925 | 7040 | 37.28 | 37.28 | 90 | 5180 | 6025 | 35.80 | 35.80 | 180 | 5180 | 6025 |
| 54 | B | .. | .. | 7990 | 8130 | 37.28 | 37.28 | 90 | 5975 | 6960 | 35.80 | 35.80 | 180 | 5975 | 6960 |
| 54 | C | .. | .. | 9820 | 9960 | 37.28 | 37.28 | 90 | 7330 | 8510 | 35.80 | 35.80 | 180 | 7330 | 8510 |
| 54 | D | .. | .. | 11570 | 11725 | 37.28 | 37.28 | 90 | 8635 | 10020 | 35.80 | 35.80 | 180 | 8635 | 10020 |
| 60 | A | .. | .. | 7960 | 8135 | 37.28 | 37.28 | 90 | 5960 | 6975 | 35.80 | 35.80 | 180 | 5960 | 6975 |
| 60 | B | .. | .. | 9520 | 9645 | 37.28 | 37.28 | 90 | 7110 | 8245 | 35.80 | 35.80 | 180 | 7110 | 8245 |
| 60 | C | .. | .. | 11495 | 11660 | 37.28 | 37.28 | 90 | 8585 | 9970 | 35.80 | 35.80 | 180 | 8585 | 9970 |
| 60 | D | .. | .. | 13720 | 13905 | 37.28 | 37.28 | 90 | 10230 | 11870 | 35.80 | 35.80 | 180 | 10230 | 11870 |

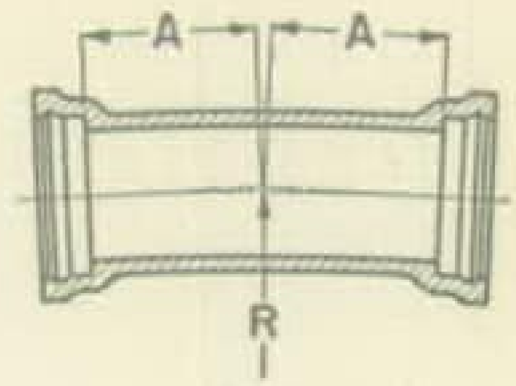
Dimensions in inches.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Bends

**Bell and Bell Bends**

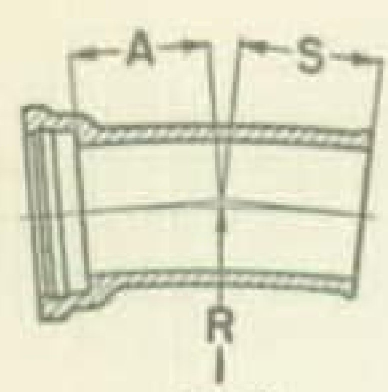



11¼°

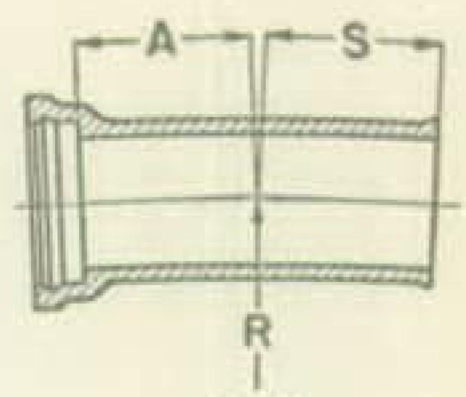



5⅝°

**Bell and Spigot Bends**




11¼°




5⅝°

| Size | Class | 11¼° Bend (1/32) | | | | | 5⅝° Bend (1/64) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dimensions | | | Weights | | Dimensions | | | Weights | |
| | | A | S | R | Bell and Spigot | Bell and Bell | A | S | R | Bell and Spigot | Bell and Bell |
| 3 | D | 11.82 | 11.82 | 120 | 55 | 75 | ...... | ...... | ...... | ...... | ...... |
| 4 | D | 11.82 | 11.82 | 120 | 70 | 95 | ...... | ...... | ...... | ...... | ...... |
| 6 | D | 11.82 | 11.82 | 120 | 105 | 140 | ...... | ...... | ...... | ...... | ...... |
| 8 | D | 11.82 | 11.82 | 120 | 150 | 200 | ...... | ...... | ...... | ...... | ...... |
| 10 | D | 11.82 | 11.82 | 120 | 205 | 265 | ...... | ...... | ...... | ...... | ...... |
| 12 | D | 11.82 | 11.82 | 120 | 260 | 340 | ...... | ...... | ...... | ...... | ...... |
| 14 | B | 17.73 | 17.73 | 180 | 375 | 455 | ...... | ...... | ...... | ...... | ...... |
| 14 | D | 17.73 | 17.73 | 180 | 450 | 545 | ...... | ...... | ...... | ...... | ...... |
| 16 | B | 17.73 | 17.73 | 180 | 455 | 565 | ...... | ...... | ...... | ...... | ...... |
| 16 | D | 17.73 | 17.73 | 180 | 565 | 695 | ...... | ...... | ...... | ...... | ...... |

Dimensions in inches.

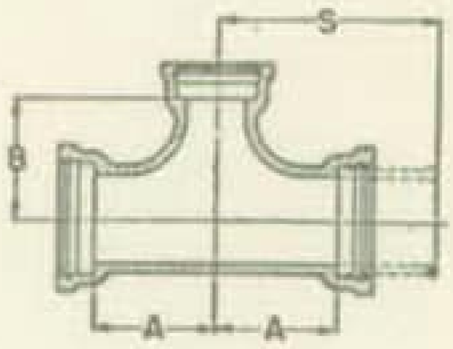
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Bends

| Size | Class | $11\frac{1}{4}$° Bend ($\frac{1}{32}$) | | | | | $5\frac{5}{8}$° Bend ($\frac{1}{64}$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dimensions | | | Weights | | Dimensions | | | Weights | |
| | | A | S | R | Bell and Spigot | Bell and Bell | A | S | R | Bell and Spigot | Bell and Bell |
| 18 | B | 17.73 | 17.73 | 180 | 540 | 670 | ...... | ...... | ...... | ...... | ...... |
| 18 | D | 17.73 | 17.73 | 180 | 685 | 835 | ...... | ...... | ...... | ...... | ...... |
| 20 | B | 23.64 | 23.64 | 240 | 800 | 955 | 23.58 | 23.58 | 480 | 800 | 955 |
| 20 | D | 23.64 | 23.64 | 240 | 1030 | 1215 | 23.58 | 23.58 | 480 | 1030 | 1215 |
| 24 | B | 23.64 | 23.64 | 240 | 1060 | 1255 | 23.58 | 23.58 | 480 | 1060 | 1255 |
| 24 | D | 23.64 | 23.64 | 240 | 1375 | 1620 | 23.58 | 23.58 | 480 | 1375 | 1620 |
| 30 | A | 23.64 | 23.64 | 240 | 1345 | 1640 | 23.58 | 23.58 | 480 | 1345 | 1640 |
| 30 | B | 23.64 | 23.64 | 240 | 1530 | 1830 | 23.58 | 23.58 | 480 | 1530 | 1830 |
| 30 | C | 23.64 | 23.64 | 240 | 1795 | 2145 | 23.58 | 23.58 | 480 | 1795 | 2145 |
| 30 | D | 23.64 | 23.64 | 240 | 2075 | 2490 | 23.58 | 23.58 | 480 | 2075 | 2490 |
| 36 | A | 23.64 | 23.64 | 240 | 1795 | 2180 | 23.58 | 23.58 | 480 | 1795 | 2180 |
| 36 | B | 23.64 | 23.64 | 240 | 2095 | 2540 | 23.58 | 23.58 | 480 | 2095 | 2540 |
| 36 | C | 23.64 | 23.64 | 240 | 2470 | 2980 | 23.58 | 23.58 | 480 | 2470 | 2980 |
| 36 | D | 23.64 | 23.64 | 240 | 2875 | 3460 | 23.58 | 23.58 | 480 | 2875 | 3460 |
| 42 | A | 23.64 | 23.64 | 240 | 2370 | 2905 | 23.58 | 23.58 | 480 | 2370 | 2905 |
| 42 | B | 23.64 | 23.64 | 240 | 2720 | 3305 | 23.58 | 23.58 | 480 | 2720 | 3305 |
| 42 | C | 23.64 | 23.64 | 240 | 3290 | 3985 | 23.58 | 23.58 | 480 | 3290 | 3985 |
| 42 | D | 23.64 | 23.64 | 240 | 3815 | 4615 | 23.58 | 23.58 | 480 | 3815 | 4615 |
| 48 | A | 23.64 | 23.64 | 240 | 3055 | 3715 | 23.58 | 23.58 | 480 | 3055 | 3715 |
| 48 | B | 23.64 | 23.64 | 240 | 3455 | 4195 | 23.58 | 23.58 | 480 | 3450 | 4195 |
| 48 | C | 23.64 | 23.64 | 240 | 4180 | 5075 | 23.58 | 23.58 | 480 | 4180 | 5075 |
| 48 | D | 23.64 | 23.64 | 240 | 4825 | 5870 | 23.58 | 23.58 | 480 | 4825 | 5870 |
| 54 | A | 23.64 | 23.64 | 240 | 3740 | 4585 | 23.58 | 23.58 | 480 | 3740 | 4585 |
| 54 | B | 23.64 | 23.64 | 240 | 4315 | 5305 | 23.58 | 23.58 | 480 | 4315 | 5305 |
| 54 | C | 23.64 | 23.64 | 240 | 5285 | 6470 | 23.58 | 23.58 | 480 | 5285 | 6470 |
| 54 | D | 23.64 | 23.64 | 240 | 6225 | 7610 | 23.58 | 23.58 | 480 | 6225 | 7610 |
| 60 | A | 23.64 | 23.64 | 240 | 4320 | 5330 | 23.58 | 23.58 | 480 | 4320 | 5330 |
| 60 | B | 23.64 | 23.64 | 240 | 5125 | 6260 | 23.58 | 23.58 | 480 | 5125 | 6260 |
| 60 | C | 23.64 | 23.64 | 240 | 6195 | 7580 | 23.58 | 23.58 | 480 | 6195 | 7580 |
| 60 | D | 23.64 | 23.64 | 240 | 7370 | 9015 | 23.58 | 23.58 | 480 | 7370 | 9015 |

Dimensions in inches.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees




### Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 3 | 3 | D | 10 | 22 | 10 | 95 | 100 |
| 4 | 3 | D | 11 | 23 | 11 | 120 | 125 |
| 4 | 4 | D | 11 | 23 | 11 | 130 | 130 |
| 6 | 3 | D | 12 | 24 | 12 | 175 | 170 |
| 6 | 4 | D | 12 | 24 | 12 | 180 | 180 |
| 6 | 6 | D | 12 | 24 | 12 | 200 | 200 |
| 8 | 4 | D | 13 | 25 | 13 | 250 | 250 |
| 8 | 6 | D | 13 | 25 | 13 | 270 | 265 |
| 8 | 8 | D | 13 | 25 | 13 | 290 | 285 |
| 10 | 4 | D | 14 | 26 | 14 | 340 | 330 |
| 10 | 6 | D | 14 | 26 | 14 | 360 | 350 |
| 10 | 8 | D | 14 | 26 | 14 | 380 | 370 |
| 10 | 10 | D | 14 | 26 | 14 | 405 | 390 |
| 12 | 4 | D | 15 | 27 | 15 | 445 | 425 |
| 12 | 6 | D | 15 | 27 | 15 | 460 | 440 |
| 12 | 8 | D | 15 | 27 | 15 | 485 | 465 |
| 12 | 10 | D | 15 | 27 | 15 | 505 | 495 |
| 12 | 12 | D | 15 | 27 | 15 | 535 | 515 |
| 14 | 4 | B | 16 | 28 | 16 | 495 | 485 |
| 14 | 4 | D | 16 | 28 | 16 | 595 | 570 |
| 14 | 6 | B | 16 | 28 | 16 | 515 | 505 |
| 14 | 6 | D | 16 | 28 | 16 | 610 | 585 |
| 14 | 8 | B | 16 | 28 | 16 | 540 | 525 |
| 14 | 8 | D | 16 | 28 | 16 | 635 | 610 |
| 14 | 10 | B | 16 | 28 | 16 | 560 | 555 |
| 14 | 10 | D | 16 | 28 | 16 | 655 | 630 |
| 14 | 12 | B | 16 | 28 | 16 | 590 | 580 |
| 14 | 12 | D | 16 | 28 | 16 | 680 | 655 |
| 14 | 14 | B | 16 | 28 | 16 | 600 | 590 |
| 14 | 14 | D | 16 | 28 | 16 | 725 | 695 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 16 | 4 | B | 17 | 29 | 17 | 620 | 615 |
| 16 | 4 | D | 17 | 29 | 17 | 765 | 740 |
| 16 | 6 | B | 17 | 29 | 17 | 635 | 630 |
| 16 | 6 | D | 17 | 29 | 17 | 775 | 755 |
| 16 | 8 | B | 17 | 29 | 17 | 660 | 655 |
| 16 | 8 | D | 17 | 29 | 17 | 800 | 775 |
| 16 | 10 | B | 17 | 29 | 17 | 685 | 680 |
| 16 | 10 | D | 17 | 29 | 17 | 825 | 800 |
| 16 | 12 | B | 17 | 29 | 17 | 710 | 710 |
| 16 | 12 | D | 17 | 29 | 17 | 850 | 825 |
| 16 | 14 | B | 17 | 29 | 17 | 720 | 715 |
| 16 | 14 | D | 17 | 29 | 17 | 885 | 860 |
| 16 | 16 | B | 17 | 29 | 17 | 760 | 755 |
| 16 | 16 | D | 17 | 29 | 17 | 935 | 915 |
| 18 | 4 | B | 18 | 30 | 18 | 755 | 745 |
| 18 | 4 | D | 18 | 30 | 18 | 945 | 915 |
| 18 | 6 | B | 18 | 30 | 18 | 770 | 765 |
| 18 | 6 | D | 18 | 30 | 18 | 955 | 925 |
| 18 | 8 | B | 18 | 30 | 18 | 795 | 785 |
| 18 | 8 | D | 18 | 30 | 18 | 980 | 950 |
| 18 | 10 | B | 18 | 30 | 18 | 820 | 810 |
| 18 | 10 | D | 18 | 30 | 18 | 1005 | 975 |
| 18 | 12 | B | 18 | 30 | 18 | 845 | 835 |
| 18 | 12 | D | 18 | 30 | 18 | 1030 | 1000 |
| 18 | 14 | B | 18 | 30 | 18 | 850 | 845 |
| 18 | 14 | D | 18 | 30 | 18 | 1055 | 1025 |
| 18 | 16 | B | 18 | 30 | 18 | 885 | 880 |
| 18 | 16 | D | 18 | 30 | 18 | 1105 | 1075 |
| 18 | 18 | B | 18 | 30 | 18 | 925 | 915 |
| 18 | 18 | D | 18 | 30 | 18 | 1155 | 1125 |
| 20 | 4 | B | 19 | 31 | 19 | 910 | 900 |
| 20 | 4 | D | 19 | 31 | 19 | 1160 | 1130 |
| 20 | 6 | B | 19 | 31 | 19 | 930 | 915 |
| 20 | 6 | D | 19 | 31 | 19 | 1175 | 1145 |
| 20 | 8 | B | 19 | 31 | 19 | 950 | 940 |
| 20 | 8 | D | 19 | 31 | 19 | 1195 | 1165 |
| 20 | 10 | B | 19 | 31 | 19 | 970 | 965 |
| 20 | 10 | D | 19 | 31 | 19 | 1215 | 1185 |
| 20 | 12 | B | 19 | 31 | 19 | 1000 | 990 |
| 20 | 12 | D | 19 | 31 | 19 | 1240 | 1210 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 20 | 14 | B | 19 | 31 | 19 | 1010 | 995 |
| 20 | 14 | D | 19 | 31 | 19 | 1270 | 1240 |
| 20 | 16 | B | 19 | 31 | 19 | 1040 | 1030 |
| 20 | 16 | D | 19 | 31 | 19 | 1315 | 1290 |
| 20 | 18 | B | 19 | 31 | 19 | 1075 | 1065 |
| 20 | 18 | D | 19 | 31 | 19 | 1360 | 1330 |
| 20 | 20 | B | 19 | 31 | 19 | 1115 | 1105 |
| 20 | 20 | D | 19 | 31 | 19 | 1420 | 1390 |
| 24 | 6 | B | 21 | 33 | 21 | 1280 | 1260 |
| 24 | 6 | D | 21 | 33 | 21 | 1655 | 1615 |
| 24 | 8 | B | 21 | 33 | 21 | 1305 | 1280 |
| 24 | 8 | D | 21 | 33 | 21 | 1675 | 1630 |
| 24 | 10 | B | 21 | 33 | 21 | 1325 | 1305 |
| 24 | 10 | D | 21 | 33 | 21 | 1695 | 1650 |
| 24 | 12 | B | 21 | 33 | 21 | 1350 | 1330 |
| 24 | 12 | D | 21 | 33 | 21 | 1715 | 1675 |
| 24 | 14 | B | 21 | 33 | 21 | 1355 | 1335 |
| 24 | 14 | D | 21 | 33 | 21 | 1745 | 1700 |
| 24 | 16 | B | 21 | 33 | 21 | 1390 | 1370 |
| 24 | 16 | D | 21 | 33 | 21 | 1785 | 1745 |
| 24 | 18 | B | 21 | 33 | 21 | 1420 | 1395 |
| 24 | 18 | D | 21 | 33 | 21 | 1825 | 1780 |
| 24 | 20 | B | 21 | 33 | 21 | 1455 | 1430 |
| 24 | 20 | D | 21 | 33 | 21 | 1880 | 1835 |
| 24 | 24 | B | 21 | 33 | 21 | 1530 | 1505 |
| 24 | 24 | D | 21 | 33 | 21 | 1985 | 1945 |
| 30 | 6 | A | 13 | 25 | 24 | 1290 | 1320 |
| 30 | 6 | B | 13 | 25 | 24 | 1450 | 1430 |
| 30 | 6 | C | 13 | 25 | 24 | 1690 | 1670 |
| 30 | 6 | D | 13 | 25 | 24 | 1945 | 1935 |
| 30 | 8 | A | 14 | 26 | 24 | 1365 | 1390 |
| 30 | 8 | B | 14 | 26 | 24 | 1525 | 1505 |
| 30 | 8 | C | 14 | 26 | 24 | 1775 | 1755 |
| 30 | 8 | D | 14 | 26 | 24 | 2040 | 2030 |
| 30 | 10 | A | 15 | 27 | 24 | 1430 | 1460 |
| 30 | 10 | B | 15 | 27 | 24 | 1605 | 1585 |
| 30 | 10 | C | 15 | 27 | 24 | 1865 | 1840 |
| 30 | 10 | D | 15 | 27 | 24 | 2135 | 2125 |
| 30 | 12 | A | 15 | 27 | 24 | 1460 | 1485 |
| 30 | 12 | B | 15 | 27 | 24 | 1630 | 1610 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 30 | 12 | C | 15 | 27 | 24 | 1885 | 1865 |
| 30 | 12 | D | 15 | 27 | 24 | 2155 | 2145 |
| 30 | 14 | A | 18 | 30 | 26 | 1625 | 1650 |
| 30 | 14 | B | 18 | 30 | 26 | 1815 | 1795 |
| 30 | 14 | C | 18 | 30 | 26 | 2135 | 2110 |
| 30 | 14 | D | 18 | 30 | 26 | 2430 | 2420 |
| 30 | 16 | A | 19 | 31 | 26 | 1710 | 1735 |
| 30 | 16 | B | 19 | 31 | 26 | 1910 | 1890 |
| 30 | 16 | C | 19 | 31 | 26 | 2250 | 2225 |
| 30 | 16 | D | 19 | 31 | 26 | 2555 | 2540 |
| 30 | 18 | A | 20 | 34 | 26 | 1840 | 1815 |
| 30 | 18 | B | 20 | 34 | 26 | 2050 | 1975 |
| 30 | 18 | C | 20 | 34 | 26 | 2425 | 2335 |
| 30 | 18 | D | 20 | 34 | 26 | 2745 | 2655 |
| 30 | 20 | A | 21 | 36 | 26 | 1945 | 1905 |
| 30 | 20 | B | 21 | 36 | 26 | 2170 | 2070 |
| 30 | 20 | C | 21 | 36 | 26 | 2580 | 2455 |
| 30 | 20 | D | 21 | 36 | 26 | 2910 | 2785 |
| 30 | 24 | A | 23 | 38 | 26 | 2130 | 2080 |
| 30 | 24 | B | 23 | 38 | 26 | 2365 | 2255 |
| 30 | 24 | C | 23 | 38 | 26 | 2825 | 2700 |
| 30 | 24 | D | 23 | 38 | 26 | 3165 | 3040 |
| 30 | 30 | A | 26 | 43 | 26 | 2445 | 2355 |
| 30 | 30 | B | 26 | 43 | 26 | 2765 | 2600 |
| 30 | 30 | C | 26 | 43 | 26 | 3245 | 3055 |
| 30 | 30 | D | 26 | 43 | 26 | 3745 | 3545 |
| 36 | 8 | A | 14 | 26 | 27 | 1785 | 1805 |
| 36 | 8 | B | 14 | 26 | 27 | 2070 | 2090 |
| 36 | 8 | C | 14 | 26 | 27 | 2420 | 2430 |
| 36 | 8 | D | 14 | 26 | 27 | 2800 | 2795 |
| 36 | 10 | A | 15 | 27 | 27 | 1875 | 1895 |
| 36 | 10 | B | 15 | 27 | 27 | 2165 | 2190 |
| 36 | 10 | C | 15 | 27 | 27 | 2525 | 2535 |
| 36 | 10 | D | 15 | 27 | 27 | 2920 | 2920 |
| 36 | 12 | A | 16 | 28 | 27 | 1960 | 1985 |
| 36 | 12 | B | 16 | 28 | 27 | 2260 | 2285 |
| 36 | 12 | C | 16 | 28 | 27 | 2635 | 2645 |
| 36 | 12 | D | 16 | 28 | 27 | 3040 | 3040 |
| 36 | 14 | A | 18 | 30 | 29 | 2110 | 2130 |
| 36 | 14 | B | 18 | 30 | 29 | 2430 | 2455 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 36 | 14 | C | 18 | 30 | 29 | 2860 | 2865 |
| 36 | 14 | D | 18 | 30 | 29 | 3295 | 3295 |
| 36 | 16 | A | 19 | 31 | 29 | 2210 | 2230 |
| 36 | 16 | B | 19 | 31 | 29 | 2540 | 2560 |
| 36 | 16 | C | 19 | 31 | 29 | 3000 | 3005 |
| 36 | 16 | D | 19 | 31 | 29 | 3440 | 3440 |
| 36 | 18 | A | 20 | 34 | 29 | 2370 | 2325 |
| 36 | 18 | B | 20 | 34 | 29 | 2715 | 2665 |
| 36 | 18 | C | 20 | 34 | 29 | 3215 | 3135 |
| 36 | 18 | D | 20 | 34 | 29 | 3690 | 3585 |
| 36 | 20 | A | 21 | 36 | 29 | 2505 | 2425 |
| 36 | 20 | B | 21 | 36 | 29 | 2865 | 2775 |
| 36 | 20 | C | 21 | 36 | 29 | 3405 | 3275 |
| 36 | 20 | D | 21 | 36 | 29 | 3890 | 3730 |
| 36 | 24 | A | 23 | 38 | 29 | 2710 | 2630 |
| 36 | 24 | B | 23 | 38 | 29 | 3080 | 2990 |
| 36 | 24 | C | 23 | 38 | 29 | 3685 | 3560 |
| 36 | 24 | D | 23 | 38 | 29 | 4190 | 4030 |
| 36 | 30 | A | 26 | 43 | 29 | 3075 | 2930 |
| 36 | 30 | B | 26 | 43 | 29 | 3535 | 3370 |
| 36 | 30 | C | 26 | 43 | 29 | 4170 | 3955 |
| 36 | 30 | D | 26 | 43 | 29 | 4850 | 4585 |
| 36 | 36 | A | 29 | 46 | 29 | 3430 | 3290 |
| 36 | 36 | B | 29 | 46 | 29 | 3995 | 3825 |
| 36 | 36 | C | 29 | 46 | 29 | 4705 | 4490 |
| 36 | 36 | D | 29 | 46 | 29 | 5465 | 5200 |
| 42 | 12 | A | 16 | 28 | 30 | 2545 | 2615 |
| 42 | 12 | B | 16 | 28 | 30 | 2895 | 2935 |
| 42 | 12 | C | 16 | 28 | 30 | 3470 | 3505 |
| 42 | 12 | D | 16 | 28 | 30 | 3990 | 4030 |
| 42 | 14 | A | 18 | 30 | 32 | 2735 | 2805 |
| 42 | 14 | B | 18 | 30 | 32 | 3110 | 3150 |
| 42 | 14 | C | 18 | 30 | 32 | 3750 | 3785 |
| 42 | 14 | D | 18 | 30 | 32 | 4305 | 4345 |
| 42 | 16 | A | 19 | 31 | 32 | 2850 | 2920 |
| 42 | 16 | B | 19 | 31 | 32 | 3235 | 3280 |
| 42 | 16 | C | 19 | 31 | 32 | 3910 | 3945 |
| 42 | 16 | D | 19 | 31 | 32 | 4485 | 4520 |
| 42 | 18 | A | 20 | 34 | 32 | 3045 | 3035 |
| 42 | 18 | B | 20 | 34 | 32 | 3455 | 3400 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 42 | 18 | C | 20 | 34 | 32 | 4180 | 4100 |
| 42 | 18 | D | 20 | 34 | 32 | 4790 | 4690 |
| 42 | 20 | A | 21 | 36 | 32 | 3205 | 3150 |
| 42 | 20 | B | 21 | 36 | 32 | 3635 | 3525 |
| 42 | 20 | C | 21 | 36 | 32 | 4405 | 4265 |
| 42 | 20 | D | 21 | 36 | 32 | 5040 | 4870 |
| 42 | 24 | A | 23 | 38 | 32 | 3430 | 3380 |
| 42 | 24 | B | 23 | 38 | 32 | 3885 | 3780 |
| 42 | 24 | C | 23 | 38 | 32 | 4730 | 4595 |
| 42 | 24 | D | 23 | 38 | 32 | 5390 | 5220 |
| 42 | 30 | A | 26 | 43 | 32 | 3865 | 3730 |
| 42 | 30 | B | 26 | 43 | 32 | 4385 | 4205 |
| 42 | 30 | C | 26 | 43 | 32 | 5310 | 5050 |
| 42 | 30 | D | 26 | 43 | 32 | 6155 | 5845 |
| 42 | 36 | A | 29 | 46 | 32 | 4250 | 4115 |
| 42 | 36 | B | 29 | 46 | 32 | 4910 | 4705 |
| 42 | 36 | C | 29 | 46 | 32 | 5885 | 5630 |
| 42 | 36 | D | 29 | 46 | 32 | 6815 | 6510 |
| 42 | 42 | A | 32 | 49 | 32 | 4745 | 4610 |
| 42 | 42 | B | 32 | 49 | 32 | 5440 | 5235 |
| 42 | 42 | C | 32 | 49 | 32 | 6565 | 6310 |
| 42 | 42 | D | 32 | 49 | 32 | 7595 | 7285 |
| 48 | 12 | A | 17 | 29 | 33 | 3345 | 3395 |
| 48 | 12 | B | 17 | 29 | 33 | 3760 | 3815 |
| 48 | 12 | C | 17 | 29 | 33 | 4520 | 4585 |
| 48 | 12 | D | 17 | 29 | 33 | 5195 | 5280 |
| 48 | 14 | A | 18 | 30 | 35 | 3475 | 3520 |
| 48 | 14 | B | 18 | 30 | 35 | 3900 | 3955 |
| 48 | 14 | C | 18 | 30 | 35 | 4710 | 4775 |
| 48 | 14 | D | 18 | 30 | 35 | 5400 | 5485 |
| 48 | 16 | A | 19 | 31 | 35 | 3615 | 3660 |
| 48 | 16 | B | 19 | 31 | 35 | 4050 | 4105 |
| 48 | 16 | C | 19 | 31 | 35 | 4900 | 4960 |
| 48 | 16 | D | 19 | 31 | 35 | 5615 | 5700 |
| 48 | 18 | A | 20 | 34 | 35 | 3860 | 3795 |
| 48 | 18 | B | 20 | 34 | 35 | 4320 | 4255 |
| 48 | 18 | C | 20 | 34 | 35 | 5230 | 5145 |
| 48 | 18 | D | 20 | 34 | 35 | 5990 | 5900 |
| 48 | 20 | A | 21 | 36 | 35 | 4055 | 3935 |
| 48 | 20 | B | 21 | 36 | 35 | 4540 | 4405 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 48 | 20 | C | 21 | 36 | 35 | 5500 | 5335 |
| 48 | 20 | D | 21 | 36 | 35 | 6285 | 6110 |
| 48 | 24 | A | 23 | 38 | 35 | 4330 | 4210 |
| 48 | 24 | B | 23 | 38 | 35 | 4830 | 4700 |
| 48 | 24 | C | 23 | 38 | 35 | 5875 | 5720 |
| 48 | 24 | D | 23 | 38 | 35 | 6700 | 6520 |
| 48 | 30 | A | 26 | 43 | 35 | 4845 | 4620 |
| 48 | 30 | B | 26 | 43 | 35 | 5445 | 5190 |
| 48 | 30 | C | 26 | 43 | 35 | 6560 | 6250 |
| 48 | 30 | D | 26 | 43 | 35 | 7580 | 7230 |
| 48 | 36 | A | 29 | 46 | 35 | 5280 | 5055 |
| 48 | 36 | B | 29 | 46 | 35 | 5995 | 5735 |
| 48 | 36 | C | 29 | 46 | 35 | 7210 | 6900 |
| 48 | 36 | D | 29 | 46 | 35 | 8320 | 7975 |
| 48 | 42 | A | 32 | 49 | 35 | 5815 | 5590 |
| 48 | 42 | B | 32 | 49 | 35 | 6565 | 6305 |
| 48 | 42 | C | 32 | 49 | 35 | 7925 | 7620 |
| 48 | 42 | D | 32 | 49 | 35 | 9150 | 8800 |
| 48 | 48 | A | 35 | 52 | 35 | 6390 | 6165 |
| 48 | 48 | B | 35 | 52 | 35 | 7220 | 6965 |
| 48 | 48 | C | 35 | 52 | 35 | 8720 | 8410 |
| 48 | 48 | D | 35 | 52 | 35 | 10065 | 9715 |
| 54 | 20 | A | 28 | 46 | 38.5 | 6015 | 5745 |
| 54 | 20 | B | 28 | 46 | 38.5 | 6885 | 6585 |
| 54 | 20 | C | 28 | 46 | 38.5 | 8460 | 8050 |
| 54 | 20 | D | 28 | 46 | 38.5 | 9885 | 9395 |
| 54 | 24 | A | 30 | 48 | 40 | 6365 | 6095 |
| 54 | 24 | B | 30 | 48 | 40 | 7275 | 6970 |
| 54 | 24 | C | 30 | 48 | 40 | 8945 | 8535 |
| 54 | 24 | D | 30 | 48 | 40 | 10420 | 9925 |
| 54 | 30 | A | 33 | 51 | 40 | 6835 | 6565 |
| 54 | 30 | B | 33 | 51 | 40 | 7845 | 7540 |
| 54 | 30 | C | 33 | 51 | 40 | 9585 | 9175 |
| 54 | 30 | D | 33 | 51 | 40 | 11270 | 10775 |
| 54 | 36 | A | 36 | 54 | 42 | 7390 | 7120 |
| 54 | 36 | B | 36 | 54 | 42 | 8550 | 8250 |
| 54 | 36 | C | 36 | 54 | 42 | 10425 | 10015 |
| 54 | 36 | D | 36 | 54 | 42 | 12245 | 11755 |
| 54 | 42 | A | 39 | 57 | 42 | 8020 | 7755 |
| 54 | 42 | B | 39 | 57 | 42 | 9120 | 8920 |
| 54 | 42 | C | 39 | 57 | 42 | 11275 | 10865 |

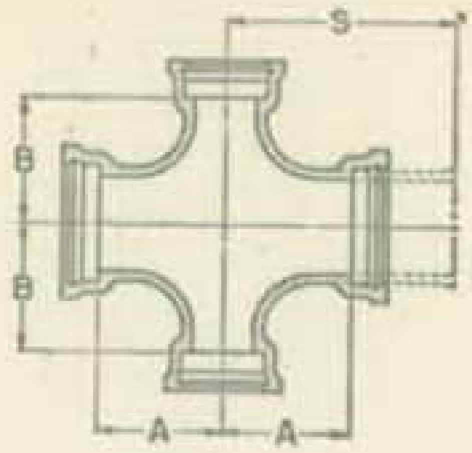
Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Tees

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 2 Bell | 3 Bell |
| 54 | 42 | D | 39 | 57 | 42 | 13230 | 12735 |
| 54 | 48 | A | 42 | 60 | 45 | 8840 | 8570 |
| 54 | 48 | B | 42 | 60 | 45 | 10140 | 9840 |
| 54 | 48 | C | 42 | 60 | 45 | 12430 | 12020 |
| 54 | 48 | D | 42 | 60 | 45 | 14535 | 14040 |
| 54 | 54 | A | 45 | 63 | 45 | 9600 | 9330 |
| 54 | 54 | B | 45 | 63 | 45 | 11070 | 10780 |
| 54 | 54 | C | 45 | 63 | 45 | 13565 | 13160 |
| 54 | 54 | D | 45 | 63 | 45 | 15955 | 15460 |
| 60 | 20 | A | 28 | 46 | 42 | 6915 | 6650 |
| 60 | 20 | B | 28 | 46 | 42 | 8160 | 7750 |
| 60 | 20 | C | 28 | 46 | 42 | 9875 | 9390 |
| 60 | 20 | D | 28 | 46 | 42 | 11685 | 11100 |
| 60 | 24 | A | 30 | 48 | 44 | 7315 | 7040 |
| 60 | 24 | B | 30 | 48 | 44 | 8600 | 8195 |
| 60 | 24 | C | 30 | 48 | 44 | 10425 | 9940 |
| 60 | 24 | D | 30 | 48 | 44 | 12290 | 11710 |
| 60 | 30 | A | 33 | 51 | 44 | 7845 | 7575 |
| 60 | 30 | B | 33 | 51 | 44 | 9265 | 8850 |
| 60 | 30 | C | 33 | 51 | 44 | 11160 | 10680 |
| 60 | 30 | D | 33 | 51 | 44 | 13265 | 12675 |
| 60 | 36 | A | 36 | 54 | 44 | 8385 | 8120 |
| 60 | 36 | B | 36 | 54 | 44 | 9980 | 9570 |
| 60 | 36 | C | 36 | 54 | 44 | 12000 | 11515 |
| 60 | 36 | D | 36 | 54 | 44 | 14260 | 13670 |
| 60 | 42 | A | 39 | 57 | 48 | 9205 | 8940 |
| 60 | 42 | B | 39 | 57 | 48 | 10900 | 10490 |
| 60 | 42 | C | 39 | 57 | 48 | 13145 | 12660 |
| 60 | 42 | D | 39 | 57 | 48 | 15595 | 15000 |
| 60 | 48 | A | 42 | 60 | 48 | 9935 | 9670 |
| 60 | 48 | B | 42 | 60 | 48 | 11730 | 11320 |
| 60 | 48 | C | 42 | 60 | 48 | 14150 | 13665 |
| 60 | 48 | D | 42 | 60 | 48 | 16770 | 16175 |
| 60 | 54 | A | 45 | 63 | 48 | 10720 | 10455 |
| 60 | 54 | B | 45 | 63 | 48 | 12695 | 12285 |
| 60 | 54 | C | 45 | 63 | 48 | 15345 | 14860 |
| 60 | 54 | D | 45 | 63 | 48 | 18230 | 17640 |
| 60 | 60 | A | 48 | 66 | 48 | 11455 | 11190 |
| 60 | 60 | B | 48 | 66 | 48 | 13625 | 13210 |
| 60 | 60 | C | 48 | 66 | 48 | 16420 | 15940 |
| 60 | 60 | D | 48 | 66 | 48 | 19575 | 18980 |

Dimensions in inches.
Large diameter tees furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses




### Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 3 | 3 | D | 10 | 22 | 10 | 125 | 130 |
| 4 | 3 | D | 11 | 23 | 11 | 150 | 155 |
| 4 | 4 | D | 11 | 23 | 11 | 170 | 170 |
| 6 | 3 | D | 12 | 24 | 12 | 205 | 200 |
| 6 | 4 | D | 12 | 24 | 12 | 220 | 220 |
| 6 | 6 | D | 12 | 24 | 12 | 260 | 255 |
| 8 | 4 | D | 13 | 25 | 13 | 290 | 290 |
| 8 | 6 | D | 13 | 25 | 13 | 325 | 325 |
| 8 | 8 | D | 13 | 25 | 13 | 370 | 370 |
| 10 | 4 | D | 14 | 26 | 14 | 380 | 370 |
| 10 | 6 | D | 14 | 26 | 14 | 415 | 405 |
| 10 | 8 | D | 14 | 26 | 14 | 455 | 445 |
| 10 | 10 | D | 14 | 26 | 14 | 505 | 495 |
| 12 | 4 | D | 15 | 27 | 15 | 485 | 465 |
| 12 | 6 | D | 15 | 27 | 15 | 515 | 495 |
| 12 | 8 | D | 15 | 27 | 15 | 560 | 540 |
| 12 | 10 | D | 15 | 27 | 15 | 610 | 590 |
| 12 | 12 | D | 15 | 27 | 15 | 665 | 645 |
| 14 | 4 | B | 16 | 28 | 16 | 535 | 525 |
| 14 | 4 | D | 16 | 28 | 16 | 635 | 610 |
| 14 | 6 | B | 16 | 28 | 16 | 570 | 560 |
| 14 | 6 | D | 16 | 28 | 16 | 665 | 640 |
| 14 | 8 | B | 16 | 28 | 16 | 620 | 610 |
| 14 | 8 | D | 16 | 28 | 16 | 710 | 685 |
| 14 | 10 | B | 16 | 28 | 16 | 670 | 660 |
| 14 | 10 | D | 16 | 28 | 16 | 760 | 730 |
| 14 | 12 | B | 16 | 28 | 16 | 730 | 720 |
| 14 | 12 | D | 16 | 28 | 16 | 810 | 785 |
| 14 | 14 | B | 16 | 28 | 16 | 745 | 740 |
| 14 | 14 | D | 16 | 28 | 16 | 890 | 860 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 16 | 4 | B | 17 | 29 | 17 | 660 | 655 |
| 16 | 4 | D | 17 | 29 | 17 | 800 | 780 |
| 16 | 6 | B | 17 | 29 | 17 | 690 | 690 |
| 16 | 6 | D | 17 | 29 | 17 | 830 | 805 |
| 16 | 8 | B | 17 | 29 | 17 | 740 | 735 |
| 16 | 8 | D | 17 | 29 | 17 | 875 | 855 |
| 16 | 10 | B | 17 | 29 | 17 | 790 | 785 |
| 16 | 10 | D | 17 | 29 | 17 | 925 | 900 |
| 16 | 12 | B | 17 | 29 | 17 | 845 | 840 |
| 16 | 12 | D | 17 | 29 | 17 | 975 | 950 |
| 16 | 14 | B | 17 | 29 | 17 | 860 | 860 |
| 16 | 14 | D | 17 | 29 | 17 | 1045 | 1020 |
| 16 | 16 | B | 17 | 29 | 17 | 940 | 940 |
| 16 | 16 | D | 17 | 29 | 17 | 1150 | 1125 |
| 18 | 4 | B | 18 | 30 | 18 | 795 | 785 |
| 18 | 4 | D | 18 | 30 | 18 | 985 | 955 |
| 18 | 6 | B | 18 | 30 | 18 | 830 | 820 |
| 18 | 6 | D | 18 | 30 | 18 | 1010 | 980 |
| 18 | 8 | B | 18 | 30 | 18 | 870 | 865 |
| 18 | 8 | D | 18 | 30 | 18 | 1055 | 1025 |
| 18 | 10 | B | 18 | 30 | 18 | 920 | 915 |
| 18 | 10 | D | 18 | 30 | 18 | 1100 | 1070 |
| 18 | 12 | B | 18 | 30 | 18 | 975 | 965 |
| 18 | 12 | D | 18 | 30 | 18 | 1150 | 1125 |
| 18 | 14 | B | 18 | 30 | 18 | 990 | 985 |
| 18 | 14 | D | 18 | 30 | 18 | 1210 | 1180 |
| 18 | 16 | B | 18 | 30 | 18 | 1060 | 1050 |
| 18 | 16 | D | 18 | 30 | 18 | 1305 | 1275 |
| 18 | 18 | B | 18 | 30 | 18 | 1135 | 1130 |
| 18 | 18 | D | 18 | 30 | 18 | 1405 | 1375 |
| 20 | 4 | B | 19 | 31 | 19 | 950 | 940 |
| 20 | 4 | D | 19 | 31 | 19 | 1195 | 1170 |
| 20 | 6 | B | 19 | 31 | 19 | 985 | 975 |
| 20 | 6 | D | 19 | 31 | 19 | 1225 | 1200 |
| 20 | 8 | B | 19 | 31 | 19 | 1030 | 1020 |
| 20 | 8 | D | 19 | 31 | 19 | 1265 | 1240 |
| 20 | 10 | B | 19 | 31 | 19 | 1075 | 1065 |
| 20 | 10 | D | 19 | 31 | 19 | 1310 | 1280 |
| 20 | 12 | B | 19 | 31 | 19 | 1125 | 1115 |
| 20 | 12 | D | 19 | 31 | 19 | 1355 | 1330 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 20 | 14 | B | 19 | 31 | 19 | 1145 | 1130 |
| 20 | 14 | D | 19 | 31 | 19 | 1420 | 1390 |
| 20 | 16 | B | 19 | 31 | 19 | 1215 | 1200 |
| 20 | 16 | D | 19 | 31 | 19 | 1515 | 1485 |
| 20 | 18 | B | 19 | 31 | 19 | 1280 | 1265 |
| 20 | 18 | D | 19 | 31 | 19 | 1600 | 1570 |
| 20 | 20 | B | 19 | 31 | 19 | 1360 | 1350 |
| 20 | 20 | D | 19 | 31 | 19 | 1720 | 1690 |
| 24 | 6 | B | 21 | 33 | 21 | 1335 | 1315 |
| 24 | 6 | D | 21 | 33 | 21 | 1705 | 1665 |
| 24 | 8 | B | 21 | 33 | 21 | 1380 | 1355 |
| 24 | 8 | D | 21 | 33 | 21 | 1745 | 1705 |
| 24 | 10 | B | 21 | 33 | 21 | 1430 | 1410 |
| 24 | 10 | D | 21 | 33 | 21 | 1785 | 1745 |
| 24 | 12 | B | 21 | 33 | 21 | 1475 | 1450 |
| 24 | 12 | D | 21 | 33 | 21 | 1825 | 1785 |
| 24 | 14 | B | 21 | 33 | 21 | 1485 | 1460 |
| 24 | 14 | D | 21 | 33 | 21 | 1885 | 1845 |
| 24 | 16 | B | 21 | 33 | 21 | 1550 | 1530 |
| 24 | 16 | D | 21 | 33 | 21 | 1975 | 1930 |
| 24 | 18 | B | 21 | 33 | 21 | 1610 | 1585 |
| 24 | 18 | D | 21 | 33 | 21 | 2045 | 2005 |
| 24 | 20 | B | 21 | 33 | 21 | 1685 | 1660 |
| 24 | 20 | D | 21 | 33 | 21 | 2155 | 2110 |
| 24 | 24 | B | 21 | 33 | 21 | 1840 | 1815 |
| 24 | 24 | D | 21 | 33 | 21 | 2370 | 2325 |
| 30 | 6 | A | 13 | 25 | 24 | 1350 | 1375 |
| 30 | 6 | B | 13 | 25 | 24 | 1505 | 1485 |
| 30 | 6 | C | 13 | 25 | 24 | 1745 | 1725 |
| 30 | 6 | D | 13 | 25 | 24 | 1995 | 1985 |
| 30 | 8 | A | 14 | 26 | 24 | 1445 | 1470 |
| 30 | 8 | B | 14 | 26 | 24 | 1600 | 1580 |
| 30 | 8 | C | 14 | 26 | 24 | 1850 | 1830 |
| 30 | 8 | D | 14 | 26 | 24 | 2110 | 2100 |
| 30 | 10 | A | 15 | 27 | 24 | 1535 | 1560 |
| 30 | 10 | B | 15 | 27 | 24 | 1705 | 1685 |
| 30 | 10 | C | 15 | 27 | 24 | 1955 | 1935 |
| 30 | 10 | D | 15 | 27 | 24 | 2220 | 2210 |
| 30 | 12 | A | 15 | 27 | 24 | 1585 | 1615 |
| 30 | 12 | B | 15 | 27 | 24 | 1750 | 1730 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 30 | 12 | C | 15 | 27 | 24 | 2000 | 1975 |
| 30 | 12 | D | 15 | 27 | 24 | 2260 | 2250 |
| 30 | 14 | A | 18 | 30 | 26 | 1775 | 1800 |
| 30 | 14 | B | 18 | 30 | 26 | 1960 | 1940 |
| 30 | 14 | C | 18 | 30 | 26 | 2300 | 2280 |
| 30 | 14 | D | 18 | 30 | 26 | 2590 | 2575 |
| 30 | 16 | A | 19 | 31 | 26 | 1895 | 1920 |
| 30 | 16 | B | 19 | 31 | 26 | 2085 | 2065 |
| 30 | 16 | C | 19 | 31 | 26 | 2460 | 2435 |
| 30 | 16 | D | 19 | 31 | 26 | 2755 | 2745 |
| 30 | 18 | A | 20 | 34 | 26 | 2060 | 2035 |
| 30 | 18 | B | 20 | 34 | 26 | 2260 | 2185 |
| 30 | 18 | C | 20 | 34 | 26 | 2680 | 2590 |
| 30 | 18 | D | 20 | 34 | 26 | 2990 | 2900 |
| 30 | 20 | A | 21 | 36 | 26 | 2205 | 2160 |
| 30 | 20 | B | 21 | 36 | 26 | 2420 | 2315 |
| 30 | 20 | C | 21 | 36 | 26 | 2890 | 2770 |
| 30 | 20 | D | 21 | 36 | 26 | 3205 | 3075 |
| 30 | 24 | A | 23 | 38 | 26 | 2470 | 2425 |
| 30 | 24 | B | 23 | 38 | 26 | 2680 | 2575 |
| 30 | 24 | C | 23 | 38 | 26 | 3250 | 3130 |
| 30 | 24 | D | 23 | 38 | 26 | 3560 | 3435 |
| 30 | 30 | A | 26 | 43 | 26 | 2920 | 2825 |
| 30 | 30 | B | 26 | 43 | 26 | 3260 | 3100 |
| 30 | 30 | C | 26 | 43 | 26 | 3825 | 3635 |
| 30 | 30 | D | 26 | 43 | 26 | 4425 | 4225 |
| 36 | 8 | A | 14 | 26 | 27 | 1865 | 1885 |
| 36 | 8 | B | 14 | 26 | 27 | 2140 | 2165 |
| 36 | 8 | C | 14 | 26 | 27 | 2490 | 2500 |
| 36 | 8 | D | 14 | 26 | 27 | 2865 | 2865 |
| 36 | 10 | A | 15 | 27 | 27 | 1970 | 1990 |
| 36 | 10 | B | 15 | 27 | 27 | 2255 | 2280 |
| 36 | 10 | C | 15 | 27 | 27 | 2615 | 2625 |
| 36 | 10 | D | 15 | 27 | 27 | 3000 | 3000 |
| 36 | 12 | A | 16 | 28 | 27 | 2085 | 2105 |
| 36 | 12 | B | 16 | 28 | 27 | 2375 | 2400 |
| 36 | 12 | C | 16 | 28 | 27 | 2745 | 2755 |
| 36 | 12 | D | 16 | 28 | 27 | 3140 | 3140 |
| 36 | 14 | A | 18 | 30 | 29 | 2255 | 2275 |
| 36 | 14 | B | 18 | 30 | 29 | 2565 | 2590 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 36 | 14 | C | 18 | 30 | 29 | 3020 | 3025 |
| 36 | 14 | D | 18 | 30 | 29 | 3435 | 3435 |
| 36 | 16 | A | 19 | 31 | 29 | 2390 | 2410 |
| 36 | 16 | B | 19 | 31 | 29 | 2705 | 2730 |
| 36 | 16 | C | 19 | 31 | 29 | 3195 | 3205 |
| 36 | 16 | D | 19 | 31 | 29 | 3625 | 3625 |
| 36 | 18 | A | 20 | 34 | 29 | 2580 | 2535 |
| 36 | 18 | B | 20 | 34 | 29 | 2915 | 2860 |
| 36 | 18 | C | 20 | 34 | 29 | 3455 | 3375 |
| 36 | 18 | D | 20 | 34 | 29 | 3920 | 3810 |
| 36 | 20 | A | 21 | 36 | 29 | 2750 | 2670 |
| 36 | 20 | B | 21 | 36 | 29 | 3095 | 3000 |
| 36 | 20 | C | 21 | 36 | 29 | 3695 | 3565 |
| 36 | 20 | D | 21 | 36 | 29 | 4160 | 4000 |
| 36 | 24 | A | 23 | 38 | 29 | 3025 | 2950 |
| 36 | 24 | B | 23 | 38 | 29 | 3375 | 3285 |
| 36 | 24 | C | 23 | 38 | 29 | 4080 | 3950 |
| 36 | 24 | D | 23 | 38 | 29 | 4545 | 4385 |
| 36 | 30 | A | 26 | 43 | 29 | 3500 | 3360 |
| 36 | 30 | B | 26 | 43 | 29 | 3980 | 3815 |
| 36 | 30 | C | 26 | 43 | 29 | 4685 | 4470 |
| 36 | 30 | D | 26 | 43 | 29 | 5445 | 5180 |
| 36 | 36 | A | 29 | 46 | 29 | 4020 | 3875 |
| 36 | 36 | B | 29 | 46 | 29 | 4675 | 4510 |
| 36 | 36 | C | 29 | 46 | 29 | 5490 | 5275 |
| 36 | 36 | D | 29 | 46 | 29 | 6365 | 6100 |
| 42 | 12 | A | 16 | 28 | 30 | 2660 | 2735 |
| 42 | 12 | B | 16 | 28 | 30 | 3005 | 3045 |
| 42 | 12 | C | 16 | 28 | 30 | 3565 | 3605 |
| 42 | 12 | D | 16 | 28 | 30 | 4080 | 4120 |
| 42 | 14 | A | 18 | 30 | 32 | 2870 | 2945 |
| 42 | 14 | B | 18 | 30 | 32 | 3235 | 3275 |
| 42 | 14 | C | 18 | 30 | 32 | 3895 | 3930 |
| 42 | 14 | D | 18 | 30 | 32 | 4440 | 4475 |
| 42 | 16 | A | 19 | 31 | 32 | 3020 | 3090 |
| 42 | 16 | B | 19 | 31 | 32 | 3395 | 3435 |
| 42 | 16 | C | 19 | 31 | 32 | 4095 | 4135 |
| 42 | 16 | D | 19 | 31 | 32 | 4650 | 4690 |
| 42 | 18 | A | 20 | 34 | 32 | 3245 | 3230 |
| 42 | 18 | B | 20 | 34 | 32 | 3640 | 3580 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 42 | 18 | C | 20 | 34 | 32 | 4405 | 4325 |
| 42 | 18 | D | 20 | 34 | 32 | 4990 | 4890 |
| 42 | 20 | A | 21 | 36 | 32 | 3435 | 3380 |
| 42 | 20 | B | 21 | 36 | 32 | 3850 | 3740 |
| 42 | 20 | C | 21 | 36 | 32 | 4675 | 4535 |
| 42 | 20 | D | 21 | 36 | 32 | 5280 | 5110 |
| 42 | 24 | A | 23 | 38 | 32 | 3725 | 3675 |
| 42 | 24 | B | 23 | 38 | 32 | 4160 | 4050 |
| 42 | 24 | C | 23 | 38 | 32 | 5090 | 4950 |
| 42 | 24 | D | 23 | 38 | 32 | 5705 | 5535 |
| 42 | 30 | A | 26 | 43 | 32 | 4260 | 4120 |
| 42 | 30 | B | 26 | 43 | 32 | 4785 | 4605 |
| 42 | 30 | C | 26 | 43 | 32 | 5770 | 5510 |
| 42 | 30 | D | 26 | 43 | 32 | 6685 | 6375 |
| 42 | 36 | A | 29 | 46 | 32 | 4780 | 4645 |
| 42 | 36 | B | 29 | 46 | 32 | 5520 | 5315 |
| 42 | 36 | C | 29 | 46 | 32 | 6575 | 6315 |
| 42 | 36 | D | 29 | 46 | 32 | 7600 | 7295 |
| 42 | 42 | A | 32 | 49 | 32 | 5515 | 5380 |
| 42 | 42 | B | 32 | 49 | 32 | 6290 | 6085 |
| 42 | 42 | C | 32 | 49 | 32 | 7570 | 7315 |
| 42 | 42 | D | 32 | 49 | 32 | 8740 | 8430 |
| 48 | 12 | A | 17 | 29 | 33 | 3455 | 3505 |
| 48 | 12 | B | 17 | 29 | 33 | 3865 | 3920 |
| 48 | 12 | C | 17 | 29 | 33 | 4610 | 4675 |
| 48 | 12 | D | 17 | 29 | 33 | 5275 | 5355 |
| 48 | 14 | A | 18 | 30 | 35 | 3600 | 3650 |
| 48 | 14 | B | 18 | 30 | 35 | 4020 | 4075 |
| 48 | 14 | C | 18 | 30 | 35 | 4845 | 4905 |
| 48 | 14 | D | 18 | 30 | 35 | 5525 | 5610 |
| 48 | 16 | A | 19 | 31 | 35 | 3775 | 3820 |
| 48 | 16 | B | 19 | 31 | 35 | 4200 | 4255 |
| 48 | 16 | C | 19 | 31 | 35 | 5070 | 5135 |
| 48 | 16 | D | 19 | 31 | 35 | 5770 | 5855 |
| 48 | 18 | A | 20 | 34 | 35 | 4040 | 3980 |
| 48 | 18 | B | 20 | 34 | 35 | 4490 | 4420 |
| 48 | 18 | C | 20 | 34 | 35 | 5435 | 5350 |
| 48 | 18 | D | 20 | 34 | 35 | 6170 | 6085 |
| 48 | 20 | A | 21 | 36 | 35 | 4265 | 4145 |
| 48 | 20 | B | 21 | 36 | 35 | 4735 | 4605 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 48 | 20 | C | 21 | 36 | 35 | 5745 | 5585 |
| 48 | 20 | D | 21 | 36 | 35 | 6505 | 6330 |
| 48 | 24 | A | 23 | 38 | 35 | 4595 | 4475 |
| 48 | 24 | B | 23 | 38 | 35 | 5080 | 4945 |
| 48 | 24 | C | 23 | 38 | 35 | 6205 | 6045 |
| 48 | 24 | D | 23 | 38 | 35 | 6985 | 6805 |
| 48 | 30 | A | 26 | 43 | 35 | 5195 | 4965 |
| 48 | 30 | B | 26 | 43 | 35 | 5810 | 5555 |
| 48 | 30 | C | 26 | 43 | 35 | 6970 | 6660 |
| 48 | 30 | D | 26 | 43 | 35 | 8055 | 7705 |
| 48 | 36 | A | 29 | 46 | 35 | 5740 | 5515 |
| 48 | 36 | B | 29 | 46 | 35 | 6535 | 6275 |
| 48 | 36 | C | 29 | 46 | 35 | 7815 | 7510 |
| 48 | 36 | D | 29 | 46 | 35 | 9020 | 8675 |
| 48 | 42 | A | 32 | 49 | 35 | 6480 | 6250 |
| 48 | 42 | B | 32 | 49 | 35 | 7305 | 7050 |
| 48 | 42 | C | 32 | 49 | 35 | 8805 | 8490 |
| 48 | 42 | D | 32 | 49 | 35 | 10150 | 9800 |
| 48 | 48 | A | 35 | 52 | 35 | 7300 | 7075 |
| 48 | 48 | B | 35 | 52 | 35 | 8235 | 7980 |
| 48 | 48 | C | 35 | 52 | 35 | 9945 | 9630 |
| 48 | 48 | D | 35 | 52 | 35 | 11465 | 11115 |
| 54 | 20 | A | 28 | 46 | 38.5 | 6225 | 5955 |
| 54 | 20 | B | 28 | 46 | 38.5 | 7075 | 6775 |
| 54 | 20 | C | 28 | 46 | 38.5 | 8695 | 8285 |
| 54 | 20 | D | 28 | 46 | 38.5 | 10085 | 9595 |
| 54 | 24 | A | 30 | 48 | 40 | 6655 | 6390 |
| 54 | 24 | B | 30 | 48 | 40 | 7540 | 7230 |
| 54 | 24 | C | 30 | 48 | 40 | 9280 | 8875 |
| 54 | 24 | D | 30 | 48 | 40 | 10715 | 10225 |
| 54 | 30 | A | 33 | 51 | 40 | 7205 | 6930 |
| 54 | 30 | B | 33 | 51 | 40 | 8230 | 7925 |
| 54 | 30 | C | 33 | 51 | 40 | 10005 | 9600 |
| 54 | 30 | D | 33 | 51 | 40 | 11750 | 11255 |
| 54 | 36 | A | 36 | 54 | 42 | 7920 | 7650 |
| 54 | 36 | B | 36 | 54 | 42 | 9190 | 8890 |
| 54 | 36 | C | 36 | 54 | 42 | 11125 | 10720 |
| 54 | 36 | D | 36 | 54 | 42 | 13040 | 12545 |
| 54 | 42 | A | 39 | 57 | 42 | 8795 | 8525 |
| 54 | 42 | B | 39 | 57 | 42 | 10075 | 9770 |
| 54 | 42 | C | 39 | 57 | 42 | 12270 | 11860 |

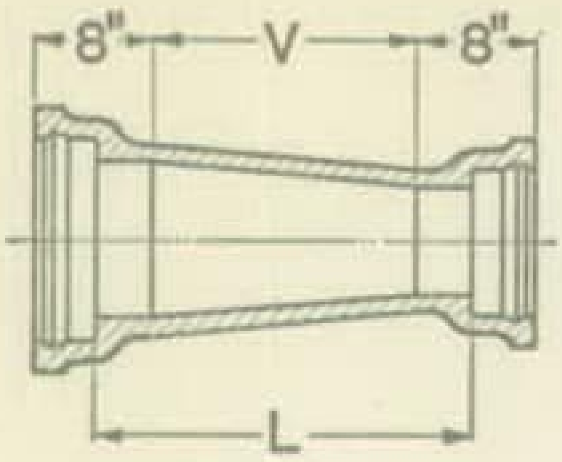
Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Crosses

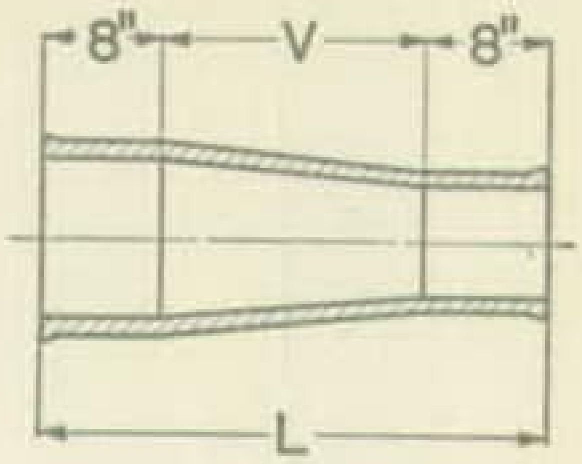
| Nominal Diam. Inches | | Class | Dimensions Inches | | | Approx. Weight, Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | 3 Bell | 4 Bell |
| 54 | 42 | D | 39 | 57 | 42 | 14345 | 13850 |
| 54 | 48 | A | 42 | 60 | 45 | 10030 | 9760 |
| 54 | 48 | B | 42 | 60 | 45 | 11450 | 11155 |
| 54 | 48 | C | 42 | 60 | 45 | 13960 | 13550 |
| 54 | 48 | D | 42 | 60 | 45 | 16290 | 15795 |
| 54 | 54 | A | 45 | 63 | 45 | 11155 | 10885 |
| 54 | 54 | B | 45 | 63 | 45 | 12860 | 12560 |
| 54 | 54 | C | 45 | 63 | 45 | 15735 | 15315 |
| 54 | 54 | D | 45 | 63 | 45 | 18465 | 17970 |
| 60 | 20 | A | 28 | 46 | 42 | 7130 | 6865 |
| 60 | 20 | B | 28 | 46 | 42 | 8345 | 7940 |
| 60 | 20 | C | 28 | 46 | 42 | 10145 | 9635 |
| 60 | 20 | D | 28 | 46 | 42 | 11890 | 11300 |
| 60 | 24 | A | 30 | 48 | 44 | 7615 | 7350 |
| 60 | 24 | B | 30 | 48 | 44 | 8870 | 8460 |
| 60 | 24 | C | 30 | 48 | 44 | 10770 | 10290 |
| 60 | 24 | D | 30 | 48 | 44 | 12590 | 12000 |
| 60 | 30 | A | 33 | 51 | 44 | 8225 | 7955 |
| 60 | 30 | B | 33 | 51 | 44 | 9650 | 9235 |
| 60 | 30 | C | 33 | 51 | 44 | 11585 | 11100 |
| 60 | 30 | D | 33 | 51 | 44 | 13735 | 13145 |
| 60 | 36 | A | 36 | 54 | 44 | 8880 | 8615 |
| 60 | 36 | B | 36 | 54 | 44 | 10530 | 10120 |
| 60 | 36 | C | 36 | 54 | 44 | 12610 | 12130 |
| 60 | 36 | D | 36 | 54 | 44 | 14935 | 14340 |
| 60 | 42 | A | 39 | 57 | 48 | 10065 | 9800 |
| 60 | 42 | B | 39 | 57 | 48 | 11825 | 11415 |
| 60 | 42 | C | 39 | 57 | 48 | 14235 | 13755 |
| 60 | 42 | D | 39 | 57 | 48 | 16815 | 16220 |
| 60 | 48 | A | 42 | 60 | 48 | 11075 | 10810 |
| 60 | 48 | B | 42 | 60 | 48 | 12935 | 12530 |
| 60 | 48 | C | 42 | 60 | 48 | 15595 | 15110 |
| 60 | 48 | D | 42 | 60 | 48 | 18375 | 17785 |
| 60 | 54 | A | 45 | 63 | 48 | 12190 | 11930 |
| 60 | 54 | B | 45 | 63 | 48 | 14325 | 13915 |
| 60 | 54 | C | 45 | 63 | 48 | 17320 | 16840 |
| 60 | 54 | D | 45 | 63 | 48 | 20520 | 19925 |
| 60 | 60 | A | 48 | 66 | 48 | 13210 | 12945 |
| 60 | 60 | B | 48 | 66 | 48 | 15630 | 15220 |
| 60 | 60 | C | 48 | 66 | 48 | 18815 | 18335 |
| 60 | 60 | D | 48 | 66 | 48 | 22410 | 21815 |

Dimensions in inches.
Large diameter crosses furnished with ribs when requested.
For bell and spigot dimensions, see page 276.

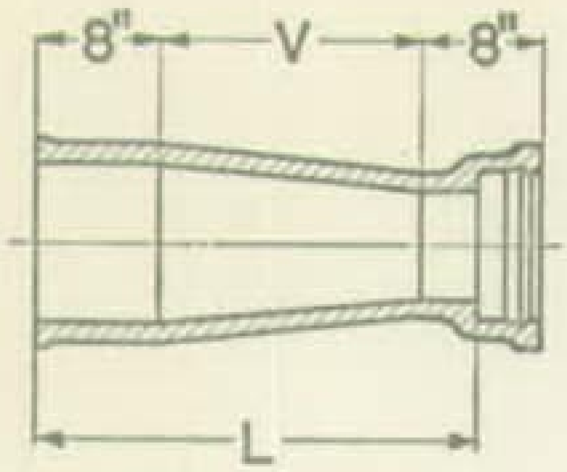
## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Reducers



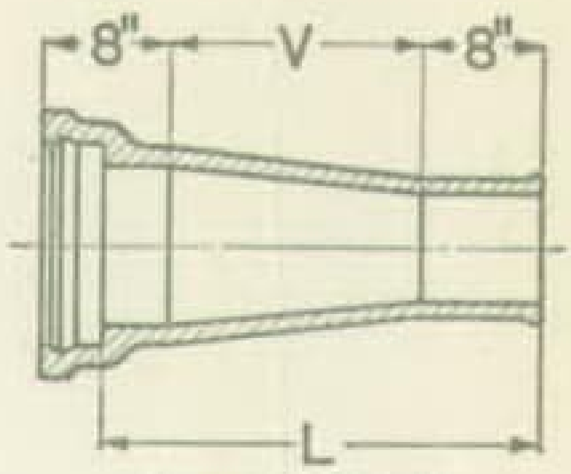
Bell & Bell



Spigot & Spigot



Small End Bell



Large End Bell

| Size | Class | V | Laying Length (L) | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot |
| 4x 3 | D | 8 | 16.5 | 20.0 | 20.5 | 24 | 70 | 55 | 55 | 40 |
| 6x 3 | D | 18 | 26.5 | 30.0 | 30.5 | 34 | 110 | 95 | 85 | 70 |
| 6x 4 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 125 | 105 | 100 | 80 |
| 8x 4 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 155 | 135 | 120 | 100 |
| 8x 6 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 180 | 155 | 145 | 120 |
| 10x 4 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 185 | 170 | 145 | 130 |
| 10x 6 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 210 | 190 | 170 | 145 |
| 10x 8 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 245 | 210 | 205 | 170 |
| 12x 4 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 225 | 205 | 175 | 155 |
| 12x 6 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 250 | 225 | 200 | 175 |
| 12x 8 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 280 | 245 | 230 | 200 |
| 12x10 | D | 18 | 26.0 | 30.0 | 30.0 | 34 | 315 | 275 | 270 | 230 |
| 14x 6 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 270 | 250 | 220 | 195 |
| 14x 6 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 305 | 280 | 250 | 225 |
| 14x 8 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 305 | 270 | 250 | 220 |
| 14x 8 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 340 | 305 | 285 | 250 |
| 14x10 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 345 | 305 | 290 | 250 |
| 14x10 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 380 | 340 | 325 | 285 |
| 14x12 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 385 | 335 | 330 | 280 |
| 14x12 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 420 | 370 | 365 | 320 |
| 16x 6 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 320 | 295 | 245 | 220 |
| 16x 6 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 365 | 340 | 290 | 265 |
| 16x 8 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 355 | 320 | 280 | 250 |

Dimensions in inches.

For bell and spigot dimensions, see page 276.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Reducers

| | | | Laying Length (L) | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Size | Class | V | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot |
| 16x 8 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 400 | 370 | 325 | 290 |
| 16x10 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 395 | 350 | 320 | 280 |
| 16x10 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 440 | 400 | 365 | 325 |
| 16x12 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 435 | 385 | 360 | 310 |
| 16x12 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 485 | 435 | 405 | 360 |
| 16x14 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 445 | 390 | 370 | 320 |
| 16x14 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 535 | 480 | 460 | 405 |
| 18x 8 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 400 | 365 | 315 | 280 |
| 18x 8 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 460 | 430 | 370 | 335 |
| 18x10 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 440 | 395 | 355 | 310 |
| 18x10 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 500 | 460 | 410 | 370 |
| 18x12 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 480 | 430 | 395 | 345 |
| 18x12 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 545 | 495 | 450 | 405 |
| 18x14 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 490 | 435 | 405 | 350 |
| 18x14 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 595 | 540 | 505 | 450 |
| 18x16 | B | 20 | 28.0 | 32.0 | 32.0 | 36 | 540 | 470 | 455 | 385 |
| 18x16 | D | 20 | 28.0 | 32.0 | 32.0 | 36 | 660 | 585 | 570 | 495 |
| 20x10 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 545 | 505 | 445 | 405 |
| 20x10 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 640 | 600 | 525 | 485 |
| 20x12 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 595 | 545 | 495 | 450 |
| 20x12 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 690 | 645 | 575 | 525 |
| 20x14 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 605 | 550 | 505 | 455 |
| 20x14 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 750 | 695 | 635 | 580 |
| 20x16 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 660 | 590 | 565 | 490 |
| 20x16 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 825 | 750 | 710 | 630 |
| 20x18 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 715 | 630 | 615 | 530 |
| 20x18 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 895 | 805 | 780 | 690 |
| 24x14 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 720 | 665 | 595 | 545 |
| 24x14 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 910 | 855 | 755 | 700 |
| 24x16 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 780 | 705 | 655 | 580 |
| 24x16 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 985 | 910 | 835 | 755 |
| 24x18 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 830 | 745 | 710 | 625 |
| 24x18 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 1,060 | 965 | 905 | 815 |
| 24x20 | B | 26 | 34.0 | 38.0 | 38.0 | 42 | 895 | 795 | 770 | 670 |
| 24x20 | D | 26 | 34.0 | 38.0 | 38.0 | 42 | 1,145 | 1,030 | 990 | 875 |
| 30x18 | A | 26 | 33.5 | 37.5 | 38.0 | 42 | 985 | 900 | 790 | 710 |
| 30x18 | B | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,045 | 960 | 865 | 780 |
| 30x18 | C | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,250 | 1,160 | 1,045 | 950 |
| 30x18 | D | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,385 | 1,290 | 1,130 | 1,040 |
| 30x20 | Short A | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,045 | 945 | 855 | 755 |
| 30x20 | Short B | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,105 | 1,010 | 930 | 830 |
| 30x20 | Short C | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,340 | 1,225 | 1,130 | 1,015 |
| 30x20 | Short D | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,475 | 1,355 | 1,220 | 1,105 |

Dimensions in inches.

For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Reducers

| Size | Class | V | Laying Length (L) | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot |
| 30x20 | Long A | 66 | 73.5 | 77.5 | 78.0 | 82 | 1,755 | 1,660 | 1,565 | 1,465 |
| 30x20 | Long B | 66 | 73.5 | 77.5 | 78.0 | 82 | 1,885 | 1,790 | 1,710 | 1,610 |
| 30x20 | Long C | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,295 | 2,180 | 2,085 | 1,970 |
| 30x20 | Long D | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,510 | 2,395 | 2,255 | 2,140 |
| 30x24 | Short A | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,170 | 1,045 | 975 | 855 |
| 30x24 | Short B | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,230 | 1,110 | 1,055 | 930 |
| 30x24 | Short C | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,510 | 1,360 | 1,300 | 1,150 |
| 30x24 | Short D | 26 | 33.5 | 37.5 | 38.0 | 42 | 1,645 | 1,495 | 1,390 | 1,240 |
| 30x24 | Long A | 66 | 73.5 | 77.5 | 78.0 | 82 | 1,975 | 1,850 | 1,785 | 1,660 |
| 30x24 | Long B | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,110 | 1,985 | 1,935 | 1,810 |
| 30x24 | Long C | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,595 | 2,445 | 2,390 | 2,235 |
| 30x24 | Long D | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,820 | 2,665 | 2,565 | 2,410 |
| 36x20 | Short A | 32 | 39.5 | 43.5 | 44.0 | 48 | 1,380 | 1,280 | 1,135 | 1,040 |
| 36x20 | Short B | 32 | 39.5 | 43.5 | 44.0 | 48 | 1,530 | 1,430 | 1,245 | 1,145 |
| 36x20 | Short C | 32 | 39.5 | 43.5 | 44.0 | 48 | 1,840 | 1,725 | 1,520 | 1,405 |
| 36x20 | Short D | 32 | 39.5 | 43.5 | 44.0 | 48 | 2,035 | 1,920 | 1,670 | 1,555 |
| 36x20 | Long A | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,105 | 2,005 | 1,860 | 1,765 |
| 36x20 | Long B | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,325 | 2,230 | 2,045 | 1,945 |
| 36x20 | Long C | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,820 | 2,705 | 2,500 | 2,385 |
| 36x20 | Long D | 66 | 73.5 | 77.5 | 78.0 | 82 | 3,120 | 3,005 | 2,755 | 2,640 |
| 36x24 | Short A | 32 | 39.5 | 43.5 | 44.0 | 48 | 1,520 | 1,400 | 1,280 | 1,155 |
| 36x24 | Short B | 32 | 39.5 | 43.5 | 44.0 | 48 | 1,675 | 1,550 | 1,390 | 1,265 |
| 36x24 | Short C | 32 | 39.5 | 43.5 | 44.0 | 48 | 2,040 | 1,885 | 1,715 | 1,565 |
| 36x24 | Short D | 32 | 39.5 | 43.5 | 44.0 | 48 | 2,235 | 2,085 | 1,875 | 1,720 |
| 36x24 | Long A | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,335 | 2,210 | 2,090 | 1,965 |
| 36x24 | Long B | 66 | 73.5 | 77.5 | 78.0 | 82 | 2,560 | 2,435 | 2,275 | 2,155 |
| 36x24 | Long C | 66 | 73.5 | 77.5 | 78.0 | 82 | 3,135 | 2,985 | 2,815 | 2,665 |
| 36x24 | Long D | 66 | 73.5 | 77.5 | 78.0 | 82 | 3,440 | 3,290 | 3,080 | 2,930 |
| 36x30 | Short A | 32 | 39.0 | 43.5 | 43.5 | 48 | 1,690 | 1,500 | 1,450 | 1,255 |
| 36x30 | Short B | 32 | 39.0 | 43.5 | 43.5 | 48 | 1,930 | 1,755 | 1,645 | 1,470 |
| 36x30 | Short C | 32 | 39.0 | 43.5 | 43.5 | 48 | 2,265 | 2,055 | 1,945 | 1,735 |
| 36x30 | Short D | 32 | 39.0 | 43.5 | 43.5 | 48 | 2,630 | 2,375 | 2,265 | 2,010 |
| 36x30 | Long A | 66 | 73.0 | 77.5 | 77.5 | 82 | 2,575 | 2,380 | 2,330 | 2,140 |
| 36x30 | Long B | 66 | 73.0 | 77.5 | 77.5 | 82 | 2,960 | 2,785 | 2,680 | 2,500 |
| 36x30 | Long C | 66 | 73.0 | 77.5 | 77.5 | 82 | 3,485 | 3,275 | 3,165 | 2,955 |
| 36x30 | Long D | 66 | 73.0 | 77.5 | 77.5 | 82 | 4,040 | 3,790 | 3,680 | 3,425 |
| 42x20 | Short A | 32 | 39.0 | 43.0 | 44.0 | 48 | 1,675 | 1,575 | 1,335 | 1,235 |
| 42x20 | Short B | 32 | 39.0 | 43.0 | 44.0 | 48 | 1,825 | 1,725 | 1,470 | 1,375 |
| 42x20 | Short C | 32 | 39.0 | 43.0 | 44.0 | 48 | 2,235 | 2,120 | 1,815 | 1,700 |
| 42x20 | Short D | 32 | 39.0 | 43.0 | 44.0 | 48 | 2,485 | 2,370 | 2,005 | 1,890 |
| 42x20 | Long A | 66 | 73.0 | 77.0 | 78.0 | 82 | 2,530 | 2,430 | 2,190 | 2,095 |
| 42x20 | Long B | 66 | 73.0 | 77.0 | 78.0 | 82 | 2,775 | 2,675 | 2,420 | 2,325 |
| 42x20 | Long C | 66 | 73.0 | 77.0 | 78.0 | 82 | 3,415 | 3,300 | 2,990 | 2,875 |
| 42x20 | Long D | 66 | 73.0 | 77.0 | 78.0 | 82 | 3,785 | 3,670 | 3,305 | 3,190 |
| 42x24 | Short A | 32 | 39.0 | 43.0 | 44.0 | 48 | 1,820 | 1,695 | 1,480 | 1,355 |

Dimensions in inches.
For bell and spigot dimensions, see page 276.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Reducers

| Size | Class | V | Laying Length (L) | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot |
| 42x24 | Short B | 32 | 39.0 | 43.0 | 44.0 | 48 | 1,975 | 1,850 | 1,620 | 1,495 |
| 42x24 | Short C | 32 | 39.0 | 43.0 | 44.0 | 48 | 2,440 | 2,290 | 2,015 | 1,865 |
| 42x24 | Short D | 32 | 39.0 | 43.0 | 44.0 | 48 | 2,690 | 2,540 | 2,210 | 2,060 |
| 42x24 | Long A | 66 | 73.0 | 77.0 | 78.0 | 82 | 2,770 | 2,645 | 2,430 | 2,305 |
| 42x24 | Long B | 66 | 73.0 | 77.0 | 78.0 | 82 | 3,020 | 2,895 | 2,665 | 2,540 |
| 42x24 | Long C | 66 | 73.0 | 77.0 | 78.0 | 82 | 3,745 | 3,590 | 3,320 | 3,170 |
| 42x24 | Long D | 66 | 73.0 | 77.0 | 78.0 | 82 | 4,125 | 3,975 | 3,645 | 3,495 |
| 42x30 | Short A | 32 | 38.5 | 43.0 | 43.5 | 48 | 1,990 | 1,800 | 1,650 | 1,460 |
| 42x30 | Short B | 32 | 38.5 | 43.0 | 43.5 | 48 | 2,235 | 2,060 | 1,885 | 1,705 |
| 42x30 | Short C | 32 | 38.5 | 43.0 | 43.5 | 48 | 2,670 | 2,465 | 2,250 | 2,040 |
| 42x30 | Short D | 32 | 38.5 | 43.0 | 43.5 | 48 | 3,095 | 2,840 | 2,615 | 2,360 |
| 42x30 | Long A | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,015 | 2,820 | 2,675 | 2,480 |
| 42x30 | Long B | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,435 | 3,255 | 3,080 | 2,905 |
| 42x30 | Long C | 66 | 72.5 | 77.0 | 77.5 | 82 | 4,105 | 3,895 | 3,680 | 3,475 |
| 42x30 | Long D | 66 | 72.5 | 77.0 | 77.5 | 82 | 4,750 | 4,495 | 4,270 | 4,015 |
| 42x36 | Short A | 32 | 38.5 | 43.0 | 43.5 | 48 | 2,240 | 1,995 | 1,900 | 1,655 |
| 42x36 | Short B | 32 | 38.5 | 43.0 | 43.5 | 48 | 2,570 | 2,285 | 2,215 | 1,930 |
| 42x36 | Short C | 32 | 38.5 | 43.0 | 43.5 | 48 | 3,060 | 2,740 | 2,635 | 2,315 |
| 42x36 | Short D | 32 | 38.5 | 43.0 | 43.5 | 48 | 3,540 | 3,180 | 3,060 | 2,700 |
| 42x36 | Long A | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,400 | 3,155 | 3,060 | 2,820 |
| 42x36 | Long B | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,925 | 3,640 | 3,570 | 3,285 |
| 42x36 | Long C | 66 | 72.5 | 77.0 | 77.5 | 82 | 4,690 | 4,370 | 4,270 | 3,945 |
| 42x36 | Long D | 66 | 72.5 | 77.0 | 77.5 | 82 | 5,445 | 5,080 | 4,960 | 4,600 |
| 48x30 | Short A | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,525 | 3,335 | 3,125 | 2,935 |
| 48x30 | Short B | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,990 | 3,815 | 3,540 | 3,360 |
| 48x30 | Short C | 66 | 72.5 | 77.0 | 77.5 | 82 | 4,780 | 4,570 | 4,235 | 4,025 |
| 48x30 | Short D | 66 | 72.5 | 77.0 | 77.5 | 82 | 5,530 | 5,275 | 4,890 | 4,635 |
| 48x30 | Long A | 132 | 138.5 | 143.0 | 143.5 | 148 | 5,870 | 5,675 | 5,470 | 5,275 |
| 48x30 | Long B | 132 | 138.5 | 143.0 | 143.5 | 148 | 6,675 | 6,500 | 6,225 | 6,050 |
| 48x30 | Long C | 132 | 138.5 | 143.0 | 143.5 | 148 | 7,995 | 7,785 | 7,450 | 7,240 |
| 48x30 | Long D | 132 | 138.5 | 143.0 | 143.5 | 148 | 9,230 | 8,975 | 8,590 | 8,335 |
| 48x36 | Short A | 66 | 72.5 | 77.0 | 77.5 | 82 | 3,930 | 3,685 | 3,530 | 3,285 |
| 48x36 | Short B | 66 | 72.5 | 77.0 | 77.5 | 82 | 4,495 | 4,215 | 4,045 | 3,760 |
| 48x36 | Short C | 66 | 72.5 | 77.0 | 77.5 | 82 | 5,385 | 5,065 | 4,840 | 4,520 |
| 48x36 | Short D | 66 | 72.5 | 77.0 | 77.5 | 82 | 6,245 | 5,880 | 5,605 | 5,240 |
| 48x36 | Long A | 132 | 138.5 | 143.0 | 143.5 | 148 | 6,560 | 6,315 | 6,155 | 5,915 |
| 48x36 | Long B | 132 | 138.5 | 143.0 | 143.5 | 148 | 7,510 | 7,225 | 7,055 | 6,770 |
| 48x36 | Long C | 132 | 138.5 | 143.0 | 143.5 | 148 | 9,005 | 8,685 | 8,460 | 8,140 |
| 48x36 | Long D | 132 | 138.5 | 143.0 | 143.5 | 148 | 10,445 | 10,080 | 9,805 | 9,440 |
| 48x42 | Short A | 66 | 72.0 | 77.0 | 77.0 | 82 | 4,410 | 4,070 | 4,010 | 3,670 |
| 48x42 | Short B | 66 | 72.0 | 77.0 | 77.0 | 82 | 5,010 | 4,655 | 4,560 | 4,205 |
| 48x42 | Short C | 66 | 72.0 | 77.0 | 77.0 | 82 | 6,065 | 5,640 | 5,515 | 5,095 |
| 48x42 | Short D | 66 | 72.0 | 77.0 | 77.0 | 82 | 7,015 | 6,535 | 6,375 | 5,895 |
| 48x42 | Long A | 132 | 138.0 | 143.0 | 143.0 | 148 | 7,350 | 7,010 | 6,950 | 6,610 |
| 48x42 | Long B | 132 | 138.0 | 143.0 | 143.0 | 148 | 8,385 | 8,030 | 7,935 | 7,580 |

Dimensions in inches.

For bell and spigot dimensions, see page 276.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Reducers

| Size | Class | V | Laying Length (L) | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot |
| 48x42 | Long C | 132 | 138.0 | 143.0 | 143.0 | 148 | 10,150 | 9,730 | 9,605 | 9,185 |
| 48x42 | Long D | 132 | 138.0 | 143.0 | 143.0 | 148 | 11,750 | 11,270 | 11,110 | 10,630 |
| 54x36 | Short A | 66 | 72.0 | 76.5 | 77.5 | 82 | 4,435 | 4,190 | 3,925 | 3,680 |
| 54x36 | Short B | 66 | 72.0 | 76.5 | 77.5 | 82 | 5,145 | 4,860 | 4,545 | 4,260 |
| 54x36 | Short C | 66 | 72.0 | 76.5 | 77.5 | 82 | 6,205 | 5,885 | 5,500 | 5,180 |
| 54x36 | Short D | 66 | 72.0 | 76.5 | 77.5 | 82 | 7,270 | 6,910 | 6,450 | 6,085 |
| 54x36 | Long A | 132 | 138.0 | 142.5 | 143.5 | 148 | 7,375 | 7,130 | 6,865 | 6,620 |
| 54x36 | Long B | 132 | 138.0 | 142.5 | 143.5 | 148 | 8,550 | 8,265 | 7,950 | 7,665 |
| 54x36 | Long C | 132 | 138.0 | 142.5 | 143.5 | 148 | 10,345 | 10,025 | 9,640 | 9,320 |
| 54x36 | Long D | 132 | 138.0 | 142.5 | 143.5 | 148 | 12,140 | 11,775 | 11,320 | 10,955 |
| 54x42 | Short A | 66 | 71.5 | 76.5 | 77.0 | 82 | 4,925 | 4,585 | 4,415 | 4,075 |
| 54x42 | Short B | 66 | 71.5 | 76.5 | 77.0 | 82 | 5,675 | 5,315 | 5,075 | 4,720 |
| 54x42 | Short C | 66 | 71.5 | 76.5 | 77.0 | 82 | 6,900 | 6,480 | 6,200 | 5,775 |
| 54x42 | Short D | 66 | 71.5 | 76.5 | 77.0 | 82 | 8,070 | 7,590 | 7,250 | 6,770 |
| 54x42 | Long A | 132 | 137.5 | 142.5 | 143.0 | 148 | 8,190 | 7,850 | 7,675 | 7,335 |
| 54x42 | Long B | 132 | 137.5 | 142.5 | 143.0 | 148 | 9,455 | 9,100 | 8,855 | 8,500 |
| 54x42 | Long C | 132 | 137.5 | 142.5 | 143.0 | 148 | 11,535 | 11,110 | 10,830 | 10,405 |
| 54x42 | Long D | 132 | 137.5 | 142.5 | 143.0 | 148 | 13,500 | 13,015 | 12,675 | 12,195 |
| 54x48 | Short A | 66 | 71.5 | 76.5 | 77.0 | 82 | 5,500 | 5,100 | 4,985 | 4,585 |
| 54x48 | Short B | 66 | 71.5 | 76.5 | 77.0 | 82 | 6,290 | 5,835 | 5,690 | 5,240 |
| 54x48 | Short C | 66 | 71.5 | 76.5 | 77.0 | 82 | 7,655 | 7,110 | 6,950 | 6,405 |
| 54x48 | Short D | 66 | 71.5 | 76.5 | 77.0 | 82 | 8,935 | 8,300 | 8,115 | 7,475 |
| 54x48 | Long A | 132 | 137.5 | 142.5 | 143.0 | 148 | 9,180 | 8,780 | 8,665 | 8,265 |
| 54x48 | Long B | 132 | 137.5 | 142.5 | 143.0 | 148 | 10,495 | 10,040 | 9,895 | 9,440 |
| 54x48 | Long C | 132 | 137.5 | 142.5 | 143.0 | 148 | 12,800 | 12,255 | 12,095 | 11,550 |
| 54x48 | Long D | 132 | 137.5 | 142.5 | 143.0 | 148 | 14,940 | 14,300 | 14,120 | 13,480 |
| 60x36 | Short A | 66 | 72.0 | 76.5 | 77.5 | 82 | 4,885 | 4,640 | 4,255 | 4,010 |
| 60x36 | Short B | 66 | 72.0 | 76.5 | 77.5 | 82 | 5,740 | 5,455 | 5,065 | 4,780 |
| 60x36 | Short C | 66 | 72.0 | 76.5 | 77.5 | 82 | 6,885 | 6,565 | 6,060 | 5,735 |
| 60x36 | Short D | 66 | 72.0 | 76.5 | 77.5 | 82 | 8,135 | 7,770 | 7,160 | 6,800 |
| 60x36 | Long A | 132 | 138.0 | 142.5 | 143.5 | 148 | 8,085 | 7,840 | 7,455 | 7,210 |
| 60x36 | Long B | 132 | 138.0 | 142.5 | 143.5 | 148 | 9,555 | 9,270 | 8,880 | 8,595 |
| 60x36 | Long C | 132 | 138.0 | 142.5 | 143.5 | 148 | 11,460 | 11,140 | 10,635 | 10,315 |
| 60x36 | Long D | 132 | 138.0 | 142.5 | 143.5 | 148 | 13,560 | 13,200 | 12,590 | 12,225 |
| 60x42 | Short A | 66 | 71.5 | 76.5 | 77.0 | 82 | 5,380 | 5,040 | 4,750 | 4,410 |
| 60x42 | Short B | 66 | 71.5 | 76.5 | 77.0 | 82 | 6,280 | 5,925 | 5,610 | 5,255 |
| 60x42 | Short C | 66 | 71.5 | 76.5 | 77.0 | 82 | 7,600 | 7,175 | 6,770 | 6,350 |
| 60x42 | Short D | 66 | 71.5 | 76.5 | 77.0 | 82 | 8,955 | 8,475 | 7,980 | 7,500 |
| 60x42 | Long A | 132 | 137.5 | 142.5 | 143.0 | 148 | 8,915 | 8,575 | 8,285 | 7,945 |
| 60x42 | Long B | 132 | 137.5 | 142.5 | 143.0 | 148 | 10,485 | 10,135 | 9,815 | 9,460 |
| 60x42 | Long C | 132 | 137.5 | 142.5 | 143.0 | 148 | 12,680 | 12,260 | 11,855 | 11,435 |
| 60x42 | Long D | 132 | 137.5 | 142.5 | 143.0 | 148 | 14,960 | 14,480 | 13,990 | 13,510 |
| 60x48 | Short A | 66 | 71.5 | 76.5 | 77.0 | 82 | 5,965 | 5,565 | 5,335 | 4,935 |
| 60x48 | Short B | 66 | 71.5 | 76.5 | 77.0 | 82 | 6,915 | 6,460 | 6,240 | 5,785 |
| 60x48 | Short C | 66 | 71.5 | 76.5 | 77.0 | 82 | 8,365 | 7,820 | 7,540 | 6,995 |

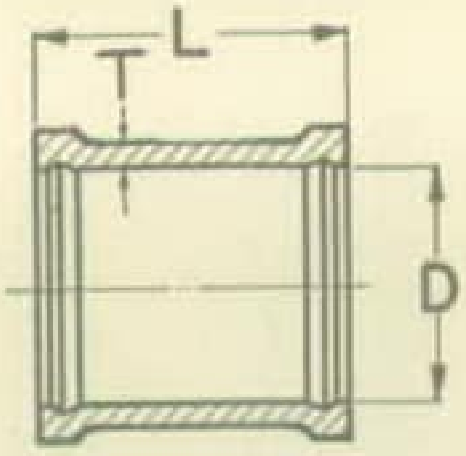
Dimensions in inches.
For bell and spigot dimensions, see page 276.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Bell and Spigot Reducers

| Size | Class | V | Laying Length (L) | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot | Bell & Bell | Large End Bell | Small End Bell | Spigot & Spigot |
| 60x48 | Short D | 66 | 71.5 | 76.5 | 77.0 | 82 | 9,840 | 9,200 | 8,865 | 8,230 |
| 60x48 | Long A | 132 | 137.5 | 142.5 | 143.0 | 148 | 9,925 | 9,525 | 9,295 | 8,895 |
| 60x48 | Long B | 132 | 137.5 | 142.5 | 143.0 | 148 | 11,555 | 11,100 | 10,880 | 10,430 |
| 60x48 | Long C | 132 | 137.5 | 142.5 | 143.0 | 148 | 13,975 | 13,430 | 13,150 | 12,605 |
| 60x48 | Long D | 132 | 137.5 | 142.5 | 143.0 | 148 | 16,440 | 15,800 | 15,470 | 14,830 |
| 60x54 | Short A | 66 | 71.0 | 76.5 | 76.5 | 82 | 6,515 | 6,005 | 5,885 | 5,370 |
| 60x54 | Short B | 66 | 71.0 | 76.5 | 76.5 | 82 | 7,615 | 7,020 | 6,945 | 6,345 |
| 60x54 | Short C | 66 | 71.0 | 76.5 | 76.5 | 82 | 9,265 | 8,560 | 8,435 | 7,730 |
| 60x54 | Short D | 66 | 71.0 | 76.5 | 76.5 | 82 | 10,970 | 10,150 | 10,000 | 9,180 |
| 60x54 | Long A | 132 | 137.0 | 142.5 | 142.5 | 148 | 10,825 | 10,315 | 10,195 | 9,685 |
| 60x54 | Long B | 132 | 137.0 | 142.5 | 142.5 | 148 | 12,710 | 12,110 | 12,035 | 11,440 |
| 60x54 | Long C | 132 | 137.0 | 142.5 | 142.5 | 148 | 15,475 | 14,770 | 14,645 | 13,940 |
| 60x54 | Long D | 132 | 137.0 | 142.5 | 142.5 | 148 | 18,345 | 17,525 | 17,375 | 16,550 |

Dimensions in inches.
For bell and spigot dimensions, see page 276.

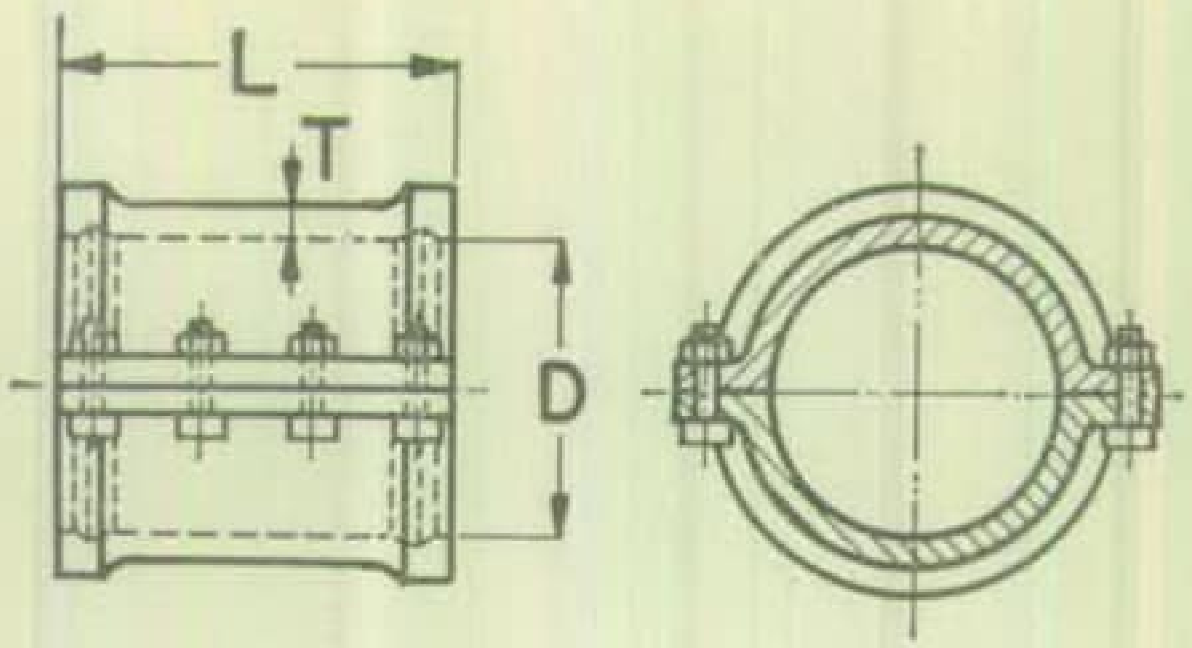
# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Solid Sleeves




| Nom'l Diam. Inches | Class | D | L | T | Approx. Weight Pounds | Nom'l Diam. Inches | Class | D | L | T | Approx. Weight Pounds |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | D | 4.76 | 10 | .65 | 35 | 36 | A | 39.00 | 15 | 1.25 | 810 |
| 3 | D | 4.76 | 15 | .65 | 50 | 36 | B | 39.40 | 15 | 1.40 | 920 |
| 4 | D | 5.80 | 10 | .65 | 45 | 36 | C | 39.80 | 15 | 1.60 | 1055 |
| 4 | D | 5.80 | 15 | .65 | 65 | 36 | D | 40.20 | 15 | 1.80 | 1195 |
| 6 | D | 7.90 | 10 | .70 | 65 | 36 | A | 39.00 | 24 | 1.25 | 1175 |
| 6 | D | 7.90 | 15 | .70 | 90 | 36 | B | 39.40 | 24 | 1.40 | 1340 |
| 8 | D | 10.10 | 12 | .75 | 100 | 36 | C | 39.80 | 24 | 1.60 | 1540 |
| 8 | D | 10.10 | 15 | .75 | 120 | 36 | D | 40.20 | 24 | 1.80 | 1750 |
| 10 | D | 12.20 | 12 | .80 | 130 | 42 | A | 45.30 | 15 | 1.40 | 1050 |
| 10 | D | 12.20 | 18 | .80 | 180 | 42 | B | 45.60 | 15 | 1.50 | 1140 |
| 12 | D | 14.30 | 14 | .85 | 185 | 42 | C | 46.20 | 15 | 1.75 | 1340 |
| 12 | D | 14.30 | 18 | .85 | 225 | 42 | D | 46.70 | 15 | 1.95 | 1530 |
| 14 | B | 16.20 | 15 | .85 | 215 | 42 | A | 45.30 | 24 | 1.40 | 1530 |
| 14 | B | 16.20 | 18 | .85 | 255 | 42 | B | 45.60 | 24 | 1.50 | 1660 |
| 14 | D | 16.50 | 15 | .90 | 235 | 42 | C | 46.20 | 24 | 1.75 | 1960 |
| 14 | D | 16.50 | 18 | .90 | 275 | 42 | D | 46.70 | 24 | 1.95 | 2230 |
| 16 | B | 18.50 | 15 | .90 | 270 | 48 | A | 51.60 | 15 | 1.50 | 1280 |
| 16 | B | 18.50 | 24 | .90 | 400 | 48 | B | 51.90 | 15 | 1.65 | 1435 |
| 16 | D | 18.90 | 15 | 1.00 | 300 | 48 | C | 52.50 | 15 | 1.95 | 1710 |
| 16 | D | 18.90 | 24 | 1.00 | 445 | 48 | D | 53.10 | 15 | 2.20 | 1950 |
| 18 | B | 20.60 | 15 | .95 | 320 | 48 | A | 51.60 | 24 | 1.50 | 1865 |
| 18 | B | 20.60 | 24 | .95 | 470 | 48 | B | 51.90 | 24 | 1.65 | 2080 |
| 18 | D | 21.00 | 15 | 1.05 | 360 | 48 | C | 52.50 | 24 | 1.95 | 2490 |
| 18 | D | 21.00 | 24 | 1.05 | 530 | 48 | D | 53.10 | 24 | 2.20 | 2845 |
| 20 | B | 22.70 | 15 | 1.00 | 370 | 54 | A | 57.70 | 15 | 1.60 | 1580 |
| 20 | B | 22.70 | 24 | 1.00 | 540 | 54 | B | 58.20 | 15 | 1.80 | 1800 |
| 20 | D | 23.10 | 15 | 1.15 | 435 | 54 | C | 58.90 | 15 | 2.15 | 2115 |
| 20 | D | 23.10 | 24 | 1.15 | 640 | 54 | D | 59.50 | 15 | 2.45 | 2410 |
| 24 | B | 26.90 | 15 | 1.05 | 470 | 54 | A | 57.70 | 24 | 1.60 | 2280 |
| 24 | B | 26.90 | 24 | 1.05 | 685 | 54 | B | 58.20 | 24 | 1.80 | 2595 |
| 24 | D | 27.40 | 15 | 1.25 | 575 | 54 | C | 58.90 | 24 | 2.15 | 3080 |
| 24 | D | 27.40 | 24 | 1.25 | 840 | 54 | D | 59.50 | 24 | 2.45 | 3525 |
| 30 | A | 32.80 | 15 | 1.15 | 625 | 60 | A | 63.90 | 15 | 1.70 | 1850 |
| 30 | B | 33.10 | 15 | 1.15 | 630 | 60 | B | 64.50 | 15 | 1.90 | 2075 |
| 30 | C | 33.50 | 15 | 1.32 | 735 | 60 | C | 65.30 | 15 | 2.25 | 2455 |
| 30 | D | 33.80 | 15 | 1.50 | 860 | 60 | D | 65.90 | 15 | 2.60 | 2850 |
| 30 | A | 32.80 | 24 | 1.15 | 910 | 60 | A | 63.90 | 24 | 1.70 | 2670 |
| 30 | B | 33.10 | 24 | 1.15 | 920 | 60 | B | 64.50 | 24 | 1.90 | 3000 |
| 30 | C | 33.50 | 24 | 1.32 | 1075 | 60 | C | 65.30 | 24 | 2.25 | 3570 |
| 30 | D | 33.80 | 24 | 1.50 | 1250 | 60 | D | 65.90 | 24 | 2.60 | 4150 |

Dimensions in inches.

## Dimensions and Weights—Standard Split Sleeve

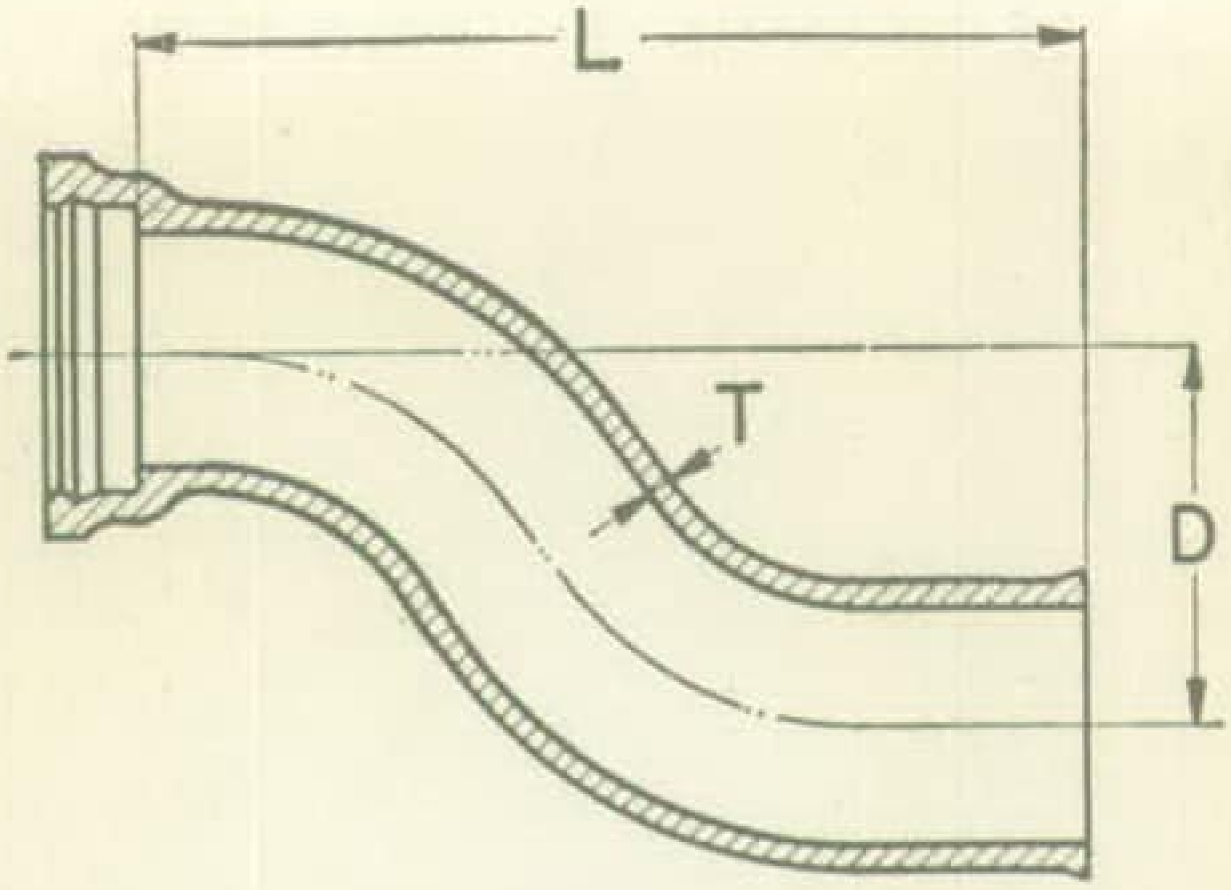



SPLIT SLEEVE

| Size | Class | Dimensions in Inches | | | Weight Pounds |
|---|---|---|---|---|---|
| | | D | T | L | |
| 3 | D | 4.76 | .65 | 15 | 80 |
| 4 | D | 5.80 | .65 | 15 | 100 |
| 6 | D | 7.90 | .70 | 15 | 130 |
| 8 | D | 10.10 | .75 | 15 | 165 |
| 10 | D | 12.20 | .80 | 18 | 245 |
| 12 | D | 14.30 | .85 | 18 | 295 |
| 14 | B | 16.20 | .85 | 18 | 310 |
| 14 | D | 16.50 | .90 | 18 | 355 |
| 16 | B | 18.50 | .90 | 24 | 510 |
| 16 | D | 18.90 | 1.00 | 24 | 575 |
| 18 | B | 20.60 | .95 | 24 | 585 |
| 18 | D | 21.00 | 1.05 | 24 | 685 |
| 20 | B | 22.70 | 1.00 | 24 | 665 |
| 20 | D | 23.10 | 1.15 | 24 | 800 |
| 24 | B | 26.90 | 1.05 | 24 | 820 |
| 24 | D | 27.40 | 1.25 | 24 | 1010 |

Sleeves will be furnished assembled with suitable gasket, steel bolts and nuts. Weights include weights of bolts, nuts and gaskets.

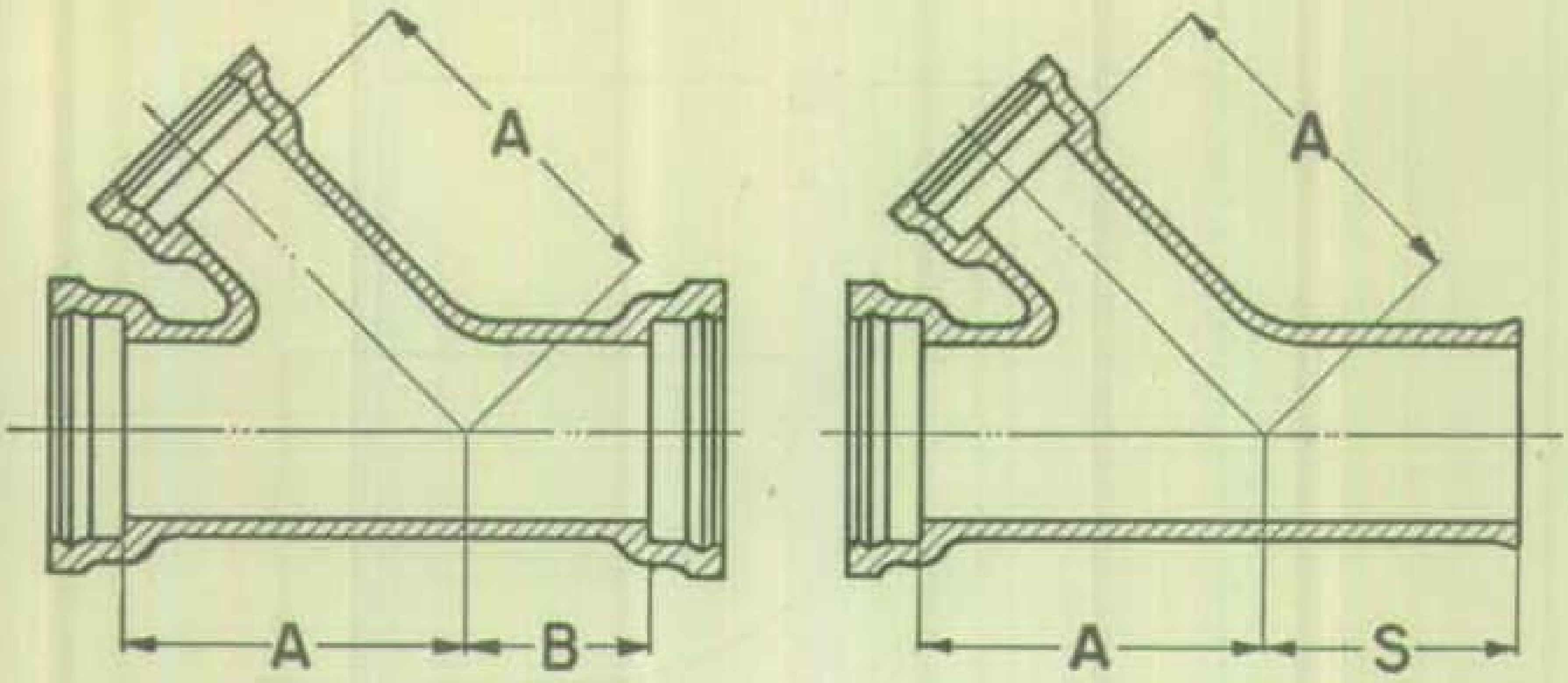
# Dimensions and Weights of A.W.W.A.-N.E.W.W.A. Standard Bell and Spigot Offsets




OFFSETS

| Size | Class | Dimensions in Inches T | L | D | Weight Pounds |
|---|---|---|---|---|---|
| 3 | D | .48 | 27 | 6 | 60 |
| 3 | D | .48 | 30 | 12 | 70 |
| 3 | D | .48 | 38 | 18 | 80 |
| 4 | D | .52 | 27 | 6 | 80 |
| 4 | D | .52 | 30 | 12 | 90 |
| 4 | D | .52 | 38 | 18 | 110 |
| 6 | D | .55 | 28 | 6 | 120 |
| 6 | D | .55 | 34 | 12 | 145 |
| 6 | D | .55 | 41 | 18 | 175 |
| 8 | D | .60 | 29 | 6 | 180 |
| 8 | D | .60 | 36 | 12 | 220 |
| 8 | D | .60 | 43 | 18 | 260 |
| 10 | D | .68 | 30 | 6 | 245 |
| 10 | D | .68 | 38 | 12 | 305 |
| 10 | D | .68 | 46 | 18 | 365 |
| 12 | D | .75 | 34 | 6 | 350 |
| 12 | D | .75 | 45 | 12 | 450 |
| 12 | D | .75 | 56 | 18 | 550 |
| 14 | B | .66 | 35 | 6 | 375 |
| 14 | B | .66 | 46 | 12 | 475 |
| 14 | B | .66 | 57 | 18 | 580 |
| 14 | D | .82 | 35 | 6 | 455 |
| 14 | D | .82 | 46 | 12 | 580 |
| 14 | D | .82 | 57 | 18 | 710 |
| 16 | B | .70 | 35 | 6 | 460 |
| 16 | B | .70 | 48 | 12 | 600 |
| 16 | B | .70 | 58 | 18 | 710 |
| 16 | D | .89 | 35 | 6 | 570 |
| 16 | D | .89 | 48 | 12 | 750 |
| 16 | D | .89 | 58 | 18 | 895 |

## Dimensions and Weights of A.W.W.A.-N.E.W.W.A. Standard Type 2 Bell & Spigot WYE Branches



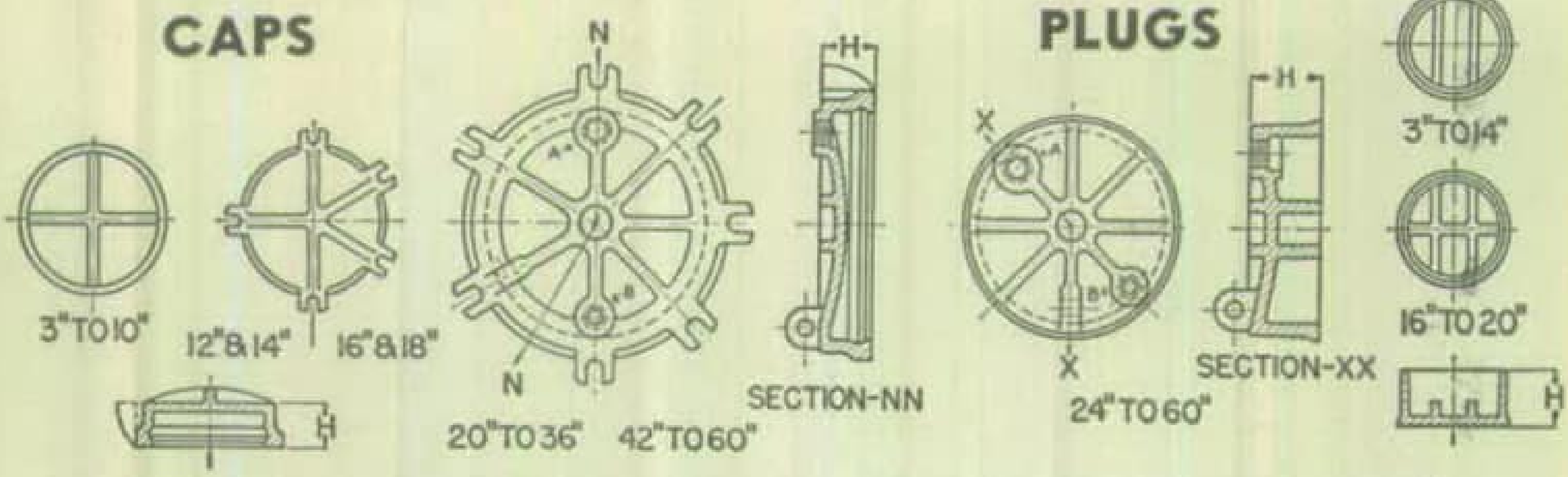

| Size | | Class | Dimensions—Inches | | | Weight—Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | All Bell | B-S-B |
| 3 | 3 | D | 9.50 | 10.50 | 7.00 | 95 | 80 |
| 4 | 4 | D | 10.50 | 11.50 | 7.50 | 125 | 110 |
| 6 | 4 | D | 13.00 | 13.00 | 9.00 | 185 | 160 |
| 6 | 6 | D | 13.00 | 13.00 | 9.00 | 200 | 175 |
| 8 | 4 | D | 16.00 | 14.00 | 10.00 | 270 | 235 |
| 8 | 6 | D | 16.00 | 14.00 | 10.00 | 285 | 255 |
| 8 | 8 | D | 16.00 | 14.00 | 10.00 | 310 | 275 |
| 10 | 6 | D | 18.50 | 15.50 | 11.50 | 390 | 355 |
| 10 | 8 | D | 18.50 | 15.50 | 11.50 | 420 | 380 |
| 10 | 10 | D | 18.50 | 15.50 | 11.50 | 445 | 400 |
| 12 | 6 | D | 21.50 | 15.50 | 11.50 | 515 | 470 |
| 12 | 8 | D | 21.50 | 15.50 | 11.50 | 545 | 500 |
| 12 | 10 | D | 21.50 | 15.50 | 11.50 | 570 | 525 |
| 12 | 12 | D | 21.50 | 15.50 | 11.50 | 605 | 555 |
| 14 | 6 | B | 24.00 | 16.00 | 12.00 | 580 | 525 |
| 14 | 6 | D | 24.00 | 16.00 | 12.00 | 670 | 615 |
| 14 | 8 | B | 24.00 | 16.00 | 12.00 | 610 | 555 |
| 14 | 8 | D | 24.00 | 16.00 | 12.00 | 700 | 645 |
| 14 | 10 | B | 24.00 | 16.00 | 12.00 | 640 | 590 |
| 14 | 10 | D | 24.00 | 16.00 | 12.00 | 730 | 675 |
| 14 | 12 | B | 24.00 | 16.00 | 12.00 | 675 | 620 |
| 14 | 12 | D | 24.00 | 16.00 | 12.00 | 765 | 710 |
| 14 | 14 | B | 24.00 | 16.00 | 12.00 | 680 | 625 |
| 14 | 14 | D | 24.00 | 16.00 | 12.00 | 800 | 750 |
| 16 | 8 | B | 31.00 | 17.50 | 13.50 | 890 | 820 |
| 16 | 8 | D | 31.00 | 17.50 | 13.50 | 1070 | 995 |
| 16 | 10 | B | 31.00 | 17.50 | 13.50 | 935 | 860 |
| 16 | 10 | D | 31.00 | 17.50 | 13.50 | 1110 | 1035 |
| 16 | 12 | B | 31.00 | 17.50 | 13.50 | 980 | 905 |
| 16 | 12 | D | 31.00 | 17.50 | 13.50 | 1155 | 1080 |

## Dimensions and Weights of A.W.W.A.-N.E.W.W.A. Standard Type 2 Bell & Spigot WYE Branches

| Size | | Class | Dimensions—Inches | | | Weight—Pounds | |
|---|---|---|---|---|---|---|---|
| Run | Branch | | A | S | B | All Bell | B-S-B |
| 16 | 14 | B | 31.00 | 17.50 | 13.50 | 990 | 915 |
| 16 | 14 | D | 31.00 | 17.50 | 13.50 | 1205 | 1130 |
| 16 | 16 | B | 31.00 | 17.50 | 13.50 | 1040 | 965 |
| 16 | 16 | D | 31.00 | 17.50 | 13.50 | 1285 | 1205 |
| 18 | 10 | B | 34.00 | 18.00 | 14.00 | 1150 | 1065 |
| 18 | 10 | D | 34.00 | 18.00 | 14.00 | 1400 | 1310 |
| 18 | 12 | B | 34.00 | 18.00 | 14.00 | 1195 | 1110 |
| 18 | 12 | D | 34.00 | 18.00 | 14.00 | 1445 | 1355 |
| 18 | 14 | B | 34.00 | 18.00 | 14.00 | 1205 | 1120 |
| 18 | 14 | D | 34.00 | 18.00 | 14.00 | 1500 | 1415 |
| 18 | 16 | B | 34.00 | 18.00 | 14.00 | 1270 | 1185 |
| 18 | 16 | D | 34.00 | 18.00 | 14.00 | 1585 | 1495 |
| 18 | 18 | B | 34.00 | 18.00 | 14.00 | 1305 | 1225 |
| 18 | 18 | D | 34.00 | 18.00 | 14.00 | 1655 | 1565 |
| 20 | 12 | B | 37.00 | 18.75 | 14.75 | 1455 | 1355 |
| 20 | 12 | D | 37.00 | 18.75 | 14.75 | 1770 | 1650 |
| 20 | 14 | B | 37.00 | 18.75 | 14.75 | 1465 | 1365 |
| 20 | 14 | D | 37.00 | 18.75 | 14.75 | 1830 | 1715 |
| 20 | 16 | B | 37.00 | 18.75 | 14.75 | 1530 | 1430 |
| 20 | 16 | D | 37.00 | 18.75 | 14.75 | 1920 | 1805 |
| 20 | 18 | B | 37.00 | 18.75 | 14.75 | 1585 | 1485 |
| 20 | 18 | D | 37.00 | 18.75 | 14.75 | 1995 | 1880 |
| 20 | 20 | B | 37.00 | 18.75 | 14.75 | 1630 | 1530 |
| 20 | 20 | D | 37.00 | 18.75 | 14.75 | 2055 | 1935 |
| 24 | 16 | | 40.00 | 12.75 | 8.75 | | |
| 24 | 18 | | 40.00 | 18.75 | 14.75 | | |
| 24 | 20 | | 40.00 | 18.75 | 14.75 | | |
| 24 | 24 | | 42.00 | 19.75 | 15.75 | | |
| 30 | 20 | | 49.50 | 17.00 | 12.50 | | |
| 30 | 24 | | 49.50 | 17.00 | 12.50 | | |
| 30 | 30 | | 52.50 | 22.75 | 18.25 | | |
| 36 | 24 | | 54.00 | 19.75 | 15.25 | | |
| 36 | 30 | | 56.00 | 19.75 | 15.25 | | |
| 36 | 36 | | 60.00 | 24.00 | 19.50 | | |
| 42 | 24 | | 60.00 | 16.75 | 11.75 | | |
| 42 | 30 | | 63.00 | 16.75 | 11.75 | | |
| 42 | 36 | | 66.00 | 21.00 | 16.00 | | |
| 42 | 42 | | 69.00 | 25.25 | 20.25 | | |
| 48 | 30 | | 68.00 | 14.00 | 9.00 | | |
| 48 | 36 | | 71.00 | 18.00 | 13.00 | | |
| 48 | 42 | | 74.00 | 22.25 | 17.25 | | |
| 48 | 48 | | 77.00 | 26.50 | 21.50 | | |

24" and larger sizes are sometimes reinforced with ribs and bolts when necessary. Consult the manufacturer for his recommendations. Weights of these sizes are dependent upon individual company reinforcement design.

# Dimensions and Weights of A.W.W.A.-N.E.W.W.A.

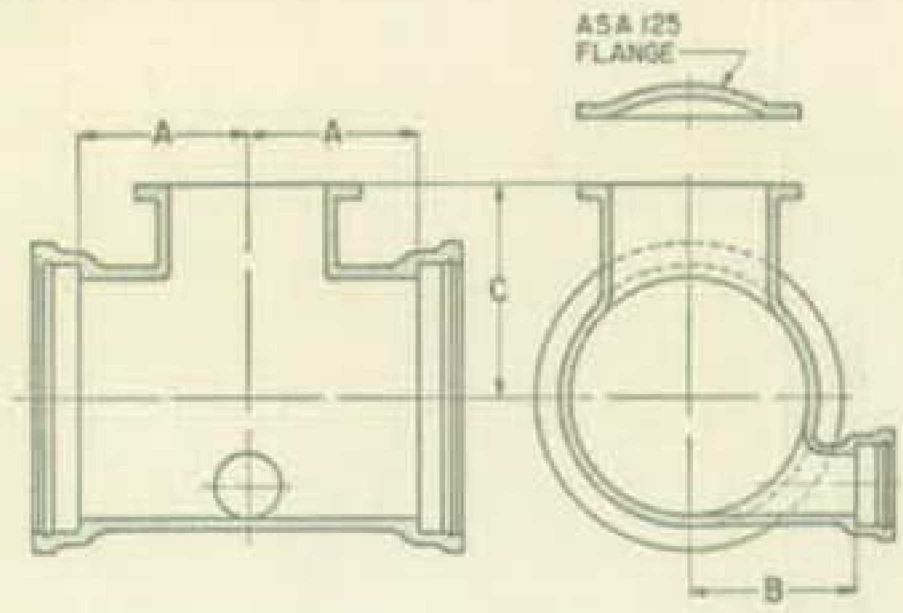



| Size | Class | CAPS H | CAPS No. of Lugs | CAPS Weight Without Lugs | CAPS Weight With Lugs | PLUGS H | PLUGS No. of Ribs | PLUGS Weight |
|---|---|---|---|---|---|---|---|---|
| 3 | D | 4.60 | 0 | 20 | .... | 5.50 | 0 | 7 |
| 4 | D | 4.60 | 0 | 25 | .... | 5.50 | 0 | 8 |
| 6 | D | 4.65 | 0 | 40 | .... | 5.50 | 0 | 14 |
| 8 | D | 4.75 | 0 | 60 | .... | 5.50 | 2 | 25 |
| 10 | D | 4.75 | 0 | 85 | .... | 6.00 | 2 | 40 |
| 12 | D | 4.75 | 4 | 110 | 140 | 6.00 | 2 | 50 |
| 14 | B | 4.90 | 4 | 135 | 165 | 6.00 | 2 | 60 |
| 14 | D | 4.90 | 4 | 150 | 180 | 6.00 | 2 | 65 |
| 16 | B | 5.00 | 6 | 185 | 230 | 6.50 | 3 | 90 |
| 16 | D | 5.00 | 6 | 200 | 245 | 6.50 | 3 | 95 |
| 18 | B | 5.00 | 6 | 230 | 280 | 6.50 | 3 | 110 |
| 18 | D | 5.00 | 6 | 250 | 300 | 6.50 | 3 | 120 |
| 20 | B | 5.00 | 6 | 280 | 330 | 6.50 | 3 | 150 |
| 20 | D | 5.00 | 6 | 310 | 360 | 6.50 | 3 | 155 |
| 24 | B | 5.25 | 6 | 390 | 440 | 8.00 | 4 | 375 |
| 24 | D | 5.25 | 6 | 440 | 490 | 8.00 | 4 | 470 |
| 30 | A | 5.75 | 6 | 590 | 665 | 8.00 | 4 | 480 |
| 30 | B | 5.75 | 6 | 595 | 670 | 8.00 | 4 | 555 |
| 30 | C | 5.75 | 6 | 645 | 725 | 8.00 | 4 | 640 |
| 30 | D | 5.75 | 6 | 700 | 785 | 8.00 | 4 | 725 |
| 36 | A | 6.00 | 6 | 845 | 925 | 8.00 | 4 | 680 |
| 36 | B | 6.00 | 6 | 915 | 995 | 8.00 | 4 | 785 |
| 36 | C | 6.00 | 6 | 1000 | 1085 | 8.00 | 4 | 915 |
| 36 | D | 6.00 | 6 | 1085 | 1170 | 8.00 | 4 | 1050 |
| 42 | A | 7.00 | 8 | 1275 | 1395 | 9.00 | 4 | 990 |
| 42 | B | 7.00 | 8 | 1395 | 1520 | 9.00 | 4 | 1140 |
| 42 | C | 7.00 | 8 | 1545 | 1675 | 9.00 | 4 | 1355 |
| 42 | D | 7.00 | 8 | 1685 | 1820 | 9.00 | 4 | 1550 |
| 48 | A | 7.00 | 8 | 1790 | 1915 | 9.00 | 4 | 1340 |
| 48 | B | 7.00 | 8 | 1945 | 2075 | 9.00 | 4 | 1505 |
| 48 | C | 7.00 | 8 | 2140 | 2275 | 9.00 | 4 | 1800 |
| 48 | D | 7.00 | 8 | 2335 | 2475 | 9.00 | 4 | 2045 |
| 54 | A | 7.50 | 8 | 2375 | 2515 | 9.00 | 4 | 1695 |
| 54 | B | 7.50 | 8 | 2555 | 2700 | 9.00 | 4 | 1945 |
| 54 | C | 7.50 | 8 | 2800 | 2950 | 9.00 | 4 | 2355 |
| 54 | D | 7.50 | 8 | 3045 | 3195 | 9.00 | 4 | 2735 |
| 60 | A | 7.50 | 8 | 2900 | 3045 | 9.00 | 4 | 2045 |
| 60 | B | 7.50 | 8 | 3105 | 3250 | 9.00 | 4 | 2435 |
| 60 | C | 7.50 | 8 | 3395 | 3545 | 9.00 | 4 | 2905 |
| 60 | D | 7.50 | 8 | 3680 | 3835 | 9.00 | 4 | 3395 |

Note: Bosses A & B cast on only when so ordered. Tap boss A for 3" W.I. pipe. Tap boss B for 2" W.I. pipe.

For lug dimensions see page 314.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Blow-Off Branches with Manhole




| Size | Class | Dimensions | | | Weight | Size | Class | Dimensions | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | | | | A | B | C | |
| 30x 6 | A | 21 | 20 | 26.0 | 2220 | 42x16 | C | 21 | 26 | 32.0 | 4640 |
| 30x 6 | B | 21 | 20 | 26.0 | 2380 | 42x16 | D | 21 | 26 | 32.0 | 5205 |
| 30x 6 | C | 21 | 20 | 26.0 | 2720 | 48x12 | A | 21 | 30 | 35.0 | 4330 |
| 30x 6 | D | 21 | 20 | 26.0 | 3045 | 48x12 | B | 21 | 30 | 35.0 | 4790 |
| 30x 8 | A | 21 | 20 | 26.0 | 2240 | 48x12 | C | 21 | 30 | 35.0 | 5655 |
| 30x 8 | B | 21 | 20 | 26.0 | 2400 | 48x12 | D | 21 | 30 | 35.0 | 6415 |
| 30x 8 | C | 21 | 20 | 26.0 | 2735 | 48x16 | A | 21 | 30 | 35.0 | 4345 |
| 30x 8 | D | 21 | 20 | 26.0 | 3060 | 48x16 | B | 21 | 30 | 35.0 | 4795 |
| 30x12 | A | 21 | 20 | 26.0 | 2285 | 48x16 | C | 21 | 30 | 35.0 | 5710 |
| 30x12 | B | 21 | 20 | 26.0 | 2435 | 48x16 | D | 21 | 30 | 35.0 | 6455 |
| 30x12 | C | 21 | 20 | 26.0 | 2770 | 54x12 | A | 28 | 33 | 38.5 | 6155 |
| 30x12 | D | 21 | 20 | 26.0 | 3090 | 54x12 | B | 28 | 33 | 38.5 | 6975 |
| 36x 8 | A | 21 | 23 | 29.0 | 2760 | 54x12 | C | 28 | 33 | 38.5 | 8370 |
| 36x 8 | B | 21 | 23 | 29.0 | 3110 | 54x12 | D | 28 | 33 | 38.5 | 9695 |
| 36x 8 | C | 21 | 23 | 29.0 | 3555 | 54x16 | A | 28 | 33 | 38.5 | 6160 |
| 36x 8 | D | 21 | 23 | 29.0 | 4005 | 54x16 | B | 28 | 33 | 38.5 | 6985 |
| 36x12 | A | 21 | 23 | 29.0 | 2805 | 54x16 | C | 28 | 33 | 38.5 | 8425 |
| 36x12 | B | 21 | 23 | 29.0 | 3145 | 54x16 | D | 28 | 33 | 38.5 | 9735 |
| 36x12 | C | 21 | 23 | 29.0 | 3590 | 60x12 | A | 28 | 36 | 42.0 | 7065 |
| 36x12 | D | 21 | 23 | 29.0 | 4035 | 60x12 | B | 28 | 36 | 42.0 | 8145 |
| 42x12 | A | 21 | 26 | 32.0 | 3535 | 60x12 | C | 28 | 36 | 42.0 | 9715 |
| 42x12 | B | 21 | 26 | 32.0 | 3900 | 60x12 | D | 28 | 36 | 42.0 | 11400 |
| 42x12 | C | 21 | 26 | 32.0 | 4570 | 60x16 | A | 28 | 36 | 42.0 | 7065 |
| 42x12 | D | 21 | 26 | 32.0 | 5170 | 60x16 | B | 28 | 36 | 42.0 | 8145 |
| 42x16 | A | 21 | 26 | 32.0 | 3555 | 60x16 | C | 28 | 36 | 42.0 | 9770 |
| 42x16 | B | 21 | 26 | 32.0 | 3910 | 60x16 | D | 28 | 36 | 42.0 | 11445 |

Dimensions in inches.

For dimensions and drilling of flanges, see page 345.

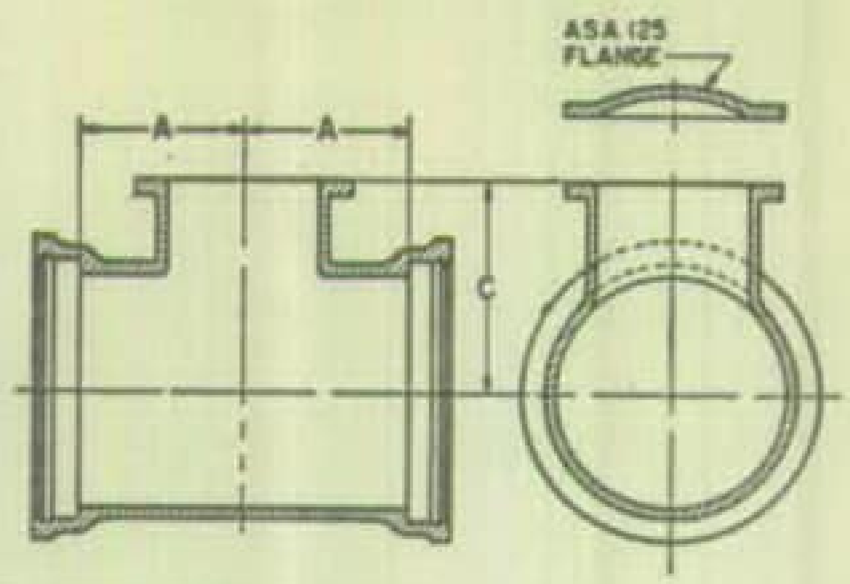
For bell dimensions, see page 276.

Above weights include weights of blank flange, steel bolts, nuts and gasket which equal 299 #.

Manholes are regularly furnished with 20" blank flange, bolts, nuts and gasket.

# Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Manhole Pipe

(Bell-Bell & Flg. Tee)




| Size | Class | Dimensions | | Weight |
|---|---|---|---|---|
| | | A | C | |
| 30 | A | 21 | 26 | 2155 |
| 30 | B | 21 | 26 | 2320 |
| 30 | C | 21 | 26 | 2660 |
| 30 | D | 21 | 26 | 2990 |
| 36 | A | 21 | 29 | 2675 |
| 36 | B | 21 | 29 | 3025 |
| 36 | C | 21 | 29 | 3485 |
| 36 | D | 21 | 29 | 3935 |
| 42 | A | 21 | 32 | 3400 |
| 42 | B | 21 | 32 | 3775 |
| 42 | C | 21 | 32 | 4470 |
| 42 | D | 21 | 32 | 5075 |
| 48 | A | 21 | 35 | 4185 |
| 48 | B | 21 | 35 | 4655 |
| 48 | C | 21 | 35 | 5540 |
| 48 | D | 21 | 35 | 6320 |
| 54 | A | 28 | 38.5 | 5995 |
| 54 | B | 28 | 38.5 | 6835 |
| 54 | C | 28 | 38.5 | 8255 |
| 54 | D | 28 | 38.5 | 9600 |
| 60 | A | 28 | 42 | 6900 |
| 60 | B | 28 | 42 | 8005 |
| 60 | C | 28 | 42 | 9595 |
| 60 | D | 28 | 42 | 11310 |

NOTE:—Above weights include the weights of blank flange, steel bolts, nuts and gasket which equal 299 #.

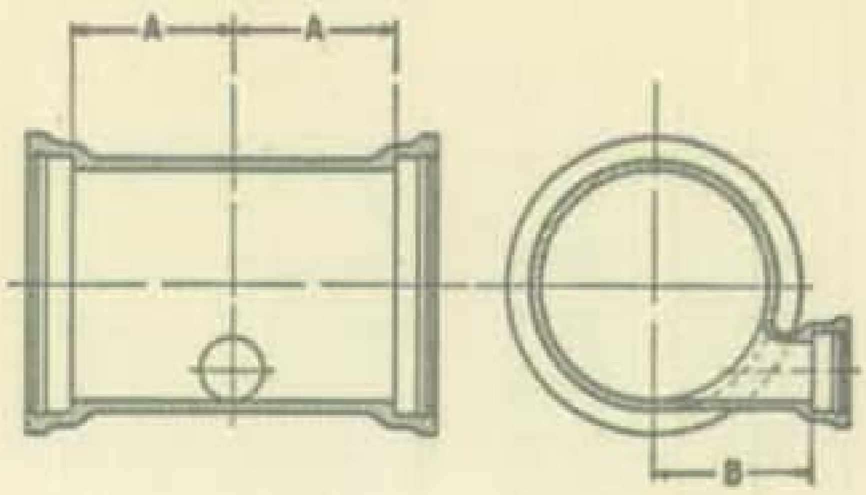
Dimensions in inches.

For dimensions and drilling of flanges, see page 345.

For bell dimensions, see page 276.

Manholes are regularly furnished with 20″ blank flange, bolts, nuts and gasket.

## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Blow-Off Branches




| Size | Class | A | B | Weight | Size | Class | A | B | Weight |
|---|---|---|---|---|---|---|---|---|---|
| 8x3 | D | 12 | 7 | 225 | 24x 6 | B | 12 | 16 | 920 |
| 8x4 | D | 12 | 7 | 230 | 24x 6 | D | 12 | 16 | 1165 |
| 10x3 | D | 12 | 8 | 290 | 24x 8 | B | 12 | 16 | 935 |
| 10x4 | D | 12 | 8 | 300 | 24x 8 | D | 12 | 16 | 1175 |
| 10x6 | D | 12 | 8 | 310 | 30x 6 | A | 13 | 20 | 1325 |
| 12x3 | D | 12 | 10 | 365 | 30x 6 | B | 13 | 20 | 1435 |
| 12x4 | D | 12 | 10 | 370 | 30x 6 | C | 13 | 20 | 1675 |
| 12x6 | D | 12 | 10 | 385 | 30x 6 | D | 13 | 20 | 1940 |
| 14x4 | B | 12 | 11 | 415 | 30x 8 | A | 13 | 20 | 1345 |
| 14x4 | D | 12 | 11 | 480 | 30x 8 | B | 13 | 20 | 1455 |
| 14x6 | B | 12 | 11 | 425 | 30x 8 | C | 13 | 20 | 1690 |
| 14x6 | D | 12 | 11 | 495 | 30x 8 | D | 13 | 20 | 1950 |
| 16x4 | B | 12 | 12 | 510 | 30x12 | A | 13 | 20 | 1385 |
| 16x4 | D | 12 | 12 | 605 | 30x12 | B | 13 | 20 | 1490 |
| 16x6 | B | 12 | 12 | 525 | 30x12 | C | 13 | 20 | 1725 |
| 16x6 | D | 12 | 12 | 620 | 30x12 | D | 13 | 20 | 1980 |
| 18x4 | B | 12 | 13 | 600 | 36x 8 | A | 13 | 23 | 1750 |
| 18x4 | D | 12 | 13 | 730 | 36x 8 | B | 13 | 23 | 2025 |
| 18x6 | B | 12 | 13 | 615 | 36x 8 | C | 13 | 23 | 2345 |
| 18x6 | D | 12 | 13 | 740 | 36x 8 | D | 13 | 23 | 2695 |
| 20x4 | B | 12 | 14 | 700 | 36x12 | A | 13 | 23 | 1800 |
| 20x4 | D | 12 | 14 | 870 | 36x12 | B | 13 | 23 | 2065 |
| 20x6 | B | 12 | 14 | 710 | 36x12 | C | 13 | 23 | 2375 |
| 20x6 | D | 12 | 14 | 880 | 36x12 | D | 13 | 23 | 2720 |

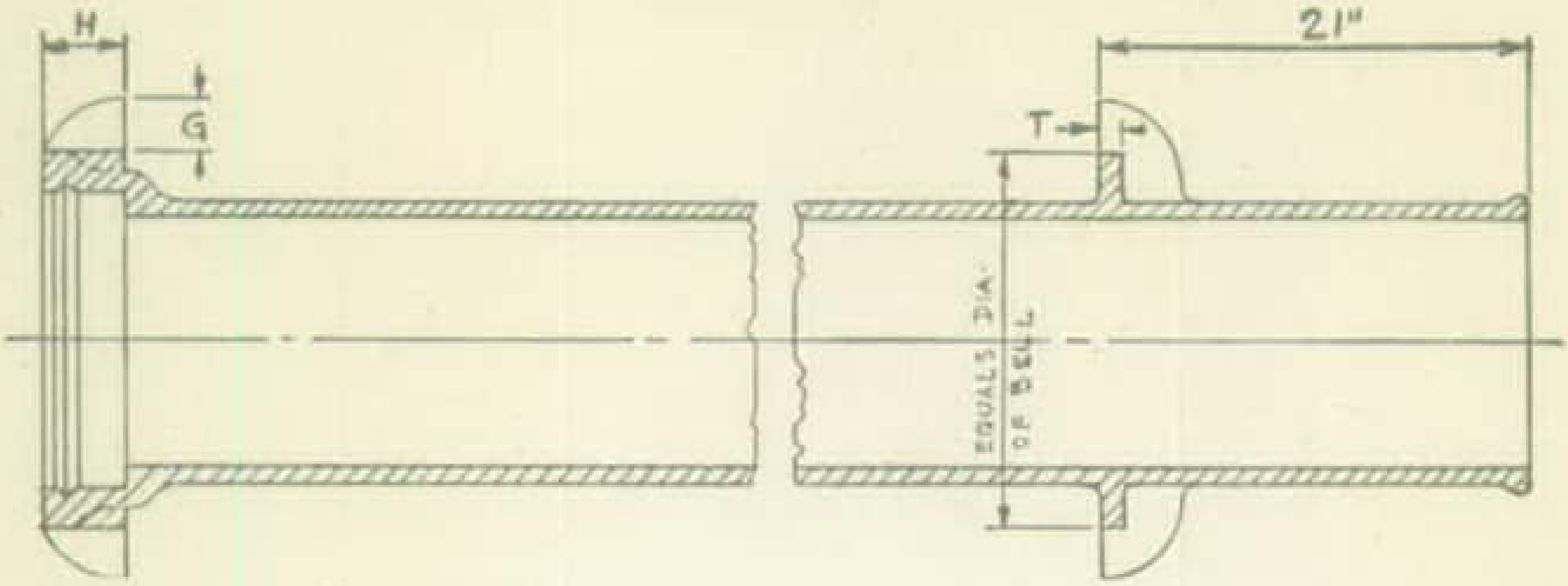
Dimensions in inches.
For bell dimensions, see page 276.

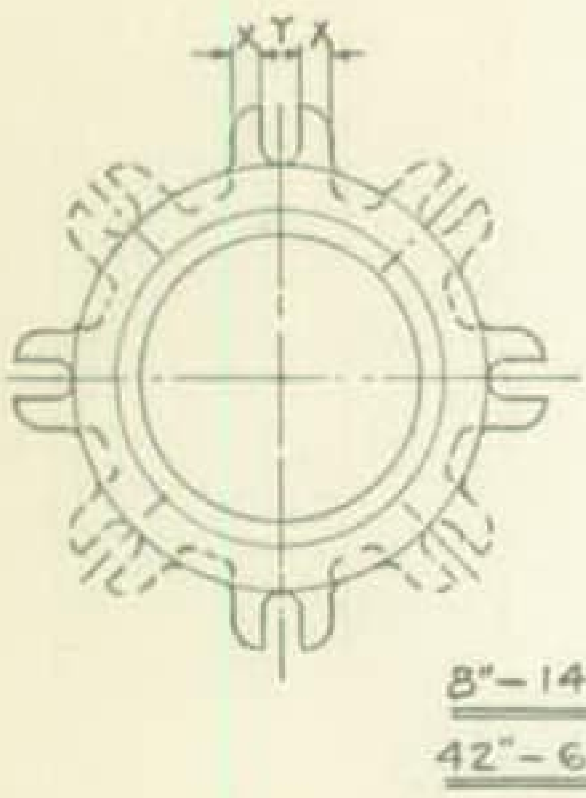
## Dimensions and Weights of A.W.W.A.—N.E.W.W.A. Standard Blow-Off Branches

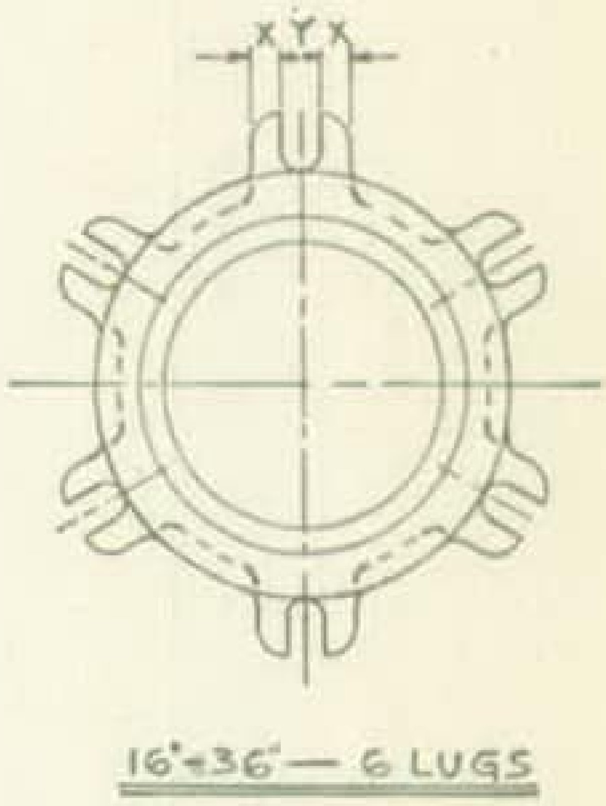
| Size | Class | A | B | Weight | Size | Class | A | B | Weight |
|---|---|---|---|---|---|---|---|---|---|
| 42x12 | A | 15 | 26 | 2555 | 54x12 | A | 19 | 33 | 4505 |
| 42x12 | B | 15 | 26 | 2850 | 54x12 | B | 19 | 33 | 5170 |
| 42x12 | C | 15 | 26 | 3395 | 54x12 | C | 19 | 33 | 6245 |
| 42x12 | D | 15 | 26 | 3895 | 54x12 | D | 19 | 33 | 7295 |
| 42x16 | A | 15 | 26 | 2575 | 54x16 | A | 19 | 33 | 4515 |
| 42x16 | B | 15 | 26 | 2870 | 54x16 | B | 19 | 33 | 5175 |
| 42x16 | C | 15 | 26 | 3460 | 54x16 | C | 19 | 33 | 6300 |
| 42x16 | D | 15 | 26 | 3940 | 54x16 | D | 19 | 33 | 7340 |
| 48x12 | A | 17 | 30 | 3435 | 60x12 | A | 21 | 36 | 5540 |
| 48x12 | B | 17 | 30 | 3840 | 60x12 | B | 21 | 36 | 6430 |
| 48x12 | C | 17 | 30 | 4610 | 60x12 | C | 21 | 36 | 7740 |
| 48x12 | D | 17 | 30 | 5300 | 60x12 | D | 21 | 36 | 9155 |
| 48x16 | A | 17 | 30 | 3440 | 60x16 | A | 21 | 36 | 5555 |
| 48x16 | B | 17 | 30 | 3850 | 60x16 | B | 21 | 36 | 6440 |
| 48x16 | C | 17 | 30 | 4660 | 60x16 | C | 21 | 36 | 7795 |
| 48x16 | D | 17 | 30 | 5335 | 60x16 | D | 21 | 36 | 9185 |

Dimensions in inches.
For bell dimensions, see page 276.

## Standard Lugs for Pipe and Fittings, A.W.W.A.-N.E.W.W.A.




NOTE: A pair of lugs is placed on the vertical axis of each bell, the others at equal distances around circumference. Since there are only 6 lugs on fittings for sizes 16" through 36" purchaser should furnish sketch showing location of lugs.

Lugs on spigot ends of pipe are located, unless otherwise ordered, with face of lug 21" from end of spigot. This dimension varies for fittings.

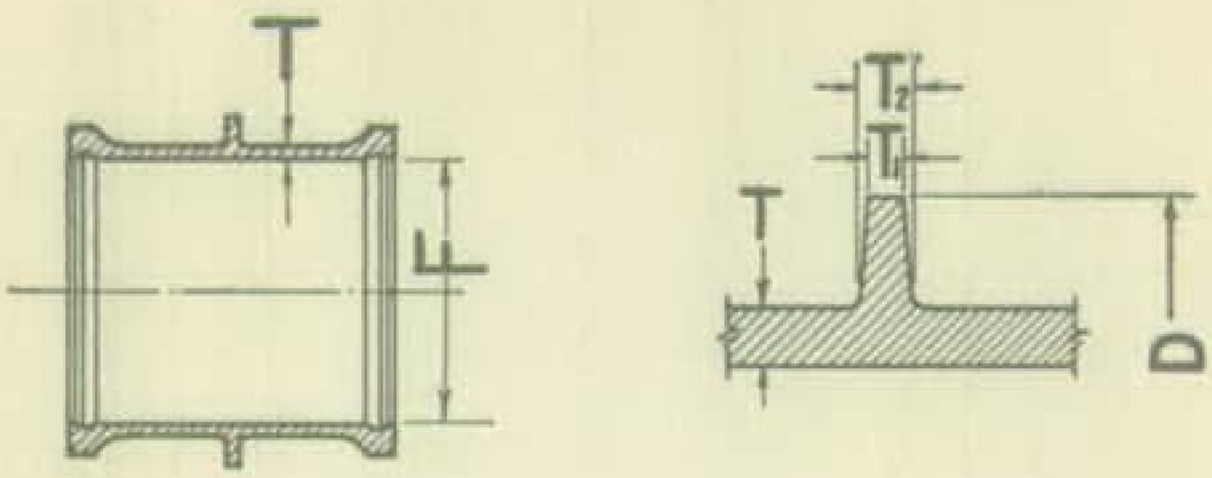
Pipe and fittings furnished with lugs only when specifically ordered.

For dimensions see page 314.

## Standard Lugs for Pipe and Fittings, A.W.W.A.-N.E.W.W.A.

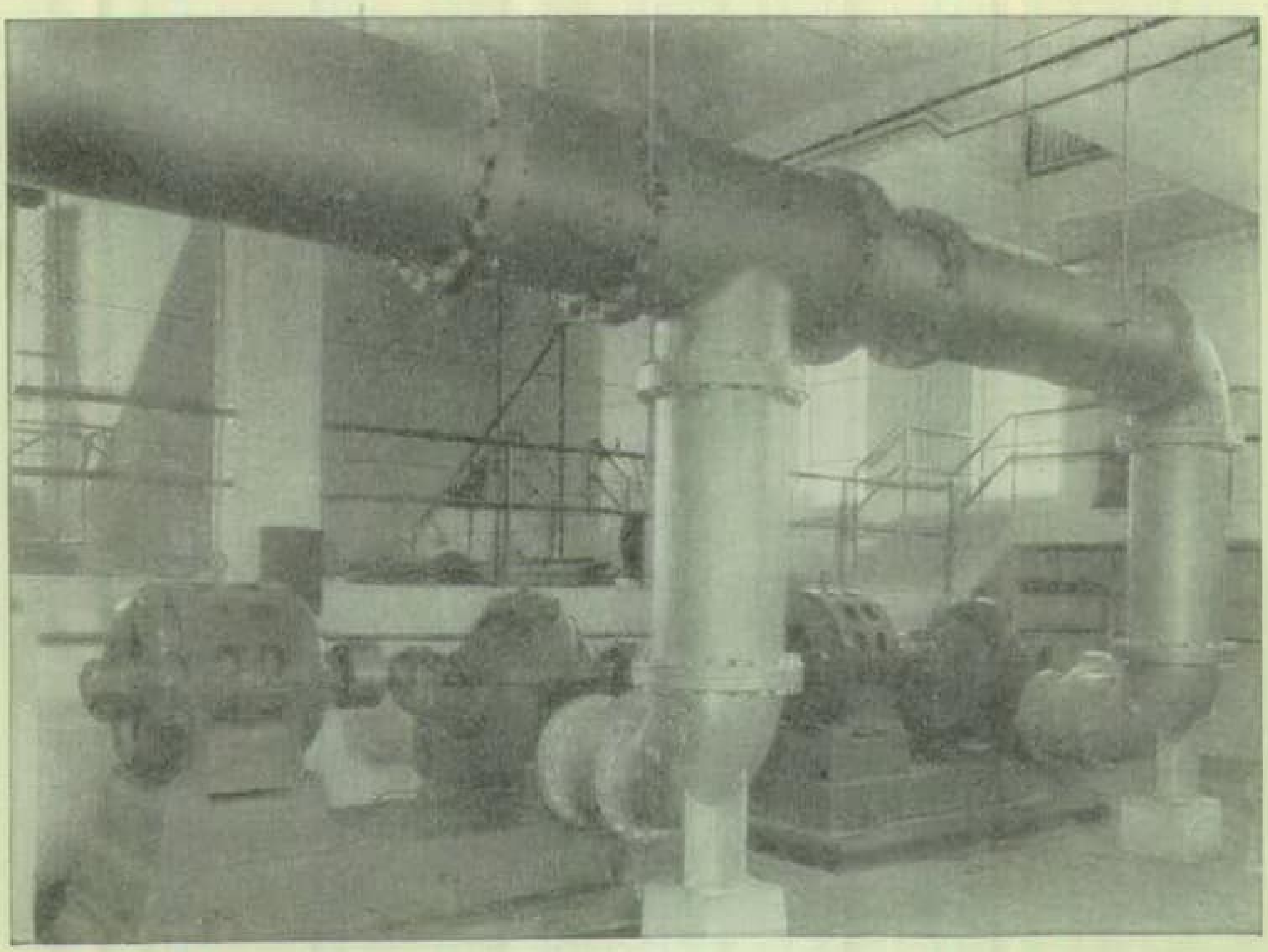
| Nominal Diameter Pipe | Class | Number of Lugs on Each End | Dimensions in Inches | | | | | | | Weight of Lugs | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | G | H | T | X | Y | Diam. of Bolt | Length of Bolt | Bell End | Spigot End |
| 8 | A B | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 40 |
| 8 | C D | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 40 |
| 10 | A B | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 40 |
| 10 | C D | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 40 |
| 12 | A B | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 40 |
| 12 | C D | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 45 |
| 14 | A B | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 40 |
| 14 | C D | 4 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 30 | 45 |
| 16 | A B | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 45 | 65 |
| 16 | C D | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 45 | 70 |
| 18 | A B | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 50 | 70 |
| 18 | C D | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 50 | 75 |
| 20 | A B | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 50 | 70 |
| 20 | C D | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 50 | 75 |
| 24 | A B | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 50 | 75 |
| 24 | C D | 6 | 2.50 | 4.00 | 1.00 | 1.25 | 1.63 | 1.38 | 24.50 | 50 | 80 |
| 30 | A | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 75 | 115 |
| 30 | B | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 75 | 115 |
| 30 | C | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 80 | 125 |
| 30 | D | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 85 | 135 |
| 36 | A | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 80 | 120 |
| 36 | B | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 80 | 130 |
| 36 | C | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 85 | 135 |
| 36 | D | 6 | 3.00 | 4.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 85 | 145 |
| 42 | A | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 120 | 185 |
| 42 | B | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 125 | 190 |
| 42 | C | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 130 | 205 |
| 42 | D | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 135 | 220 |
| 48 | A | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 125 | 190 |
| 48 | B | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 130 | 200 |
| 48 | C | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 135 | 220 |
| 48 | D | 8 | 3.00 | 5.00 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 140 | 235 |
| 54 | A | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 140 | 215 |
| 54 | B | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 145 | 230 |
| 54 | C | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 150 | 245 |
| 54 | D | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 150 | 260 |
| 60 | A | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 145 | 220 |
| 60 | B | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 145 | 235 |
| 60 | C | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 150 | 255 |
| 60 | D | 8 | 3.00 | 5.50 | 1.50 | 1.50 | 2.00 | 1.75 | 25.50 | 155 | 275 |

## Laying Dimensions and Weights of Standard Wall Sleeves



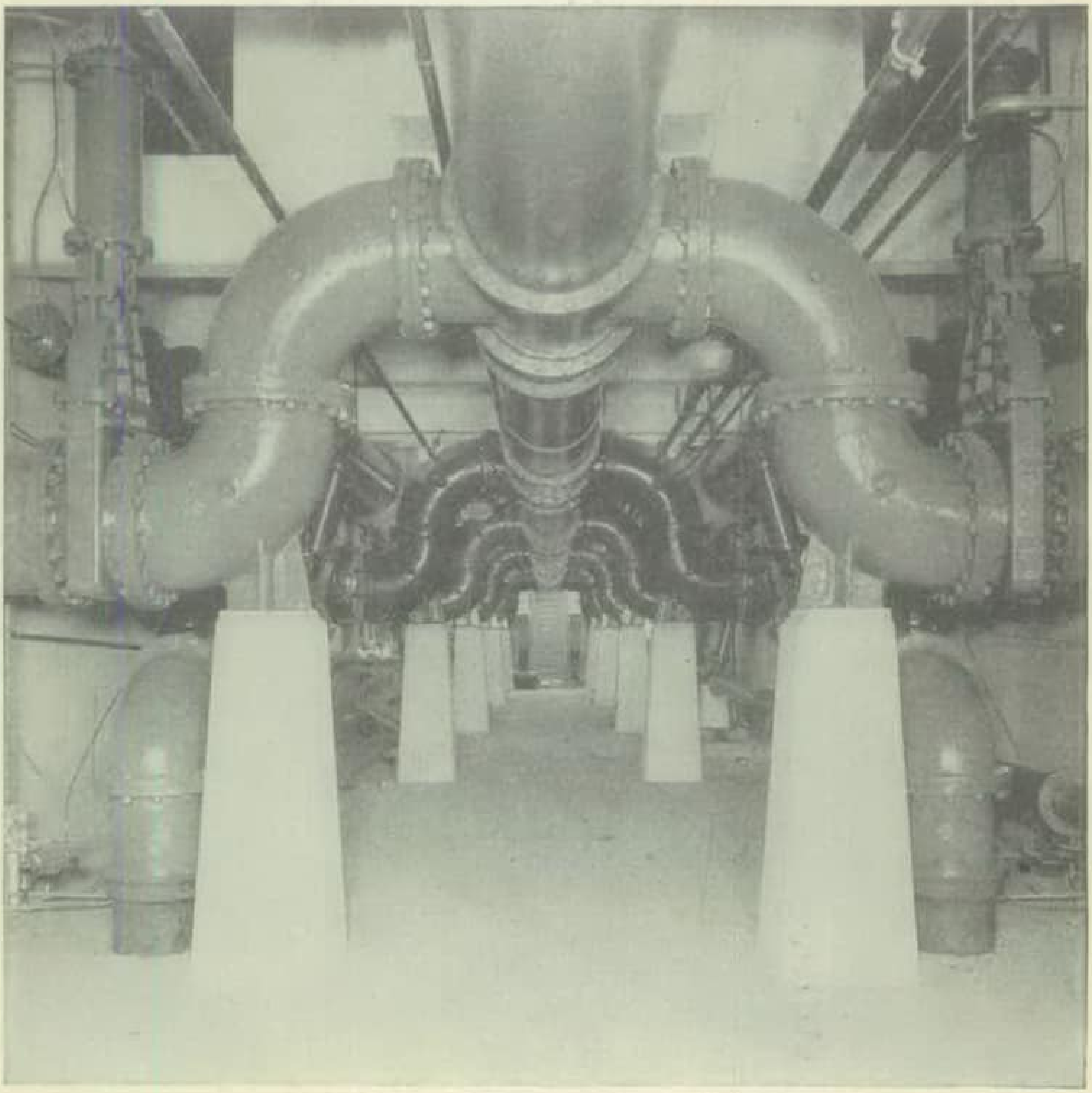

| Size | Class | T | F | Intermediate Flange | | | | Length and Weight | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Short Type | | Long Type | |
| | | | | $T_2$ | $T_1$ | D | Wt. | Length | Weight | Length | Weight |
| 3 | D | 0.65 | 4.76 | 0.75 | 0.50 | 9.00 | 6 | 10 | 40 | 15 | 55 |
| 4 | D | 0.65 | 5.80 | 0.75 | 0.50 | 10.00 | 6 | 10 | 50 | 15 | 70 |
| 6 | D | 0.70 | 7.90 | 0.75 | 0.50 | 12.00 | 7 | 10 | 70 | 15 | 95 |
| 8 | D | 0.75 | 10.10 | 0.75 | 0.50 | 14.50 | 10 | 12 | 110 | 15 | 130 |
| 10 | D | 0.80 | 12.20 | 0.75 | 0.50 | 16.50 | 10 | 12 | 140 | 18 | 190 |
| 12 | D | 0.85 | 14.30 | 0.75 | 0.50 | 19.00 | 13 | 14 | 200 | 18 | 240 |
| 14 | B | 0.85 | 16.20 | 1.00 | 0.75 | 22.00 | 29 | 15 | 245 | 18 | 285 |
| 14 | D | 0.90 | 16.50 | 1.00 | 0.75 | 22.00 | 26 | 15 | 260 | 18 | 300 |
| 16 | B | 0.90 | 18.50 | 1.00 | 0.75 | 24.50 | 33 | 15 | 305 | 24 | 435 |
| 16 | D | 1.00 | 18.90 | 1.00 | 0.75 | 24.50 | 29 | 15 | 330 | 24 | 475 |
| 18 | B | 0.95 | 20.60 | 1.00 | 0.75 | 26.75 | 37 | 15 | 355 | 24 | 505 |
| 18 | D | 1.05 | 21.00 | 1.00 | 0.75 | 26.75 | 32 | 15 | 390 | 24 | 560 |
| 20 | B | 1.00 | 22.70 | 1.00 | 0.75 | 29.00 | 41 | 15 | 410 | 24 | 580 |
| 20 | D | 1.15 | 23.10 | 1.00 | 0.75 | 29.00 | 35 | 15 | 470 | 24 | 675 |
| 24 | B | 1.05 | 26.90 | 1.00 | 0.75 | 33.50 | 50 | 15 | 520 | 24 | 735 |
| 24 | D | 1.25 | 27.40 | 1.00 | 0.75 | 33.50 | 41 | 15 | 615 | 24 | 880 |
| 30 | B | 1.15 | 33.10 | 1.25 | 1.00 | 40.00 | 80 | 15 | 710 | 24 | 1000 |
| 30 | D | 1.50 | 33.80 | 1.25 | 1.00 | 40.00 | 56 | 15 | 915 | 24 | 1305 |
| 36 | B | 1.40 | 39.40 | 1.25 | 1.00 | 47.00 | 98 | 15 | 1020 | 24 | 1440 |
| 36 | D | 1.80 | 40.20 | 1.25 | 1.00 | 47.00 | 67 | 15 | 1260 | 24 | 1815 |
| 42 | B | 1.50 | 45.60 | 1.50 | 1.25 | 54.50 | 171 | 15 | 1310 | 24 | 1830 |
| 42 | D | 1.95 | 46.70 | 1.50 | 1.25 | 54.50 | 115 | 15 | 1645 | 24 | 2345 |
| 48 | B | 1.65 | 51.90 | 1.50 | 1.25 | 61.25 | 198 | 15 | 1635 | 24 | 2280 |
| 48 | D | 2.20 | 53.10 | 1.50 | 1.25 | 61.25 | 126 | 15 | 2075 | 24 | 2970 |

Dimensions in inches.

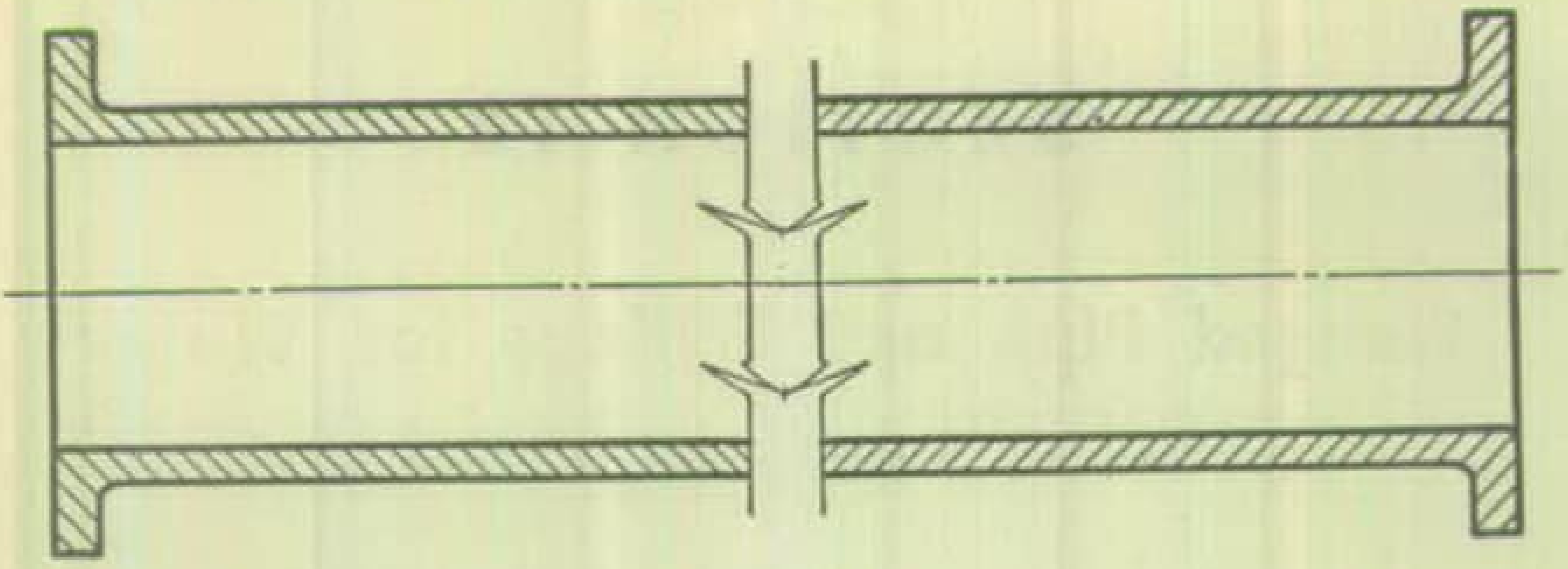


# SECTION 13

## Flanged Pipe and Fittings for Water



## Standard Thicknesses and Weights of Pit Cast Cast Iron Flanged Pipe A.W.W.A. 1908 Specifications



CLASS "A"

| Size | Outside Dia. | Thickness | Barrel Wt./Ft. | Wt./Flg. | Weight* 12' Flg. Pipe |
|---|---|---|---|---|---|
| 3 | 3.80 | 0.39 | 13.0 | 6 | 170 |
| 4 | 4.80 | 0.42 | 18.0 | 10 | 235 |
| 6 | 6.90 | 0.44 | 27.9 | 14 | 365 |
| 8 | 9.05 | 0.46 | 38.7 | 22 | 510 |
| 10 | 11.10 | 0.50 | 52.0 | 29 | 680 |
| 12 | 13.20 | 0.54 | 67.0 | 45 | 895 |
| 14 | 15.30 | 0.57 | 82.3 | 54 | 1095 |
| 16 | 17.40 | 0.60 | 98.8 | 67 | 1320 |
| 18 | 19.50 | 0.64 | 118.3 | 70 | 1560 |
| 20 | 21.60 | 0.67 | 137.5 | 89 | 1830 |
| 24 | 25.80 | 0.76 | 186.5 | 123 | 2485 |
| 30 | 31.74 | 0.88 | 266.2 | 191 | 3575 |
| 36 | 37.96 | 0.99 | 358.7 | 286 | 4875 |
| 42 | 44.20 | 1.10 | 464.7 | 408 | 6390 |
| 48 | 50.50 | 1.26 | 608.1 | 491 | 8280 |
| CLASS "B" | | | | | |
| 3 | 3.96 | 0.42 | 14.6 | 6 | 185 |
| 4 | 5.00 | 0.45 | 20.1 | 10 | 260 |
| 6 | 7.10 | 0.48 | 31.1 | 13 | 400 |
| 8 | 9.05 | 0.51 | 42.7 | 22 | 555 |
| 10 | 11.10 | 0.57 | 58.8 | 29 | 765 |
| 12 | 13.20 | 0.62 | 76.5 | 45 | 1010 |
| 14 | 15.30 | 0.66 | 94.7 | 54 | 1245 |
| 16 | 17.40 | 0.70 | 114.6 | 67 | 1510 |
| 18 | 19.50 | 0.75 | 137.8 | 70 | 1795 |
| 20 | 21.60 | 0.80 | 163.1 | 89 | 2135 |
| 24 | 25.80 | 0.89 | 217.3 | 123 | 2855 |
| 30 | 32.00 | 1.03 | 312.7 | 184 | 4120 |
| 36 | 38.30 | 1.15 | 418.8 | 274 | 5575 |
| 42 | 44.50 | 1.28 | 542.3 | 393 | 7295 |
| 48 | 50.80 | 1.42 | 687.3 | 474 | 9195 |

Flanges are American Standard, Class 125.

*Weight includes two flanges with calculated weight of pipe rounded off to nearest 5 lb.

Dimensions in inches.

## Standard Thicknesses and Weights of Pit Cast Cast Iron Flanged Pipe A.W.W.A. 1908 Specifications

CLASS "C"

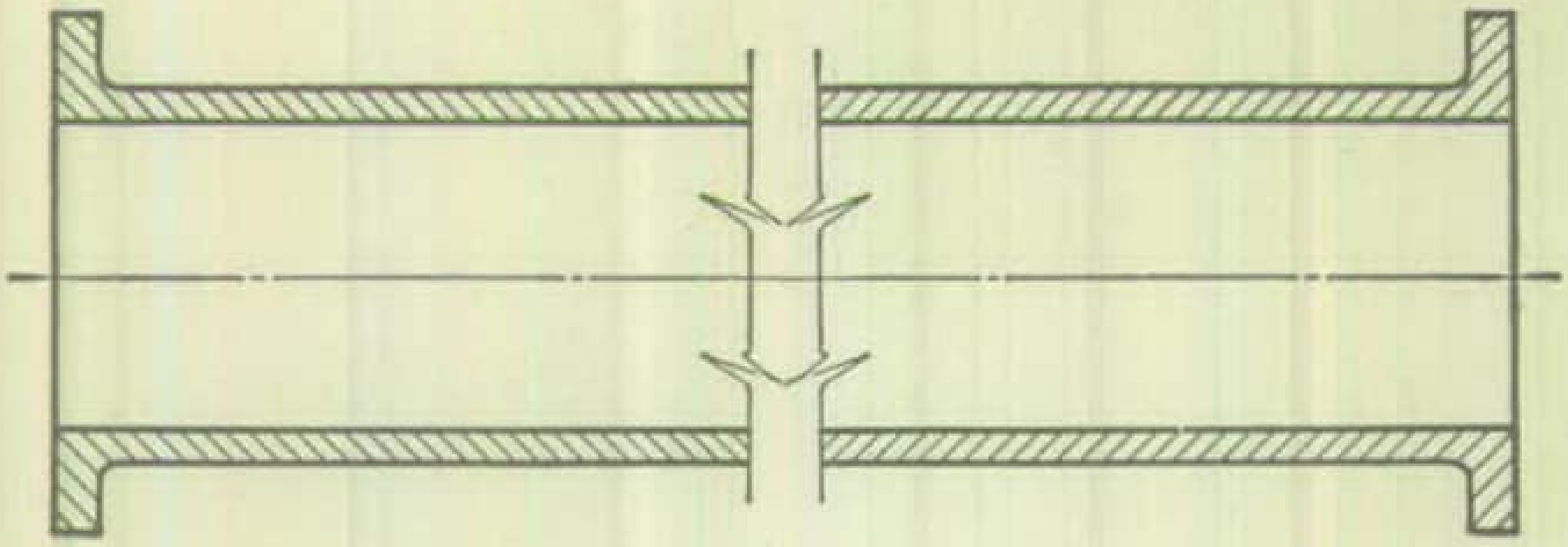
| Size | Outside Dia. | Thickness | Barrel Wt./Ft. | Wt./Flg. | Weight* 12′ Flg. Pipe |
|---|---|---|---|---|---|
| 3 | 3.96 | 0.45 | 15.5 | 6 | 200 |
| 4 | 5.00 | 0.48 | 21.3 | 10 | 275 |
| 6 | 7.10 | 0.51 | 32.9 | 13 | 420 |
| 8 | 9.30 | 0.56 | 48.0 | 21 | 620 |
| 10 | 11.40 | 0.62 | 65.5 | 28 | 840 |
| 12 | 13.50 | 0.68 | 85.5 | 43 | 1110 |
| 14 | 15.65 | 0.74 | 108.1 | 51 | 1400 |
| 16 | 17.80 | 0.80 | 133.3 | 63 | 1725 |
| 18 | 19.92 | 0.87 | 162.5 | 65 | 2080 |
| 20 | 22.06 | 0.92 | 190.6 | 82 | 2450 |
| 24 | 26.32 | 1.04 | 257.7 | 112 | 3315 |
| 30 | 32.40 | 1.20 | 367.0 | 173 | 4750 |
| 36 | 38.70 | 1.36 | 497.8 | 259 | 6490 |
| 42 | 45.10 | 1.54 | 657.5 | 364 | 8620 |
| 48 | 51.40 | 1.71 | 832.9 | 439 | 10875 |
| CLASS "D" | | | | | |
| 3 | 3.96 | 0.48 | 16.4 | 6 | 210 |
| 4 | 5.00 | 0.52 | 22.8 | 10 | 295 |
| 6 | 7.10 | 0.55 | 35.3 | 13 | 450 |
| 8 | 9.30 | 0.60 | 51.2 | 21 | 655 |
| 10 | 11.40 | 0.68 | 71.5 | 28 | 915 |
| 12 | 13.50 | 0.75 | 93.7 | 43 | 1210 |
| 14 | 15.65 | 0.82 | 119.2 | 51 | 1530 |
| 16 | 17.80 | 0.89 | 147.5 | 63 | 1895 |
| 18 | 19.92 | 0.96 | 178.4 | 65 | 2270 |
| 20 | 22.06 | 1.03 | 212.3 | 82 | 2710 |
| 24 | 26.32 | 1.16 | 286.1 | 112 | 3655 |
| 30 | 32.74 | 1.37 | 421.3 | 163 | 5380 |
| 36 | 39.16 | 1.58 | 582.0 | 242 | 7470 |
| 42 | 45.58 | 1.78 | 764.2 | 341 | 9850 |
| 48 | 51.98 | 1.96 | 961.0 | 406 | 12345 |

Flanges are American Standard, Class 125.

*Weight includes two flanges with calculated weight of pipe rounded off to nearest 5 lb.

Dimensions in inches.

## Standard Thicknesses and Weights of Pit Cast Cast Iron Flanged Pipe—A.S.A. A21.2 Specifications



| Size | CLASS 100 | | | | | CLASS 150 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Outside Diam. | Thickness | Bbl. Wt. Per Ft. | Wt. Per Flg. | Wt.* 12′ Flg. Pipe | Outside Diam. | Thickness | Bbl. Wt. Per Ft. | Wt. Per Flg. | Wt.* 12′ Flg. Pipe |
| 3 | 3.80″ | 0.37″ | 12.4 | 6 | 160 | 3.80″ | 0.37″ | 12.4 | 6 | 160 |
| 4 | 4.80″ | 0.40″ | 17.3 | 10 | 230 | 4.80″ | 0.40″ | 17.3 | 10 | 230 |
| 6 | 6.90″ | 0.43″ | 27.3 | 14 | 355 | 6.90″ | 0.43″ | 27.3 | 14 | 355 |
| 8 | 9.05″ | 0.46″ | 38.7 | 22 | 510 | 9.05″ | 0.46″ | 38.7 | 22 | 510 |
| 10 | 11.10″ | 0.50″ | 52.0 | 29 | 680 | 11.10″ | 0.54″ | 55.9 | 29 | 730 |
| 12 | 13.20″ | 0.54″ | 67.0 | 45 | 895 | 13.20″ | 0.58″ | 71.8 | 45 | 950 |
| 14 | 15.30″ | 0.58″ | 83.7 | 54 | 1110 | 15.65″ | 0.63″ | 92.8 | 51 | 1215 |
| 16 | 17.40″ | 0.63″ | 103.6 | 67 | 1375 | 17.80″ | 0.68″ | 114.1 | 63 | 1495 |
| 18 | 19.50″ | 0.68″ | 125.4 | 70 | 1645 | 19.92″ | 0.79″ | 148.1 | 65 | 1905 |
| 20 | 21.60″ | 0.71″ | 145.4 | 89 | 1925 | 22.06″ | 0.83″ | 172.7 | 82 | 2235 |
| 24 | 25.80″ | 0.80″ | 196.0 | 123 | 2600 | 26.32″ | 0.93″ | 231.5 | 112 | 3000 |
| 30 | 32.00″ | 0.94″ | 286.2 | 184 | 3800 | 32.40″ | 1.10″ | 337.5 | 173 | 4395 |
| 36 | 38.30″ | 1.13″ | 411.7 | 274 | 5490 | 38.70″ | 1.22″ | 448.2 | 259 | 5895 |
| 42 | 44.50″ | 1.16″ | 492.8 | 393 | 6700 | 45.10″ | 1.35″ | 578.9 | 364 | 7675 |
| 48 | 50.80″ | 1.37″ | 663.8 | 474 | 8915 | 51.40″ | 1.48″ | 724.2 | 439 | 9570 |

Flanges are American Standard, Class 125.

*Weight includes two flanges with calculated weight of pipe rounded off to nearest five pounds.

Classes correspond to Table No. 3, A.S.A. A21.2 Specifications.

Dimensions in inches.

## Standard Thicknesses and Weights of Pit Cast Cast Iron Flanged Pipe—A.S.A. A21.2 Specifications—Continued

| Size | CLASS 200 | | | | | CLASS 250 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Out-side Diam. | Thick-ness | Bbl. Wt. Per Ft. | Wt. Per Flg. | Wt.* 12′ Flg. Pipe | Out-side Diam. | Thick-ness | Bbl. Wt. Per Ft. | Wt. Per Flg. | Wt.* 12′ Flg. Pipe |
| 3 | 3.80″ | 0.37″ | 12.4 | 11 | 170 | 3.80″ | 0.37″ | 12.4 | 11 | 170 |
| 4 | 4.80″ | 0.40″ | 17.3 | 17 | 240 | 4.80″ | 0.40″ | 17.3 | 17 | 240 |
| 6 | 6.90″ | 0.43″ | 27.3 | 29 | 385 | 6.90″ | 0.43″ | 27.3 | 29 | 385 |
| 8 | 9.05″ | 0.46″ | 38.7 | 43 | 550 | 9.05″ | 0.50″ | 41.9 | 43 | 590 |
| 10 | 11.10″ | 0.58″ | 59.8 | 61 | 840 | 11.40″ | 0.63″ | 66.5 | 59 | 915 |
| 12 | 13.20″ | 0.63″ | 77.6 | 89 | 1110 | 13.50″ | 0.68″ | 85.5 | 85 | 1195 |
| 14 | 15.65″ | 0.68″ | 99.8 | 108 | 1415 | 15.65″ | 0.79″ | 115.1 | 108 | 1595 |
| 16 | 17.80″ | 0.79″ | 131.7 | 134 | 1850 | 17.80″ | 0.85″ | 141.2 | 134 | 1960 |
| 18 | 19.92″ | 0.85″ | 158.9 | 163 | 2235 | 19.92″ | 0.92″ | 171.3 | 163 | 2380 |
| 20 | 22.06″ | 0.90″ | 186.7 | 200 | 2640 | 22.06″ | 0.97″ | 200.5 | 200 | 2805 |
| 24 | 26.32″ | 1.00″ | 248.2 | 296 | 3570 | 26.32″ | 1.17″ | 288.4 | 296 | 4055 |
| 30 | 32.74″ | 1.19″ | 368.0 | 403 | 5220 | 32.74″ | 1.39″ | 427.1 | 403 | 5930 |
| 36 | 39.16″ | 1.43″ | 528.9 | 549 | 7445 | 39.16″ | 1.54″ | 567.9 | 549 | 7915 |
| 42 | 45.58″ | 1.58″ | 681.4 | 738 | 9655 | 45.58″ | 1.71″ | 735.3 | 738 | 10300 |
| 48 | 51.98″ | 1.73″ | 852.1 | 1071 | 12365 | 51.98″ | 2.02″ | 989.2 | 1071 | 14010 |

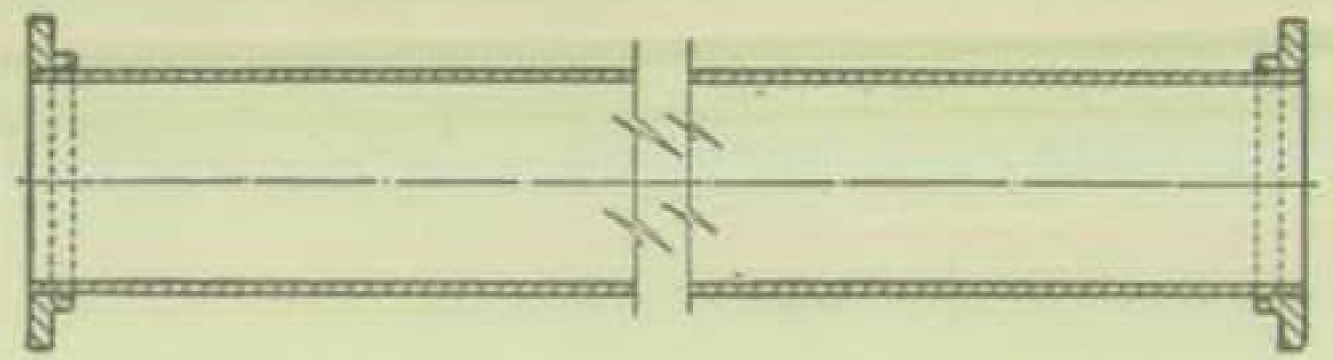
All Flanges American Standard Class 250, with allowance for raised face.

*Weight includes two flanges with calculated pipe weights rounded off to nearest five pounds.

Classes correspond to Table No. 3, A.S.A. A21.2 Specifications.

Dimensions in inches.

## Flanged Pipe With Threaded Flanges



| Nominal Inside Diameter Inches | Class or Maximum Working Pressure | Outside Diameter of Pipe Inches | Minimum Thickness of Pipe Inches | Weight Pounds | | | Weight—with Flanges—Pounds | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | One Flange Only | | Per Foot Without Flanges | 12 Foot Length | | 16 Foot Length | | 18 Foot Length | |
| | | | | A.S.A. 125 | A.S.A. 250 | | Per Foot | Per Length | Per Foot | Per Length | Per Foot | Per Length |
| 3 | 150 | 3.96 | 0.38 | 7 | .......... | 13.3 | 14.6 | 175 | 14.1 | 225 | 14.1 | 255 |
| 3 | 250 | 3.96 | 0.38 | 7 | .......... | 13.3 | 14.6 | 175 | 14.1 | 225 | 14.1 | 255 |
| 3 | 250 | 3.96 | 0.38 | .......... | 12 | 13.3 | 15.4 | 185 | 14.7 | 235 | 14.7 | 265 |
| 4 | 150 | 4.80 | 0.38 | 13 | .......... | 16.5 | 18.8 | 225 | 18.1 | 290 | 18.1 | 325 |
| 4 | 250 | 4.80 | 0.38 | 13 | .......... | 16.5 | 18.8 | 225 | 18.1 | 290 | 18.1 | 325 |
| 4 | 250 | 4.80 | 0.38 | .......... | 20 | 16.5 | 20.0 | 240 | 19.1 | 305 | 18.6 | 335 |
| 6 | 150 | 6.90 | 0.38 | 17 | .......... | 24.3 | 27.1 | 325 | 26.6 | 425 | 26.1 | 470 |
| 6 | 250 | 6.90 | 0.38 | 17 | .......... | 24.3 | 27.1 | 325 | 26.6 | 425 | 26.1 | 470 |
| 6 | 250 | 6.90 | 0.38 | .......... | 34 | 24.3 | 30.0 | 360 | 28.4 | 455 | 28.1 | 505 |
| 8 | 150 | 9.05 | 0.41 | 27 | .......... | 34.7 | 39.2 | 470 | 38.1 | 610 | 37.8 | 680 |
| 8 | 250 | 9.05 | 0.41 | 27 | .......... | 34.7 | 39.2 | 470 | 38.1 | 610 | 37.8 | 680 |
| 8 | 250 | 9.05 | 0.41 | .......... | 50 | 34.7 | 42.9 | 515 | 40.9 | 655 | 40.3 | 725 |
| 10 | 150 | 11.10 | 0.44 | 38 | .......... | 46.0 | 52.5 | 630 | 50.6 | 810 | 50.3 | 905 |
| 10 | 250 | 11.10 | 0.44 | 38 | .......... | 46.0 | 52.5 | 630 | 50.6 | 810 | 50.3 | 905 |
| 10 | 250 | 11.10 | 0.44 | .......... | 70 | 46.0 | 57.5 | 690 | 54.7 | 875 | 53.9 | 970 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 150 | 13.20 | 0.48 | 58 | .......... | 59.8 | 69.6 | 835 | 67.2 | 1075 | 66.1 | 1190 |
| 12 | 250 | 13.20 | 0.52 | 58 | .......... | 64.6 | 74.2 | 890 | 71.9 | 1150 | 71.1 | 1280 |
| 12 | 250 | 13.20 | 0.52 | .......... | 102 | 64.6 | 81.7 | 980 | 77.5 | 1240 | 75.8 | 1365 |
| 14 | 150 | 15.30 | 0.51 | 72 | .......... | 73.9 | 85.8 | 1030 | 82.8 | 1325 | 81.9 | 1475 |
| 14 | 250 | 15.30 | 0.59 | 72 | .......... | 85.1 | 97.1 | 1165 | 94.1 | 1505 | 93.1 | 1675 |
| 14 | 250 | 15.30 | 0.59 | .......... | 130 | 85.1 | 106.7 | 1280 | 101.2 | 1620 | 99.4 | 1790 |
| 16 | 150 | 17.40 | 0.54 | 90 | .......... | 89.2 | 104.2 | 1250 | 100.3 | 1605 | 99.2 | 1785 |
| 16 | 250 | 17.40 | 0.63 | 90 | .......... | 103.6 | 118.8 | 1425 | 115.0 | 1840 | 113.6 | 2045 |
| 16 | 250 | 17.40 | 0.63 | .......... | 162 | 103.6 | 130.4 | 1565 | 123.8 | 1980 | 121.7 | 2190 |
| 18 | 150 | 19.50 | 0.58 | 90 | .......... | 107.6 | 122.5 | 1470 | 118.8 | 1900 | 117.5 | 2115 |
| 18 | 250 | 19.50 | 0.68 | 90 | .......... | 125.4 | 140.4 | 1685 | 136.6 | 2185 | 135.3 | 2435 |
| 18 | 250 | 19.50 | 0.68 | .......... | 200 | 125.4 | 158.8 | 1905 | 150.3 | 2405 | 147.5 | 2655 |
| 20 | 150 | 21.60 | 0.62 | 115 | .......... | 127.5 | 146.7 | 1760 | 141.9 | 2270 | 140.3 | 2525 |
| 20 | 250 | 21.60 | 0.72 | 115 | .......... | 147.4 | 166.7 | 2000 | 161.9 | 2590 | 160.3 | 2885 |
| 20 | 250 | 21.60 | 0.72 | .......... | 245 | 147.4 | 188.3 | 2260 | 178.1 | 2850 | 174.7 | 3145 |
| 24 | 150 | 25.80 | 0.73 | 160 | .......... | 179.4 | 206.2 | 2475 | 199.4 | 3190 | 197.2 | 3550 |
| 24 | 250 | 25.80 | 0.79 | 160 | .......... | 193.7 | 220.4 | 2645 | 213.8 | 3420 | 211.4 | 3805 |
| 24 | 250 | 25.80 | 0.79 | .......... | 370 | 193.7 | 255.4 | 3065 | 240.0 | 3840 | 234.7 | 4225 |

Class 150 and 250 are normally furnished with flanges meeting A.S.A. Class 125 specifications. See page 345.

Class 250 can also be furnished with flanges meeting A.S.A. Class 250 specifications. See page 364.

All sizes of flanged pipe can be made to meet requirements for pipe with greater wall thickness than shown.

Weights shown are subject to a variation of not more than 10% for individual pieces and not more than a total of 5% on any one shipment of 100 or more pieces. To obtain the weight of any short length of pipe, figure length from face to face of flanges and add the weight of two flanges.

After facing flanges, an inspection limit of plus or minus 1/16 inch shall be allowed on all contact surface to contact surface dimensions of full length or short length flanged pipe in sizes up to and including 10 inches; and plus or minus 1/8 inch on sizes larger than 10 inches.

Minimum thickness recommended for cast iron pipe to be threaded for pressure service is .38″.

Minimum thickness shown in table is A.S.A. standard for centrifugally cast pipe with 5 ft. cover, condition B, except where such indicated thickness is less than .38″, in which case .38″ is shown.

## Dimensions of ASA B18.2 Regular Unfinished Square Head and Heavy Unfinished Hexagon Head Bolts and Heavy Unfinished Hexagon Nuts for American Standard Flanges

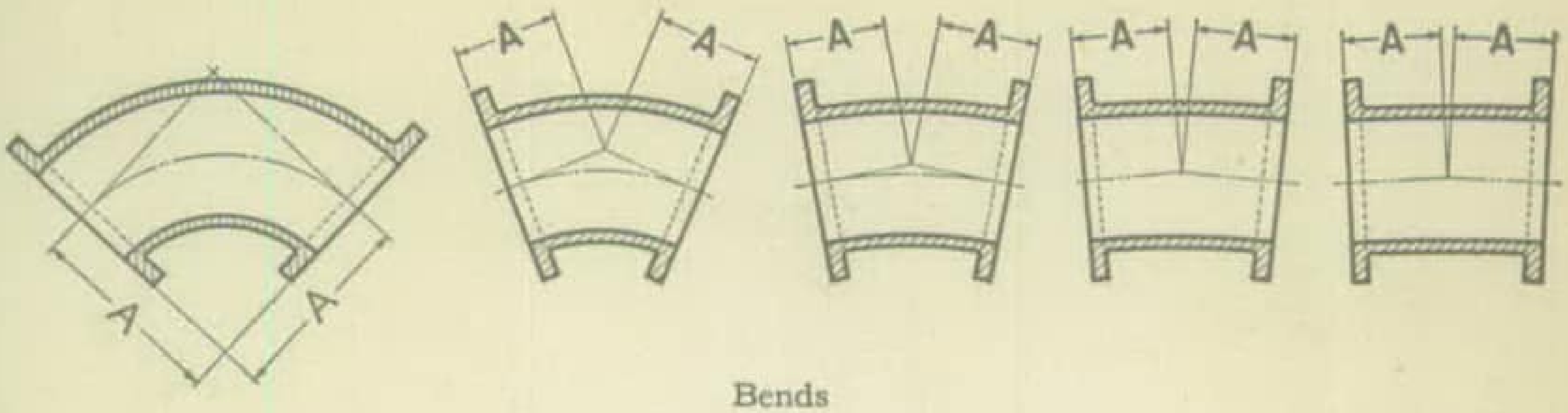
| Dia. of Bolt | Threads Per Inch | Area at Root of Thread | BOLTS | | | | | | NUTS | | | Load at 10,000 psi Stress | Weight per 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hexagon Heads | | | Square Heads | | | Hexagon | | | | | | | |
| | | | Width Across | | Height | Width Across | | Height | Width Across | | Height | | Hex. Head | Sq. Head | Hex. Nut | Inch Under Head |
| | | | Flats | Corners | | Flats | Corners | | Flats | Corners | | | | | | |
| 1/2" | 13 | 0.126 | 7/8 | 0.969 | 7/16 | 3/4 | 0.995 | 21/64 | 7/8 | 0.969 | 1/2 | 1260 | 8.2 | 5.1 | 6.6 | 5.6 |
| 5/8" | 11 | 0.202 | 1 1/16 | 1.175 | 17/32 | 15/16 | 1.244 | 27/64 | 1 1/16 | 1.175 | 5/8 | 2020 | 14 | 10 | 11 | 8.7 |
| 3/4" | 10 | 0.302 | 1 1/4 | 1.382 | 5/8 | 1 1/8 | 1.494 | 1/2 | 1 1/4 | 1.382 | 3/4 | 3020 | 24 | 18 | 19 | 12.5 |
| 7/8" | 9 | 0.419 | 1 7/16 | 1.589 | 23/32 | 1 5/16 | 1.742 | 19/32 | 1 7/16 | 1.589 | 7/8 | 4190 | 36 | 29 | 28 | 17.0 |
| 1" | 8 | 0.551 | 1 5/8 | 1.796 | 13/16 | 1 1/2 | 1.991 | 21/32 | 1 5/8 | 1.796 | 1 | 5510 | 53 | 42 | 41 | 22.3 |
| 1 1/8" | 7 | 0.693 | 1 13/16 | 2.002 | 29/32 | 1 11/16 | 2.239 | 3/4 | 1 13/16 | 2.002 | 1 1/8 | 6930 | 73 | 60 | 56 | 28.2 |
| 1 1/4" | 7 | 0.890 | 2 | 2.209 | 1 | 1 7/8 | 2.489 | 27/32 | 2 | 2.209 | 1 1/4 | 8900 | 94 | 84 | 73 | 34.8 |
| 1 1/2" | 6 | 1.294 | 2 3/8 | 2.622 | 1 3/16 | 2 1/4 | 2.986 | 1 | 2 3/8 | 2.622 | 1 1/2 | 12940 | 162 | 143 | 123 | 50.07 |
| 1 3/4" | 5 | 1.744 | 2 3/4 | 3.035 | 1 3/8 | 2 5/8 | 3.485 | 1 5/32 | 2 3/4 | 3.035 | 1 3/4 | 17440 | 254 | 226 | 208 | 68.15 |
| 2" | 4 1/2 | 2.300 | 3 1/8 | 3.449 | 1 9/16 | 3 | 3.982 | 1 11/32 | 3 1/8 | 3.449 | 2 | 23000 | 377 | 343 | 303 | 89.00 |
| 2 1/4" | 4 1/2 | 3.021 | 3 1/2 | 3.862 | 1 3/4 | 3 3/8 | 4.479 | 1 1/2 | 3 1/2 | 3.862 | 2 1/4 | 30210 | 538 | 484 | 422 | 112.7 |

Weights from AISC Manual 1948.

All bolts and nuts shall be threaded in accordance with American Standard for Screw Threads, ASA B1.1 Coarse Thread Series, Class 2 Fit.

Weights in pounds.

## Dimensions and Weights of Flanged Fittings for Water

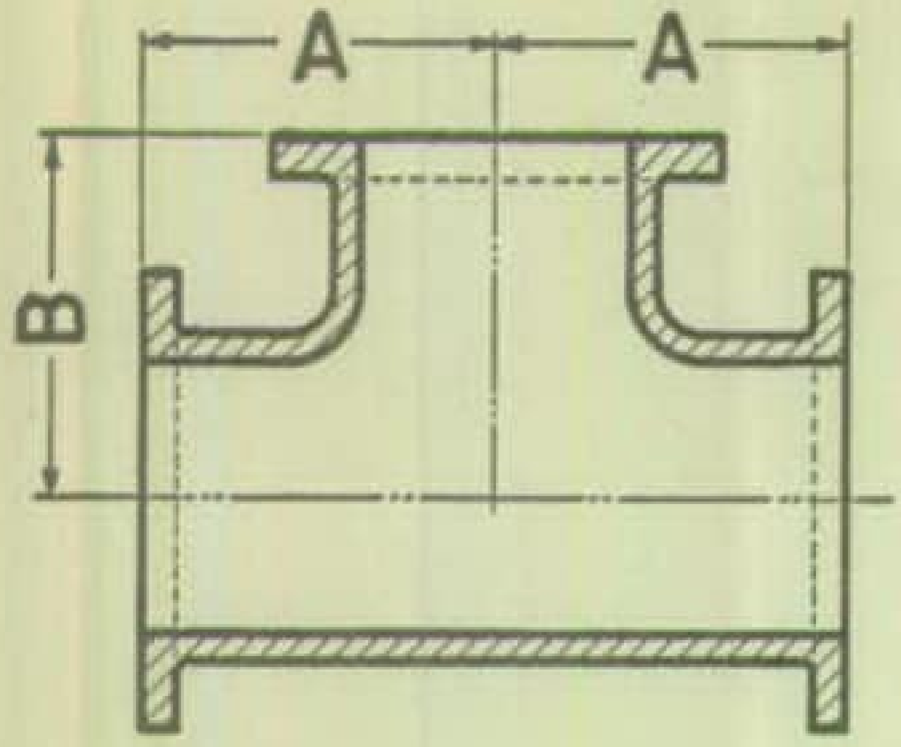



Bends

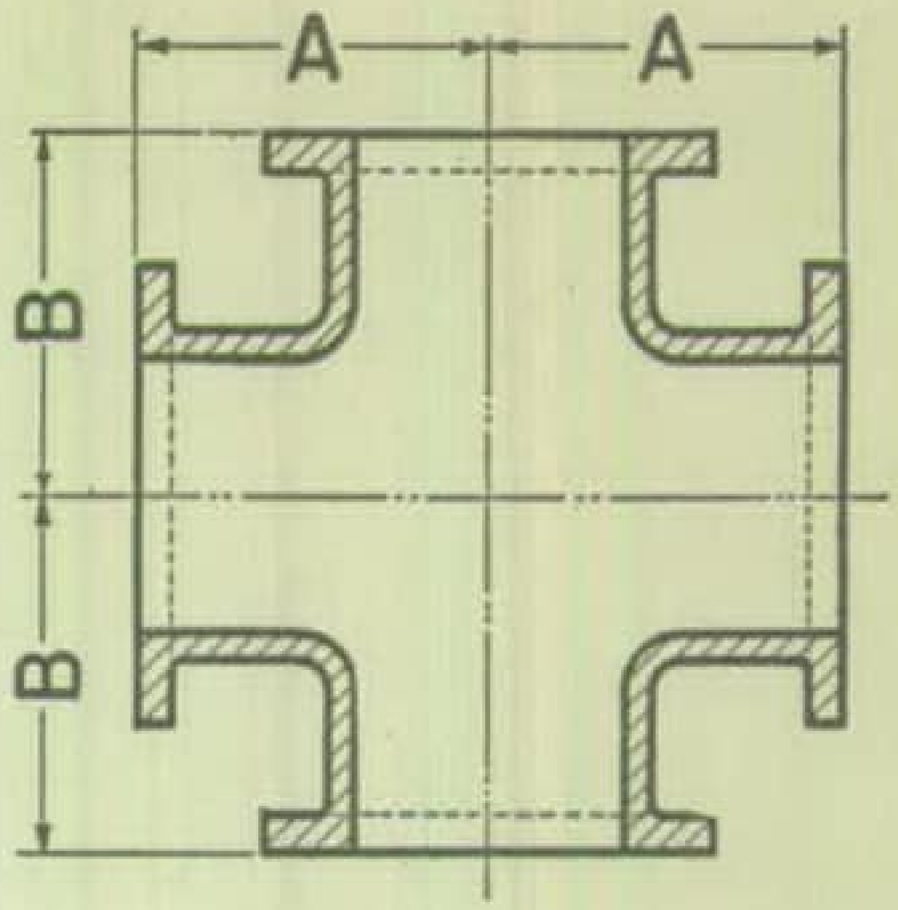
| Size | Class | 90° Bend (¼) | | 45° Bend (⅛) | | 22½° Bend ($\frac{1}{16}$) | | 11¼° Bend ($\frac{1}{32}$) | | 5⅝° Bend ($\frac{1}{64}$) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | Wt. | A | Wt. | A | Wt. | A | Wt. | A | Wt. |
| 6 | D | 16 | 100 | 9.94 | 80 | 9.55 | 80 | ...... | ...... | ...... | ...... |
| 8 | D | 16 | 145 | 9.94 | 125 | 9.55 | 125 | ...... | ...... | ...... | ...... |
| 10 | D | 16 | 205 | 9.94 | 170 | 9.55 | 170 | ...... | ...... | ...... | ...... |
| 12 | D | 16 | 285 | 9.94 | 240 | 9.55 | 240 | ...... | ...... | ...... | ...... |
| 14 | B | 18 | 330 | 14.91 | 330 | 14.32 | 330 | ...... | ...... | ...... | ...... |
| 14 | D | 18 | 380 | 14.91 | 385 | 14.32 | 385 | ...... | ...... | ...... | ...... |
| 16 | B | 24 | 495 | 14.91 | 405 | 14.32 | 405 | ...... | ...... | ...... | ...... |
| 16 | D | 24 | 590 | 14.91 | 475 | 14.32 | 475 | ...... | ...... | ...... | ...... |
| 18 | B | 24 | 575 | 14.91 | 465 | 14.32 | 465 | ...... | ...... | ...... | ...... |
| 18 | D | 24 | 690 | 14.91 | 550 | 14.32 | 550 | ...... | ...... | ...... | ...... |
| 20 | B | 24 | 690 | 19.88 | 690 | 19.10 | 690 | 23.64 | 820 | 23.58 | 820 |
| 20 | D | 24 | 830 | 19.88 | 830 | 19.10 | 830 | 23.64 | 1000 | 23.58 | 1000 |
| 24 | B | 30 | 1105 | 24.85 | 1105 | 23.87 | 1105 | 23.64 | 1105 | 23.58 | 1105 |
| 24 | D | 30 | 1350 | 24.85 | 1350 | 23.87 | 1350 | 23.64 | 1345 | 23.58 | 1345 |
| 30 | A | 36 | 1640 | 24.85 | 1435 | 23.87 | 1435 | 23.64 | 1430 | 23.58 | 1430 |
| 30 | B | 36 | 1845 | 24.85 | 1600 | 23.87 | 1600 | 23.64 | 1600 | 23.58 | 1600 |
| 30 | C | 36 | 2075 | 24.85 | 1790 | 23.87 | 1790 | 23.64 | 1790 | 23.58 | 1790 |
| 30 | D | 36 | 2315 | 24.85 | 1985 | 23.87 | 1985 | 23.64 | 1985 | 23.58 | 1985 |
| 36 | A | 48 | 2830 | 37.28 | 2690 | 35.80 | 2690 | 23.64 | 1985 | 23.58 | 1985 |
| 36 | B | 48 | 3180 | 37.28 | 3015 | 35.80 | 3015 | 23.64 | 2195 | 23.58 | 2195 |
| 36 | C | 48 | 3650 | 37.28 | 3455 | 35.80 | 3455 | 23.64 | 2475 | 23.58 | 2475 |
| 36 | D | 48 | 4145 | 37.28 | 3915 | 35.80 | 3915 | 23.64 | 2770 | 23.58 | 2770 |
| 42 | A | 48 | 3740 | 37.28 | 3560 | 35.80 | 3560 | 23.64 | 2645 | 23.58 | 2645 |
| 42 | B | 48 | 4200 | 37.28 | 3985 | 35.80 | 3985 | 23.64 | 2920 | 23.58 | 2920 |
| 42 | C | 48 | 4865 | 37.28 | 4605 | 35.80 | 4605 | 23.64 | 3310 | 23.58 | 3310 |
| 42 | D | 48 | 5485 | 37.28 | 5185 | 35.80 | 5185 | 23.64 | 3685 | 23.58 | 3685 |
| 48 | A | 54 | 5280 | 37.28 | 4565 | 35.80 | 4565 | 23.64 | 3375 | 23.58 | 3375 |
| 48 | B | 54 | 5815 | 37.28 | 5005 | 35.80 | 5005 | 23.64 | 3655 | 23.58 | 3655 |
| 48 | C | 54 | 6770 | 37.28 | 5790 | 35.80 | 5790 | 23.64 | 4155 | 23.58 | 4155 |
| 48 | D | 54 | 7610 | 37.28 | 6475 | 35.80 | 6475 | 23.64 | 4590 | 23.58 | 4590 |

Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water




Tees




Crosses

| Size | | Class | Dimensions | | Weight | |
|---|---|---|---|---|---|---|
| Run | Branch | | A | B | Tee | Cross |
| 6 | 4 | D | 12 | 12 | 120 | 145 |
| 6 | 6 | D | 12 | 12 | 135 | 165 |
| 8 | 4 | D | 13 | 13 | 180 | 205 |
| 8 | 6 | D | 13 | 13 | 185 | 225 |
| 8 | 8 | D | 13 | 13 | 200 | 260 |
| 10 | 4 | D | 14 | 14 | 245 | 270 |
| 10 | 6 | D | 14 | 14 | 260 | 295 |
| 10 | 8 | D | 14 | 14 | 275 | 320 |
| 10 | 10 | D | 14 | 14 | 290 | 360 |
| 12 | 4 | D | 15 | 15 | 345 | 370 |
| 12 | 6 | D | 15 | 15 | 350 | 385 |
| 12 | 8 | D | 15 | 15 | 370 | 420 |
| 12 | 10 | D | 15 | 15 | 395 | 455 |
| 12 | 12 | D | 15 | 15 | 415 | 515 |
| 14 | 4 | B | 16 | 16 | 400 | 425 |
| 14 | 4 | D | 16 | 16 | 460 | 485 |
| 14 | 6 | B | 16 | 16 | 410 | 445 |
| 14 | 6 | D | 16 | 16 | 470 | 500 |
| 14 | 8 | B | 16 | 16 | 425 | 485 |
| 14 | 8 | D | 16 | 16 | 490 | 535 |
| 14 | 10 | B | 16 | 16 | 450 | 520 |
| 14 | 10 | D | 16 | 16 | 500 | 565 |

Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water

| Size | | Class | Dimensions | | Weight | |
|---|---|---|---|---|---|---|
| Run | Branch | | A | B | Tee | Cross |
| 14 | 12 | B | 16 | 16 | 475 | 585 |
| 14 | 12 | D | 16 | 16 | 525 | 625 |
| 14 | 14 | B | 16 | 16 | 485 | 600 |
| 14 | 14 | D | 16 | 16 | 555 | 675 |
| 16 | 4 | B | 17 | 17 | 500 | 525 |
| 16 | 4 | D | 17 | 17 | 595 | 615 |
| 16 | 6 | B | 17 | 17 | 510 | 545 |
| 16 | 6 | D | 17 | 17 | 600 | 625 |
| 16 | 8 | B | 17 | 17 | 530 | 580 |
| 16 | 8 | D | 17 | 17 | 610 | 665 |
| 16 | 10 | B | 17 | 17 | 550 | 620 |
| 16 | 10 | D | 17 | 17 | 630 | 695 |
| 16 | 12 | B | 17 | 17 | 580 | 680 |
| 16 | 12 | D | 17 | 17 | 655 | 745 |
| 16 | 14 | B | 17 | 17 | 580 | 695 |
| 16 | 14 | D | 17 | 17 | 680 | 790 |
| 16 | 16 | B | 17 | 17 | 610 | 745 |
| 16 | 16 | D | 17 | 17 | 715 | 855 |
| 18 | 4 | B | 18 | 18 | 600 | 625 |
| 18 | 4 | D | 18 | 18 | 715 | 740 |
| 18 | 6 | B | 18 | 18 | 610 | 645 |
| 18 | 6 | D | 18 | 18 | 715 | 750 |
| 18 | 8 | B | 18 | 18 | 625 | 675 |
| 18 | 8 | D | 18 | 18 | 735 | 785 |
| 18 | 10 | B | 18 | 18 | 645 | 715 |
| 18 | 10 | D | 18 | 18 | 755 | 815 |
| 18 | 12 | B | 18 | 18 | 670 | 770 |
| 18 | 12 | D | 18 | 18 | 785 | 870 |
| 18 | 14 | B | 18 | 18 | 680 | 785 |
| 18 | 14 | D | 18 | 18 | 795 | 900 |
| 18 | 16 | B | 18 | 18 | 700 | 825 |
| 18 | 16 | D | 18 | 18 | 825 | 955 |
| 18 | 18 | B | 18 | 18 | 720 | 870 |
| 18 | 18 | D | 18 | 18 | 850 | 1005 |
| 20 | 6 | B | 19 | 19 | 755 | 790 |
| 20 | 6 | D | 19 | 19 | 895 | 930 |
| 20 | 8 | B | 19 | 19 | 780 | 825 |
| 20 | 8 | D | 19 | 19 | 915 | 960 |
| 20 | 10 | B | 19 | 19 | 790 | 855 |
| 20 | 10 | D | 19 | 19 | 925 | 990 |
| 20 | 12 | B | 19 | 19 | 820 | 910 |
| 20 | 12 | D | 19 | 19 | 955 | 1040 |
| 20 | 14 | B | 19 | 19 | 820 | 920 |

Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water

| Size | | Class | Dimensions | | Weight | |
|---|---|---|---|---|---|---|
| Run | Branch | | A | B | Tee | Cross |
| 20 | 14 | D | 19 | 19 | 970 | 1075 |
| 20 | 16 | B | 19 | 19 | 845 | 960 |
| 20 | 16 | D | 19 | 19 | 1000 | 1130 |
| 20 | 18 | B | 19 | 19 | 860 | 995 |
| 20 | 18 | D | 19 | 19 | 1015 | 1165 |
| 20 | 20 | B | 19 | 19 | 890 | 1070 |
| 20 | 20 | D | 19 | 19 | 1055 | 1245 |
| 24 | 6 | B | 21 | 21 | 1080 | 1115 |
| 24 | 6 | D | 21 | 21 | 1305 | 1335 |
| 24 | 8 | B | 21 | 21 | 1095 | 1140 |
| 24 | 8 | D | 21 | 21 | 1315 | 1360 |
| 24 | 10 | B | 21 | 21 | 1115 | 1185 |
| 24 | 10 | D | 21 | 21 | 1330 | 1385 |
| 24 | 12 | B | 21 | 21 | 1140 | 1225 |
| 24 | 12 | D | 21 | 21 | 1355 | 1430 |
| 24 | 14 | B | 21 | 21 | 1140 | 1230 |
| 24 | 14 | D | 21 | 21 | 1365 | 1465 |
| 24 | 16 | B | 21 | 21 | 1165 | 1280 |
| 24 | 16 | D | 21 | 21 | 1390 | 1510 |
| 24 | 18 | B | 21 | 21 | 1170 | 1295 |
| 24 | 18 | D | 21 | 21 | 1400 | 1535 |
| 24 | 20 | B | 21 | 21 | 1200 | 1365 |
| 24 | 20 | D | 21 | 21 | 1435 | 1600 |
| 24 | 24 | B | 21 | 21 | 1270 | 1500 |
| 24 | 24 | D | 21 | 21 | 1520 | 1755 |
| 30 | 12 | A | 15 | 24 | 1225 | 1320 |
| 30 | 12 | B | 15 | 24 | 1330 | 1415 |
| 30 | 12 | C | 15 | 24 | 1445 | 1525 |
| 30 | 12 | D | 15 | 24 | 1565 | 1635 |
| 30 | 14 | A | 18 | 26 | 1385 | 1500 |
| 30 | 14 | B | 18 | 26 | 1515 | 1625 |
| 30 | 14 | C | 18 | 26 | 1680 | 1805 |
| 30 | 14 | D | 18 | 26 | 1825 | 1930 |
| 30 | 16 | A | 19 | 26 | 1460 | 1595 |
| 30 | 16 | B | 19 | 26 | 1595 | 1720 |
| 30 | 16 | C | 19 | 26 | 1775 | 1915 |
| 30 | 16 | D | 19 | 26 | 1925 | 2065 |
| 30 | 18 | A | 20 | 26 | 1520 | 1675 |
| 30 | 18 | B | 20 | 26 | 1665 | 1805 |
| 30 | 18 | C | 20 | 26 | 1860 | 2020 |
| 30 | 18 | D | 20 | 26 | 2015 | 2165 |
| 30 | 20 | A | 21 | 26 | 1610 | 1795 |
| 30 | 20 | B | 21 | 26 | 1750 | 1930 |

Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water

| Size | | Class | Dimensions | | Weight | |
|---|---|---|---|---|---|---|
| Run | Branch | | A | B | Tee | Cross |
| 30 | 20 | C | 21 | 26 | 1955 | 2160 |
| 30 | 20 | D | 21 | 26 | 2125 | 2295 |
| 30 | 24 | A | 23 | 26 | 1775 | 2040 |
| 30 | 24 | B | 23 | 26 | 1930 | 2170 |
| 30 | 24 | C | 23 | 26 | 2170 | 2455 |
| 30 | 24 | D | 23 | 26 | 2350 | 2590 |
| 30 | 30 | A | 26 | 26 | 2015 | 2370 |
| 30 | 30 | B | 26 | 26 | 2235 | 2610 |
| 30 | 30 | C | 26 | 26 | 2480 | 2870 |
| 30 | 30 | D | 26 | 26 | 2725 | 3130 |
| 36 | 12 | A | 16 | 27 | 1745 | 1830 |
| 36 | 12 | B | 16 | 27 | 1880 | 1960 |
| 36 | 12 | C | 16 | 27 | 2065 | 2140 |
| 36 | 12 | D | 16 | 27 | 2265 | 2325 |
| 36 | 14 | A | 18 | 29 | 1885 | 1995 |
| 36 | 14 | B | 18 | 29 | 2045 | 2150 |
| 36 | 14 | C | 18 | 29 | 2275 | 2385 |
| 36 | 14 | D | 18 | 29 | 2505 | 2595 |
| 36 | 16 | A | 19 | 29 | 1975 | 2100 |
| 36 | 16 | B | 19 | 29 | 2140 | 2260 |
| 36 | 16 | C | 19 | 29 | 2390 | 2525 |
| 36 | 16 | D | 19 | 29 | 2625 | 2745 |
| 36 | 18 | A | 20 | 29 | 2050 | 2195 |
| 36 | 18 | B | 20 | 29 | 2230 | 2355 |
| 36 | 18 | C | 20 | 29 | 2495 | 2540 |
| 36 | 18 | D | 20 | 29 | 2750 | 2880 |
| 36 | 20 | A | 21 | 29 | 2145 | 2320 |
| 36 | 20 | B | 21 | 29 | 2335 | 2485 |
| 36 | 20 | C | 21 | 29 | 2615 | 2795 |
| 36 | 20 | D | 21 | 29 | 2875 | 3030 |
| 36 | 24 | A | 23 | 29 | 2340 | 2580 |
| 36 | 24 | B | 23 | 29 | 2540 | 2755 |
| 36 | 24 | C | 23 | 29 | 2870 | 3110 |
| 36 | 24 | D | 23 | 29 | 3145 | 3350 |
| 36 | 30 | A | 26 | 29 | 2605 | 2925 |
| 36 | 30 | B | 26 | 29 | 2880 | 3200 |
| 36 | 30 | C | 26 | 29 | 3215 | 3540 |
| 36 | 30 | D | 26 | 29 | 3570 | 3890 |
| 36 | 36 | A | 29 | 29 | 2975 | 3455 |
| 36 | 36 | B | 29 | 29 | 3270 | 3765 |
| 36 | 36 | C | 29 | 29 | 3670 | 4185 |
| 36 | 36 | D | 29 | 29 | 4090 | 4615 |
| 42 | 12 | A | 16 | 30 | 2300 | 2385 |

Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water

| Size | | Class | Dimensions | | Weight | |
|---|---|---|---|---|---|---|
| Run | Branch | | A | B | Tee | Cross |
| 42 | 12 | B | 16 | 30 | 2485 | 2560 |
| 42 | 12 | C | 16 | 30 | 2745 | 2810 |
| 42 | 12 | D | 16 | 30 | 2990 | 3050 |
| 42 | 14 | A | 18 | 32 | 2490 | 2590 |
| 42 | 14 | B | 18 | 32 | 2695 | 2785 |
| 42 | 14 | C | 18 | 32 | 3010 | 3105 |
| 42 | 14 | D | 18 | 32 | 3295 | 3375 |
| 42 | 16 | A | 19 | 32 | 2585 | 2710 |
| 42 | 16 | B | 19 | 32 | 2810 | 2920 |
| 42 | 16 | C | 19 | 32 | 3150 | 3265 |
| 42 | 16 | D | 19 | 32 | 3450 | 3550 |
| 42 | 18 | A | 20 | 32 | 2685 | 2815 |
| 42 | 18 | B | 20 | 32 | 2915 | 3030 |
| 42 | 18 | C | 20 | 32 | 3275 | 3410 |
| 42 | 18 | D | 20 | 32 | 3595 | 3700 |
| 42 | 20 | A | 21 | 32 | 2790 | 2960 |
| 42 | 20 | B | 21 | 32 | 3035 | 3185 |
| 42 | 20 | C | 21 | 32 | 3425 | 3580 |
| 42 | 20 | D | 21 | 32 | 3755 | 3880 |
| 42 | 24 | A | 23 | 32 | 3015 | 3235 |
| 42 | 24 | B | 23 | 32 | 3285 | 3475 |
| 42 | 24 | C | 23 | 32 | 3725 | 3930 |
| 42 | 24 | D | 23 | 32 | 4075 | 4240 |
| 42 | 30 | A | 26 | 32 | 3335 | 3610 |
| 42 | 30 | B | 26 | 32 | 3665 | 3940 |
| 42 | 30 | C | 26 | 32 | 4130 | 4400 |
| 42 | 30 | D | 26 | 32 | 4570 | 4825 |
| 42 | 36 | A | 29 | 32 | 3725 | 4150 |
| 42 | 36 | B | 29 | 32 | 4105 | 4525 |
| 42 | 36 | C | 29 | 32 | 4630 | 5040 |
| 42 | 36 | D | 29 | 32 | 5140 | 5550 |
| 42 | 42 | A | 32 | 32 | 4185 | 4815 |
| 42 | 42 | B | 32 | 32 | 4610 | 5255 |
| 42 | 42 | C | 32 | 32 | 5220 | 5860 |
| 42 | 42 | D | 32 | 32 | 5785 | 6425 |
| 48 | 16 | A | 19 | 35 | 3245 | 3360 |
| 48 | 16 | B | 19 | 35 | 3470 | 3575 |
| 48 | 16 | C | 19 | 35 | 3900 | 4005 |
| 48 | 16 | D | 19 | 35 | 4250 | 4335 |
| 48 | 18 | A | 20 | 35 | 3365 | 3485 |
| 48 | 18 | B | 20 | 35 | 3605 | 3700 |
| 48 | 18 | C | 20 | 35 | 4060 | 4165 |
| 48 | 18 | D | 20 | 35 | 4425 | 4515 |

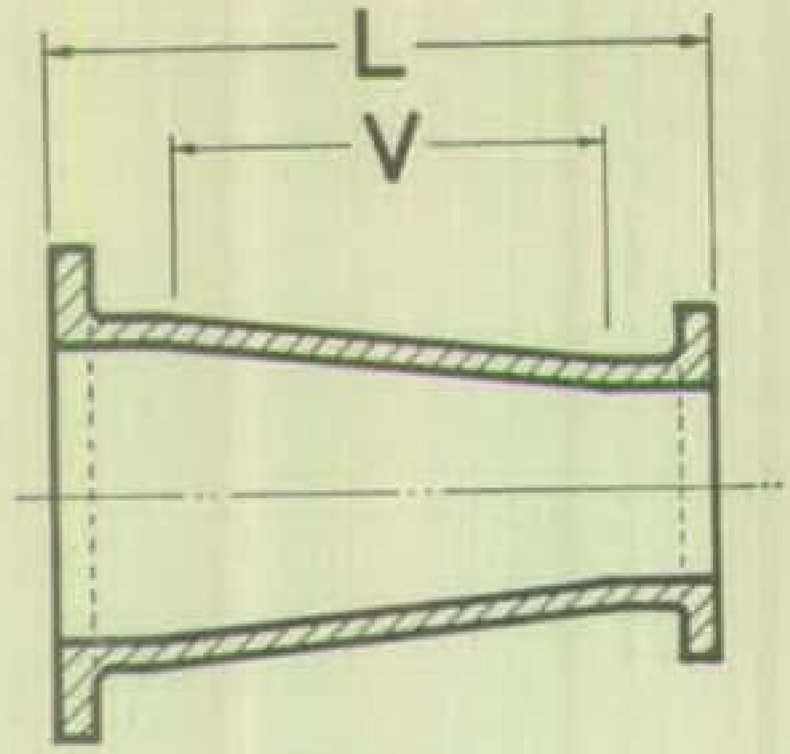
Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water

| Size | | Class | Dimensions | | Weight | |
|---|---|---|---|---|---|---|
| Run | Branch | | A | B | Tee | Cross |
| 48 | 20 | A | 21 | 35 | 3500 | 3640 |
| 48 | 20 | B | 21 | 35 | 3750 | 3880 |
| 48 | 20 | C | 21 | 35 | 4230 | 4365 |
| 48 | 20 | D | 21 | 35 | 4620 | 4720 |
| 48 | 24 | A | 23 | 35 | 3765 | 3950 |
| 48 | 24 | B | 23 | 35 | 4035 | 4200 |
| 48 | 24 | C | 23 | 35 | 4580 | 4755 |
| 48 | 24 | D | 23 | 35 | 4990 | 5130 |
| 48 | 30 | A | 26 | 35 | 4140 | 4375 |
| 48 | 30 | B | 26 | 35 | 4485 | 4725 |
| 48 | 30 | C | 26 | 35 | 5060 | 5280 |
| 48 | 30 | D | 26 | 35 | 5575 | 5775 |
| 48 | 36 | A | 29 | 35 | 4585 | 4940 |
| 48 | 36 | B | 29 | 35 | 4965 | 5320 |
| 48 | 36 | C | 29 | 35 | 5630 | 5970 |
| 48 | 36 | D | 29 | 35 | 6220 | 6550 |
| 48 | 42 | A | 32 | 35 | 5085 | 5600 |
| 48 | 42 | B | 32 | 35 | 5510 | 6050 |
| 48 | 42 | C | 32 | 35 | 6260 | 6765 |
| 48 | 42 | D | 32 | 35 | 6915 | 7415 |
| 48 | 48 | A | 35 | 35 | 5620 | 6345 |
| 48 | 48 | B | 35 | 35 | 6085 | 6810 |
| 48 | 48 | C | 35 | 35 | 6915 | 7640 |
| 48 | 48 | D | 35 | 35 | 7640 | 8350 |

Laying dimensions are A.W.W.A.—N.E.W.W.A.
Flanges are American Standard, Class 125.
Dimensions in inches.

## Dimensions and Weights of Flanged Fittings for Water




**Reducers**

| Size | Class | L | V | Weight |
|---|---|---|---|---|
| 6x 4 | D | 26 | 18 | 90 |
| 8x 4 | D | 26 | 18 | 110 |
| 8x 6 | D | 26 | 18 | 130 |
| 10x 4 | D | 26 | 18 | 135 |
| 10x 6 | D | 26 | 18 | 155 |
| 10x 8 | D | 26 | 18 | 185 |
| 12x 4 | D | 26 | 18 | 175 |
| 12x 6 | D | 26 | 18 | 195 |
| 12x 8 | D | 26 | 18 | 220 |
| 12x10 | D | 26 | 18 | 250 |
| 14x 6 | B | 28 | 20 | 215 |
| 14x 6 | D | 28 | 20 | 240 |
| 14x 8 | B | 28 | 20 | 245 |
| 14x 8 | D | 28 | 20 | 265 |
| 14x10 | B | 28 | 20 | 275 |
| 14x10 | D | 28 | 20 | 300 |
| 14x12 | B | 28 | 20 | 320 |
| 14x12 | D | 28 | 20 | 340 |
| 16x 6 | B | 28 | 20 | 250 |
| 16x 6 | D | 28 | 20 | 280 |
| 16x 8 | B | 28 | 20 | 280 |
| 16x 8 | D | 28 | 20 | 305 |
| 16x10 | B | 28 | 20 | 315 |
| 16x10 | D | 28 | 20 | 340 |
| 16x12 | B | 28 | 20 | 355 |
| 16x12 | D | 28 | 20 | 385 |
| 16x14 | B | 28 | 20 | 365 |
| 16x14 | D | 28 | 20 | 425 |

Dimensions in inches.
Flanges are ASA 125. For dimensions and drilling of flanges, see page 345.

## Dimensions and Weights of Flanged Fittings for Water

### Reducers

| Size | Class | L | V | Weight |
|---|---|---|---|---|
| 18x 8 | B | 28 | 20 | 310 |
| 18x 8 | D | 28 | 20 | 345 |
| 18x10 | B | 28 | 20 | 345 |
| 18x10 | D | 28 | 20 | 375 |
| 18x12 | B | 28 | 20 | 385 |
| 18x12 | D | 28 | 20 | 425 |
| 18x14 | B | 28 | 20 | 395 |
| 18x14 | D | 28 | 20 | 460 |
| 18x16 | B | 28 | 20 | 430 |
| 18x16 | D | 28 | 20 | 505 |
| 20x10 | B | 34 | 26 | 445 |
| 20x10 | D | 34 | 26 | 500 |
| 20x12 | B | 34 | 26 | 495 |
| 20x12 | D | 34 | 26 | 550 |
| 20x14 | B | 34 | 26 | 505 |
| 20x14 | D | 34 | 26 | 600 |
| 20x16 | B | 34 | 26 | 545 |
| 20x16 | D | 34 | 26 | 655 |
| 20x18 | B | 34 | 26 | 585 |
| 20x18 | D | 34 | 26 | 700 |
| 24x14 | B | 34 | 26 | 610 |
| 24x14 | D | 34 | 26 | 725 |
| 24x16 | B | 34 | 26 | 655 |
| 24x16 | D | 34 | 26 | 780 |
| 24x18 | B | 34 | 26 | 690 |
| 24x18 | D | 34 | 26 | 835 |
| 24x20 | B | 34 | 26 | 750 |
| 24x20 | D | 34 | 26 | 900 |
| 30x18 | A | 33.5 | 26 | 815 |
| 30x18 | B | 33.5 | 26 | 870 |
| 30x18 | C | 33.5 | 26 | 985 |
| 30x18 | D | 33.5 | 26 | 1045 |
| 30x20 | A | 73.5 | 66 | 1585 |
| 30x20 | B | 73.5 | 66 | 1705 |
| 30x20 | C | 73:5 | 66 | 2010 |
| 30x20 | D | 73.5 | 66 | 2150 |
| 30x24 | A | 73.5 | 66 | 1795 |
| 30x24 | B | 73.5 | 66 | 1920 |
| 30x24 | C | 73.5 | 66 | 2280 |
| 30x24 | D | 73.5 | 66 | 2430 |
| 36x20 | A | 73.5 | 66 | 1940 |
| 36x20 | B | 73.5 | 66 | 2085 |

Dimensions in inches.
Flanges are ASA 125. For dimensions and drilling of flanges, see page 345.

# Dimensions and Weights of Flanged Fittings for Water

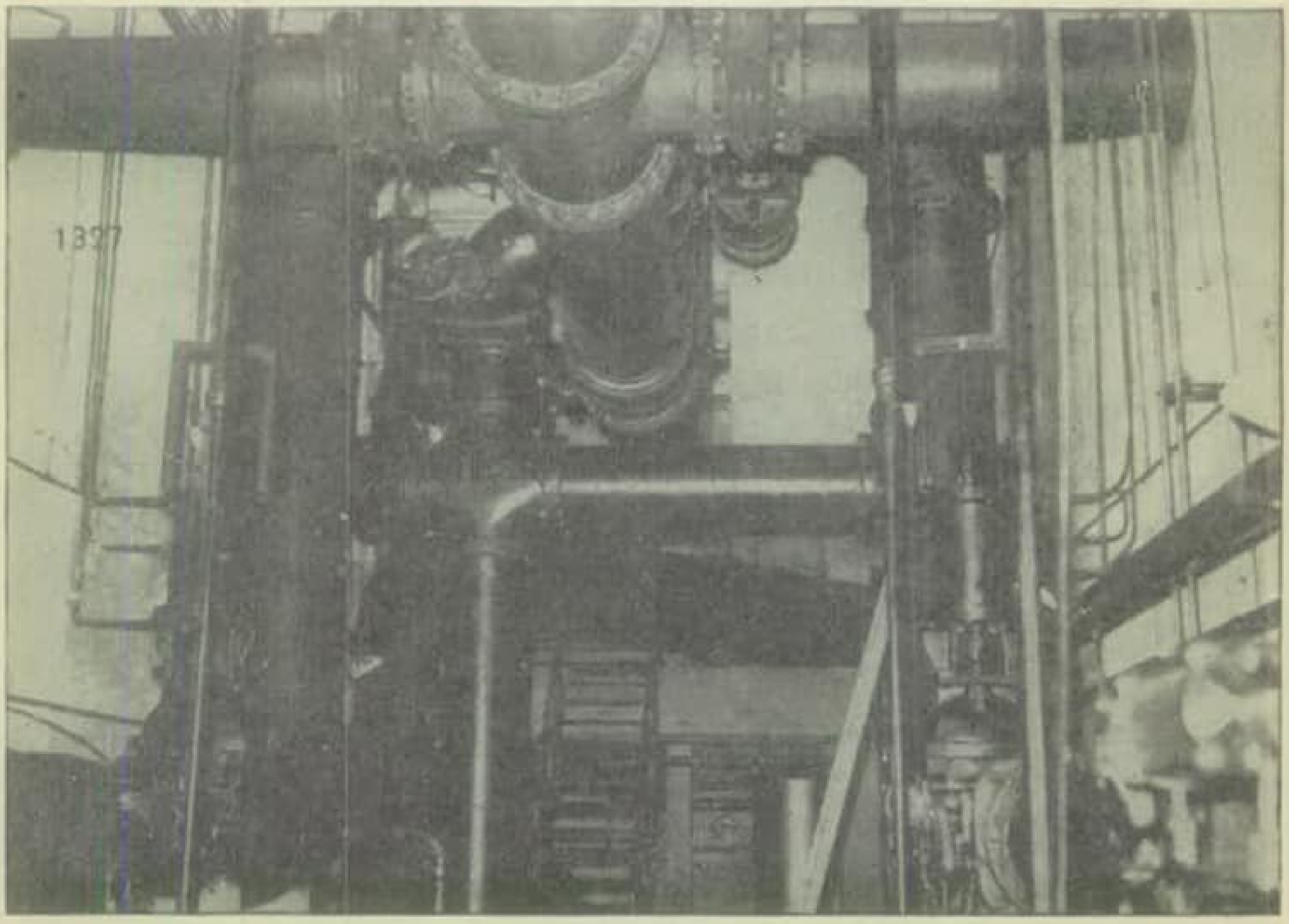
## Reducers

| Size | Class | L | V | Weight |
|---|---|---|---|---|
| 36x20 | C | 73.5 | 66 | 2460 |
| 36x20 | D | 73.5 | 66 | 2670 |
| 36x24 | A | 73.5 | 66 | 2160 |
| 36x24 | B | 73.5 | 66 | 2310 |
| 36x24 | C | 73.5 | 66 | 2745 |
| 36x24 | D | 73.5 | 66 | 2960 |
| 36x30 | A | 73 | 66 | 2375 |
| 36x30 | B | 73 | 66 | 2675 |
| 36x30 | C | 73 | 66 | 3055 |
| 36x30 | D | 73 | 66 | 3445 |
| 42x20 | A | 73 | 66 | 2330 |
| 42x20 | B | 73 | 66 | 2515 |
| 42x20 | C | 73 | 66 | 2970 |
| 42x20 | D | 73 | 66 | 3215 |
| 42x24 | A | 73 | 66 | 2565 |
| 42x24 | B | 73 | 66 | 2750 |
| 42x24 | C | 73 | 66 | 3270 |
| 42x24 | D | 73 | 66 | 3525 |
| 42x30 | A | 72.5 | 66 | 2780 |
| 42x30 | B | 72.5 | 66 | 3130 |
| 42x30 | C | 72.5 | 66 | 3590 |
| 42x30 | D | 72.5 | 66 | 4035 |
| 42x36 | A | 72.5 | 66 | 3170 |
| 42x36 | B | 72.5 | 66 | 3560 |
| 42x36 | C | 72.5 | 66 | 4100 |
| 42x36 | D | 72.5 | 66 | 4635 |
| 48x30 | A | 72.5 | 66 | 3250 |
| 48x30 | B | 72.5 | 66 | 3605 |
| 48x30 | C | 72.5 | 66 | 4140 |
| 48x30 | D | 72.5 | 66 | 4635 |
| 48x36 | A | 72.5 | 66 | 3665 |
| 48x36 | B | 72.5 | 66 | 4050 |
| 48x36 | C | 72.5 | 66 | 4670 |
| 48x36 | D | 72.5 | 66 | 5260 |
| 48x42 | A | 72 | 66 | 4110 |
| 48x42 | B | 72 | 66 | 4545 |
| 48x42 | C | 72 | 66 | 5265 |
| 48x42 | D | 72 | 66 | 5910 |

Dimensions in inches.
Flanges are ASA 125. For dimensions and drilling of flanges, see page 345.

## SECTION 14

# A.S.A. Flanged Fittings



American Standard

# Cast Iron Pipe Flanges and Flanged Fittings, Class 125

## Introductory Notes

**1. SCOPE**

This standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 125, covers:

(a) pressure ratings,
(b) sizes and method of designating openings of reducing fittings,
(c) marking,
(d) minimum requirements for materials,
(e) dimensions and tolerances,
(f) bolt, nut, and gasket dimensions,
(g) tests.

**2. PRESSURE RATING**

These flanges and fittings are rated as follows:

For maximum saturated steam service pressures of

125 psi (gage) sizes 1 to 12 in., incl.
100 psi (gage) sizes 14 to 24 in., incl.
50 psi (gage) sizes 30 to 48 in., incl.

For maximum liquid and gas service pressures at 150° F. of

175 psi (gage) sizes 1 to 12 in., incl.
150 psi (gage) sizes 14 to 48 in., incl.
for flanges only.[1]

**3. SIZE***

The size of the flanges and fittings scheduled in the following tables is identified by the corresponding "nominal pipe size." For pipe 14 in. and larger the corresponding OD of the pipe is given.

[1] It will be noted that water service ratings as shown for sizes 14 in. and larger in this standard are applicable to flanges only and not to fittings. Water service ratings on fittings 14 in. and larger are withheld in this issue of the standard pending receipt of final report on research work which is now being conducted by ASA Sectional Committee A21.

*A Simplified Practice Recommendation on Pipe Fittings is published by the U. S. Department of Commerce, National Bureau of Standards, Division of Simplified Practice.

Reducing fittings shall be designated by the size of the openings in their proper sequence as indicated in the sketches, Fig. 1.

#### 4. MARKING

*Fittings.*—The manufacturer's name or trade mark and numerals as shown below to indicate the maximum saturated steam service pressure shall be cast on the exterior surface of all fittings.

| *For Sizes* | *Numerals* |
|---|---|
| 1 to 12 in., incl. | 125 |
| 14 to 24 in., incl. | 100 |
| 30 to 48 in., incl. | 50 |

*Flanges.*—The manufacturer's name or trade mark shall be cast on all loose flanges.

The above marking requirements comply with principles established in MSS Standard Practice SP-25–1936.

#### 5. MATERIAL

*Castings.*—The dimensions prescribed in this standard are based upon gray iron castings of high quality produced under regular control of chemical and physical properties by a recognized process. The manufacturer shall be prepared to certify that his product has been so produced and that the chemical and physical properties thereof, as proved by test specimens, are at least equal to the requirements shown herein which are taken from the ASTM Specification A 126–1942.

| *Class A* (regular gray iron) | |
|---|---|
| Sulphur | 0.12 per cent maximum |
| Phosphorous | 0.75 per cent maximum |
| Tensile strength | 21,000 psi minimum |

| *Class B* (higher strength gray iron) | |
|---|---|
| Sulphur | 0.12 per cent maximum |
| Phosphorous | 0.75 per cent maximum |
| Tensile strength | 31,000 psi minimum |

It is intended that material required by this standard shall be in accordance with the requirements specified herein or the latest edition of ASTM A 126.

Flanges and fittings shall be made of material at least equal to the requirements of Class A iron for sizes 12 in. and smaller and Class B iron for sizes 14 in. and larger.

*Bolting.*—The bolting used with these flanges and fittings shall be made of carbon steel which conforms to the requirements of MSS Standard Practice SP-39–1945 for bolts.*

## Fitting Dimensions and Tolerances

### 6. WALL THICKNESS

It is recognized that some variations are absolutely unavoidable in the making of patterns and castings. Equipment shall be designed to produce wall thicknesses given in the tables. Wall thickness at no point shall be less than 87½ per cent of the thickness given in the tables.

### 7. CENTER TO FACE DIMENSIONS

*a. Side Outlet Fittings.*—Side outlet elbows, side outlet tees, and side outlet crosses, shall have all openings on intersecting center lines. Long radius elbows with side outlet shall have the side outlet on the radial center line of the elbow.

*b. Elbows.*—1. The center to face dimensions for straight size 90 deg. elbows, 90 deg. long radius elbows, 45 deg. elbows, side outlet elbows, and double branch elbows are shown in Table 4.

2. Reducing 90 deg. elbows, reducing 90 deg. long radius elbows, reducing side outlet elbows, and reducing double branch elbows shall have same center to face dimensions as straight size fittings shown in Table 4 corresponding to the size of the larger opening.

3. For 90 deg. long radius elbows with side outlet the center to face dimensions of side outlet shall be the same as dimension "A," Table 4, for a straight size 90 deg. elbow corresponding to the size of the larger opening.

4. Special degree elbows ranging from 1 to 45 deg., inclusive, shall have the same center to face dimensions given for 45 deg. elbows and those over 45 deg. and up to 90 deg., inclusive, shall have the same center to face dimensions given for 90 deg. elbows. The angle designation of an elbow is its deflection from straight line flow and is the angle between the flange faces.

---

*The carbon steel bolts prescribed for the flanges in this standard are based upon using a flat ring gasket which extends to the bolts.

In all cases where these cast iron flanges are bolted to a steel flange, the latter shall be plain faced, i.e., without projection or raised face.

Where cast iron to cast iron flanges or cast iron to steel flanges are used with full-face gaskets, higher strength bolts may properly be used.

Where cast iron flanges are bolted to a steel flange and flat ring gasket is used, carbon steel bolts prescribed in this standard shall be employed.

*c. Tees, Crosses, and Laterals.*—1. The center to face dimensions for straight size tees and crosses, with or without side outlet, and laterals are shown in Table 4.

2. Reducing tees and reducing crosses, with or without side outlet, and reducing laterals, sizes 16 in. and smaller, shall have the same center to face dimensions as straight size fittings shown in Table 4 corresponding to the size of the largest opening.

For sizes 18 in. and larger, if: (1) The outlet of a reducing tee, (2) the branch of a reducing lateral, or, if (3) the largest outlet of a reducing side outlet tee, reducing cross, and reducing side outlet cross is the same size or smaller than given in Tables 5 and 6 (short body pattern), the center to face dimensions shown in these tables shall be used. If a branch or any outlet is larger than shown in Tables 5 and 6, the center to face dimensions shall be the same as for the straight size fitting shown in Table 4 corresponding to the size of the largest opening.

Tees, crosses, and laterals, reducing on the run only, shall have the same center to face dimensions as straight size fittings shown in Table 4 corresponding to the size of the largest opening.

3. Tees reducing on both runs are generally known as bull head tees and have the same center to face dimensions as straight size fittings corresponding to the size of the outlet.

*d. True Y's.*—Center to face dimensions for straight size true Y's are shown in Table 4. Reducing sizes are considered special and should be made to suit conditions.

*e. Reducers and Eccentric Reducers.*—The face to face dimensions for all reductions of reducers and eccentric reducers shall be the same as given in Table 4 for the larger opening.

**8. CENTER TO FACE TOLERANCES**

An inspection tolerance of plus or minus 1/32 in. shall be allowed on all center to contact surface dimensions for sizes up to and including 10 in. and plus or minus 1/16 in. on sizes larger than 10 in. An inspection tolerance of plus or minus 1/16 in. shall be allowed on all contact surface to contact surface dimensions for sizes up to and including 10 in. and plus or minus 1/8 in. on sizes larger than 10 in. The largest opening in the fitting governs the tolerance to be applied to all openings.

**9. THREAD OF SCREWED FLANGES**

The flanges shall have an American Standard Taper Pipe Thread in accordance with ASA B2.1–1945. The thread shall be concentric with the axis of the flange and variations in alignment shall not exceed 1/16 in. per ft.

Threads shall be chamfered approximately to the major diameter of the thread at the back of the flange at an angle of approximately 45 deg. with the axis of the thread for the purpose of easy entrance in making a joint and for the protection of the thread. The chamfer shall be concentric with the thread, and shall be included in measurements of the thread length.

The gaging notch of working gage should come flush with the bottom of chamfer and the maximum allowable thread variation is one turn large or one turn small from the gaging notch.

#### 10. FACINGS*

These cast iron flanges and flanged fittings shall be plain faced; i.e., without projection or raised face and finished in accordance with MSS SP-6–1947.

#### 11. FLANGE BOLT HOLES

Bolt holes shall be in multiples of four so that fittings may be made to face in any quarter. The bolt holes shall straddle the center line.

For bolts smaller than 1¾ in. in diameter, the bolt holes shall be ⅛ in. larger than the nominal diameter of the bolt; for bolts 1¾ in. in diameter and larger, bolt holes shall be ¼ in. larger than the nominal diameter of the bolt.

#### 12. SPOT FACING

*Flanges.*—The bolt holes of these cast iron flanges need not be spot faced for ordinary service except, as follows: In sizes 12 in. and smaller when rough flanges, after facing, are oversize more than ⅛ in. in thickness, they shall be spot faced to the specified thickness of flange (minimum) with a plus tolerance of 1/16 in. In sizes 14 to 24 in., inclusive, when rough flanges, after facing, are oversize more than 3/16 in. in thickness they shall be spot faced to the specified thickness of flange (minimum) with a plus tolerance of 1/16 in. In sizes 30 in. and larger when rough flanges, after facing, are oversize more than ¼ in. in thickness they shall be spot faced to the specified thickness of flange (minimum) with a plus tolerance of ⅛ in.

*Fittings.*—The bolt holes of the flanges on these cast iron fittings need not be spot faced on sizes smaller than 18 in. for ordinary service, except as required for oversize thickness of flanges as indicated above. The bolt

*See footnote on page 338.

holes of all flanges on fittings 18 to 24 in., inclusive, shall be spot faced to the specified thickness of the flange (minimum) with a plus tolerance of 1/16 in., and of all flanges on fittings sizes 30 to 48 in., inclusive, they shall be spot faced to the specified thickness of the flange (minimum) with a plus tolerance of 1/8 in.

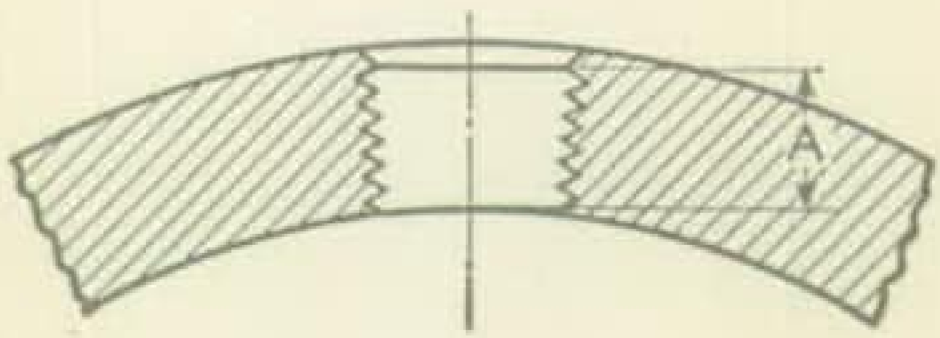
Where spot facing of flanges and fittings is necessary, the spot facing diameter shall be in accordance with MSS Standard Practice SP-9–1947.

### 13. CROSSES AND LATERALS

Crosses and laterals (Y-branches) both straight and reducing shall be reinforced where necessary to compensate for the inherent weakness in the casting design.

### 14. DRAIN TAPPINGS

Holes may be tapped in the wall of fitting if the metal thickness is sufficient to provide the effective length of thread specified in Table 1; where thread length is insufficient or size of tapping is such that reinforcement of opening is necessary, a boss should be added.




**Minimum Thread Length**

TABLE NO. 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Size of tapping | 3/8 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 |
| Length of thread, "A" | 0.41 | 0.53 | 0.55 | 0.68 | 0.71 | 0.72 | 0.76 |

All dimensions given in inches.

In no case shall the effective length of thread "A" be less than that shown in table above. These lengths are equal to the effective thread lengths of American Standard External Pipe Threads (ASA B2.1–1945).

The method of designating the locations of the tapped holes for drains is shown in Fig. 2. Each possible location is designated by a letter so that desired locations for the various types of fittings may be definitely specified without the use of further sketches or description. For further detail in applying tappings, see MSS Standard Practice SP-28–1945.

## Bolt, Nut, and Gasket Dimensions

**15. BOLTS AND NUTS**

Bolts shall have American Standard Regular Unfinished Square Heads or American Standard Heavy Unfinished Hexagonal Heads and the nuts shall be American Standard Heavy Unfinished Hexagonal dimensions all as specified in American Standard for Wrench Head Bolts and Nuts and Wrench Openings (ASA B18.2–1941). For bolts of 1¾ in. in diameter and larger, bolt-studs with a nut on each end are recommended.

Hexagonal nuts for pipe sizes 1 to 48 in. can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 48 to 96 in. can be conveniently pulled up with box wrenches.

All bolts, or bolt-studs if used, and all nuts shall be threaded in accordance with American Standard for Screw Threads (ASA B1.1–1935) Coarse-Thread Series, Class 2 Fit.

**16. GASKETS***

Ring gaskets shall be in accordance with dimensions given in Table 2.

**17. TESTS**

These fittings shall be designed to withstand, without showing leaks hydrostatic test pressures of twice the rated steam pressure. Hydrostatic tests of cast iron fittings covered by this standard are not required unless specified by the user.

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*See footnote on page 338.

## Class 125 Cast Iron Flanges and Fittings

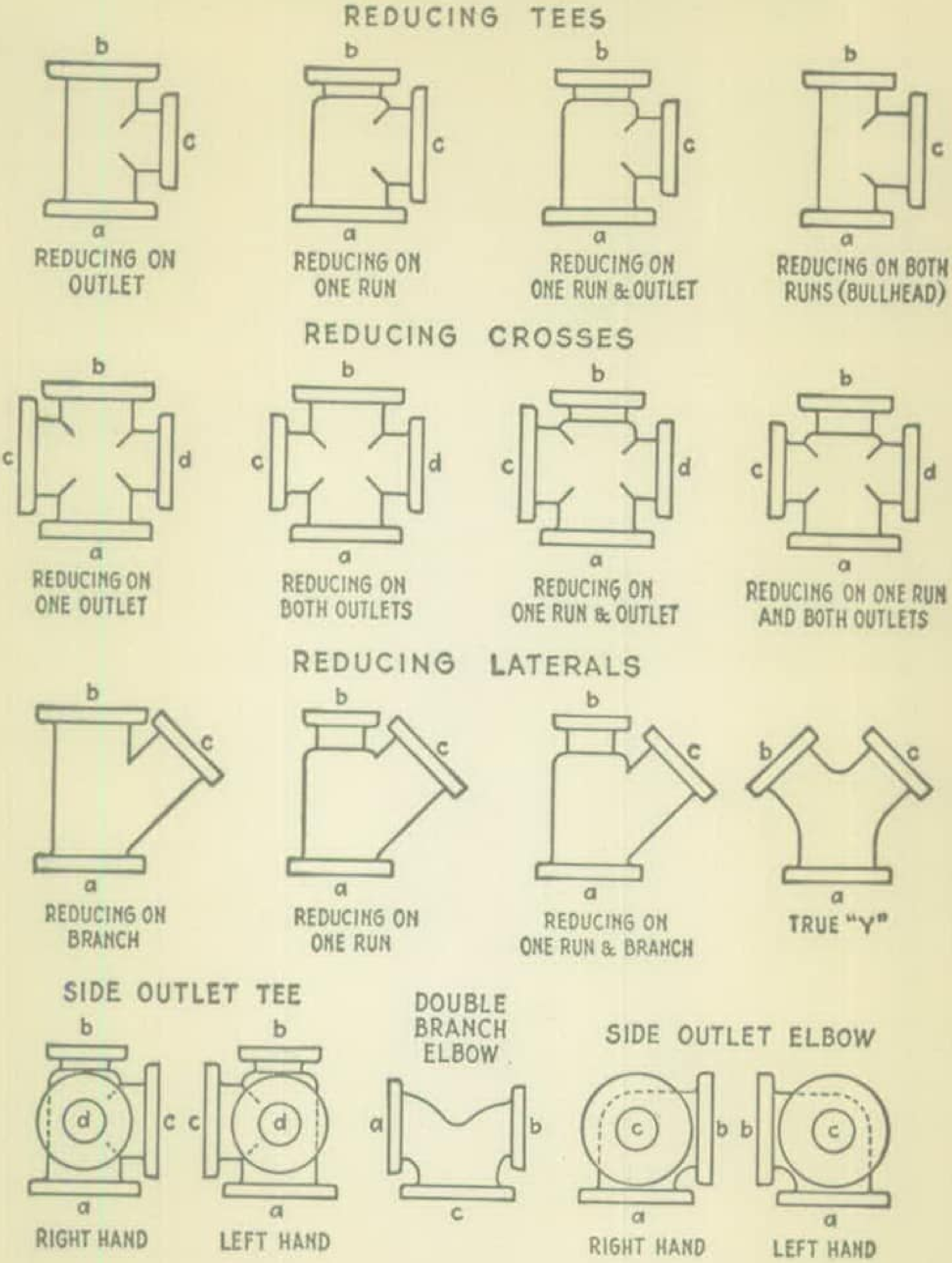



***Fig. 1 Method of Designating Outlets of Reducing Fittings in Specifications***

*Note:* The largest opening establishes the basic size of a reducing fitting. The largest opening is named first, except for bull head tees which are reducing on both runs and for double branch elbows where both branches are reducing, the outlet is the largest opening and named last in both cases.

In designating the openings of reducing fittings they should be read in the order indicated by the sequence of the letters a, b, c, and d. In designating the outlets of side outlet reducing fittings the side outlet is named last and in the case of the cross which is not shown the side outlet is designated by the letter e.

## Class 125 Cast Iron Flanges and Fittings

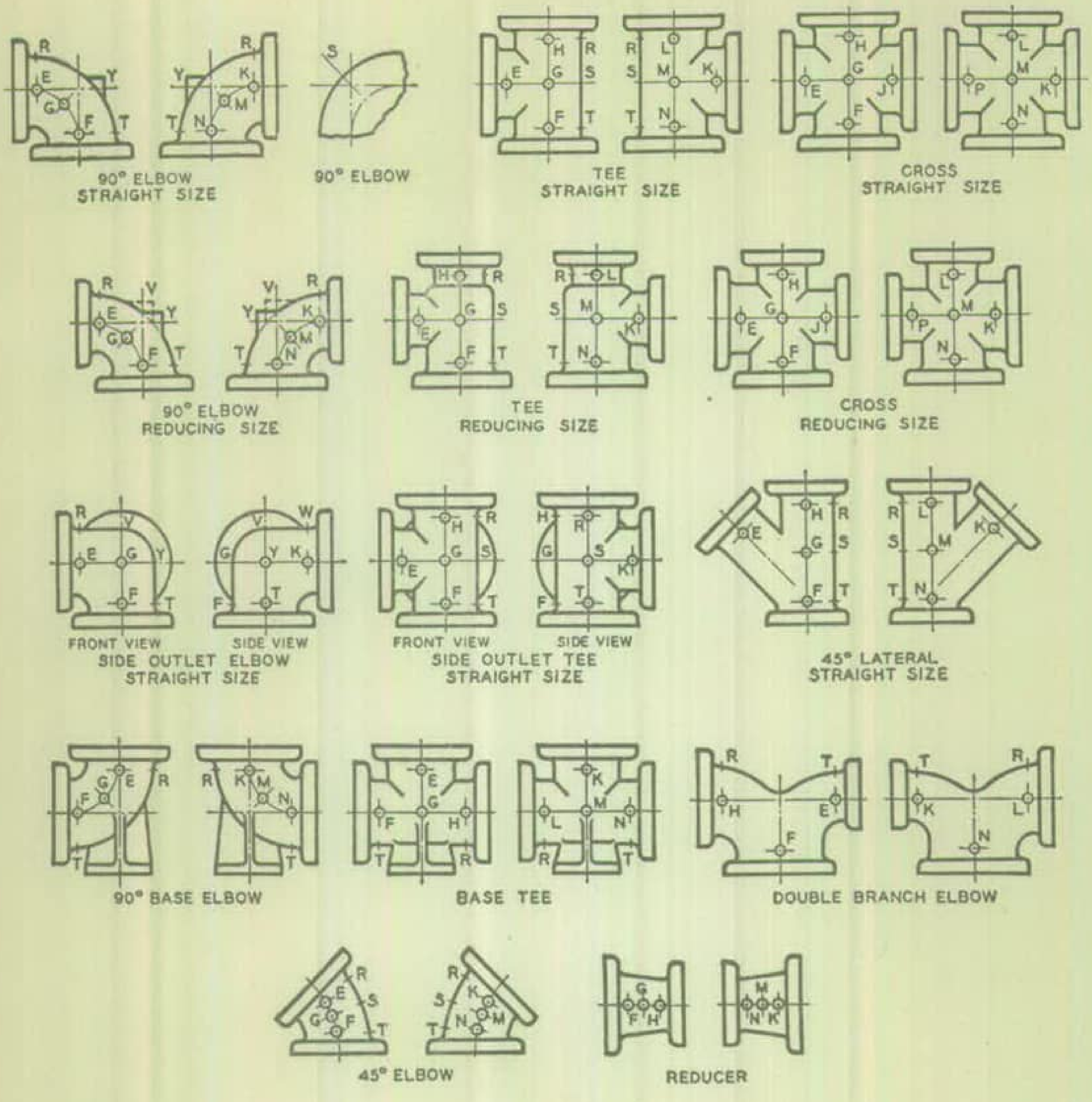



***Fig. 2 Method of Designating Location of Tapped Holes for Drains When Specified***

*Note:* The above sketches show two views of the same fitting and represent fittings with symmetrical shapes, with the exception of the side outlet elbow and the side outlet tee (straight sizes).

# Class 125 Cast Iron Flanges and Fittings

## Dimensions of Cast Iron Flanges, Bolts, and Ring Gaskets

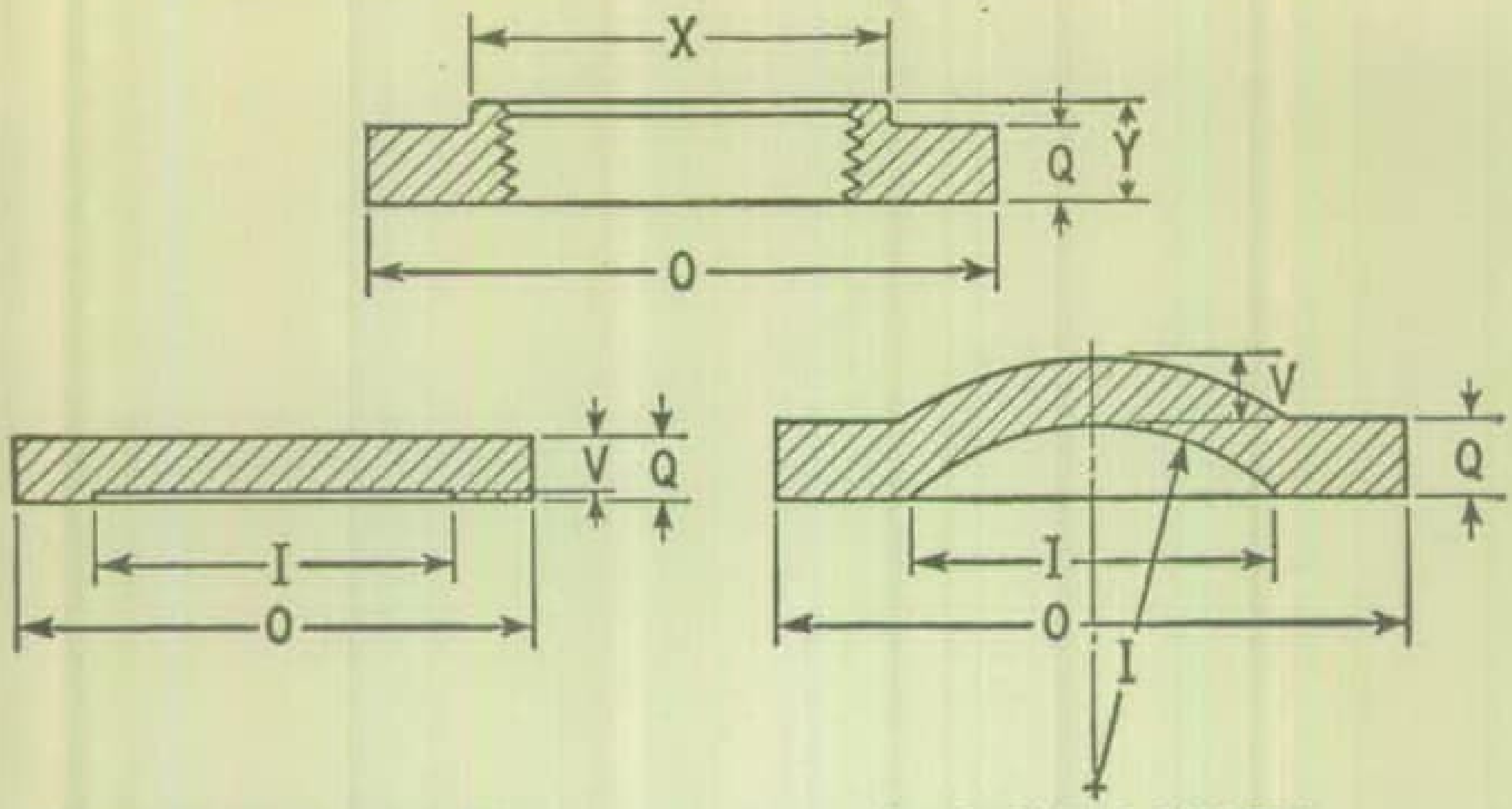
TABLE NO. 2

| Nominal Pipe Size | Diam. of Flange | Thickness[1] of Flange (Min.) | Diam. of Bolt Circle | Number[2] of Bolts | Diam. of Bolts | Diam.[2] of Bolt Holes | Length[3,4] of Bolts | Length[3,4] of Bolt-Stud With Two Nuts | Size of Flat Ring Gasket |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4¼ | 7/16 | 3⅛ | 4 | ½ | ⅝ | 1¾ | ........ | 1x2⅝ |
| 1¼ | 4⅝ | ½ | 3½ | 4 | ½ | ⅝ | 2 | ........ | 1¼x3 |
| 1½ | 5 | 9/16 | 3⅞ | 4 | ½ | ⅝ | 2 | ........ | 1½x3⅜ |
| 2 | 6 | ⅝ | 4¾ | 4 | ⅝ | ¾ | 2¼ | ........ | 2x4⅛ |
| 2½ | 7 | 11/16 | 5½ | 4 | ⅝ | ¾ | 2½ | ........ | 2½x4⅞ |
| 3 | 7½ | ¾ | 6 | 4 | ⅝ | ¾ | 2½ | ........ | 3x5⅜ |
| 3½ | 8½ | 13/16 | 7 | 8 | ⅝ | ¾ | 2¾ | ........ | 3½x6⅜ |
| 4 | 9 | 15/16 | 7½ | 8 | ⅝ | ¾ | 3 | ........ | 4x6⅞ |
| 5 | 10 | 15/16 | 8½ | 8 | ¾ | ⅞ | 3 | ........ | 5x7¾ |
| 6 | 11 | 1 | 9½ | 8 | ¾ | ⅞ | 3¼ | ........ | 6x8¾ |
| 8 | 13½ | 1⅛ | 11¾ | 8 | ¾ | ⅞ | 3½ | ........ | 8x11 |
| 10 | 16 | 1 3/16 | 14¼ | 12 | ⅞ | 1 | 3¾ | ........ | 10x13⅜ |
| 12 | 19 | 1¼ | 17 | 12 | ⅞ | 1 | 3¾ | ........ | 12x16⅛ |
| 14 OD | 21 | 1⅜ | 18¾ | 12 | 1 | 1⅛ | 4¼ | ........ | 14x17¾ |
| 16 OD | 23½ | 1 7/16 | 21¼ | 16 | 1 | 1⅛ | 4½ | ........ | 16x20¼ |
| 18 OD | 25 | 1 9/16 | 22¾ | 16 | 1⅛ | 1¼ | 4¾ | ........ | 18x21⅝ |
| 20 OD | 27½ | 1 11/16 | 25 | 20 | 1⅛ | 1¼ | 5 | ........ | 20x23⅞ |
| 24 OD | 32 | 1⅞ | 29½ | 20 | 1¼ | 1⅜ | 5½ | ........ | 24x28¼ |
| 30 OD | 38¾ | 2⅛ | 36 | 28 | 1¼ | 1⅜ | 6¼ | ........ | 30x34¾ |
| 36 OD | 46 | 2⅜ | 42¾ | 32 | 1½ | 1⅝ | 7 | ........ | 36x41¼ |
| 42 OD | 53 | 2⅝ | 49½ | 36 | 1½ | 1⅝ | 7½ | ........ | 42x48 |
| 48 OD | 59½ | 2¾ | 56 | 44 | 1½ | 1⅝ | 7¾ | ........ | 48x54½ |
| *54 OD | 66¼ | 3 | 62¾ | 44 | 1¾ | 2 | 8½ | 10½ | 54x61 |
| *60 OD | 73 | 3⅛ | 69¼ | 52 | 1¾ | 2 | 8¾ | 10¾ | 60x67½ |
| *72 OD | 86½ | 3½ | 82½ | 60 | 1¾ | 2 | 9½ | 11½ | 72x80¾ |
| *84 OD | 99¾ | 3⅞ | 95½ | 64 | 2 | 2¼ | 10½ | 12¾ | 84x93½ |
| *96 OD | 113¼ | 4¼ | 108½ | 68 | 2¼ | 2½ | 11½ | 14 | 96x106¼ |

All dimensions given in inches.

* These sizes are included for convenience and do not carry a definite rating.
[1] For facing, see Introductory Note 10.
[2] For flange bolt holes, see Introductory Note 11.
[3] For spot facing, see Introductory Note 12.
[4] For bolts and nuts, see Introductory Note 15.

# Class 125 Cast Iron Flanges and Fittings




10 IN. AND SMALLER — 12 IN. AND LARGER

## Dimensions of Screwed Companion and Blind Flanges[2,3]

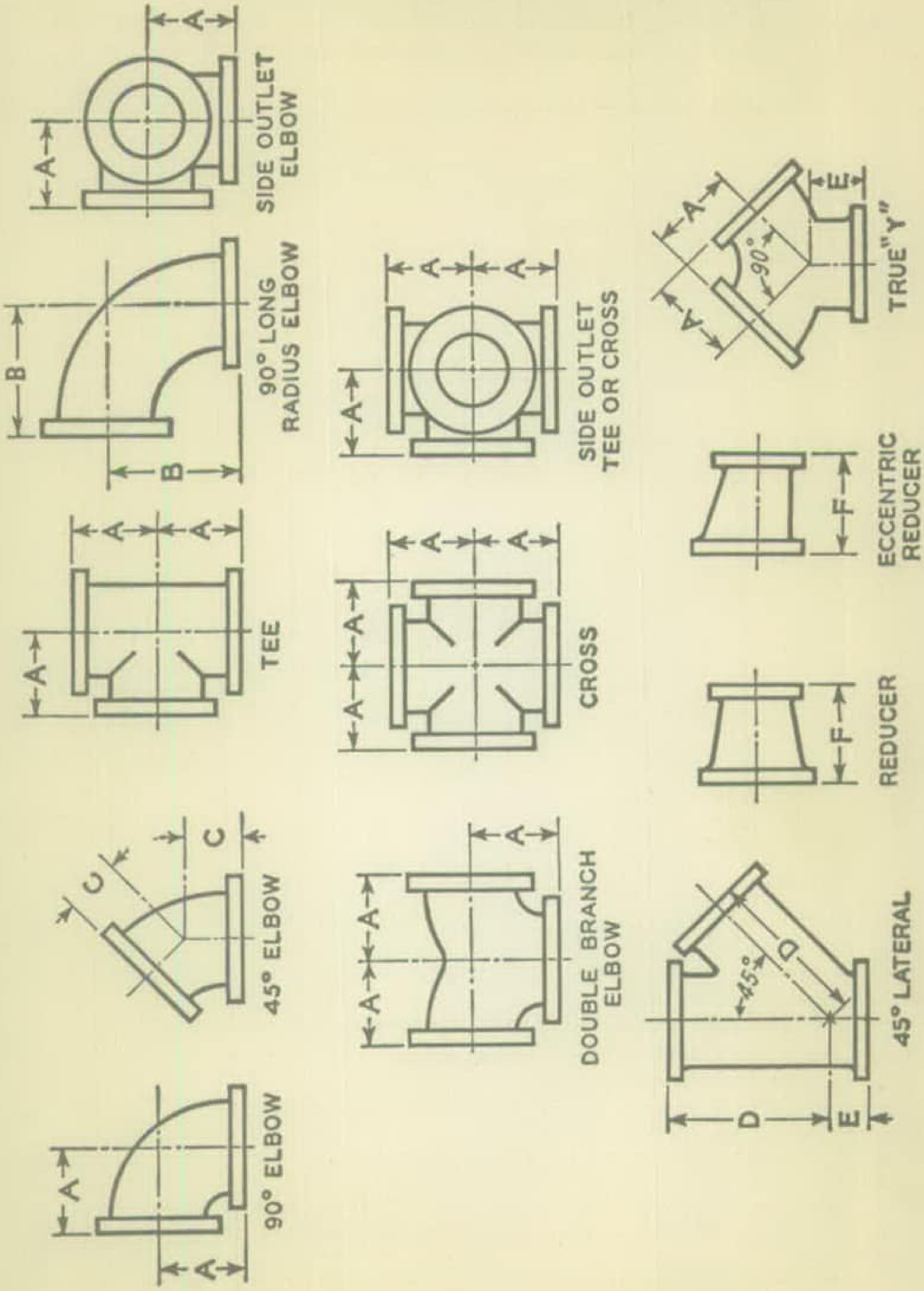
TABLE NO. 3

| Nominal[6] Pipe Size<br>I | Diam. of Flange<br>O | Thickness[1] of Flange (Min.)<br>Q | Wall[4] Thickness<br>V | Diam. Hub (Min.)<br>X | Length of Hub and Threads[5] (Min.)<br>Y |
|---|---|---|---|---|---|
| 1 | 4 1/4 | 7/16 | 3/8 | 1 15/16 | 11/16 |
| 1 1/4 | 4 5/8 | 1/2 | 7/16 | 2 5/16 | 13/16 |
| 1 1/2 | 5 | 9/16 | 1/2 | 2 9/16 | 7/8 |
| 2 | 6 | 5/8 | 9/16 | 3 1/16 | 1 |
| 2 1/2 | 7 | 11/16 | 5/8 | 3 9/16 | 1 1/8 |
| 3 | 7 1/2 | 3/4 | 11/16 | 4 1/4 | 1 3/16 |
| 3 1/2 | 8 1/2 | 13/16 | 3/4 | 4 13/16 | 1 1/4 |
| 4 | 9 | 15/16 | 7/8 | 5 5/16 | 1 5/16 |
| 5 | 10 | 15/16 | 7/8 | 6 7/16 | 1 7/16 |
| 6 | 11 | 1 | 15/16 | 7 9/16 | 1 9/16 |
| 8 | 13 1/2 | 1 1/8 | 1 1/16 | 9 11/16 | 1 3/4 |
| 10 | 16 | 1 3/16 | 1 1/8 | 11 15/16 | 1 15/16 |
| 12 | 19 | 1 1/4 | 13/16 | 14 1/16 | 2 3/16 |
| 14 OD | 21 | 1 3/8 | 7/8 | 15 3/8 | 2 1/4 |
| 16 OD | 23 1/2 | 1 7/16 | 1 | 17 1/2 | 2 1/2 |
| 18 OD | 25 | 1 9/16 | 1 1/16 | 19 5/8 | 2 11/16 |
| 20 OD | 27 1/2 | 1 11/16 | 1 1/8 | 21 3/4 | 2 7/8 |
| 24 OD | 32 | 1 7/8 | 1 1/4 | 26 | 3 1/4 |
| 30 OD | 38 3/4 | 2 1/8 | 1 7/16 | ............ | ............ |
| 36 OD | 46 | 2 3/8 | 1 5/8 | ............ | ............ |
| 42 OD | 53 | 2 5/8 | 1 13/16 | ............ | ............ |
| 48 OD | 59 1/2 | 2 3/4 | 2 | ............ | ............ |

All dimensions given in inches.

[1] For facing, see Introductory Note 10.
[2] For flange bolt holes, refer to Table 2, also see Introductory Note 11.
[3] For spot facing, see Introductory Note 12.
[4] For wall thickness tolerance, see Introductory Note 6.
[5] For thread of screwed flanges, see Introductory Note 9.
[6] All blind flanges for sizes 12 in. and larger must be dished with inside radius equal to the port diameter.

## Class 125 Cast Iron Flanges and Fittings




The illustrations on this page apply to Table 4

# Class 125 Cast Iron Flanges and Fittings

## Dimensions of Elbows, Double Branch Elbows, Tees, Crosses, Laterals, True Y's (Straight Sizes), and Reducers [1,2,3,5,12]

TABLE NO. 4

| Nominal Pipe Size | Inside Diam. of Fittings | Center[6,7,8,9] to Face 90 Deg. Elbow Tees, Crosses, True "Y" and Double Branch Elbow A | Center to Face 90 Deg. Long Radius Elbow[6,7,8] B | Center[8] to Face 45 Deg. Elbow C | Center[10] to Face Lateral D | Short Center[10] to Face True "Y" and Lateral E | Face[11] to Face Reducer F | Diam. of Flange | Thickness of Flange (Min.) | Wall[4] Thickness |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3½ | 5 | 1¾ | 5¾ | 1¾ | ....... | 4¼ | 7/16 | 5/16 |
| 1¼ | 1¼ | 3¾ | 5½ | 2 | 6¼ | 1¾ | ....... | 4⅝ | ½ | 5/16 |
| 1½ | 1½ | 4 | 6 | 2¼ | 7 | 2 | ....... | 5 | 9/16 | 5/16 |
| 2 | 2 | 4½ | 6½ | 2½ | 8 | 2½ | 5 | 6 | ⅝ | 5/16 |
| 2½ | 2½ | 5 | 7 | 3 | 9½ | 2½ | 5½ | 7 | 11/16 | 5/16 |
| 3 | 3 | 5½ | 7¾ | 3 | 10 | 3 | 6 | 7½ | ¾ | ⅜ |
| 3½ | 3½ | 6 | 8½ | 3½ | 11½ | 3 | 6½ | 8½ | 13/16 | 7/16 |
| 4 | 4 | 6½ | 9 | 4 | 12 | 3 | 7 | 9 | 15/16 | ½ |
| 5 | 5 | 7½ | 10¼ | 4½ | 13½ | 3½ | 8 | 10 | 15/16 | ½ |
| 6 | 6 | 8 | 11½ | 5 | 14½ | 3½ | 9 | 11 | 1 | 9/16 |
| 8 | 8 | 9 | 14 | 5½ | 17½ | 4½ | 11 | 13½ | 1⅛ | ⅝ |
| 10 | 10 | 11 | 16½ | 6½ | 20½ | 5 | 12 | 16 | 1 3/16 | ¾ |
| 12 | 12 | 12 | 19 | 7½ | 24½ | 5½ | 14 | 19 | 1¼ | 13/16 |
| 14 OD | 14 | 14 | 21½ | 7½ | 27 | 6 | 16 | 21 | 1⅜ | ⅞ |
| 16 OD | 16 | 15 | 24 | 8 | 30 | 6½ | 18 | 23½ | 1 7/16 | 1 |
| 18 OD | 18 | 16½ | 26½ | 8½ | 32 | 7 | 19 | 25 | 1 9/16 | 1 1/16 |
| 20 OD | 20 | 18 | 29 | 9½ | 35 | 8 | 20 | 27½ | 1 11/16 | 1⅛ |
| 24 OD | 24 | 22 | 34 | 11 | 40½ | 9 | 24 | 32 | 1⅞ | 1¼ |
| 30 OD | 30 | 25 | 41½ | 15 | 49 | 10 | 30 | 38¾ | 2⅛ | 1 7/16 |
| 36 OD | 36 | 28* | 49 | 18 | ....... | ....... | 36 | 46 | 2⅜ | 1⅝ |
| 42 OD | 42 | 31* | 56½ | 21 | ....... | ....... | 42 | 53 | 2⅝ | 1 13/16 |
| 48 OD | 48 | 34* | 64 | 24 | ....... | ....... | 48 | 59½ | 2¾ | 2 |

All dimensions given in inches.

For weights, see tables 1A, 2A, 3A, 4A and 5A, beginning with page 354.

*Does not apply to true Y's or double branch elbows.

[1] For facing, see Introductory Note 10.

[2] For flange bolt holes, refer to Table 2, also see Introductory Note 11.

[3] For spot facing, see Introductory Note 12.

[4] For wall thickness tolerance, see Introductory Note 6.

[5] For center to face tolerances, see Introductory Note 8.

[6] For intersecting center lines of side outlet elbows, see Introductory Note 7a.

[7] For center to face dimensions of reducing elbows and side outlet elbows, see Introductory Note 7b2 and 3.

[8] For center to face dimensions of special degree elbows, see Introductory Note 7b4.

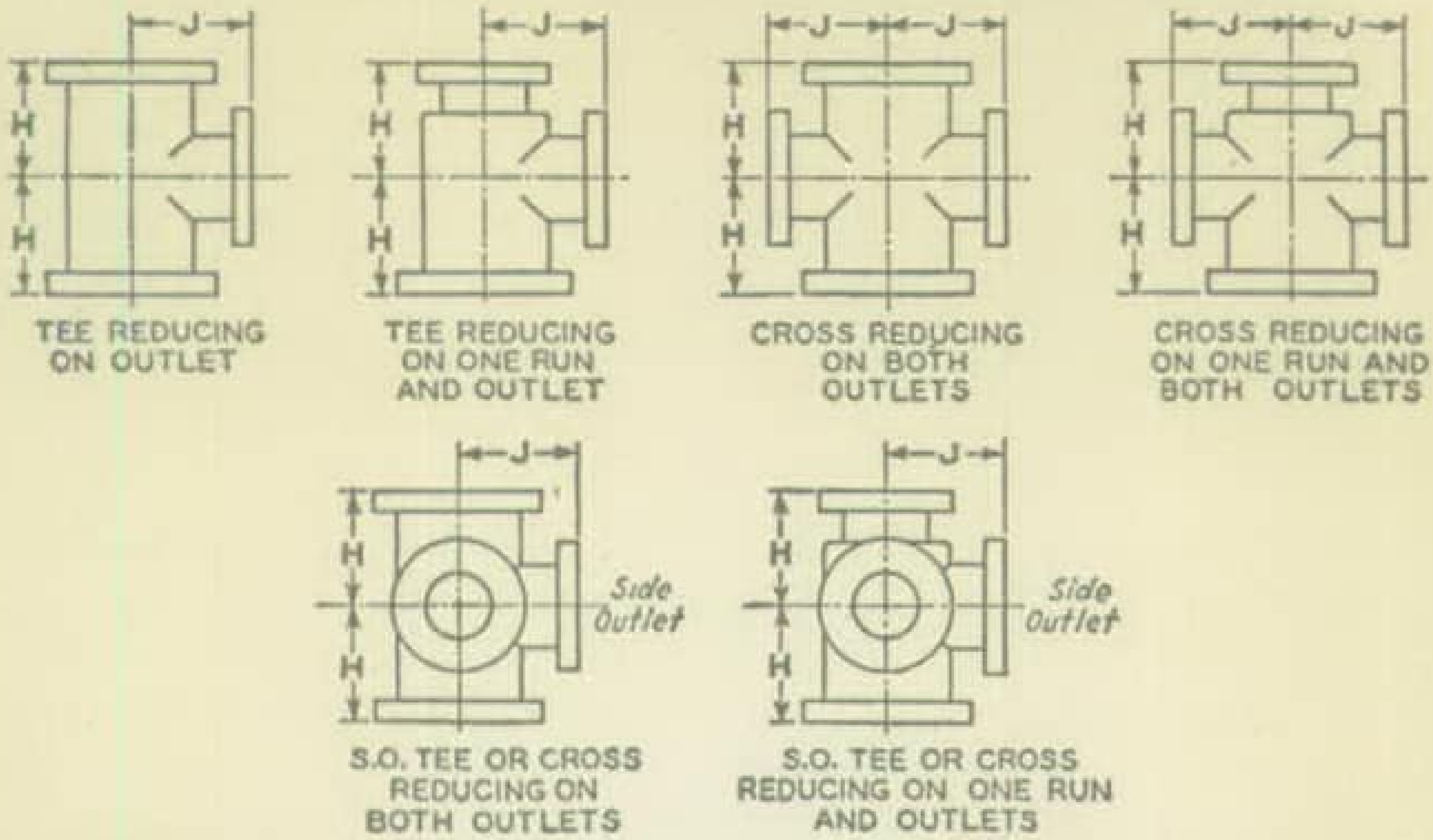
[9] For center to face dimensions of reducing tees and crosses, see Table 5.

[10] For center to face dimensions of reducing laterals, see Table 6.

[11] For face to face dimensions of reducers and eccentric reducers, see Introductory Note 7e.

[12] For reinforcement of crosses and laterals, see Introductory Note 13.

## Class 125 Cast Iron Flanges and Fittings




### Dimensions of Reducing Tees and Reducing Crosses (Short Body Patterns)[1, 2, 3, 4, 5, 10]

TABLE NO. 5

| Nominal Pipe Size | Size[6, 9] of Outlet and Smaller | Center[7, 8] to Face Run H | Center to Face Outlet or Side Outlet J |
|---|---|---|---|
| 18 OD | 12 | 13 | 15½ |
| 20 OD | 14 | 14 | 17 |
| 24 OD | 16 | 15 | 19 |
| 30 OD | 20 | 18 | 23 |
| 36 OD | 24 | 20 | 26 |
| 42 OD | 24 | 23 | 30 |
| 48 OD | 30 | 26 | 34 |

All reducing tees and crosses, sizes, 16 in. and smaller, shall have same center to face dimensions as straight size fittings, corresponding to the size of the largest opening. See Table 4. See Introductory Note 7c2 and 7c3.

All dimensions given in inches.

[1] For facing, see Introductory Note 10.

[2] For flange bolt holes refer to Table 2, also see Introductory Note 11.

[3] For spot facing, see Introductory Note 12.

[4] For flange dimensions, wall thickness, and port diameter, see Table 4.

[5] For center to face tolerances, see Introductory Note 8.

[6] For center to face dimensions of tees and crosses having outlets larger than given in the above table, see Introductory Note 7c2.

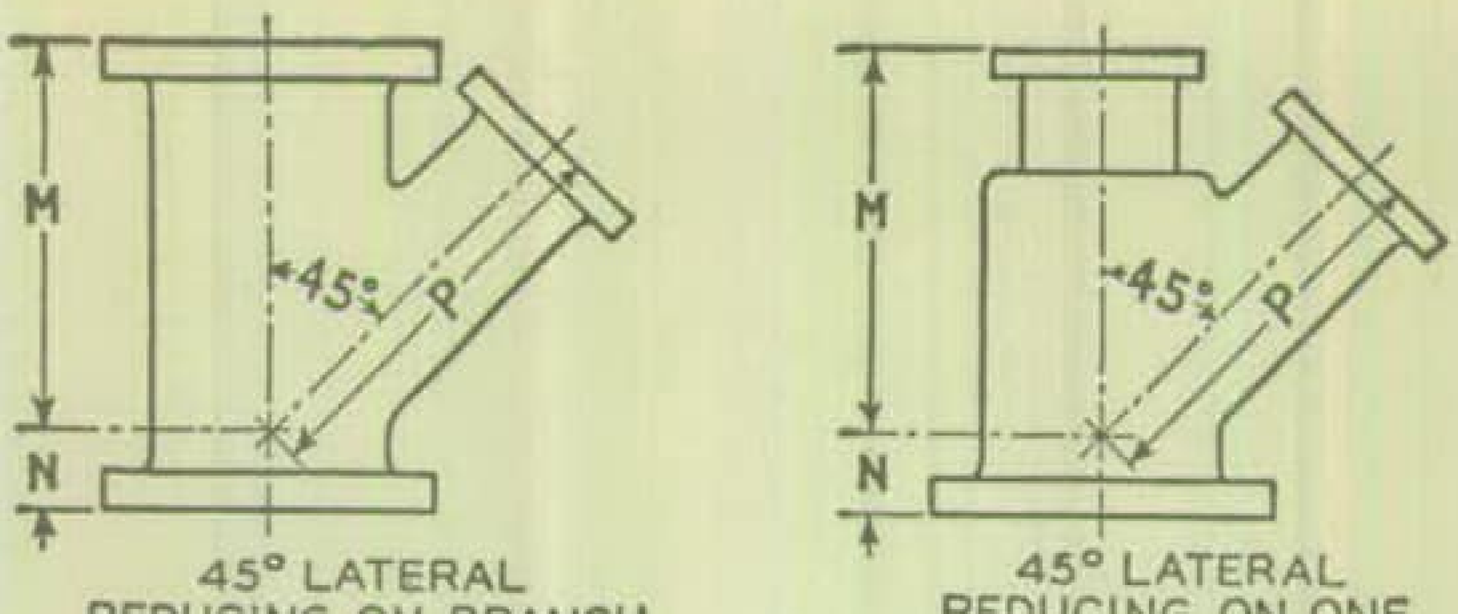
[7] For center to face dimensions of tees and crosses reducing on one run only, see Introductory Note 7c2.

[8] For center to face dimensions of tees reducing on both runs, known as bull head tees, see Introductory Note 7c3.

[9] For center to face dimensions of reducing side outlet tees and crosses having two different size reductions on the outlets, see Introductory Note 7c2.

[10] For reinforcement of crosses, see Introductory Note 13.

## Class 125 Cast Iron Flanges and Fittings




### Reducing Laterals (Short Body Pattern)[1,2,3,4,5,8]

TABLE NO. 6

| Nominal Pipe Size | Size[6] of Branch and Smaller | Center[7] to Face Run M | Center to Face Run N | Center to Face Branch P |
|---|---|---|---|---|
| 18 OD | 8 | 25 | 1 | 27½ |
| 20 OD | 10 | 27 | 1 | 29½ |
| 24 OD | 12 | 31½ | ½ | 34½ |
| 30 OD | 14 | 39 | 0 | 42 |

All reducing laterals sizes 16 inches and smaller, shall have same center to face dimensions as straight size fittings corresponding to size of the largest opening. See Table 4. See Introductory Note 7c2.

All dimensions given in inches.

[1] For facing, see Introductory Note 10.

[2] For flange bolt holes refer to Table 2, also see Introductory Note 11.

[3] For spot facing, see Introductory Note 12.

[4] For flange dimensions, wall thickness, and port diameter, see Table 4.

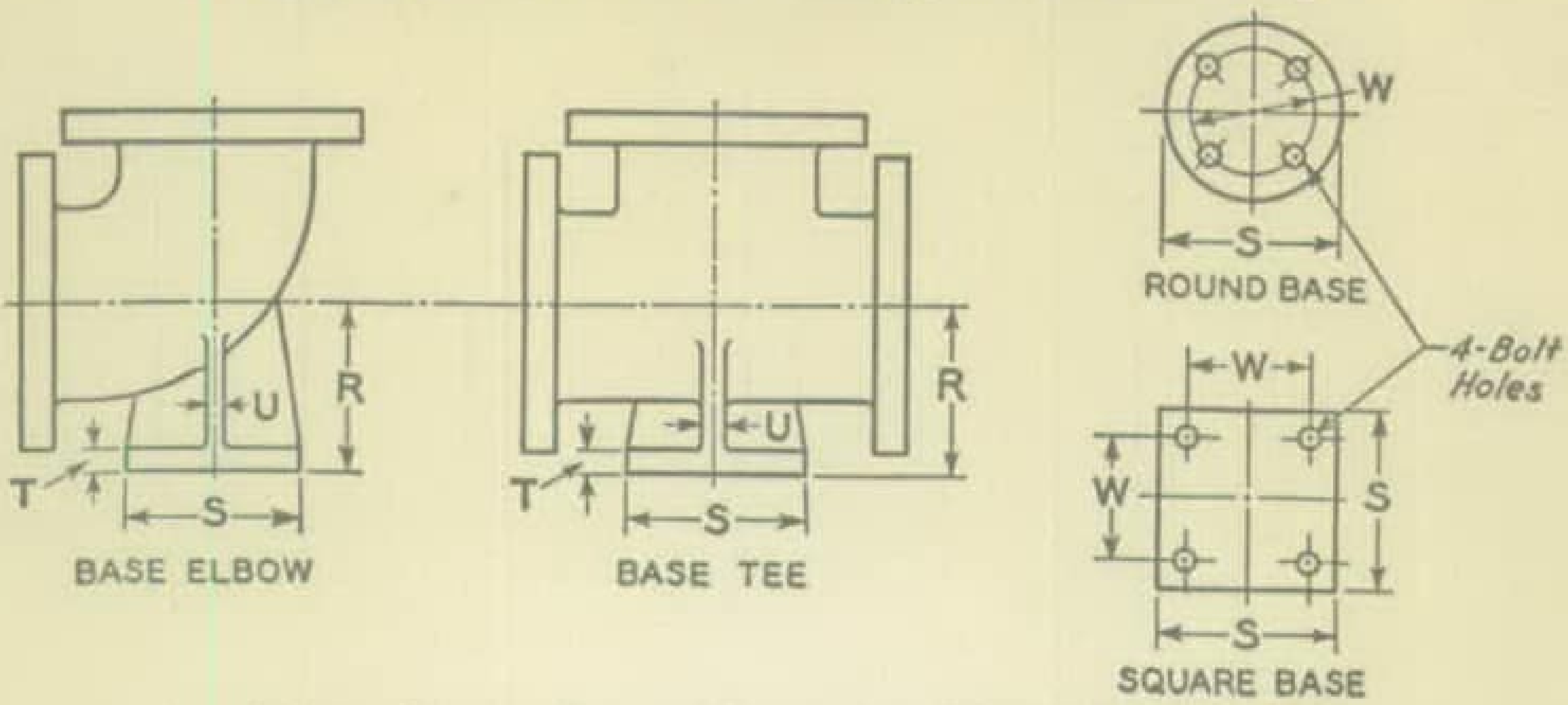
[5] For center to face tolerances, see Introductory Note 8.

[6] For center to face dimensions of laterals having branch larger than given in the above table, see Introductory Note 7c2.

[7] For center to face dimensions of lateral reducing on run only, see Inductory Note 7c2.

[8] For reinforcement of laterals, see Introductory Note 13.

# Class 125 Cast Iron Flanges and Fittings




## Dimensions of Base Elbows and Base Tees[1,3,5,6]

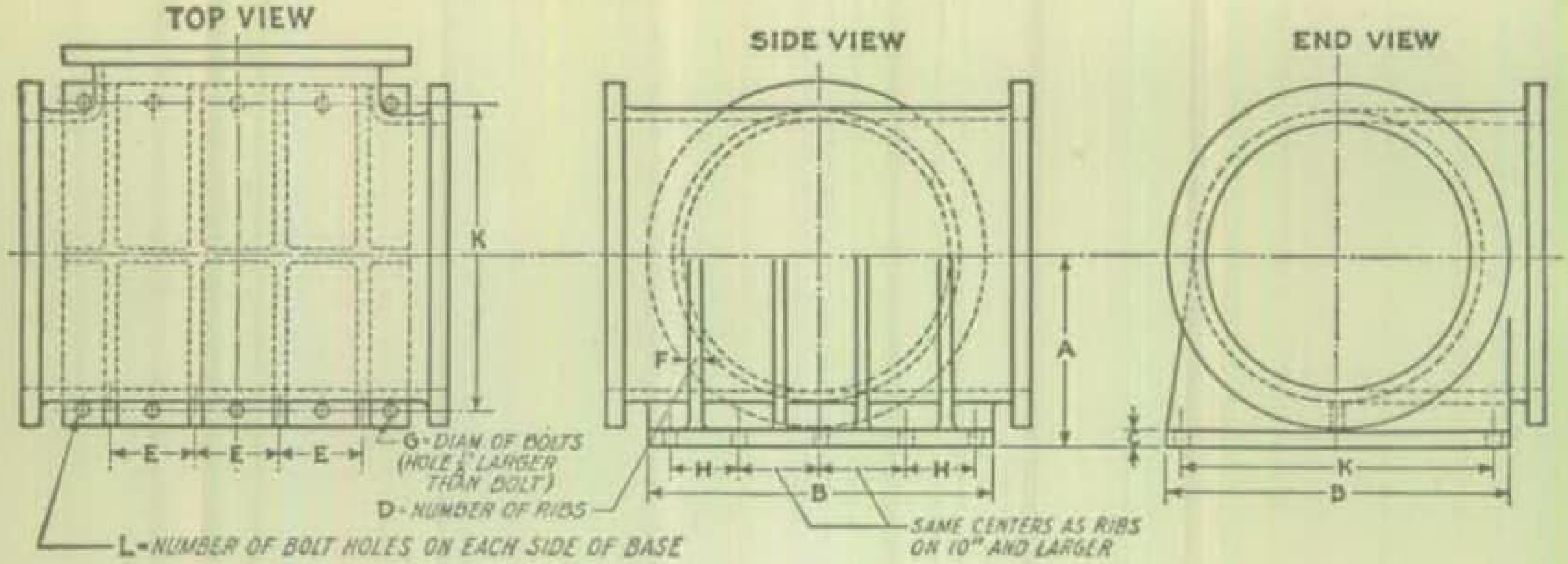
TABLE NO. 7

| Nominal[6] Pipe Size | Center to Base R | Diam. of[2,4] Round Base or Width of Square Base S | Thickness of Base T | Thickness of Ribs U | Size of Supporting Pipe for Base | Base Drilling[2] Bolt Circl or Bolt Spacing W | Diam. of Drilled Holes |
|---|---|---|---|---|---|---|---|
| 1 | 3½ | 3½ | 7/16 | 3/8 | ¾ | 2¾ | 5/8 |
| 1¼ | 3⅝ | 3½ | 7/16 | 3/8 | ¾ | 2¾ | 5/8 |
| 1½ | 3¾ | 4¼ | 7/16 | ½ | 1 | 3⅛ | 5/8 |
| 2 | 4⅛ | 4⅝ | ½ | ½ | 1¼ | 3½ | 5/8 |
| 2½ | 4½ | 4⅝ | ½ | ½ | 1¼ | 3½ | 5/8 |
| 3 | 4⅞ | 5 | 9/16 | ½ | 1½ | 3⅞ | 5/8 |
| 3½ | 5¼ | 5 | 9/16 | ½ | 1½ | 3⅞ | 5/8 |
| 4 | 5½ | 6 | 5/8 | ½ | 2 | 4¾ | ¾ |
| 5 | 6¼ | 7 | 11/16 | 5/8 | 2½ | 5½ | ¾ |
| 6 | 7 | 7 | 11/16 | 5/8 | 2½ | 5½ | ¾ |
| 8 | 8⅜ | 9 | 15/16 | 7/8 | 4 | 7½ | ¾ |
| 10 | 9¾ | 9 | 15/16 | 7/8 | 4 | 7½ | ¾ |
| 12 | 11¼ | 11 | 1 | 1 | 6 | 9½ | 7/8 |
| 14 OD | 12½ | 11 | 1 | 1 | 6 | 9½ | 7/8 |
| 16 OD | 13¾ | 11 | 1 | 1 | 6 | 9½ | 7/8 |
| 18 OD | 15 | 13½ | 1⅛ | 1⅛ | 8 | 11¾ | 7/8 |
| 20 OD | 16 | 13½ | 1⅛ | 1⅛ | 8 | 11¾ | 7/8 |
| 24 OD | 18½ | 13½ | 1⅛ | 1⅛ | 8 | 11¾ | 7/8 |

All dimensions given in inches.

[1] Bases not finished unless so ordered.
[2] Bolt hole template shown for round base is the same as for the flange of the supporting pipe size, except using only four holes in all cases so placed as to straddle center lines. The bases of these fittings are intended for support in compression and are not to be used for anchors or supports in tension or shear.
[3] The base dimensions apply to all straight and reducing sizes.
[4] For reducing fitting the size and center to face dimension of base are determined by the size of the largest opening of fitting. In the case of reducing base elbows orders shall specify whether the base shall be opposite the larger or smaller opening.
[5] For the fitting dimensions, refer to Tables 4 and 5.
[6] For tees, sizes larger than 24 in., anchorage fittings are recommended, see Tables 8 and 9.

# Class 125 Cast Iron Flanges and Fittings




## Dimensions of Anchorage Bases for Tees (Straight Sizes)[1,2]

TABLE NO. 8

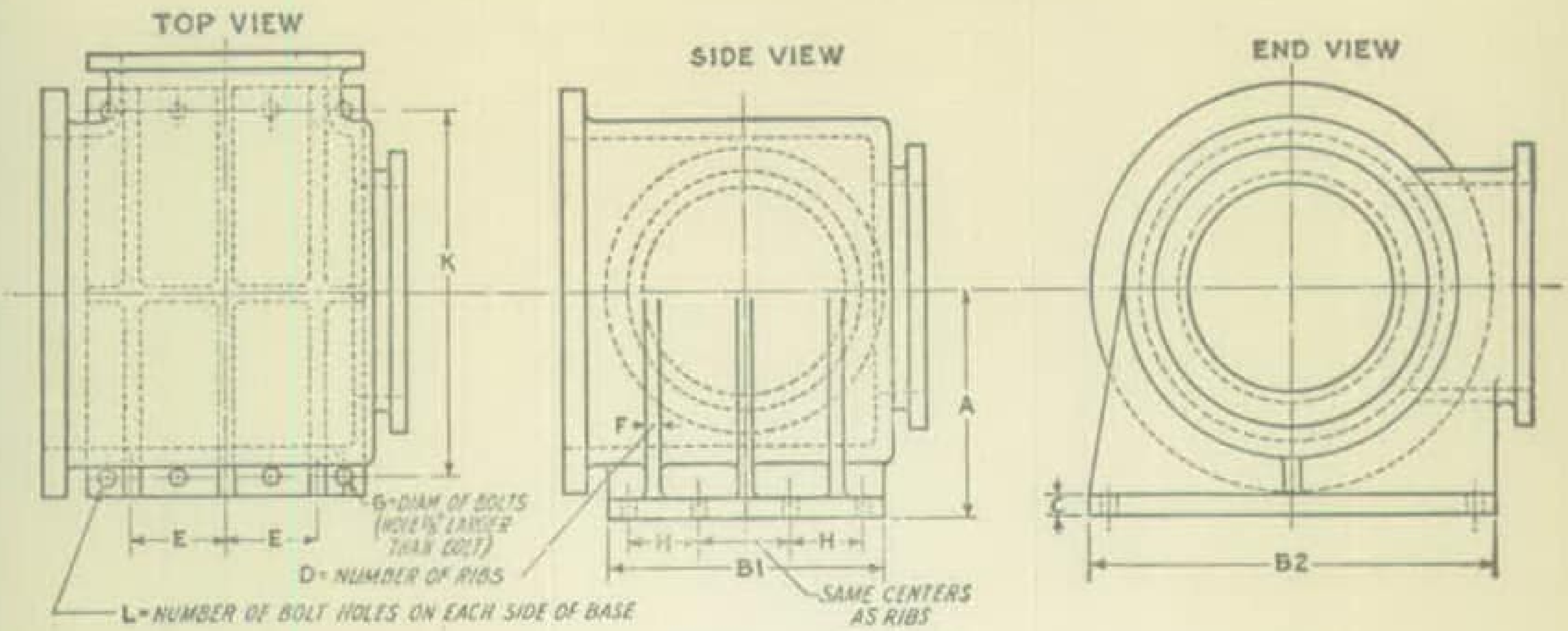
| Nominal Pipe Size | Center to Base A | Width and Length of Square Base B | Thickness[1] of Base C | Number of Ribs D | Centers of Ribs and Inside Bolts E | Thickness of Ribs F | Diam. of Bolts G | Longitudinal Centers From End Bolt to 2nd Bolt H | Transverse Bolt Centers K | Number of Bolt Holes on Each Side of Bases L |
|---|---|---|---|---|---|---|---|---|---|---|
| 2½ | 4½ | 7 | 11/16 | 1 | ....... | 7/16 | ⅝ | 4½ | 4½ | 2 |
| 3 | 4⅞ | 7½ | ¾ | 1 | ....... | 7/16 | ⅝ | 5 | 5 | 2 |
| 3½ | 5¼ | 8½ | 13/16 | 1 | ....... | 7/16 | ⅝ | 6 | 6 | 2 |
| 4 | 5½ | 9 | 15/16 | 2 | 4¼ | ½ | ⅝ | 3¼ | 6½ | 3 |
| 5 | 6¼ | 10 | 15/16 | 2 | 5 | ½ | ⅞ | 3¾ | 7½ | 3 |
| 6 | 7 | 11 | 1 | 2 | 6 | 9/16 | ⅞ | 4⅜ | 8¾ | 3 |
| 8 | 8⅜ | 13½ | 1⅛ | 2 | 8 | ⅝ | 1 | 5½ | 11 | 3 |
| 10 | 9¾ | 16 | 1 3/16 | 3 | 4⅞ | ¾ | 1⅛ | 4¼ | 13⅜ | 4 |
| 12 | 11¼ | 19 | 1¼ | 3 | 5¾ | 13/16 | 1¼ | 4⅞ | 15½ | 4 |
| 14 OD | 12½ | 21 | 1⅜ | 3 | 6¾ | ⅞ | 1¼ | 5½ | 17¾ | 4 |
| 16 OD | 13¾ | 23½ | 1 7/16 | 3 | 7¾ | 1 | 1⅜ | 6 | 19¾ | 4 |
| 18 OD | 15 | 25 | 1 9/16 | 3 | 8½ | 1 1/16 | 1⅜ | 6⅝ | 21¾ | 4 |
| 20 OD | 16 | 27½ | 1 11/16 | 3 | 9½ | 1⅛ | 1½ | 7¼ | 24 | 4 |
| 24 OD | 18½ | 32 | 1⅞ | 3 | 11⅜ | 1¼ | 1⅝ | 8½ | 28⅜ | 4 |
| 30 OD | 22 | 38¾ | 2⅛ | 4 | 9⅜ | 1 7/16 | 1¾ | 7⅞ | 34½ | 5 |
| 36 OD | 25½ | 46 | 2⅜ | 4 | 11¼ | 1⅝ | 1⅞ | 9⅛ | 40¾ | 5 |
| 42 OD | 29¼ | 53 | 2⅝ | 4 | 13 | 1 13/16 | 2 | 10⅜ | 46¾ | 5 |
| 48 OD | 32¾ | 59½ | 2¾ | 4 | 14⅞ | 2 | 2¼ | 11¾ | 53¼ | 5 |

All dimensions given in inches.

[1] Bases not finished unless so ordered.

[2] For the tee dimensions, refer to Table 4.

# Class 125 Cast Iron Flanges and Fittings




## Dimensions of Anchorage Bases for Reducing Tees (Short Body Pattern)[1,3]

TABLE NO. 9

| Nominal Pipe Size | Outlet[2] Sizes and Smaller | Center to Base A | Length of Base B1 | Width of Base B2 | Thickness[2] of Base C | Number of Ribs D | Centers of Ribs and Inside Bolts E | Thickness of Ribs F | Diam. of Bolts G | Longitudinal Center From End Bolt to 2nd Bolt H | Transverse Bolt Centers K | Number of Bolt Holes on Each Side of Base L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 OD | 12 | 15 | 19 | 25 | 1 9/16 | 3 | 5 1/4 | 1 1/16 | 1 1/4 | 5 1/8 | 21 1/2 | 4 |
| 20 OD | 14 | 16 | 21 | 27 1/2 | 1 11/16 | 3 | 6 | 1 1/8 | 1 1/4 | 5 3/8 | 23 1/4 | 4 |
| 24 OD | 16 | 18 1/2 | 23 1/2 | 32 | 1 7/8 | 3 | 7 | 1 1/4 | 1 3/8 | 6 1/4 | 28 | 4 |
| 30 OD | 20 | 22 | 27 1/2 | 38 3/4 | 2 1/8 | 3 | 9 | 1 7/16 | 1 1/2 | 7 1/4 | 34 3/4 | 4 |
| 36 OD | 24 | 25 1/2 | 32 | 46 | 2 3/8 | 3 | 10 3/4 | 1 5/8 | 1 1/2 | 8 3/8 | 41 1/2 | 4 |
| 42 OD | 24 | 29 1/4 | 36 1/2 | 53 | 2 5/8 | 4 | 8 1/2 | 1 13/16 | 1 5/8 | 7 1/2 | 48 1/2 | 5 |
| 48 OD | 30 | 32 3/4 | 41 3/4 | 59 1/2 | 2 3/4 | 4 | 9 3/4 | 2 | 1 5/8 | 8 1/4 | 53 3/4 | 5 |

Reducing tees sizes 16 in. and smaller, shall have the same base dimensions as a straight size tee shown in Table 8 corresponding to size of the largest opening.

All dimensons given in inches.

[1] Bases not finished unless so ordered.

[2] For sizes 18 inches and larger, if the outlet is the same size or smaller than given in Table 9 (short body pattern), the base dimensions shown in this table shall be used. If the outlet is larger than shown in Table 9, the base dimensions shall be the same as for the straight size tee shown in Table 8, corresponding to the size of the largest opening.

Tees reducing on run only shall have the same base dimensions as straight size tees shown in Table 8 corresponding to the size of the largest opening.

[3] For the reducing tee dimensions, refer to Table 5.

# APPENDIX[1]

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**Table 1A Theoretical Weights of Class 125 Flanges, Elbows, Crosses, Tees, Side Outlet Tees, and Laterals[2]**

| Nominal Pipe Size | Companion Flanges Lb | Blind Flanges Lb | 90 Deg Elbow Lb | 45 Deg Elbow Lb | 90 Deg Long Radius Elbow Lb | Side Outlet Elbow Lb | Tees Lb | Cross and Side Outlet Tees (Not Ribbed) Lb | Laterals[3] (Not Ribbed) Lb |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 5 | 4 | 7 | 8 | 9 | 11 | 10 |
| 1 ¼ | 2 | 3 | 7 | 6 | 9 | 10 | 11 | 15 | 13 |
| 1 ½ | 3 | 3 | 9 | 8 | 11 | 13 | 15 | 19 | 17 |
| 2 | 5 | 5 | 14 | 12 | 16 | 20 | 21 | 28 | 25 |
| 2 ½ | 7 | 7 | 19 | 17 | 23 | 28 | 30 | 39 | 36 |
| 3 | 8 | 9 | 24 | 20 | 28 | 34 | 37 | 48 | 44 |
| 3 ½ | 11 | 12 | 31 | 27 | 37 | 46 | 49 | 63 | 59 |
| 4 | 14 | 16 | 41 | 36 | 48 | 59 | 64 | 82 | 75 |
| 5 | 17 | 20 | 52 | 45 | 62 | 74 | 81 | 105 | 96 |
| 6 | 22 | 25 | 68 | 60 | 85 | 96 | 105 | 135 | 125 |
| 8 | 31 | 42 | 110 | 94 | 145 | 150 | 165 | 210 | 210 |
| 10 | 45 | 63 | 175 | 145 | 230 | 240 | 270 | 330 | 340 |
| 12 | 63 | 88 | 250 | 220 | 350 | 340 | 380 | 470 | 520 |
| 14 O.D. | 82 | 115 | 350 | 270 | 470 | 470 | 530 | 650 | 680 |
| 16 O.D. | 105 | 160 | 470 | 360 | 670 | 620 | 700 | 850 | 950 |
| 18 O.D. | 120 | 190 | 580 | 420 | 840 | 760 | 860 | 1040 | 1150 |
| 20 O.D. | 150 | 250 | 740 | 540 | 1080 | 970 | 1100 | 1330 | 1480 |
| 24 O.D. | 220 | 370 | 1160 | 800 | 1640 | 1510 | 1730 | 2080 | 2080 |
| 30 O.D. | ... | 620 | 1850 | 1430 | 2800 | 2350 | 2710 | 3210 | 3680 |
| 36 O.D. | ... | 990 | 2800 | 2280 | 4450 | 3500 | 4050 | 4750 | .... |
| 42 O.D. | ... | 1470 | 4010 | 3380 | 6610 | 4930 | 5790 | 6710 | .... |
| 48 O.D. | ... | 2000 | 5400 | 4680 | 9250 | 6520 | 7620 | 8740 | .... |

All dimensions given in inches.

[1] For information only, not mandatory.

[2] All weights listed are for fittings faced and drilled, based on minimum thicknesses and dimensions given in preceding tables, without allowances for variation. Cast iron is assumed to weigh 0.26 lb per cu in.

[3] Weights of crosses and laterals do not include reinforcing ribs.

# APPENDIX

REPRINT FROM ASA-B16a-1939

## Table 2A Theoretical Weights of Class 125 Reducing Elbows Reducers, and Eccentric Reducers[1]

| Nominal Pipe Size | Reducing Elbows Lb | Reducers and Eccentric Reducers Lb | Nominal Pipe Size | Reducing Elbows Lb | Reducers and Eccentric Reducers Lb |
|---|---|---|---|---|---|
| 3 × 2½ | 22 | 19 | 12 × 10 | 220 | 180 |
| 3 × 2 | 19 | 16 | 12 × 8 | 190 | 155 |
| 3 × 1½ | 17 | | 12 × 6 | 165 | 140 |
| 3½ × 3 | 28 | 24 | 14 × 12 | 320 | 250 |
| 3½ × 2 | 24 | 20 | 14 × 10 | 280 | 220 |
| 4 × 3½ | 37 | 31 | 14 × 8 | 240 | 200 |
| 4 × 3 | 33 | 28 | 16 × 14 | 420 | 340 |
| 4 × 2½ | 31 | 26 | 16 × 12 | 380 | 310 |
| 4 × 2 | 29 | 24 | 16 × 10 | 340 | 280 |
| 5 × 4 | 48 | 39 | 16 × 8 | 300 | 250 |
| 5 × 3 | 40 | 32 | 18 × 16 | 540 | 430 |
| 5 × 2½ | 37 | 31 | 18 × 14 | 480 | 380 |
| 6 × 5 | 60 | 50 | 18 × 12 | 440 | 350 |
| 6 × 4 | 56 | 47 | 18 × 10 | 390 | 320 |
| 6 × 3½ | 51 | 43 | 20 × 18 | 680 | 520 |
| 6 × 3 | 47 | 39 | 20 × 16 | 640 | 490 |
| 8 × 6 | 90 | 77 | 20 × 14 | 570 | 450 |
| 8 × 5 | 82 | 71 | 20 × 12 | 520 | 410 |
| 8 × 4 | 77 | 66 | 24 × 20 | 1010 | 760 |
| 10 × 8 | 150 | 120 | 24 × 18 | 930 | 700 |
| 10 × 6 | 125 | 100 | 24 × 16 | 880 | 670 |
| 10 × 5 | 115 | 95 | 24 × 12 | 740 | 580 |

All dimensions given in inches.

[1] All weights listed are for fittings faced and drilled, based on minimum thicknesses and dimensions given in preceding tables, without allowances for variation. Cast iron is assumed to weigh 0.26 lb per cu in.

# APPENDIX

REPRINT FROM ASA-B16a-1939

## Table 3A Theoretical Weights of Class 125 Reducing Laterals[1]

| Nominal Pipe Size | Lateral[2] Reducing Outlet (Not Ribbed) Lb | Nominal Pipe Size | Lateral[2] Reducing Outlet (Not Ribbed) Lb |
|---|---|---|---|
| 3 × 3 × 2½ | 42 | 12 × 12 × 10 | 470 |
| 3 × 3 × 2 | 39 | 12 × 12 × 8 | 430 |
| 3 × 3 × 1½ | 36 | 12 × 12 × 6 | 400 |
| 3½ × 3½ × 3 | 55 | 14 × 14 × 12 | 640 |
| 3½ × 3½ × 2½ | 52 | 14 × 14 × 10 | 590 |
| 3½ × 3½ × 2 | 49 | 14 × 14 × 8 | 550 |
| 4 × 4 × 3½ | 70 | 16 × 16 × 14 | 880 |
| 4 × 4 × 3 | 66 | 16 × 16 × 12 | 830 |
| 4 × 4 × 2½ | 63 | 16 × 16 × 10 | 790 |
| 4 × 4 × 2 | 60 | 16 × 16 × 8 | 740 |
| 5 × 5 × 4 | 93 | 18 × 18 × 16 | 1100 |
| 5 × 5 × 3½ | 86 | 18 × 18 × 14 | 1030 |
| 5 × 5 × 3 | 82 | 18 × 18 × 12 | 980 |
| 5 × 5 × 2½ | 79 | 18 × 18 × 10 | 930 |
| 6 × 6 × 5 | 120 | 20 × 20 × 18 | 1400 |
| 6 × 6 × 4 | 115 | 20 × 20 × 16 | 1350 |
| 6 × 6 × 3½ | 105 | 20 × 20 × 14 | 1270 |
| 6 × 6 × 3 | 105 | 20 × 20 × 12 | 1220 |
| | | 20 × 20 × 10 | *840 |
| 8 × 8 × 6 | 195 | | |
| 8 × 8 × 5 | 180 | 24 × 24 × 20 | 2040 |
| 8 × 8 × 4 | 175 | 24 × 24 × 18 | 1950 |
| | | 24 × 24 × 16 | 1890 |
| 10 × 10 × 8 | 310 | 24 × 24 × 14 | 1810 |
| 10 × 10 × 6 | 280 | 24 × 24 × 12 | *1250 |
| 10 × 10 × 5 | 270 | | |

All dimensions given in inches.

[1] Weights of laterals do not include reinforcing ribs.
[2] All weights listed are for fittings faced and drilled, based on minimum thicknesses and dimensions given in preceding tables, without allowances for variation. Cast iron is assumed to weigh 0.26 lb per cu in.
* These sizes made in the short body pattern only

## APPENDIX

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### Table 4A Theoretical Weights of Class 125 Reducing Tees[1]

| Size | Weight Lb | Size | Weight Lb | Size | Weight Lb |
|---|---|---|---|---|---|
| 3 × 3 × 2½ | 36 | 6 × 6 × 3 | 89 | 14 × 14 × 10 | 480 |
| 3 × 3 × 2 | 33 | 6 × 5 × 6 | 100 | 14 × 14 × 8 | 460 |
| 3 × 3 × 1½ | 31 | 6 × 5 × 5 | 95 | 14 × 12 × 14 | 510 |
| 3 × 2½ × 3 | 35 | 6 × 5 × 4 | 92 | 14 × 12 × 12 | 490 |
| 3 × 2½ × 2½ | 34 | 6 × 5 × 3 | 84 | 14 × 12 × 10 | 460 |
| 3 × 2½ × 2 | 31 | 6 × 4 × 6 | 98 | 14 × 12 × 8 | 440 |
| 3 × 2½ × 1½ | 29 | 6 × 4 × 5 | 93 | 14 × 10 × 14 | 490 |
| 3 × 2 × 3 | 33 | 6 × 4 × 4 | 89 | 14 × 10 × 12 | 470 |
| 3 × 2 × 2½ | 32 | 6 × 4 × 3 | 82 | 14 × 10 × 10 | 450 |
| 3 × 2 × 2 | 29 | 6 × 3 × 6 | 92 | 14 × 10 × 8 | 420 |
| 3 × 2 × 1½ | 27 | 6 × 3 × 5 | 86 | 14 × 8 × 14 | 480 |
| 3 × 1½ × 3 | 32 | 6 × 3 × 4 | 83 | 14 × 8 × 12 | 460 |
| 3 × 1½ × 2½ | 30 | 6 × 3 × 3 | 76 | 14 × 8 × 10 | 430 |
| 3 × 1½ × 2 | 27 | 8 × 8 × 6 | 150 | 14 × 8 × 8 | 410 |
| 3 × 1½ × 1½ | 25 | 8 × 8 × 5 | 145 | 16 × 16 × 14 | 670 |
| 3½ × 3½ × 3 | 46 | 8 × 8 × 4 | 145 | 16 × 16 × 12 | 650 |
| 3½ × 3½ × 2½ | 44 | 8 × 6 × 8 | 155 | 16 × 16 × 10 | 620 |
| 3½ × 3½ × 2 | 42 | 8 × 6 × 6 | 140 | 16 × 16 × 8 | 610 |
| 4 × 4 × 3½ | 60 | 8 × 6 × 5 | 135 | 16 × 14 × 16 | 680 |
| 4 × 4 × 3 | 57 | 8 × 6 × 4 | 130 | 16 × 14 × 14 | 650 |
| 4 × 4 × 2½ | 55 | 8 × 5 × 8 | 150 | 16 × 14 × 12 | 630 |
| 4 × 4 × 2 | 53 | 8 × 5 × 6 | 135 | 16 × 14 × 10 | 600 |
| 4 × 3 × 4 | 57 | 8 × 5 × 5 | 130 | 16 × 14 × 8 | 580 |
| 4 × 3 × 3 | 50 | 8 × 5 × 4 | 125 | 16 × 12 × 16 | 670 |
| 4 × 3 × 2½ | 49 | 8 × 4 × 8 | 150 | 16 × 12 × 14 | 640 |
| 4 × 3 × 2 | 46 | 8 × 4 × 6 | 135 | 16 × 12 × 12 | 620 |
| 4 × 2½ × 4 | 56 | 8 × 4 × 5 | 130 | 16 × 12 × 10 | 590 |
| 4 × 2½ × 3 | 49 | 8 × 4 × 4 | 125 | 16 × 12 × 8 | 570 |
| 4 × 2½ × 2½ | 47 | 10 × 10 × 8 | 250 | 16 × 10 × 16 | 650 |
| 4 × 2½ × 2 | 45 | 10 × 10 × 6 | 240 | 16 × 10 × 14 | 620 |
| 4 × 2 × 4 | 54 | 10 × 10 × 5 | 230 | 16 × 10 × 12 | 600 |
| 4 × 2 × 3 | 47 | 10 × 8 × 10 | 260 | 16 × 10 × 10 | 570 |
| 4 × 2 × 2½ | 45 | 10 × 8 × 8 | 240 | 16 × 10 × 8 | 550 |
| 4 × 2 × 2 | 43 | 10 × 8 × 6 | 220 | 16 × 8 × 16 | 640 |
| 5 × 5 × 4 | 78 | 10 × 6 × 10 | 250 | 16 × 8 × 14 | 610 |
| 5 × 5 × 3½ | 74 | 10 × 6 × 8 | 230 | 16 × 8 × 12 | 580 |
| 5 × 5 × 3 | 70 | 10 × 6 × 6 | 210 | 16 × 8 × 10 | 560 |
| 5 × 5 × 2½ | 68 | 12 × 12 × 10 | 360 | 16 × 8 × 8 | 540 |
| 5 × 4 × 5 | 78 | 12 × 12 × 8 | 340 | 18 × 18 × 16 | 860 |
| 5 × 4 × 4 | 75 | 12 × 12 × 6 | 320 | 18 × 18 × 14 | 820 |
| 5 × 4 × 3 | 68 | 12 × 10 × 12 | 370 | 18 × 18 × 12 | *660 |
| 5 × 4 × 2½ | 66 | 12 × 10 × 10 | 340 | 18 × 18 × 10 | *640 |
| 5 × 3 × 5 | 72 | 12 × 10 × 8 | 320 | 20 × 20 × 18 | 1060 |
| 5 × 3 × 4 | 68 | 12 × 10 × 6 | 310 | 20 × 20 × 16 | 1040 |
| 5 × 3 × 3 | 61 | 12 × 8 × 12 | 350 | 20 × 20 × 14 | *840 |
| 5 × 3 × 2½ | 59 | 12 × 8 × 10 | 330 | 20 × 20 × 12 | *820 |
| 5 × 2½ × 5 | 70 | 12 × 8 × 8 | 310 | 20 × 20 × 10 | *790 |
| 5 × 2½ × 4 | 67 | 12 × 8 × 6 | 300 | 24 × 24 × 20 | 1640 |
| 5 × 2½ × 3 | 60 | 12 × 6 × 12 | 340 | 24 × 24 × 18 | 1600 |
| 5 × 2½ × 2½ | 58 | 12 × 6 × 10 | 320 | 24 × 24 × 16 | *1170 |
| 6 × 6 × 5 | 99 | 12 × 6 × 8 | 300 | 24 × 24 × 14 | *1140 |
| 6 × 6 × 4 | 96 | 12 × 6 × 6 | 280 | 24 × 24 × 12 | *1110 |
| 6 × 6 × 3½ | 92 | 14 × 14 × 12 | 500 | ........ | .... |

All dimensions given in inches.

[1] All weights listed are for fittings faced and drilled, based on minimum thicknesses and dimensions given in preceding tables, without allowances for variation. Cast iron is assumed to weigh 0.26 lb per cu in.

* These sizes made in short body pattern only

# APPENDIX

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## Table 5A Theoretical Weights of Class 125 Reducing Crosses[1,2]

| Size | Weight Lb | Size | Weight Lb |
|---|---|---|---|
| 3 × 3 × 2½ × 2½ | 44 | 12 × 12 × 10 × 10 | 420 |
| 3 × 3 × 2 × 2 | 40 | 12 × 12 × 8 × 8 | 380 |
| 3 × 3 × 1½ × 1½ | 36 | 12 × 12 × 6 × 6 | 350 |
| 3½ × 3½ × 3 × 3 | 57 | | |
| 3½ × 3½ × 2½ × 2½ | 53 | 14 × 14 × 12 × 12 | 600 |
| | | 14 × 14 × 10 × 10 | 550 |
| 3½ × 3½ × 2 × 2 | 47 | 14 × 14 × 8 × 8 | 500 |
| 4 × 4 × 3½ × 3½ | 74 | | |
| 4 × 4 × 3 × 3 | 68 | 16 × 16 × 14 × 14 | 790 |
| 4 × 4 × 2½ × 2½ | 64 | 16 × 16 × 12 × 12 | 740 |
| 4 × 4 × 2 × 2 | 59 | 16 × 16 × 10 × 10 | 690 |
| | | 16 × 16 × 8 × 8 | 650 |
| 5 × 5 × 4 × 4 | 96 | | |
| 5 × 5 × 3½ × 3½ | 89 | 18 × 18 × 16 × 16 | 1000 |
| 5 × 5 × 3 × 3 | 82 | 18 × 18 × 14 × 14 | 930 |
| 5 × 5 × 2½ × 2½ | 78 | 18 × 18 × 12 × 12 | *750 |
| | | 18 × 18 × 10 × 10 | *700 |
| 6 × 6 × 5 × 5 | 120 | | |
| 6 × 6 × 4 × 4 | 115 | 20 × 20 × 18 × 18 | 1250 |
| 6 × 6 × 3½ × 3½ | 105 | 20 × 20 × 16 × 16 | 1200 |
| 6 × 6 × 3 × 3 | 100 | 20 × 20 × 14 × 14 | *960 |
| | | 20 × 20 × 12 × 12 | *910 |
| 8 × 8 × 6 × 6 | 190 | 20 × 20 × 10 × 10 | *860 |
| 8 × 8 × 5 × 5 | 175 | | |
| 8 × 8 × 4 × 4 | 165 | 24 × 24 × 20 × 20 | 1900 |
| | | 24 × 24 × 18 × 18 | 1810 |
| 10 × 10 × 8 × 8 | 300 | 24 × 24 × 16 × 16 | *1310 |
| 10 × 10 × 6 × 6 | 270 | 24 × 24 × 14 × 14 | *1250 |
| 10 × 10 × 5 × 5 | 250 | 24 × 24 × 12 × 12 | *1210 |
| | | .. .. .. .. .. .. .. | .... |

All dimensions given in inches.

[1] Weights of crosses do not include reinforcing ribs.

[2] All weights listed are for fittings faced and drilled, based on minimum thicknesses and dimensions given in preceding tables, without allowances for variation. Cast iron is assumed to weigh 0.26 lb per cu in.

* These sizes made in the short body pattern only.

ASA
B16b-1944

American Standard

# Cast Iron Pipe Flanges and Flanged Fittings, Class 250

## Introductory Notes

### 1. PRESSURE RATING

These flanges and fittings are rated as follows:

For maximum saturated steam service pressures of

250 psi (gage) sizes 1 to 12 in., incl.
200 psi (gage) sizes 14 to 24 in., incl.
100 psi (gage) sizes 30 to 48 in., incl.*

For maximum water service pressures at or near the ordinary range of air temperature

400 psi (gage) sizes 1 to 12 in., incl.
300 psi (gage) sizes 14 to 48 in., incl.,*

for flanges only.[1]

### 2. SIZES

The sizes of the fittings in the following tables will be identified by the corresponding "nominal pipe size."

### 3. MARKING

All fittings shall have marks cast on them indicating the manufacturer and figures indicating the service pressure rating. Sizes up to and including 12 in. shall carry the figures "250" indicating the saturated steam service pressure rating. Sizes 14 to 24 in., inclusive, shall carry the figures "200" indicating the saturated steam service pressure rating. Sizes 30 to 48 in., inclusive,* shall carry the figures "100" indicating the saturated steam service pressure rating. These marking requirements comply with principles established in MSS Standard Practice SP-25.

### 4. MATERIAL

*Castings.*—The dimensions prescribed in this standard are based upon gray iron castings of high quality produced under regular control of chemical and physical properties by a recognized process. The manufac-

* Sizes 30 to 48 in. are included for convenience where special fittings larger than 24 in. are required (see Table 2).

[1] It will be noted that water service ratings as shown for sizes 14 in. and larger in this standard are applicable to flanges only and not to fittings. Water service ratings on fittings 14 in. and larger are withheld in this issue of the standard pending receipt of final report on research work which is now being conducted by ASA Sectional Committee A21.

turer shall be prepared to certify that his product has been so produced that the chemical and physical properties thereof, as proved by test specimens, are at least equal to the requirements specified in A.S.T.M. Specification A 126. Flanges and fittings 12 in. and smaller shall be made of material at least equal to the requirements of A.S.T.M. Specification A 126, Class "A" regular gray iron.

Flanges and fittings 14 in. and larger shall be made of material at least equal to the requirements of A.S.T.M. Specification A 126, Class "B" higher strength gray iron.

Requirements of A.S.T.M. A 126 are as follows:

| | *Class A* |
|---|---|
| Sulphur | 0.12 per cent max |
| Phosphorus | 0.75 per cent max |
| Tensile strength | 21,000 psi min |
| | *Class B* |
| Sulphur | 0.12 per cent max |
| Phosphorus | 0.75 per cent max |
| Tensile strength | 31,000 psi min |

It is intended that material required by this standard shall be in accordance with the requirements shown herein or as required in the latest edition of A.S.T.M. Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings (A 126).

*Bolting.*—Carbon steel bolts shall be used with these flanges and fittings and shall be made of metal which conforms to A.S.T.M. Specification A 107.

#### 5. WALL THICKNESS TOLERANCE

Patterns shall be designed to produce castings having the wall thicknesses given in the tables. The wall thicknesses of the castings at no point shall be less than 87½ per cent of the dimensions given.

#### 6. TESTS

These fittings shall be designed to withstand, without showing leaks, hydrostatic test pressures of twice the rated steam pressure. Hydrostatic tests of cast iron fittings covered by this standard are not required unless specified by the user.

#### 7. FACING

These cast iron flanges and flanged fittings shall have a raised face $\frac{1}{16}$ in. high of the diameters given in Table 2. The raised face is included in the minimum flange thickness and center to face dimensions.

An inspection limit of plus or minus $\frac{1}{32}$ in. shall be allowed on all center to contact surface dimensions for sizes up to and including 10 in. and plus or minus $\frac{1}{16}$ in. on sizes larger than 10 in. An inspection limit of plus or minus $\frac{1}{16}$ in. shall be allowed on all contact-surface-to-contact-surface dimensions for sizes up to and including 10 in. and plus or minus $\frac{1}{8}$ in. on sizes larger than 10 in.

### 8. BOLTING

Bolt holes are in multiples of four, so that fittings may be made to face in any quarter.

Bolt holes shall straddle the center line.

For bolts having a diameter of $1\frac{1}{4}$ in. and less the bolt holes shall be drilled $\frac{1}{8}$ in. larger than the nominal diameter of the bolt. Holes for $1\frac{1}{2}$ in. diameter bolts shall be drilled $\frac{3}{16}$ in. larger than the nominal diameter of the bolt. Holes for bolts having a diameter $1\frac{3}{4}$ and 2 in. shall be drilled $\frac{1}{4}$ in. larger than the nominal diameter of the bolt.

Bolts shall be of carbon steel with American Standard regular unfinished square heads or American Standard heavy unfinished hexagonal heads and the nuts shall be of carbon steel with American Standard heavy hexagonal dimensions, all as specified in American Standard for Wrench Head Bolts and Nuts and Wrench Openings (ASA B18.2–1941). For bolts $1\frac{3}{4}$ in. in diameter and larger, bolt-studs with a nut on each end are recommended.

Hexagonal nuts for pipe sizes 1 in. to 16 in. can be conveniently pulled up with open wrenches of minimum design of heads. Hexagonal nuts for pipe sizes 18 in. to 48 in. can be conveniently pulled up with box wrenches.

All bolts, or bolt-studs if used, and all nuts shall be threaded in accordance with American Standard for Screw Threads (ASA B1.1–1935) Coarse-Thread Series, Class 2 Fit.

### 9. SPOT FACING

The bolt holes of these cast iron flanges and flanged fittings need not be spot faced for ordinary service except as follows: In sizes 12 in. and smaller when rough flanges, after facing, are oversize more than $\frac{1}{8}$ in. in thickness, they shall be spot faced to the specified thickness of flange (minimum) with a plus tolerance of $\frac{1}{16}$ in. In sizes 14 to 24 in., inclusive, when rough flanges, after facing, are oversize more than $\frac{3}{16}$ in. in thickness they shall be spot faced to the specified thickness of flange (minimum) with a plus tolerance of $\frac{1}{16}$ in. In sizes 30 in. and larger when rough flanges, after facing, are oversize more than $\frac{1}{4}$ in. in thickness they shall be spot faced to the specified thickness of flange (minimum) with a plus tolerance of ⅛ in.

**10. REDUCING FITTINGS**

Reducing elbows carry same dimensions center to face as straight size elbows corresponding to the size of the larger opening.

Tees sizes 16 in. and smaller, reducing on the outlet, have the same dimension center to face and face to face as straight size fittings corresponding to the size of the larger opening. Sizes 18 in. and larger reducing on the outlet are made in two lengths depending on the size of the outlet as given in Table 5. Tees reducing on the run only have the same dimension center to face and face to face as straight size fittings corresponding to the size of the larger opening.

Tees increasing on the outlet are generally known as Bull Head Tees and have the same center to face and face to face dimensions as straight fittings the size of the outlet.

Reducers for all reductions have the same face to face dimensions as given in Table 4 for the larger opening.

Reducing fittings listed in this standard shall be ordered by the designation of the outlets in their proper sequence as indicated in the sketches in Fig 1.

**11. ELBOWS**

Special degree elbows ranging from 1 to 45 deg., inclusive, have the same center to face dimension given for 45-deg. elbows and those over 45 deg. and up to 90 deg., inclusive, shall have the same center to face dimensions given for 90-deg. elbows. The angle designation of an elbow is its deflection from straight line flow and is the angle between the flange faces.

**12. DRAIN TAPPINGS**

The maximum size of hole that can be tapped in the wall of the fitting without adding a boss is shown in Table 1.

When bosses are required the method of designating the locations of the tapped holes for drains is shown in Fig 2. Each possible location is designated by a letter so that desired locations for the various types of fittings may be definitely specified without the use of further sketches or description.

**Maximum Size of Tapped Hole in Fitting Without Adding Bosses**

TABLE NO. 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Size of Fitting (Inches) | 2–3 | 4–5 | 6 | 8 | 10 | 12 | 14–24 |
| Size of Tapped Hole (Inches) | ⅜ | ½ | ¾ | 1 | 1¼ | 1½ | 2 |

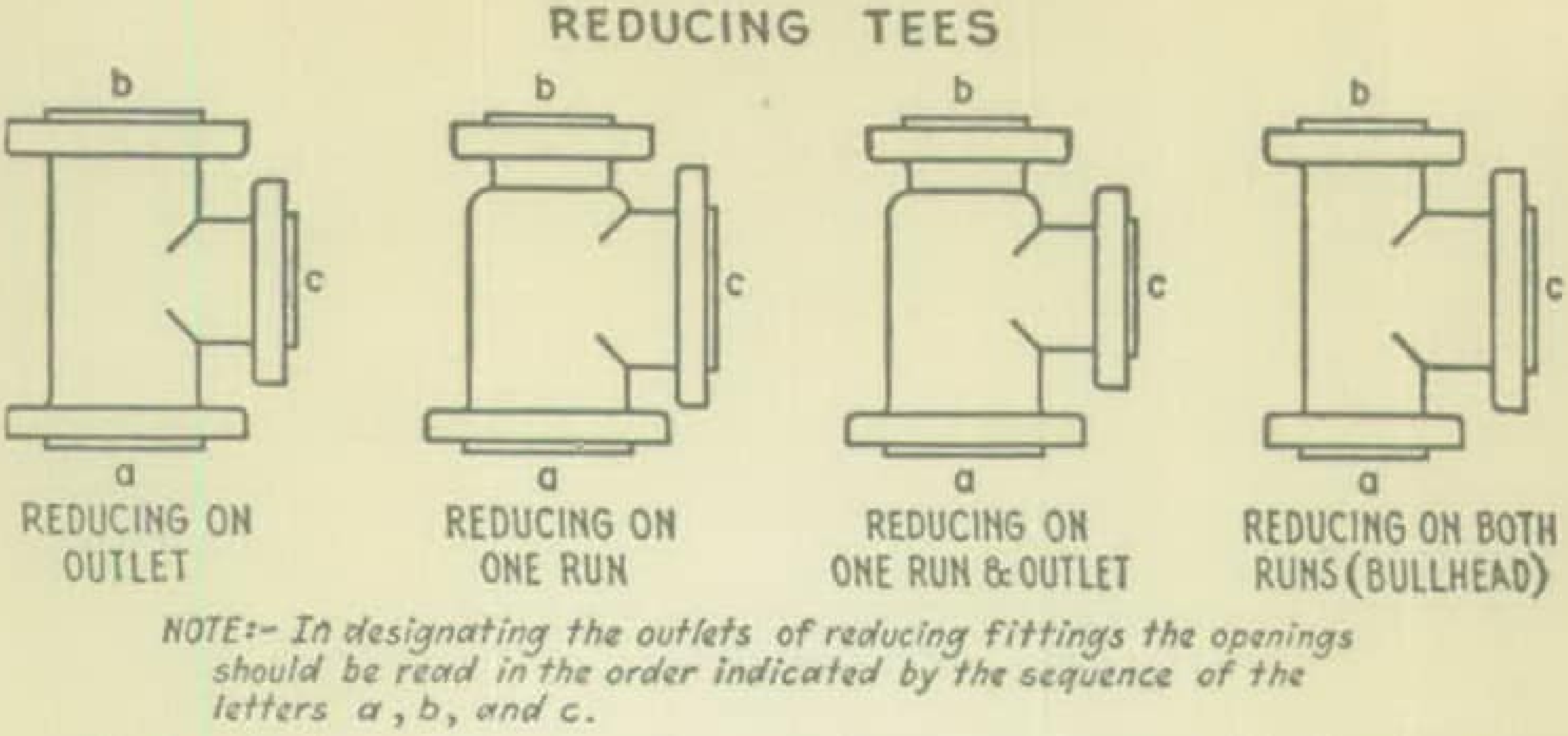



Fig. 1 Method of Designating Outlets of Reducing Fittings in Specifications

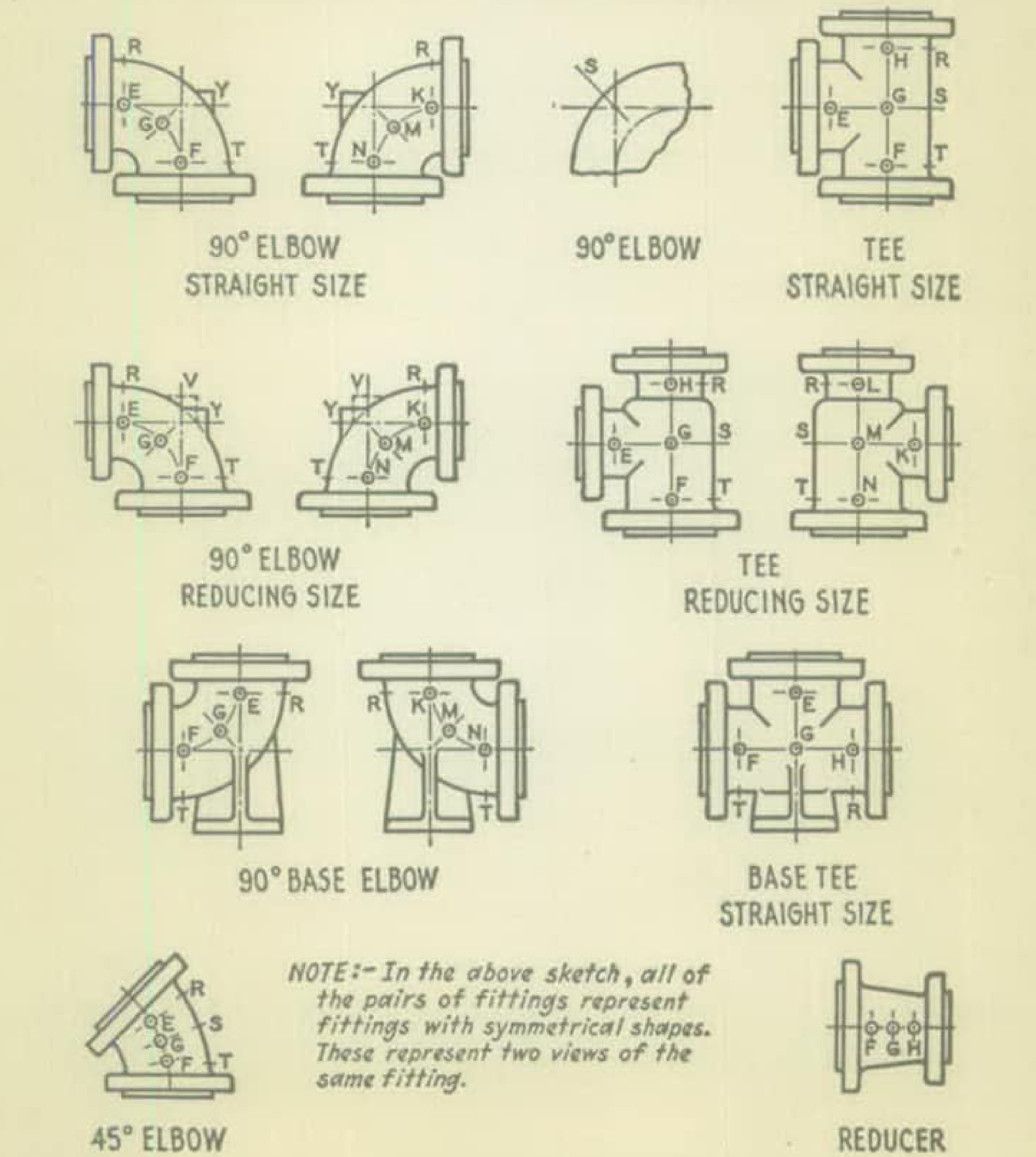



Fig. 2 Method of Designating Location of Tapped Holes for Drains When Specified

# Class 250 Cast Iron Flanges and Fittings

## Dimensions of Cast Iron Flanges, Drilling for Bolts and Their Lengths

TABLE NO. 2

| Nominal Pipe Size | Diam. of Flange | Thickness [3] of Flange (Min.) | Diam. of Raised Face | Diam. of Bolt Circle | Diam.[1] of Bolt Holes | Number [1] of Bolts | Size of Bolts | Length [2] of Bolts | Lgth.[4] of Bolt Studs with Two Nuts | Size of Ring Gasket |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 7/8 | 11/16 | 2 11/16 | 3 1/2 | 3/4 | 4 | 5/8 | 2 1/2 | .......... | 1 x 2 7/8 |
| 1 1/4 | 5 1/4 | 3/4 | 3 1/16 | 3 7/8 | 3/4 | 4 | 5/8 | 2 1/2 | .......... | 1 1/4 x 3 1/4 |
| 1 1/2 | 6 1/8 | 13/16 | 3 9/16 | 4 1/2 | 7/8 | 4 | 3/4 | 2 3/4 | .......... | 1 1/2 x 3 3/4 |
| 2 | 6 1/2 | 7/8 | 4 3/16 | 5 | 3/4 | 8 | 5/8 | 2 3/4 | .......... | 2 x 4 3/8 |
| 2 1/2 | 7 1/2 | 1 | 4 15/16 | 5 7/8 | 7/8 | 8 | 3/4 | 3 1/4 | .......... | 2 1/2 x 5 1/8 |
| 3 | 8 1/4 | 1 1/8 | 5 11/16 | 6 5/8 | 7/8 | 8 | 3/4 | 3 1/2 | .......... | 3 x 5 7/8 |
| 3 1/2 | 9 | 1 3/16 | 6 5/16 | 7 1/4 | 7/8 | 8 | 3/4 | 3 1/2 | .......... | 3 1/2 x 6 1/2 |
| 4 | 10 | 1 1/4 | 6 15/16 | 7 7/8 | 7/8 | 8 | 3/4 | 3 3/4 | .......... | 4 x 7 1/8 |
| 5 | 11 | 1 3/8 | 8 5/16 | 9 1/4 | 7/8 | 8 | 3/4 | 4 | .......... | 5 x 8 1/2 |
| 6 | 12 1/2 | 1 7/16 | 9 11/16 | 10 5/8 | 7/8 | 12 | 3/4 | 4 | .......... | 6 x 9 7/8 |
| 8 | 15 | 1 5/8 | 11 15/16 | 13 | 1 | 12 | 7/8 | 4 1/2 | .......... | 8 x12 1/8 |
| 10 | 17 1/2 | 1 7/8 | 14 1/16 | 15 1/4 | 1 1/8 | 16 | 1 | 5 1/4 | .......... | 10 x14 1/4 |
| 12 | 20 1/2 | 2 | 16 7/16 | 17 3/4 | 1 1/4 | 16 | 1 1/8 | 5 1/2 | .......... | 12 x16 5/8 |
| 14 OD | 23 | 2 1/8 | 18 15/16 | 20 1/4 | 1 1/4 | 20 | 1 1/8 | 6 | .......... | 13 1/4 x19 1/8 |
| 16 OD | 25 1/2 | 2 1/4 | 21 1/16 | 22 1/2 | 1 3/8 | 20 | 1 1/4 | 6 1/4 | .......... | 15 1/4 x21 1/4 |
| 18 OD | 28 | 2 3/8 | 23 5/16 | 24 3/4 | 1 3/8 | 24 | 1 1/4 | 6 1/2 | .......... | 17 x23 1/2 |
| 20 OD | 30 1/2 | 2 1/2 | 25 9/16 | 27 | 1 3/8 | 24 | 1 1/4 | 6 3/4 | .......... | 19 x25 3/4 |
| 24 OD | 36 | 2 3/4 | 30 1/4 | 32 | 1 11/16 | 24 | 1 1/2 | 7 3/4 | 9 1/2 | 23 x30 1/2 |
| *30 OD | 43 | 3 | 37 3/16 | 39 1/4 | 2 | 28 | 1 3/4 | 8 1/2 | 10 1/2 | 29 x37 1/2 |
| *36 OD | 50 | 3 3/8 | 43 11/16 | 46 | 2 1/4 | 32 | 2 | 9 1/2 | 11 3/4 | 34 1/2 x44 |
| *42 OD | 57 | 3 11/16 | 50 7/16 | 52 3/4 | 2 1/4 | 36 | 2 | 10 1/4 | 12 1/2 | 40 1/4 x50 3/4 |
| *48 OD | 65 | 4 | 58 7/16 | 60 3/4 | 2 1/4 | 40 | 2 | 10 3/4 | 13 | 46 x58 3/4 |

All dimensions given in inches.

* These sizes are included for convenience where special fittings larger than 24 in. are required.

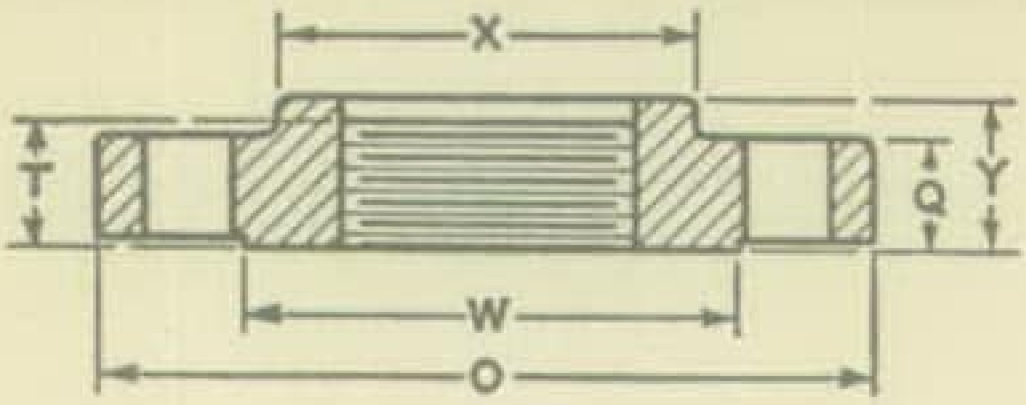
[1] Drilling templates are in multiples of four, so that fittings may be made to face in any quarter, and bolt holes straddle the center line. For bolts smaller than 1 1/2 in. the bolt holes shall be drilled 1/8 in. larger in diameter than the nominal diameter of the bolt. Holes for bolts 1 1/2 in. shall be drilled 3/16 in. larger in diameter than the nominal diameter of the bolt. Holes for bolts 1 3/4 in. and larger shall be drilled 1/4 in. larger than nominal diameter of bolts.

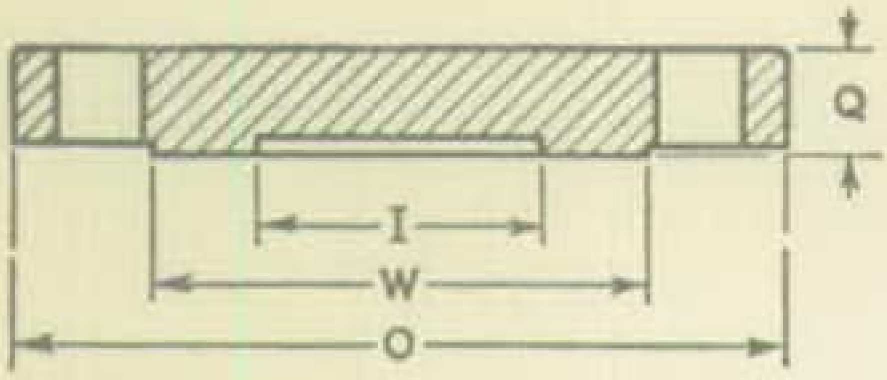
[2] For spot facing the bolt holes on both flanges and fittings, see Par. 9, Spot Facing.

[3] All Class 250 cast iron flanges have a 1/16-in. raised face. This raised face is included in the face to face, center to face, and the minimum thickness of flange dimensions.

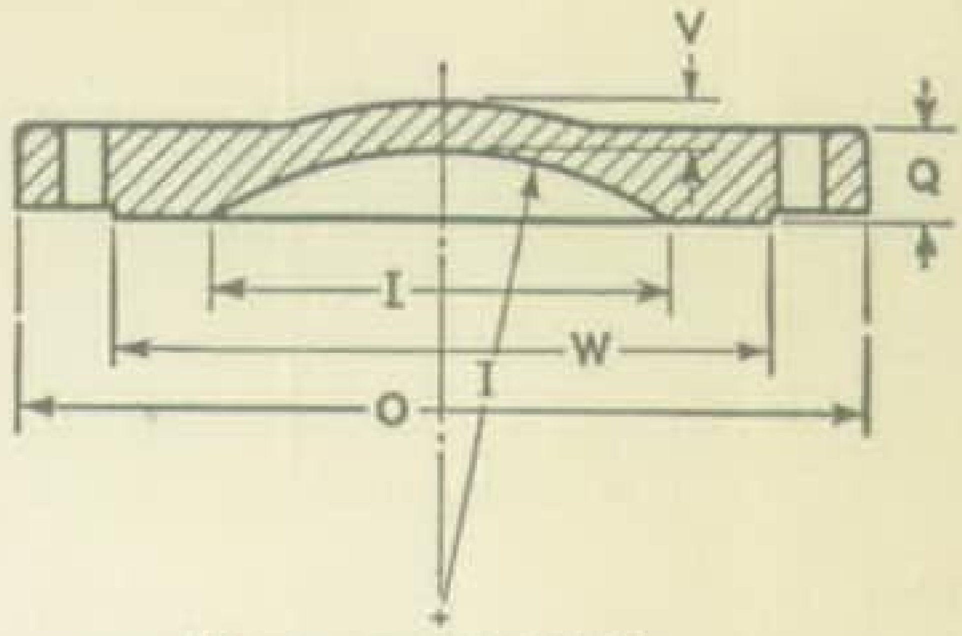
[4] For bolting specifications, see Par. 8, Bolting.

## Class 250 Cast Iron Flanges and Fittings




8 IN. AND SMALLER




10 IN. AND LARGER

### Dimensions of Screwed Companion and Blind Flanges[1,3]

TABLE NO. 3

| Nominal Pipe Size | Diam.[2] of Port I | Diam. of Flange O | Thickness[1] of Flange (Min.) Q | Wall Thickness V | Diam. Hub (Min.) X | Length Through Hub (Min.) Y | Length of Threads (Min.) T | Diam.[1] of Raised Face W |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 4 7/8 | 11/16 | ........ | 2 1/16 | 7/8 | 0.68 | 2 11/16 |
| 1 1/4 | 1 1/4 | 5 1/4 | 3/4 | ........ | 2 1/2 | 1 | 0.76 | 3 1/16 |
| 1 1/2 | 1 1/2 | 6 1/8 | 13/16 | ........ | 2 3/4 | 1 1/8 | 0.87 | 3 9/16 |
| 2 | 2 | 6 1/2 | 7/8 | ........ | 3 5/16 | 1 1/4 | 1.00 | 4 3/16 |
| 2 1/2 | 2 1/2 | 7 1/2 | 1 | ........ | 3 15/16 | 1 7/16 | 1.14 | 4 15/16 |
| 3 | 3 | 8 1/4 | 1 1/8 | ........ | 4 5/8 | 1 9/16 | 1.20 | 5 11/16 |
| 3 1/2 | 3 1/2 | 9 | 1 3/16 | ........ | 5 1/4 | 1 5/8 | 1.25 | 6 5/16 |
| 4 | 4 | 10 | 1 1/4 | ........ | 5 3/4 | 1 3/4 | 1.30 | 6 15/16 |
| 5 | 5 | 11 | 1 3/8 | ........ | 7 | 1 7/8 | 1.41 | 8 5/16 |
| 6 | 6 | 12 1/2 | 1 7/16 | ........ | 8 1/8 | 1 15/16 | 1.51 | 9 11/16 |
| 8 | 8 | 15 | 1 5/8 | ........ | 10 1/4 | 2 3/16 | 1.71 | 11 15/16 |
| 10 | 10 | 17 1/2 | 1 7/8 | 15/16 | 12 5/8 | 2 3/8 | 1.92 | 14 1/16 |
| 12 | 12 | 20 1/2 | 2 | 1 | 14 3/4 | 2 9/16 | 2.12 | 16 7/16 |
| 14 OD | 13 1/4 | 23 | 2 1/8 | 1 1/8 | 16 1/4 | 2 11/16 | 2.25 | 18 15/16 |
| 16 OD | 15 1/4 | 25 1/2 | 2 1/4 | 1 1/4 | 18 3/8 | 2 7/8 | 2.45 | 21 1/16 |
| 18 OD | 17 | 28 | 2 3/8 | 1 3/8 | ........ | ........ | ........ | 23 5/16 |
| 20 OD | 19 | 30 1/2 | 2 1/2 | 1 1/2 | ........ | ........ | ........ | 25 9/16 |
| 24 OD | 23 | 36 | 2 3/4 | 1 5/8 | ........ | ........ | ........ | 30 1/4 |

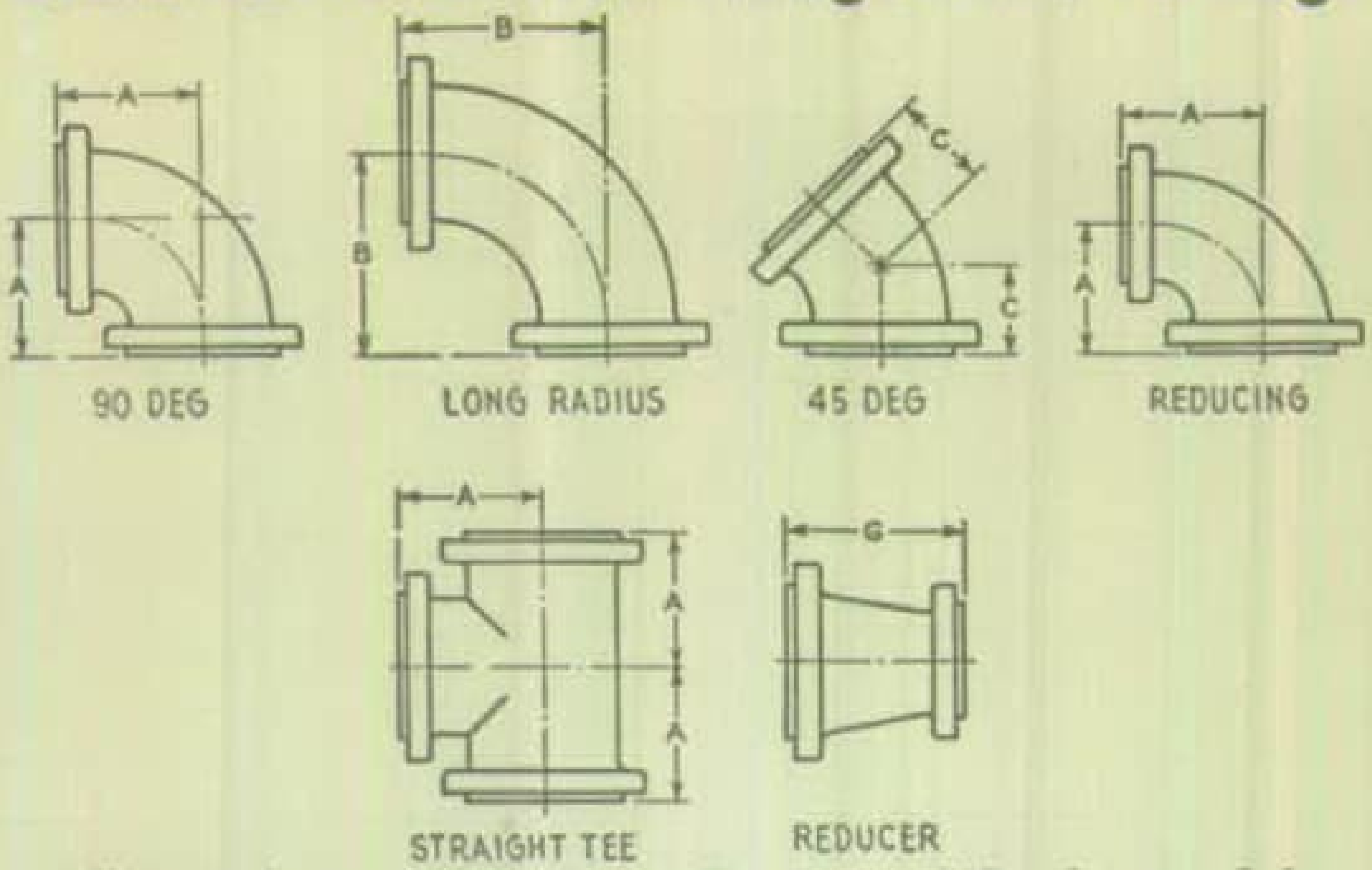
All dimensions given in inches.

[1] All Class 250 cast iron flanges have a 1/16-inch raised face. This raised face is included in the minimum thickness of flange dimensions.

[2] All blind flanges for sizes 10 inches (17 1/2 inches OD) and larger must be dished, with inside radius equal to the port diameter. The wall thickness at no point shall be less than 87 1/2 per cent of the dimensions given in the table.

[3] For drilling templates refer to Table 2.

# Class 250 Cast Iron Flanges and Fittings




## Dimensions of Elbows, Tees, and Reducers[1,6]

TABLE NO. 4

| Nominal Pipe Size | Inside Diam. of Fitting (Min.) | Wall[5] Thickness of Body | Diam. of Flange | Thickness[1] of Flange (Min.) | Diam.[1] of Raised Face | Center[1,2,3] to Face Elbow and Tee A | Center[1] to Face Long Radius Elbow B | Center[1,3] to Face 45 Deg. Elbow C | Face[1,4] to Face Reducer G |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 7/16 | 6½ | 7/8 | 4 3/16 | 5 | 6½ | 3 | 5 |
| 2½ | 2½ | ½ | 7½ | 1 | 4 15/16 | 5½ | 7 | 3½ | 5½ |
| 3 | 3 | 9/16 | 8¼ | 1⅛ | 5 11/16 | 6 | 7¾ | 3½ | 6 |
| 3½ | 3½ | 9/16 | 9 | 1 3/16 | 6 5/16 | 6½ | 8½ | 4 | 6½ |
| 4 | 4 | ⅝ | 10 | 1¼ | 6 15/16 | 7 | 9 | 4½ | 7 |
| 5 | 5 | 11/16 | 11 | 1⅜ | 8 5/16 | 8 | 10¼ | 5 | 8 |
| 6 | 6 | ¾ | 12½ | 1 7/16 | 9 11/16 | 8½ | 11½ | 5½ | 9 |
| 8 | 8 | 13/16 | 15 | 1⅝ | 11 15/16 | 10 | 14 | 6 | 11 |
| 10 | 10 | 15/16 | 17½ | 1⅞ | 14 1/16 | 11½ | 16½ | 7 | 12 |
| 12 | 12 | 1 | 20½ | 2 | 16 7/16 | 13 | 19 | 8 | 14 |
| 14 OD | 13¼ | 1⅛ | 23 | 2⅛ | 18 15/16 | 15 | 21½ | 8½ | 16 |
| 16 OD | 15¼ | 1¼ | 25½ | 2¼ | 21 1/16 | 16½ | 24 | 9½ | 18 |
| 18 OD | 17 | 1⅜ | 28 | 2⅜ | 23 5/16 | 18 | 26½ | 10 | 19 |
| 20 OD | 19 | 1½ | 30½ | 2½ | 25 9/16 | 19½ | 29 | 10½ | 20 |
| 24 OD | 23 | 1⅝ | 36 | 2¾ | 30¼ | 22½ | 34 | 12 | 24 |

All dimensions given in inches.

[1] All Class 250 cast iron flanges have a 1/16-inch raised face. This raised face is included in the face to face, center to face, and the minimum thickness of flange dimensions.

[2] Reducing elbows carry the same dimensions center to face as regular straight size elbows corresponding to the size of the larger opening. Tees 16 inch and smaller reducing on the outlet have the same dimensions center to face and face to face as straight size fittings corresponding to the size of the larger opening. Sizes 18 inch and larger reducing on the outlet are made in two lengths depending on the size of the outlet. For dimensions of the short body pattern see Table 5.

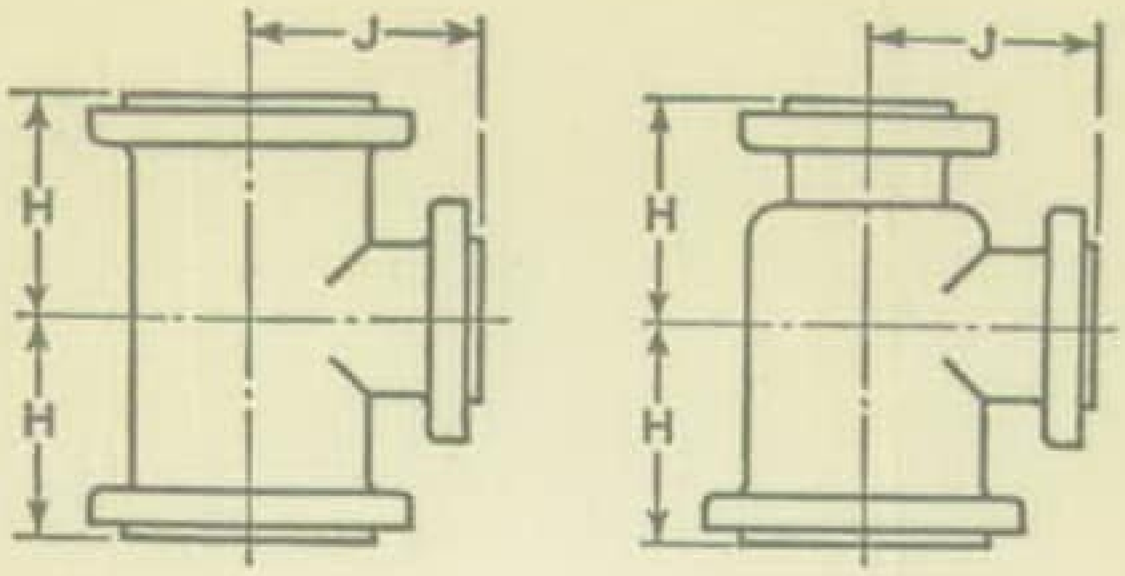
[3] Special degree elbows ranging from 1 to 45 deg., inclusive, have the same center to face dimensions given for 45-deg. elbows, and those over 45 deg. and up to 90 deg., inclusive, shall have the same center to face dimensions given for 90-deg. elbows. The angle designation of an elbow is its deflection from straight line flow and is the angle between the flange faces.

[4] Reducers, for all reductions, use the same face to face dimensions given in the above table of dimensions for the larger opening.

[5] Wall thickness at no point shall be less than 87½ per cent of the dimensions given in the table.

[6] For drilling templates refer to Table 2.

# Class 250 Cast Iron Flanges and Fittings




## Dimensions of Reducing Tees[2, 4] (Short Body Patterns)

TABLE NO. 5

| Nominal[2] Pipe Size | Size[3] of Outlet and Smaller | Center[1] to Face Run H | Face[1] to Face Run H+H | Center[1] to Face Outlet J |
|---|---|---|---|---|
| All reducing tees sizes 16 in. and smaller have same face to face and center to face dimensions as straight sizes. See Table 4 | | | | |
| 18OD | 12 | 14 | 28 | 17 |
| 20OD | 14 | 15½ | 31 | 18½ |
| 24OD | 16 | 17 | 34 | 21½ |

All dimensions given in inches.

[1] All Class 250 cast iron flanges have a 1/16-in. raised face. This raised face is included in the face to face, center to face, and the minimum thickness of flange dimensions.

[2] Short body patterns are used for sizes 18 in. and larger.

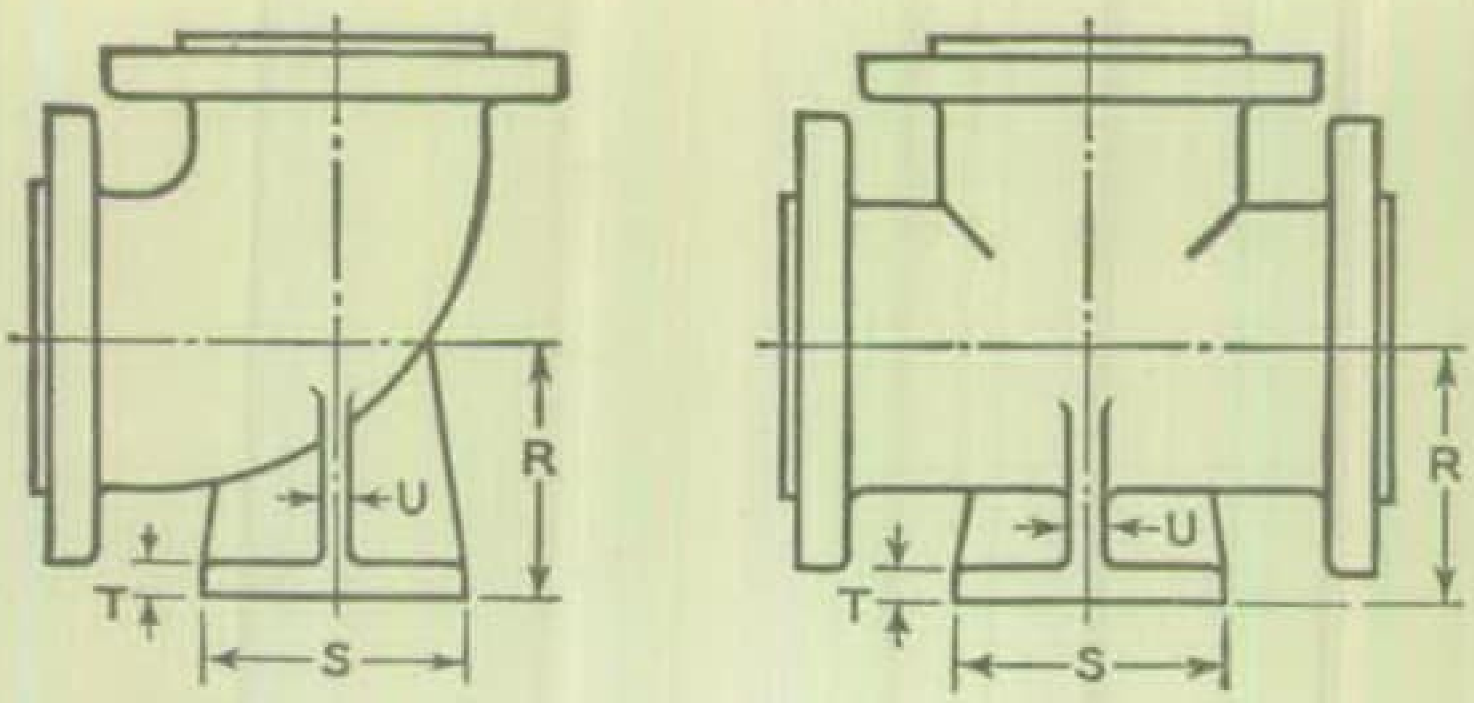
[3] Long body patterns are used when outlets are larger than given in the above table, and, therefore, have the same dimensions as straight size fittings.

[4] Tees reducing on the run only carry same dimensions center to face and face to face as straight size fittings corresponding to size of the larger opening. Tees increasing on outlet, known as Bull Head Tees, will have same center to face and face to face dimensions as a straight fitting of the size of the outlet. For example: A 12x12x18-in. tee will be governed by the dimensions of the 18-in. long body tee, given in Table 4, namely 18 in. center to face of all openings and 36 in. face to face.

For flange dimensions, wall thicknesses, and port diameters, see Table 4.

For drilling dimensions, see Table 2.

# Class 250 Cast Iron Flanges and Fittings




## Dimensions of Base Elbows and Base Tees[3,4]

TABLE NO. 6

| Nominal Pipe Size | Center to Base R | Diam.[1,2] of Round Base S | Thickness of Base T | Thickness of Ribs U | Size of Supporting Pipe for Base |
|---|---|---|---|---|---|
| 2 | 4½ | 5¼ | ¾ | ½ | 1¼ |
| 2½ | 4¾ | 5¼ | ¾ | ½ | 1¼ |
| 3 | 5¼ | 6⅛ | 13/16 | ⅝ | 1½ |
| 3½ | 5⅝ | 6⅛ | 13/16 | ⅝ | 1½ |
| 4 | 6 | 6½ | ⅞ | ⅝ | 2 |
| 5 | 6¾ | 7½ | 1 | ¾ | 2½ |
| 6 | 7½ | 7½ | 1 | ¾ | 2½ |
| 8 | 9 | 10 | 1¼ | ⅞ | 4 |
| 10 | 10½ | 10 | 1¼ | ⅞ | 4 |
| 12 | 12 | 12½ | 1 7/16 | 1 | 6 |
| 14OD | 13½ | 12½ | 1 7/16 | 1 | 6 |
| 16OD | 14¾ | 12½ | 1 7/16 | 1⅛ | 6 |
| 18OD | 16¼ | 15 | 1⅝ | 1⅛ | 8 |
| 20OD | 17⅞ | 15 | 1⅝ | 1¼ | 8 |
| 24OD | 20¾ | 17½ | 1⅞ | 1¼ | 10 |

All dimensions given in inches.

[1] Bases when drilled should be to the template of the flange of the supporting pipe size using only four holes in all cases so placed as to miss the ribs. For drilling templates refer to Table 2. These bases are intended for supports in compression and are not to be used for anchors or supports in tension or shear.

[2] Size and center to face dimension of base are determined by the size of the largest opening of fitting.

[3] Dimensions for base fittings apply to straight and reducing sizes, and long and short body patterns.

[4] Bases not finished unless so ordered.

# APPENDIX[1]

### Theoretical Weights of Class 250 Flanges, Elbows, and Tees[2]

TABLE NO. 1A

| Nominal Pipe Size | Companion Flanges, Pounds | Blind Flanges, Pounds | 90-Deg. Elbow, Pounds | 45-Deg. Elbow, Pounds | 90-Deg. Long Radius Elbow, Pounds | Tees, Pounds |
|---|---|---|---|---|---|---|
| 1 | 3 | 3 | ........ | ........ | ........ | ........ |
| 1¼ | 4 | 4 | ........ | ........ | ........ | ........ |
| 1½ | 6 | 6 | ........ | ........ | ........ | ........ |
| 2 | 7 | 8 | 20 | 18 | 23 | 32 |
| 2½ | 11 | 12 | 30 | 28 | 34 | 46 |
| 3 | 14 | 16 | 40 | 35 | 44 | 58 |
| 3½ | 18 | 20 | 49 | 44 | 55 | 76 |
| 4 | 23 | 26 | 65 | 58 | 72 | 99 |
| 5 | 29 | 34 | 87 | 76 | 98 | 135 |
| 6 | 37 | 46 | 115 | 105 | 135 | 180 |
| 8 | 56 | 75 | 185 | 155 | 220 | 280 |
| 10 | 81 | 120 | 290 | 240 | 350 | 430 |
| 12 | 115 | 155 | 410 | 340 | 510 | 620 |
| 14 OD | 155 | 210 | 560 | 440 | 710 | 870 |
| 16 OD | 195 | 270 | 750 | 620 | 960 | 1150 |
| 18 OD | ........ | 350 | 970 | 780 | 1260 | 1490 |
| 20 OD | ........ | 440 | 1220 | 960 | 1630 | 1880 |
| 24 OD | ........ | 670 | 1840 | 1430 | 2470 | 2800 |

All dimensions given in inches.

[1] For information only, not mandatory.

[2] All weights listed are for fittings faced and drilled, based on minimum thicknesses and dimensions given in preceding tables, without allowances for variation. Cast iron is assumed to weigh 0.26 pound per cubic inch.

# Appendix

## Class 250 Reducing Elbows, and Reducers, Stock Sizes and Weights[1]

TABLE NO. 2A

| Nominal Pipe Size | Reducing Elbow, Weight,[2] Pounds | Reducers, Weight,[2] Pounds | Nominal Pipe Size | Reducing Elbow, Weight,[2] Pounds | Reducers, Weight,[2] Pounds |
|---|---|---|---|---|---|
| 2½x2 | 26 | 22 | 6x4 | 93 | 77 |
| 3 x2½ | 35 | 29 | 8x6 | 155 | 130 |
| 4 x3 | 52 | 44 | 8x5 | 140 | 115 |
| 4 x2½ | 48 | 40 | 8x4 | 130 | 105 |
| 5 x4 | 78 | 63 | 10x8 | 240 | 190 |
| 5 x3 | 65 | 54 | 10x6 | 210 | 170 |
| 6 x5 | 100 | 85 | 10x5 | 190 | 155 |

All dimensions given in inches.

[1] This table is given for information only, and is not part of the standard. It is recommended that stock size fittings be used in laying out piping and that special sizes, not included in the list, be used only when absolutely necessary.

[2] The weights listed are given for convenience in estimating and shipping, and it is intended that they be used for no other purpose.

## Class 250 Reducing Tees, Stock Sizes and Weights[1]

TABLE NO. 3A

| Nominal Pipe Size | Weight[2], Pounds | Nominal Pipe Size | Weight[2], Pounds | Nominal Pipe Size | Weight[2], Pounds |
|---|---|---|---|---|---|
| 2½x2½x2 | 42 | 5x5x2½ | 110 | 8x 8x 2 | 218 |
| 2½x2 x2 | 35 | 5x4x5 | 125 | 8x 6x 8 | 260 |
| 3 x3 x2½ | 58 | 5x4x4 | 120 | 8x 6x 6 | 240 |
| 3 x3 x2 | 53 | 6x6x5 | 170 | 10x10x 8 | 400 |
| 3 x2½x3 | 58 | 6x6x4 | 160 | 10x10x 6 | 370 |
| 3 x2½x2½ | 54 | 6x6x2½ | 149 | 10x10x 5 | 360 |
| 3 x2 x3 | 54 | 6x6x2 | 145 | 10x10x 4 | 352 |
| 3 x2 x2 | 46 | 6x6x3 | 150 | 10x 8x10 | 400 |
| 4 x4 x3 | 89 | 6x5x6 | 175 | 10x 8x 8 | 360 |
| 4 x4 x2½ | 85 | 6x5x5 | 160 | 10x 8x 6 | 340 |
| 4 x4 x2 | 80 | 8x8x6 | 260 | 10x 8x 5 | 335 |
| 4 x3 x4 | 90 | 8x8x5 | 240 | 10x 6x10 | 380 |
| 4 x3 x3 | 80 | 8x8x4 | 240 | 10x 6x 8 | 350 |
| 4 x3 x2 | 71 | 8x8x3 | 220 | 10x 6x 6 | 320 |
| 5 x5 x4 | 125 | 8x8x2½ | 223 | 8x 8x10 | 350 |
| 5 x5 x3 | 115 | ........ | ........ | ........ | ........ |

All dimensions given in inches.

[1] This table is given for information only, and is not part of the standard. It is recommended that stock size fittings be used in laying out piping and that special sizes, not included in the list, be used only when absolutely necessary.

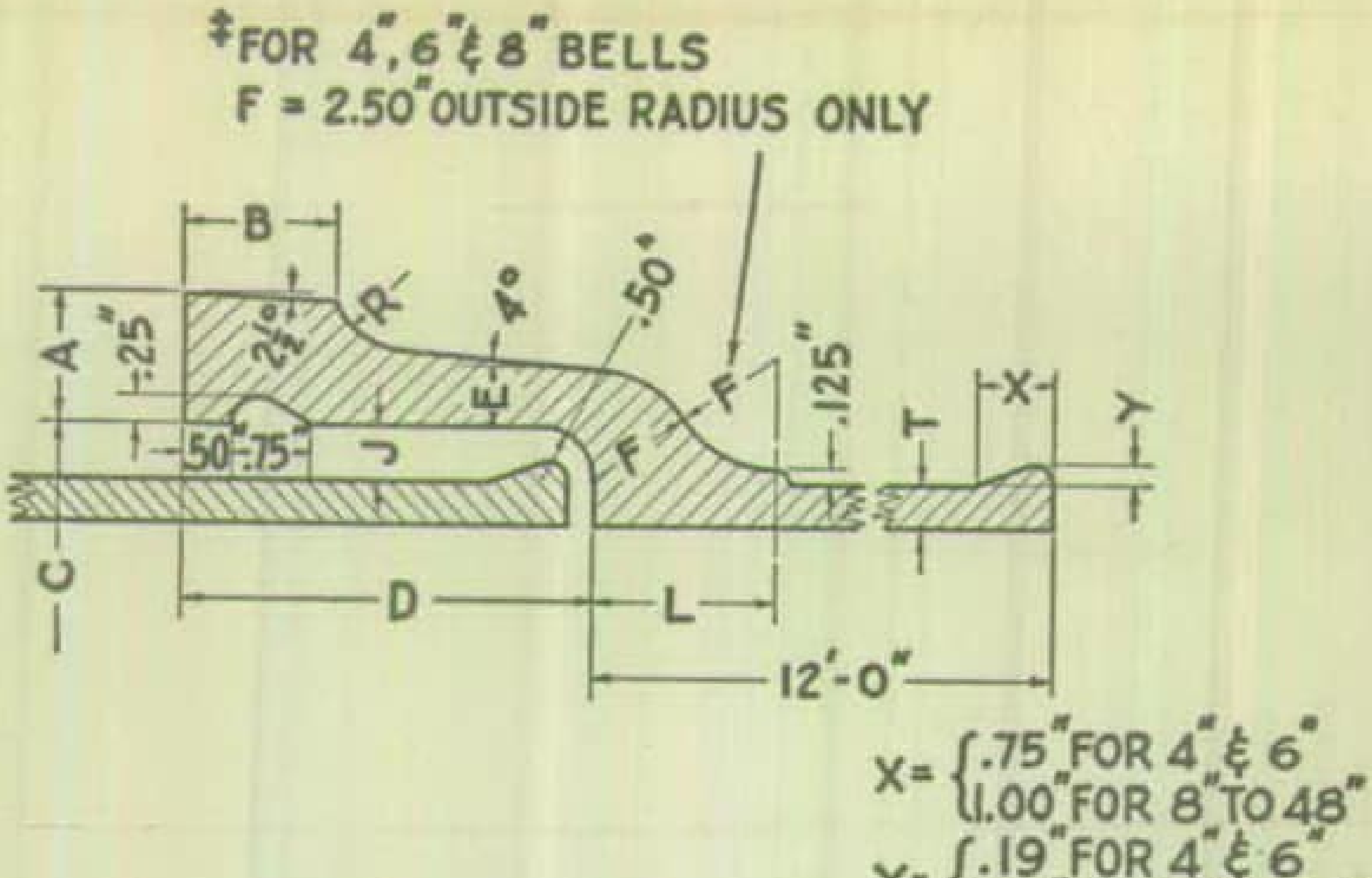
[2] The weights listed are given for convenience in estimating and shipping, and it is intended that they be used for no other purpose.

# SECTION 15

## A.G.A. Weights and Dimensions

### (Bell-and-Spigot Pipe & Fittings)

**Based on 1929 Specifications**




# BELL & SPIGOT PIPE

BELL NO. 1—STANDARD BELL

| Nom. Diam., Ins. | Actual Outside Diam., Ins. | T | Actual Inside Diam., Ins. | Dimensions in Inches | | | | | | | | | Approximate Weight in Pounds | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | A | B | C | D | E | F | J | L | R | Bell † | Per ft. * | 12' 0" Lgth. |
| 4 | 4.80 | .40 | 4.00 | 1.30 | 1.50 | 5.80 | 4.00 | .59 | ‡1.09 | .50 | 3.25 | .75 | 27.0 | 19.50 | 234 |
| 6 | 6.90 | .43 | 6.04 | 1.40 | 1.50 | 7.90 | 4.00 | .62 | ‡1.12 | .50 | 3.25 | .80 | 39.5 | 30.58 | 367 |
| 8 | 9.05 | .45 | 8.15 | 1.50 | 1.50 | 10.05 | 4.00 | .69 | ‡1.19 | .50 | 3.25 | .80 | 52.8 | 42.42 | 509 |
| 10 | 11.10 | .49 | 10.12 | 1.50 | 1.50 | 12.10 | 4.00 | .69 | 1.19 | .50 | 2.10 | .90 | 57.93 | 55.91 | 671 |
| 12 | 13.20 | .54 | 12.12 | 1.60 | 1.50 | 14.20 | 4.50 | .75 | 1.25 | .50 | 2.20 | 1.00 | 79.47 | 73.83 | 886 |
| 16 | 17.40 | .62 | 16.16 | 1.80 | 1.75 | 18.40 | 4.50 | .90 | 1.40 | .50 | 2.50 | 1.10 | 125.18 | 112.58 | 1351 |
| 20 | 21.60 | .68 | 20.24 | 2.00 | 1.75 | 22.85 | 4.50 | .97 | 1.60 | .63 | 2.80 | 1.15 | 169.10 | 153.83 | 1846 |
| 24 | 25.80 | .76 | 24.28 | 2.10 | 2.00 | 27.05 | 5.00 | 1.05 | 1.68 | .63 | 2.80 | 1.25 | 235.10 | 206.41 | 2477 |
| 30 | 31.74 | .85 | 30.04 | 2.30 | 2.00 | 32.99 | 5.00 | 1.15 | 1.78 | .63 | 3.00 | 1.30 | 315.20 | 284.00 | 3408 |
| 36 | 37.96 | .95 | 36.06 | 2.50 | 2.00 | 39.21 | 5.00 | 1.25 | 1.88 | .63 | 3.20 | 1.40 | 410.20 | 379.25 | 4551 |
| 42 | 44.20 | 1.07 | 42.06 | 2.80 | 2.00 | 45.45 | 5.00 | 1.40 | 2.03 | .63 | 3.40 | 1.45 | 537.50 | 497.66 | 5972 |
| 48 | 50.50 | 1.26 | 47.98 | 3.00 | 2.00 | 51.75 | 5.00 | 1.50 | 2.13 | .63 | 3.60 | 1.60 | 657.00 | 663.50 | 7962 |

*Note*—Pipe heavier than these standards may be made by reducing the cores, or internal diameters "C" and "D"; same for specials.

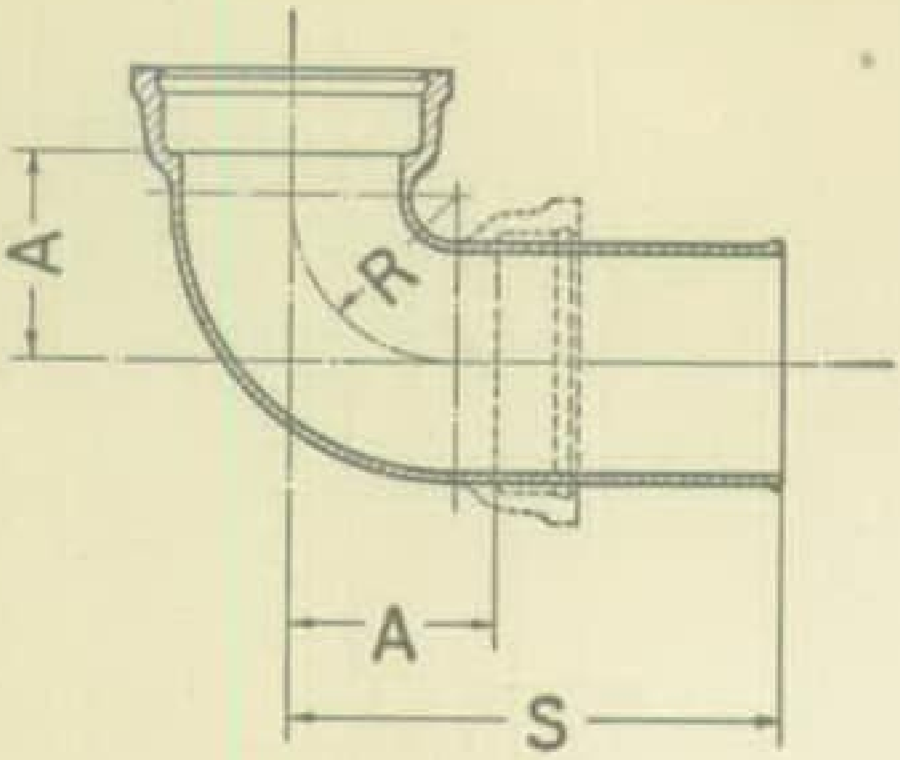
Dimension "L" for sizes 4", 6" and 8", and Dimension "F", shown in sketch as 2.50 (outside radius only), apply to bells of *straight pipe only*. For bells of *special castings* the correct dimensions for "F" and "L" are.

| *Size* | *"F"* | *"L"* |
|---|---|---|
| 4 | 1.09 | 1.90 |
| 6 | 1.12 | 2.00 |
| 8 | 1.19 | 2.10 |

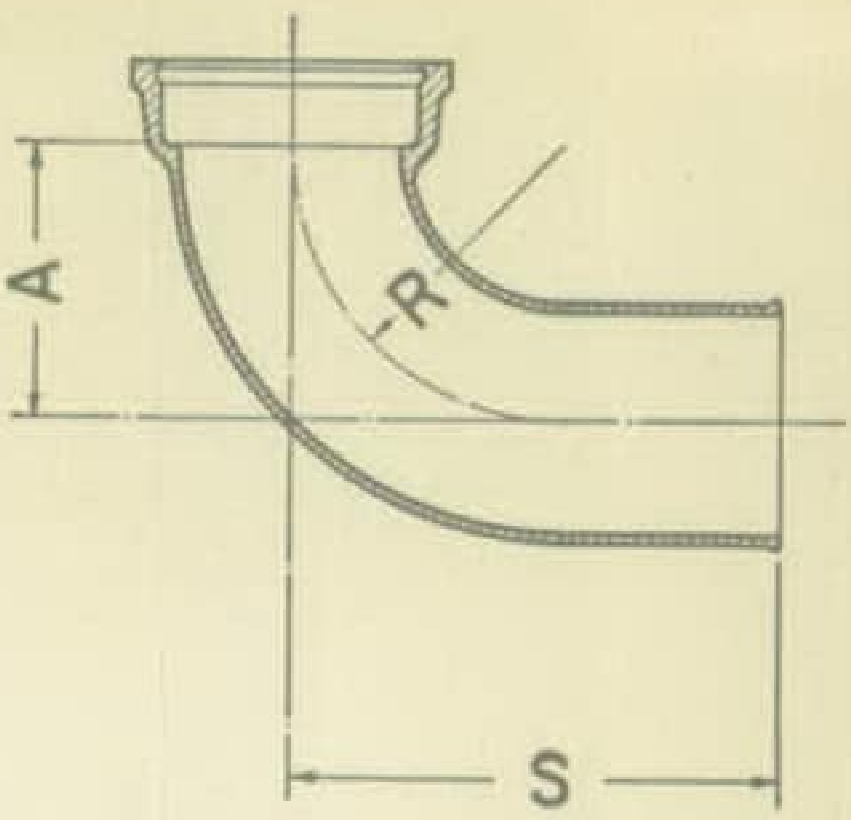
*Weight per foot includes Bell and Bead.

†Weight of Bell includes only metal beyond O. D. of pipe.

‡See Sketch for Special outside radius dimensions for 4", 6" and 8" Bells.




STANDARD
90° BEND




LONG RADIUS
90° BEND

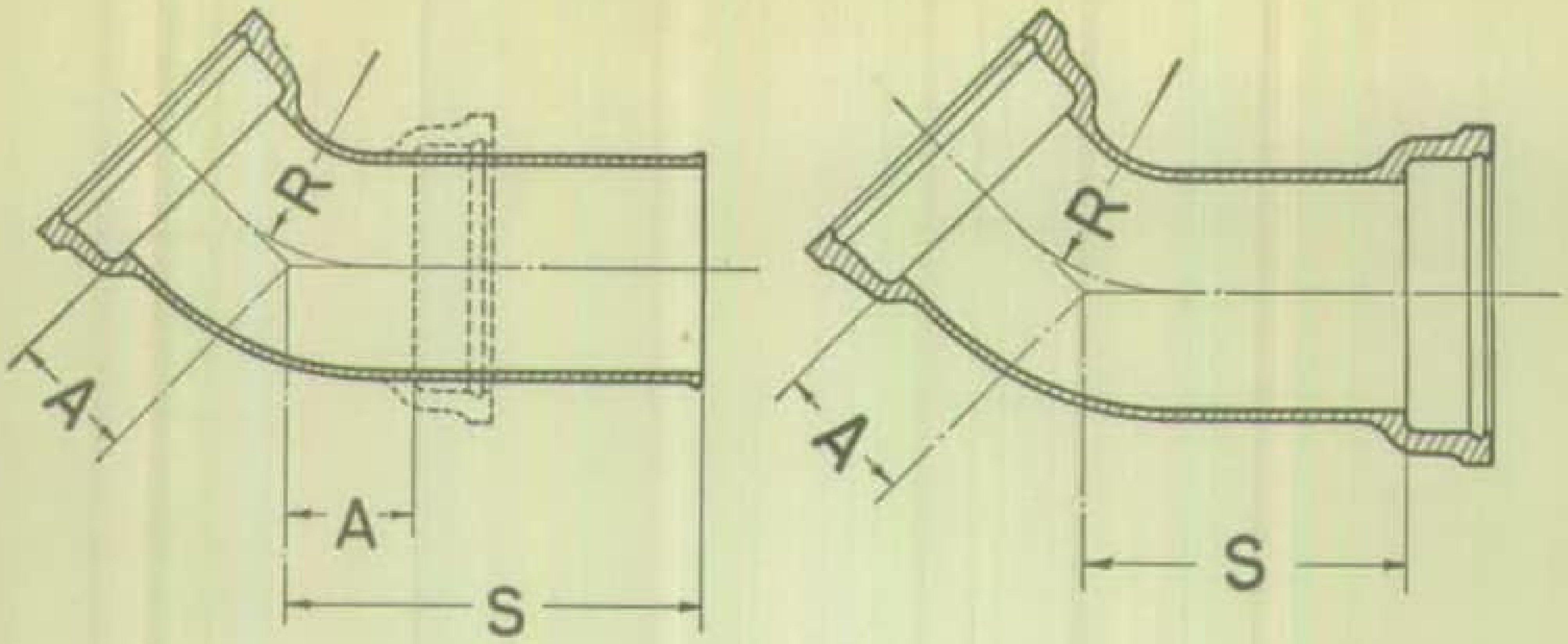
STANDARD 90° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|
| | A | R | S | 1 Bell | 2 Bells |
| 4 | 4.50 | 2.60 | 26 | 68 | 61 |
| 6 | 6.25 | 4.25 | 26 | 100 | 95 |
| 8 | 8.00 | 5.90 | 26 | 149 | 139 |
| 10 | 9.75 | 7.65 | 26 | 198 | 185 |
| 12 | 11.25 | 9.05 | 27 | 278 | 267 |
| 16 | 17.00 | 14.50 | 32 | 491 | 486 |
| 20 | 19.00 | 16.20 | 34 | 707 | 699 |
| 24 | 21.00 | 18.20 | 36 | 1003 | 1002 |
| 30 | 24.00 | 21.00 | 39 | 1478 | 1467 |
| 36 | 28.00 | 24.80 | 42 | 2121 | 2122 |
| 42 | 32.00 | 28.60 | 45 | 2984 | 3025 |
| 48 | 35.00 | 31.40 | 48 | 4193 | 4184 |

LONG RADIUS 90° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds |
|---|---|---|---|---|
| | A | R | S | |
| 24 | 30 | 30 | 42 | 1158 |
| 30 | 36 | 36 | 48 | 1791 |
| 36 | 48 | 48 | 60 | 2926 |
| 42 | 60 | 60 | 72 | 4550 |
| 48 | 66 | 66 | 78 | 6527 |

See Page 372 for Bell and Spigot Dimensions.




TYPE 1
45° BEND

TYPE 2
45° BEND

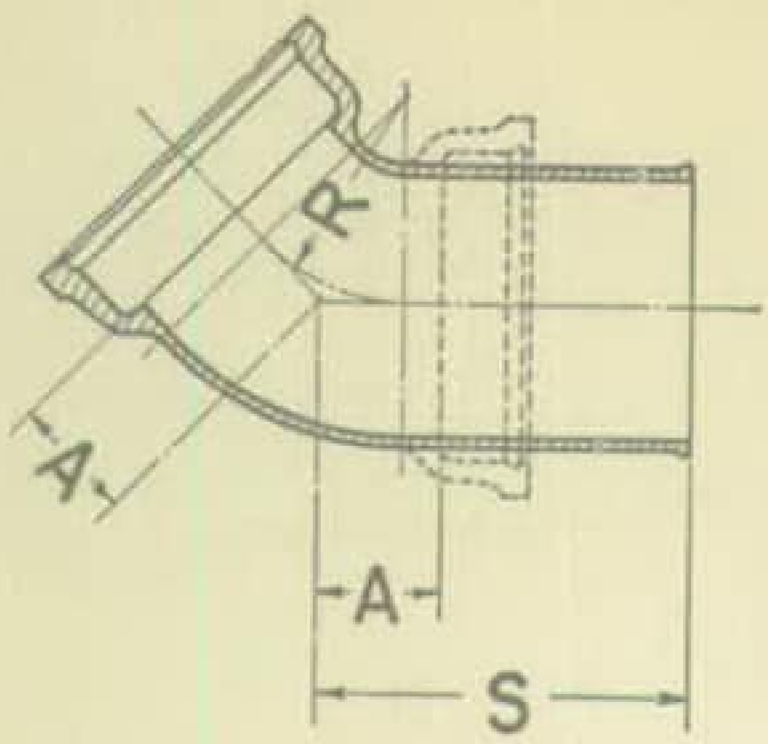
TYPE 1 45° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|
| | A | R | S | 2 Bells | 1 Bell |
| 4 | 3.16 | 3.04 | 23.00 | 59 | 63 |
| 6 | 4.23 | 5.38 | 23.00 | 90 | 97 |
| 8 | 5.31 | 7.75 | 23.00 | 129 | 138 |
| 10 | 6.39 | 10.36 | 23.00 | 168 | 183 |
| 12 | 7.22 | 12.12 | 24.00 | 237 | 253 |
| 16 | 9.12 | 16.00 | 25.00 | 397 | 410 |
| 20 | 11.03 | 19.87 | 27.25 | 585 | 607 |
| 24 | 12.94 | 24.48 | 29.00 | 856 | 874 |
| 30 | 15.67 | 30.54 | 31.50 | 1274 | 1303 |

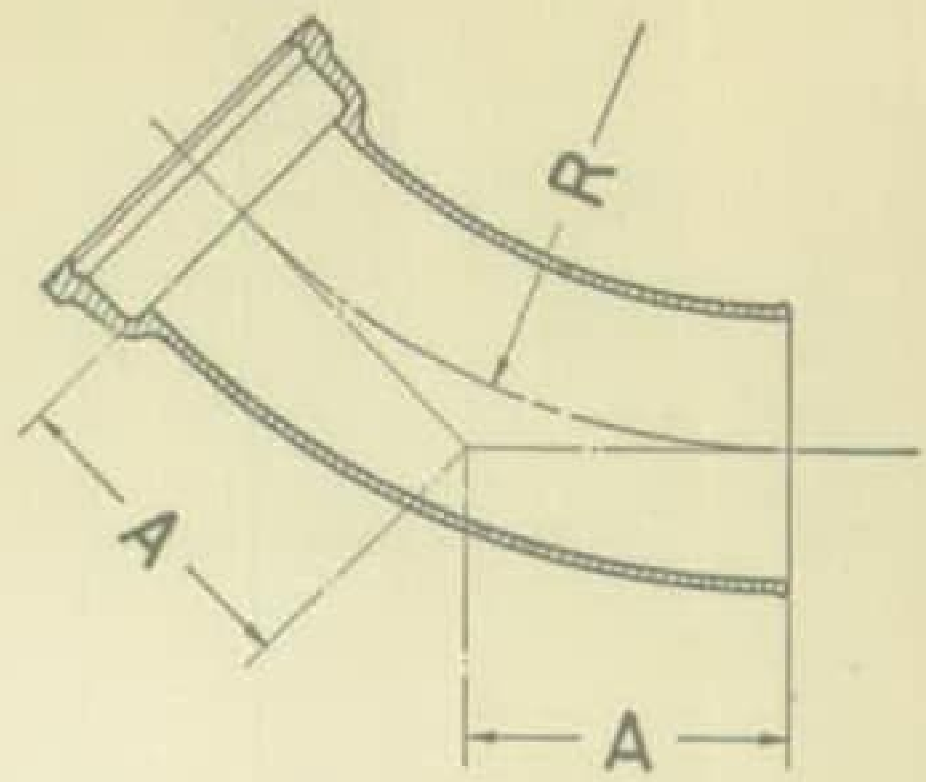
TYPE 2 45° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds |
|---|---|---|---|---|
| | A | R | S | |
| 4 | 3.16 | 3.04 | 13.65 | 74 |
| 6 | 4.23 | 5.38 | 14.48 | 113 |
| 8 | 5.31 | 7.75 | 15.31 | 161 |
| 10 | 6.39 | 10.36 | 16.14 | 210 |
| 12 | 7.22 | 12.12 | 16.97 | 291 |

See Page 372 for Bell and Spigot Dimensions.




STANDARD
45° BEND




LONG RADIUS
45° BEND

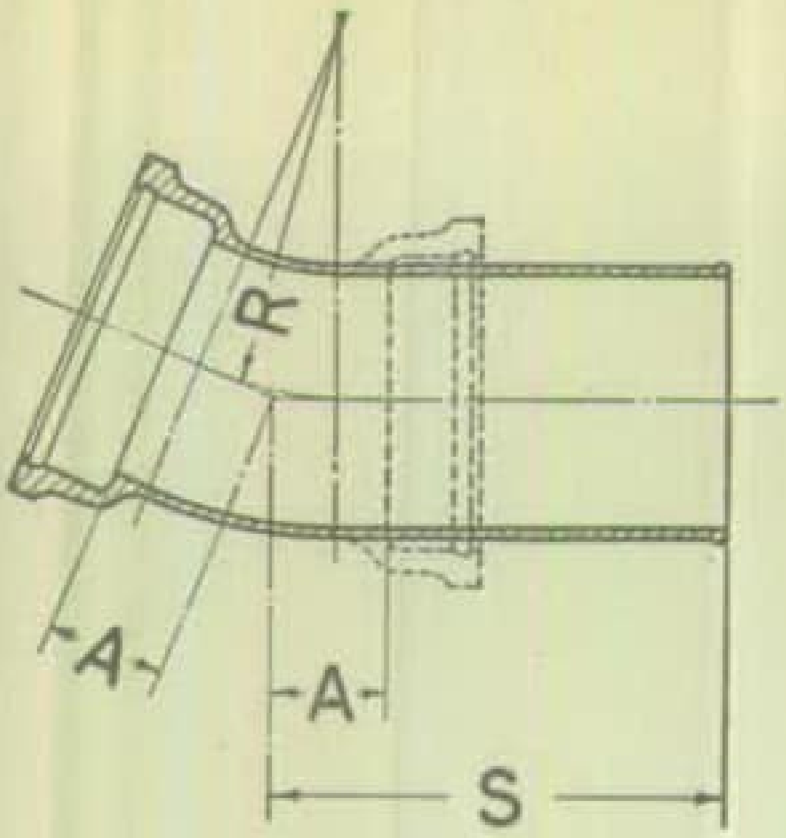
STANDARD 45° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|
| | A | R | S | 2 Bells | 1 Bell |
| 16 | 7.73 | 12.62 | 23 | 377 | 387 |
| 20 | 9.30 | 15.69 | 23 | 546 | 544 |
| 24 | 10.15 | 17.75 | 23 | 774 | 748 |
| 30 | 11.65 | 20.87 | 23 | 1111 | 1053 |
| 36 | 13.34 | 24.50 | 23 | 1557 | 1445 |
| 42 | 14.84 | 27.62 | 23 | 2149 | 1948 |
| 48 | 16.35 | 30.75 | 23 | 2903 | 2625 |

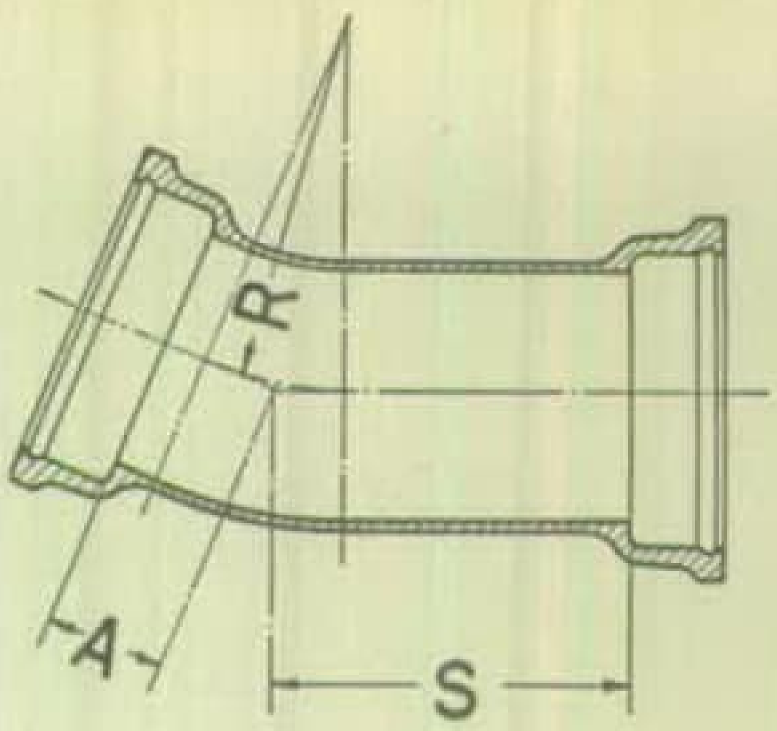
LONG RADIUS 45° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | Approximate Weight in Pounds |
|---|---|---|---|
| | A | R | |
| 16 | 19.88 | 48 | 448 |
| 20 | 19.88 | 48 | 610 |
| 24 | 24.85 | 60 | 971 |
| 30 | 24.85 | 60 | 1332 |
| 36 | 37.28 | 90 | 2446 |
| 42 | 37.28 | 90 | 3208 |
| 48 | 37.28 | 90 | 4247 |

See Page 372 for Bell and Spigot Dimensions.




TYPE 1
$22\frac{1}{2}°$ BEND




TYPE 2
$22\frac{1}{2}°$ BEND

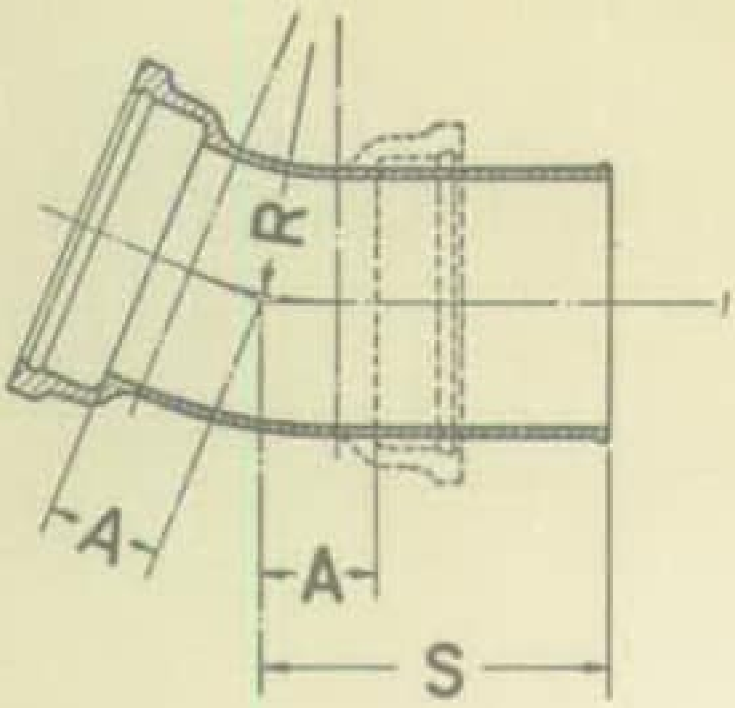
TYPE 1 $22\frac{1}{2}°$ BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|
| | A | R | S | 2 Bells | 1 Bell |
| 4 | 2.69 | 4.00 | 20.25 | 58 | 58 |
| 6 | 3.53 | 7.70 | 20.75 | 87 | 91 |
| 8 | 4.38 | 11.50 | 21.25 | 124 | 130 |
| 10 | 5.22 | 15.70 | 22.00 | 160 | 175 |
| 12 | 5.81 | 18.15 | 22.50 | 223 | 239 |
| 16 | 7.27 | 24.00 | 23.75 | 373 | 390 |
| 20 | 8.71 | 29.75 | 24.75 | 538 | 559 |
| 24 | 10.16 | 37.00 | 26.00 | 783 | 798 |
| 30 | 12.20 | 46.25 | 27.75 | 1153 | 1176 |

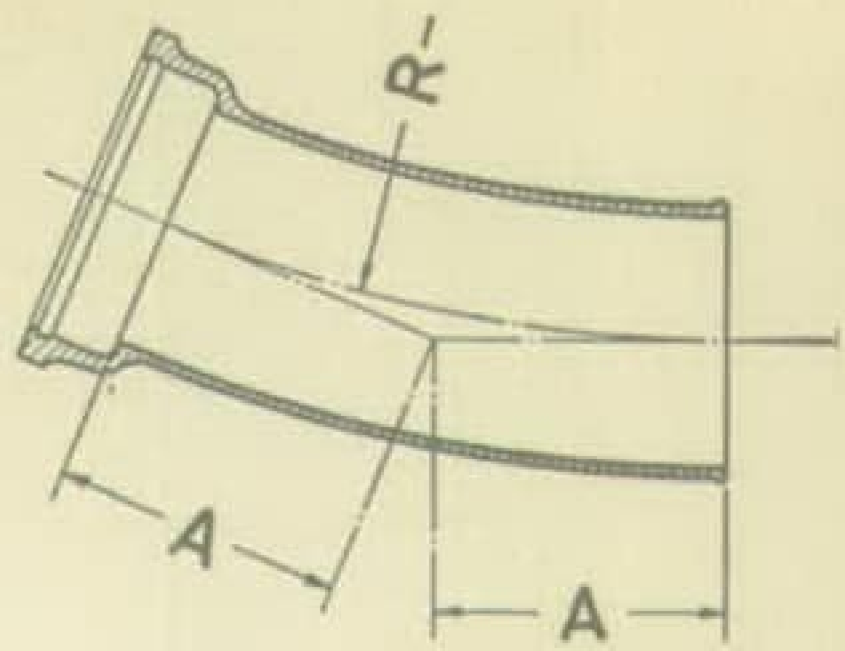
TYPE 2 $22\frac{1}{2}°$ BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds |
|---|---|---|---|---|
| | A | R | S | |
| 4 | 2.69 | 4.00 | 14.70 | 75 |
| 6 | 3.53 | 7.70 | 15.53 | 114 |
| 8 | 4.38 | 11.50 | 16.38 | 162 |
| 10 | 5.22 | 15.70 | 17.25 | 211 |
| 12 | 5.81 | 18.15 | 17.81 | 290 |

See Page 372 for Bell and Spigot Dimensions.




STANDARD
22½° BEND




LONG RADIUS
22½° BEND

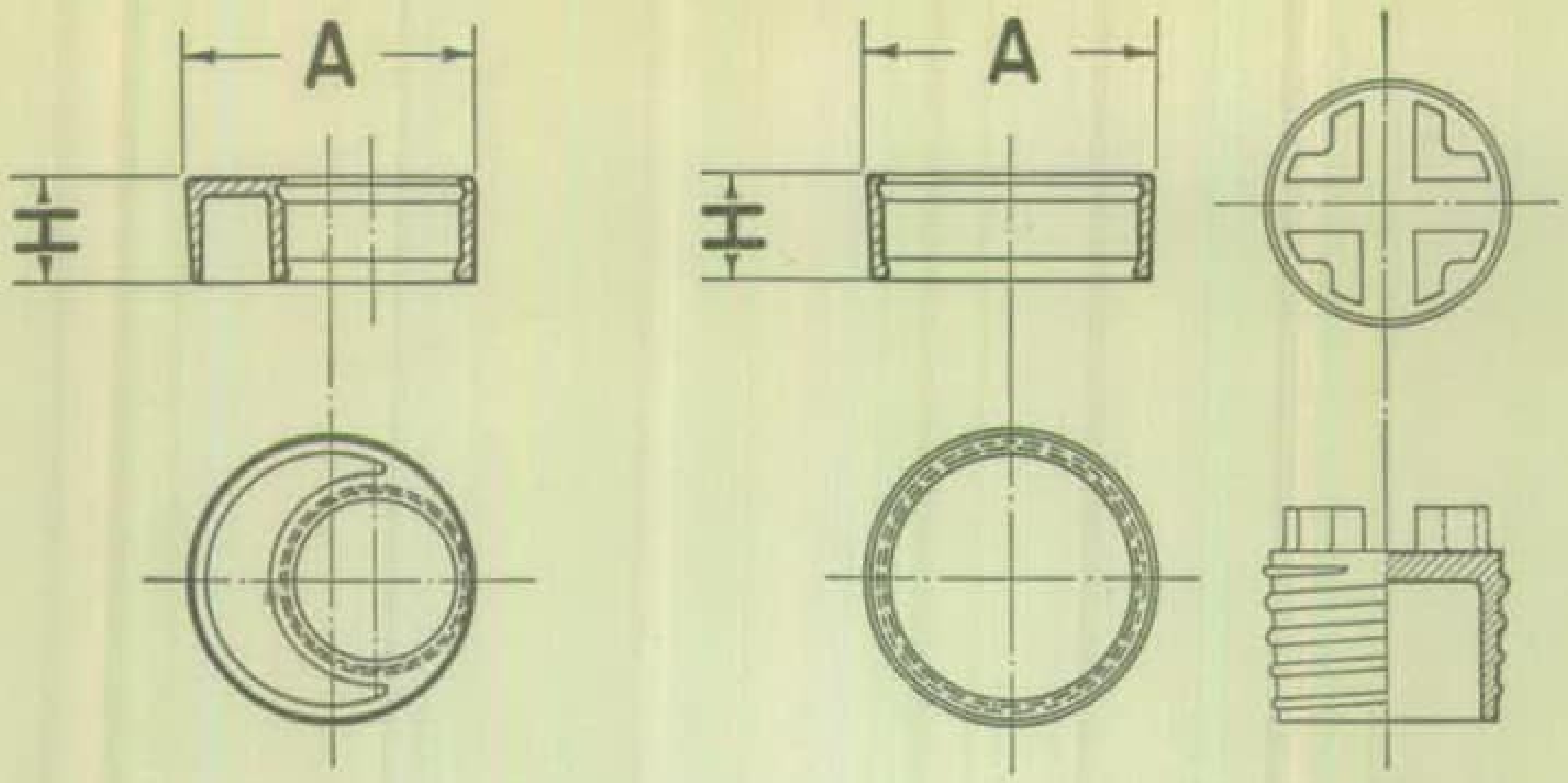
STANDARD 22½° BEND

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|
| | A | R | S | 2 Bells | 1 Bell |
| 16 | 5.00 | 12.62 | 23 | 335 | 366 |
| 20 | 5.92 | 15.69 | 23 | 475 | 508 |
| 24 | 6.33 | 17.75 | 23 | 666 | 694 |
| 30 | 7.15 | 20.87 | 23 | 935 | 966 |
| 36 | 8.07 | 24.50 | 23 | 1280 | 1306 |
| 42 | 8.89 | 27.62 | 23 | 1740 | 1744 |
| 48 | 9.72 | 30.75 | 23 | 2291 | 2319 |

LONG RADIUS 22½° BENDS

| Nominal Diameter, Inches | Dimensions in Inches | | Approximate Weight in Pounds |
|---|---|---|---|
| | A | R | |
| 16 | 19.10 | 96 | 449 |
| 20 | 19.10 | 96 | 611 |
| 24 | 23.87 | 120 | 971 |
| 30 | 23.87 | 120 | 1331 |
| 36 | 35.80 | 180 | 2446 |
| 42 | 35.80 | 180 | 3209 |
| 48 | 35.80 | 180 | 4247 |

See Page 372 for Bell and Spigot Dimensions.



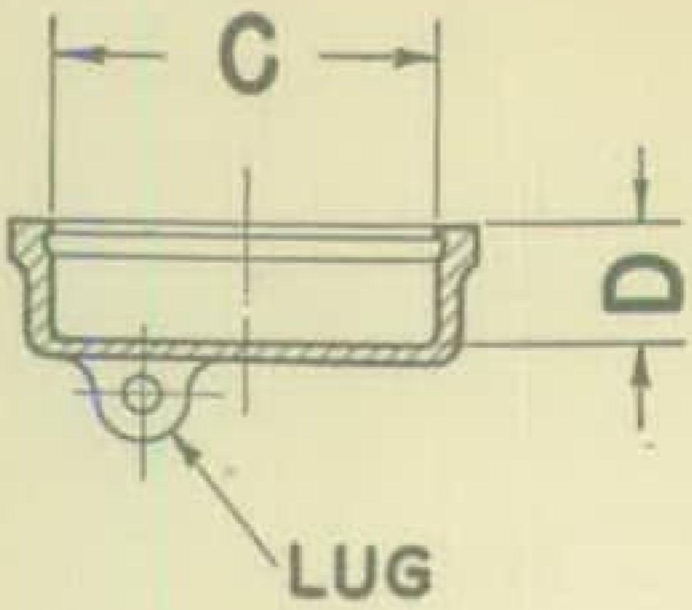

**BUSHINGS** **SCREW PLUG**

BUSHINGS

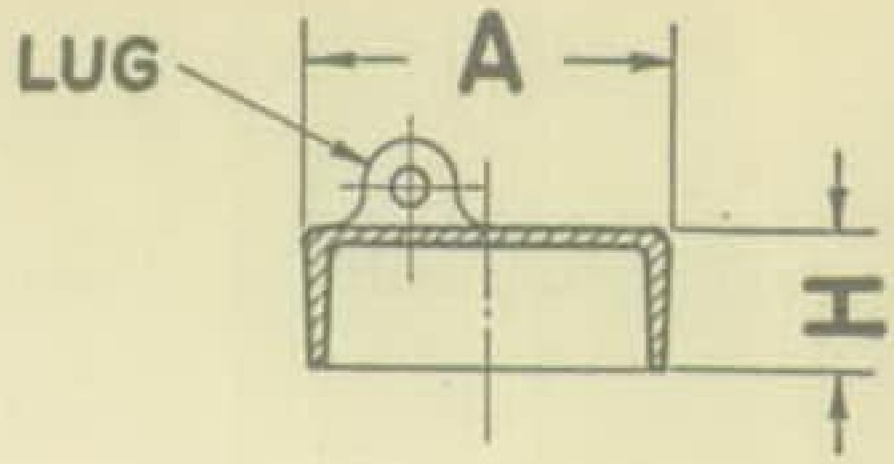
| Nominal Diameter, Inches | Dimensions in Inches | | Approximate Weight in Pounds |
|---|---|---|---|
| | A | H | |
| 6x 3 | 7.00 | 4.50 | 21 |
| 6x 4 | 7.00 | 4.50 | 13 |
| 8x 4 | 9.15 | 4.50 | 33 |
| 8x 6 | 9.15 | 4.50 | 18 |
| 10x 6 | 11.20 | 4.50 | 39 |
| 10x 8 | 11.20 | 4.50 | 20 |
| 12x 6 | 13.30 | 5.00 | 68 |
| 12x 8 | 13.30 | 5.00 | 61 |
| 12x10 | 13.30 | 5.00 | 28 |
| 16x12 | 17.50 | 5.00 | 95 |

SCREW PLUGS

| Nominal Diameter, Inches | Approximate Weight in Pounds |
|---|---|
| 3 | 7 |
| 4 | 10 |
| 6 | 20 |
| 8 | 25 |
| 10 | 45 |
| 12 | 55 |




CAP

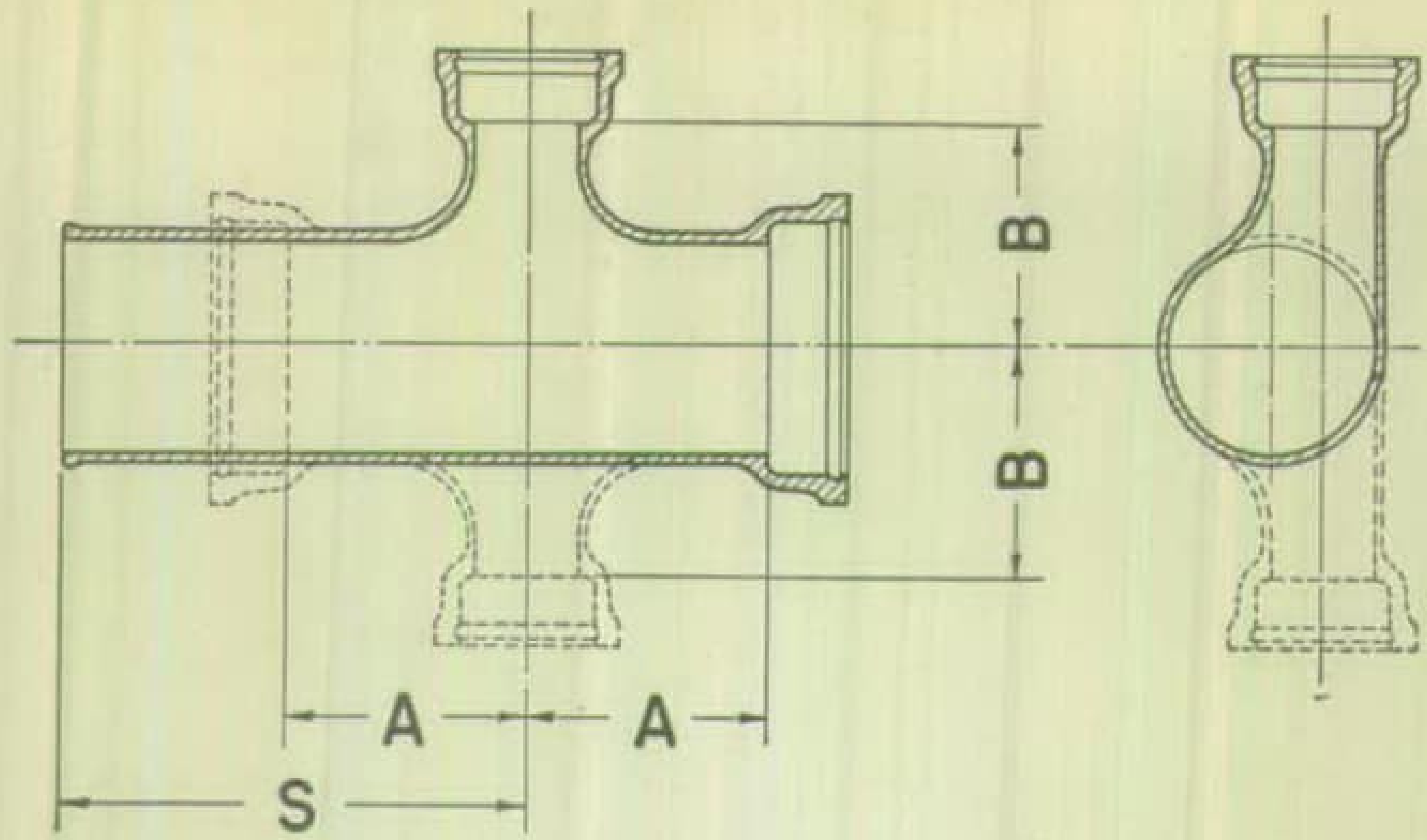



PLUG

CAPS AND PLUGS

| Nominal Diameter, Inches | Dimensions in Inches | | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|---|
| | A | H | D | C | Caps | Plugs |
| 4 | 4.90 | 4.75 | 4.00 | 5.80 | 25 | 9 |
| 6 | 7.00 | 4.75 | 4.00 | 7.90 | 37 | 16 |
| 8 | 9.15 | 4.75 | 4.00 | 10.05 | 52 | 24 |
| 10 | 11.20 | 4.75 | 4.00 | 12.10 | 65 | 34 |
| 12 | 13.30 | 5.25 | 4.50 | 14.20 | 95 | 50 |
| 16 | 17.50 | 5.25 | 4.50 | 18.40 | 151 | 83 |
| 20 | 21.70 | 5.25 | 4.50 | 22.85 | 220 | 127 |
| 24 | 25.90 | 5.75 | 5.00 | 27.05 | 330 | 193 |
| 30 | 31.84 | 5.75 | 5.00 | 32.99 | 476 | 294 |
| 36 | 38.06 | 5.75 | 5.00 | 39.21 | 668 | 433 |
| 42 | 44.30 | 5.75 | 5.00 | 45.45 | 916 | 620 |
| 48 | 50.60 | 5.75 | 5.00 | 51.75 | 1266 | 901 |

Sizes 4″ to 16″ inclusive are furnished without Lugs.




# TEES AND CROSSES

TEES AND CROSSES

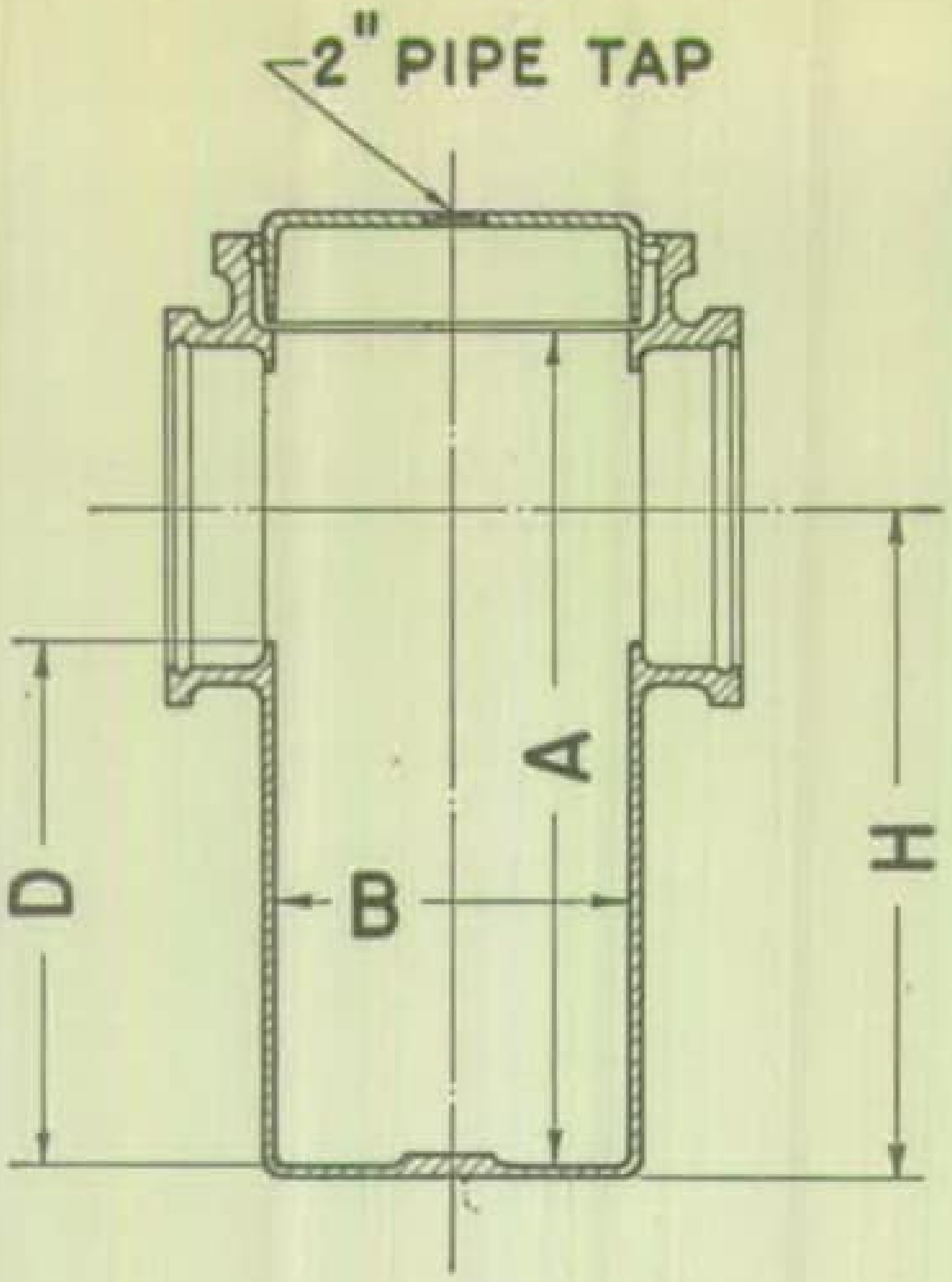
| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weights in Pounds | | | |
|---|---|---|---|---|---|---|---|
| | | | | Tees | | Crosses | |
| | A | B | S | 2 Bells | 3 Bells | 3 Bells | 4 Bells |
| 4x 4 | 8 | 8 | 26 | 106 | 105 | 138 | 137 |
| 6x 4 | 8 | 8 | 26 | 144 | 138 | 174 | 169 |
| 6x 6 | 8 | 8 | 26 | 156 | 151 | 200 | 194 |
| 8x 4 | 10 | 10 | 26 | 194 | 192 | 226 | 224 |
| 8x 6 | 10 | 10 | 26 | 208 | 206 | 254 | 251 |
| 8x 8 | 10 | 10 | 26 | 223 | 221 | 284 | 282 |
| 10x 4 | 12 | 11 | 26 | 253 | 251 | 287 | 285 |
| 10x 6 | 12 | 12 | 26 | 267 | 266 | 315 | 314 |
| 10x 8 | 12 | 12 | 26 | 283 | 282 | 348 | 346 |
| 10x10 | 12 | 12 | 26 | 296 | 295 | 373 | 372 |
| 12x 4 | 14 | 13 | 27 | 343 | 350 | 379 | 385 |
| 12x 6 | 14 | 13 | 27 | 359 | 366 | 409 | 416 |
| 12x 8 | 14 | 13 | 27 | 376 | 383 | 443 | 450 |
| 12x10 | 14 | 14 | 27 | 390 | 397 | 471 | 478 |
| 12x12 | 14 | 14 | 27 | 410 | 417 | 512 | 519 |

See Page 372 for Bell and Spigot Dimensions.

TEES AND CROSSES

| Nominal Diameter, Inches | Dimensions in Inches | | | Approximate Weight in Pounds | | | |
|---|---|---|---|---|---|---|---|
| | | | | Tees | | Crosses | |
| | A | B | S | 2 Bells | 3 Bells | 3 Bells | 4 Bells |
| 16x 6 | 14 | 14 | 29 | 536 | 534 | 582 | 580 |
| 16x 8 | 14 | 14 | 29 | 552 | 549 | 612 | 610 |
| 16x10 | 14 | 14 | 29 | 563 | 561 | 636 | 634 |
| 16x12 | 17 | 17 | 32 | 655 | 652 | 768 | 765 |
| 16x16 | 17 | 17 | 32 | 709 | 707 | 877 | 875 |
| 20x 6 | 15 | 15 | 29 | 724 | 730 | 767 | 774 |
| 20x 8 | 15 | 15 | 29 | 738 | 745 | 796 | 802 |
| 20x10 | 15 | 15 | 29 | 749 | 755 | 817 | 824 |
| 20x12 | 19 | 19 | 34 | 898 | 893 | 1011 | 1006 |
| 20x16 | 19 | 19 | 34 | 953 | 947 | 1120 | 1115 |
| 20x20 | 19 | 19 | 34 | 1001 | 995 | 1216 | 1211 |
| 24x 8 | 17 | 17 | 30 | 1023 | 1056 | 1081 | 1114 |
| 24x10 | 17 | 17 | 30 | 1034 | 1067 | 1103 | 1136 |
| 24x12 | 17 | 17 | 30 | 1056 | 1089 | 1147 | 1180 |
| 24x16 | 21 | 21 | 36 | 1289 | 1291 | 1456 | 1458 |
| 24x20 | 21 | 21 | 36 | 1336 | 1338 | 1552 | 1554 |
| 24x24 | 21 | 21 | 36 | 1403 | 1405 | 1684 | 1686 |
| 30x 8 | 20 | 20 | 32 | 1488 | 1546 | 1546 | 1604 |
| 30x10 | 20 | 20 | 32 | 1499 | 1557 | 1568 | 1626 |
| 30x12 | 20 | 20 | 32 | 1521 | 1579 | 1612 | 1670 |
| 30x16 | 24 | 24 | 39 | 1834 | 1828 | 2002 | 1995 |
| 30x20 | 24 | 24 | 39 | 1882 | 1876 | 2098 | 2091 |
| 30x24 | 24 | 24 | 39 | 1948 | 1942 | 2230 | 2223 |
| 30x30 | 24 | 24 | 39 | 2035 | 2029 | 2404 | 2398 |
| 36x12 | 25 | 25 | 34 | 2206 | 2358 | 2308 | 2460 |
| 36x16 | 25 | 25 | 34 | 2255 | 2407 | 2406 | 2558 |
| 36x20 | 25 | 25 | 34 | 2297 | 2449 | 2489 | 2641 |
| 36x24 | 28 | 28 | 42 | 2718 | 2726 | 3015 | 3023 |
| 36x30 | 28 | 28 | 42 | 2789 | 2798 | 3158 | 3166 |
| 36x36 | 28 | 28 | 42 | 2859 | 2867 | 3296 | 3305 |
| 42x16 | 29 | 29 | 36 | 3109 | 3421 | 3269 | 3580 |
| 42x20 | 29 | 29 | 36 | 3154 | 3466 | 3358 | 3670 |
| 42x24 | 29 | 29 | 36 | 3216 | 3528 | 3483 | 3794 |
| 42x30 | 32 | 32 | 45 | 3831 | 3878 | 4221 | 4268 |
| 42x36 | 32 | 32 | 45 | 3908 | 3955 | 4376 | 4423 |
| 42x42 | 32 | 32 | 45 | 3997 | 4144 | 4553 | 4701 |
| 48x16 | 32 | 32 | 39 | 4414 | 4717 | 4574 | 4876 |
| 48x20 | 32 | 32 | 39 | 4459 | 4761 | 4663 | 4965 |
| 48x24 | 32 | 32 | 39 | 4521 | 4824 | 4788 | 5090 |
| 48x30 | 32 | 32 | 39 | 4581 | 4883 | 4907 | 5209 |
| 48x36 | 35 | 35 | 48 | 5331 | 5329 | 5799 | 5797 |
| 48x42 | 35 | 35 | 48 | 5415 | 5413 | 5966 | 5964 |
| 48x48 | 35 | 35 | 48 | 5470 | 5468 | 6076 | 6074 |

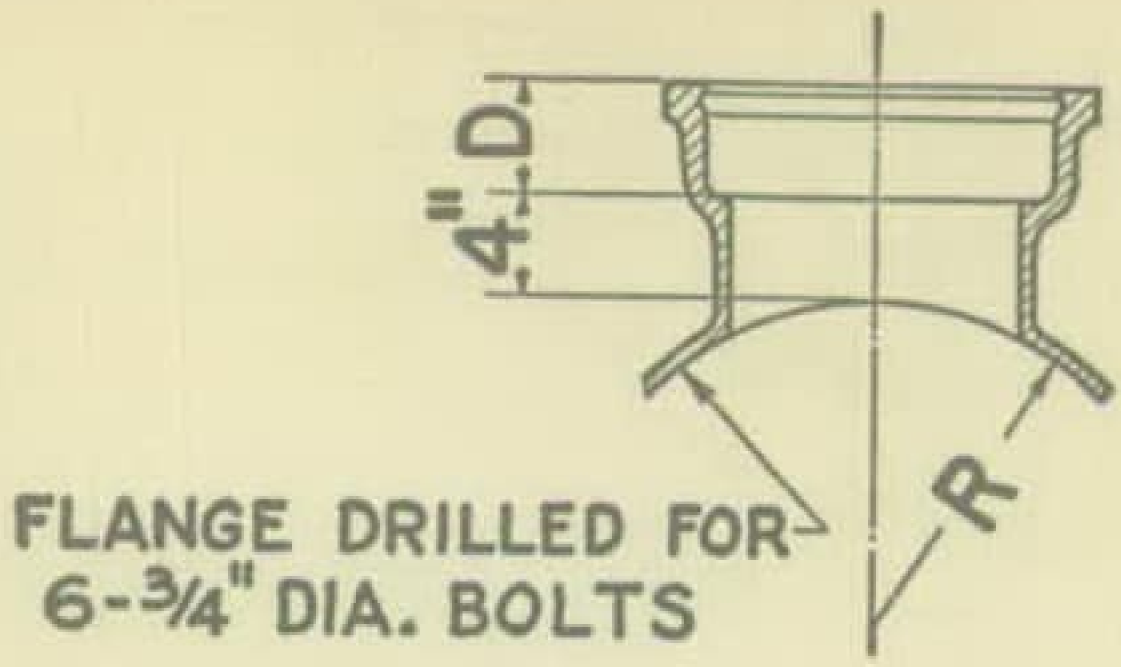
See Page 372 for Bell and Spigot Dimensions.




## LINE DRIPS
## OPEN TOP

| Nominal Diameter, Inches | Dimensions in Inches | | | | Plug Size, Inches | Capacity in Quarts | Approximate Weight in Pounds |
|---|---|---|---|---|---|---|---|
| | A | B | D | H | | | |
| 4 | 17.79 | 14.16 | 12.30 | 14.87 | 14 | 32 | 298 |
| 4 | 30.09 | 14.16 | 24.60 | 27.17 | 14 | 64 | 382 |
| 6 | 19.89 | 14.16 | 12.30 | 15.89 | 14 | 32 | 327 |
| 6 | 32.19 | 14.16 | 24.60 | 28.19 | 14 | 64 | 412 |
| 8 | 34.39 | 14.16 | 24.60 | 29.24 | 14 | 64 | 453 |
| 8 | 46.79 | 14.16 | 37.00 | 41.64 | 14 | 96 | 538 |
| 10 | 36.40 | 14.16 | 24.60 | 30.23 | 14 | 64 | 504 |
| 10 | 48.80 | 14.16 | 37.00 | 42.63 | 14 | 96 | 589 |
| 12 | 37.31 | 16.16 | 23.40 | 30.08 | 16 | 84 | 667 |
| 12 | 48.91 | 16.16 | 35.00 | 41.68 | 16 | 126 | 766 |
| 16 | 42.78 | 20.24 | 24.60 | 33.36 | 20 | 138 | 907 |
| 16 | 55.18 | 20.24 | 37.00 | 45.76 | 20 | 208 | 1051 |
| 20 | 47.92 | 24.28 | 25.40 | 36.28 | 24 | 203 | 1304 |
| 20 | 60.52 | 24.28 | 38.00 | 48.88 | 24 | 304 | 1500 |
| 24 | 49.32 | 30.04 | 22.60 | 35.59 | 30 | 280 | 1826 |
| 24 | 60.72 | 30.04 | 34.00 | 46.99 | 30 | 420 | 2070 |
| 30 | 55.27 | 36.06 | 22.60 | 38.57 | 36 | 399 | 2617 |
| 36 | 62.89 | 42.06 | 24.00 | 43.10 | 42 | 576 | 3652 |
| 42 | 69.16 | 47.98 | 24.00 | 46.29 | 48 | 752 | 5261 |
| 48 | 75.97 | 53.96 | 24.60 | 49.94 | 54 | 974 | 6506 |

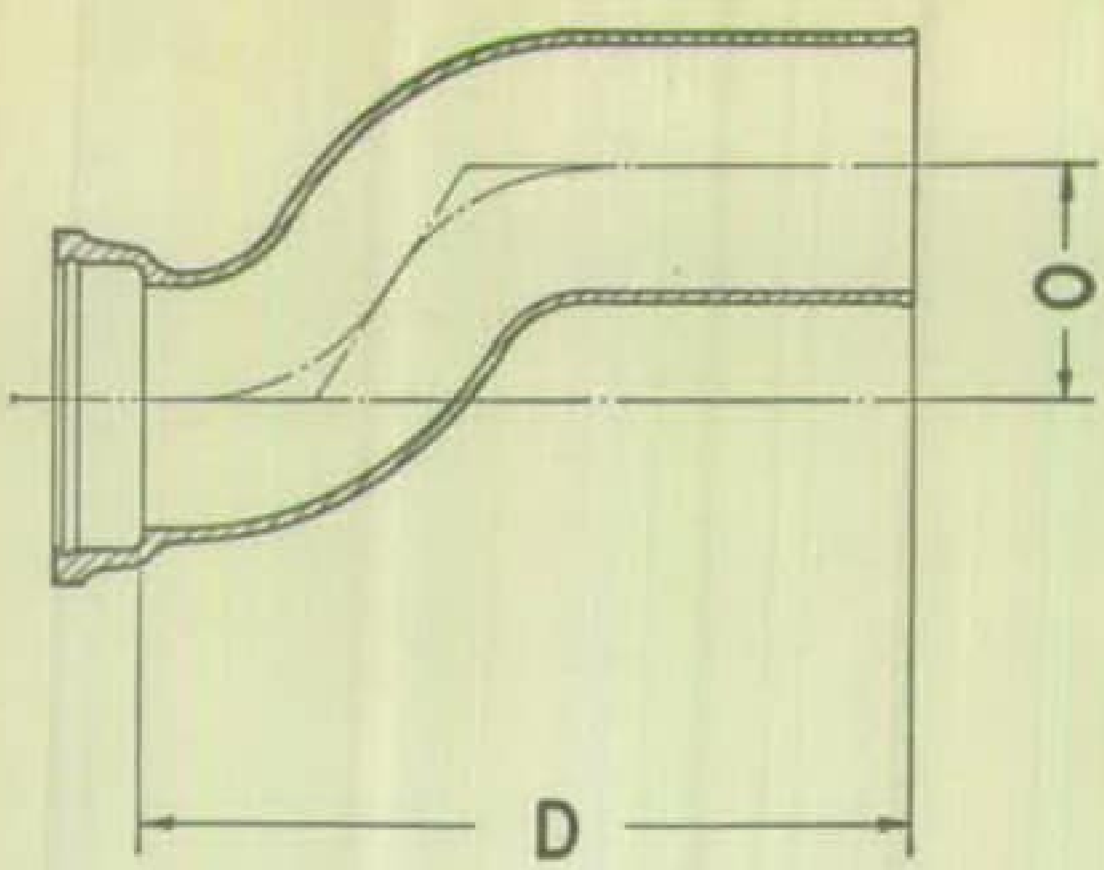
*Note*—Approx. Wts. shown do not include weight of Plug.
See Page 372 for Bell and Spigot Dimensions.




## HAT FLANGES

| Nominal Diameter; Inches | Dimensions in Inches | | Approximate Weight in Pounds |
|---|---|---|---|
| | D | R | |
| 20x 6 | 4.00 | 11.00 | 73 |
| 20x 8 | 4.00 | 11.00 | 97 |
| 20x10 | 4.00 | 11.00 | 120 |
| 20x12 | 4.50 | 11.00 | 158 |
| 24x 6 | 4.00 | 13.00 | 72 |
| 24x 8 | 4.00 | 13.00 | 96 |
| 24x10 | 4.00 | 13.00 | 117 |
| 24x12 | 4.50 | 13.00 | 156 |
| 30x 6 | 4.00 | 16.00 | 72 |
| 30x 8 | 4.00 | 16.00 | 94 |
| 30x10 | 4.00 | 16.00 | 116 |
| 30x12 | 4.50 | 16.00 | 153 |
| 36x 6 | 4.00 | 19.25 | 71 |
| 36x 8 | 4.00 | 19.25 | 93 |
| 36x10 | 4.00 | 19.25 | 116 |
| 36x12 | 4.50 | 19.25 | 150 |
| 42x 6 | 4.00 | 22.37 | 71 |
| 42x 8 | 4.00 | 22.37 | 93 |
| 42x10 | 4.00 | 22.37 | 114 |
| 42x12 | 4.50 | 22.37 | 150 |
| 48x 6 | 4.00 | 25.50 | 71 |
| 48x 8 | 4.00 | 25.50 | 93 |
| 48x10 | 4.00 | 25.50 | 113 |
| 48x12 | 4.50 | 25.50 | 150 |

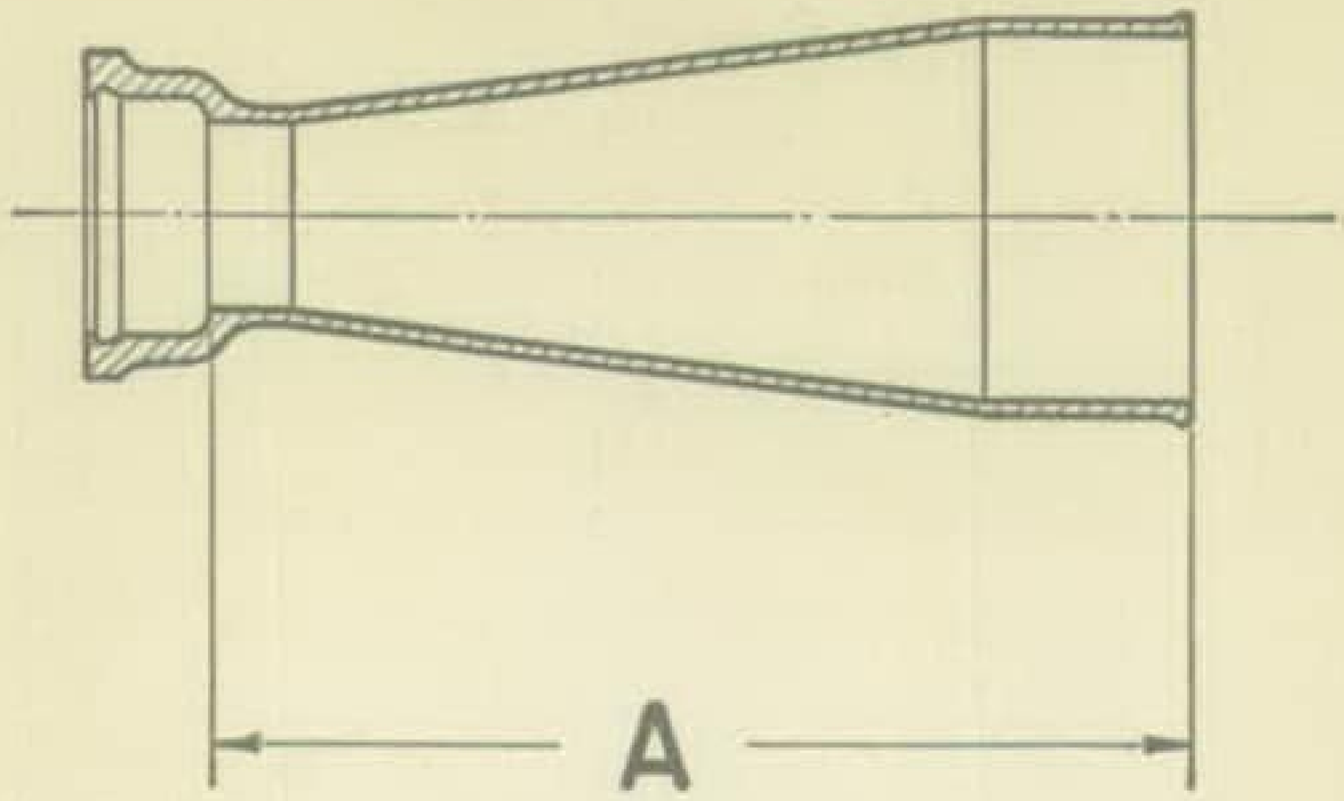
See Page 372 for Bell and Spigot Dimensions.




# OFFSETS

| Nominal Diameter, Inches | Dimensions in Inches | | Approximate Weight in Pounds |
|---|---|---|---|
| | Offset O | D | |
| 4 | 6 | 30.67 | 73 |
| 4 | 12 | 34.14 | 83 |
| 4 | 18 | 37.60 | 93 |
| 6 | 6 | 31.92 | 113 |
| 6 | 12 | 35.39 | 129 |
| 6 | 18 | 38.85 | 145 |
| 8 | 6 | 33.74 | 162 |
| 8 | 12 | 36.65 | 182 |
| 8 | 18 | 40.11 | 204 |
| 10 | 6 | 35.18 | 216 |
| 10 | 12 | 37.80 | 234 |
| 10 | 18 | 41.26 | 270 |
| 12 | 6 | 36.54 | 294 |
| 12 | 12 | 39.06 | 323 |
| 12 | 18 | 42.52 | 362 |
| 16 | 6 | 39.01 | 470 |
| 16 | 12 | 42.80 | 510 |
| 16 | 18 | 45.13 | 570 |
| 20 | 6 | 41.17 | 616 |
| 20 | 12 | 45.96 | 623 |
| 20 | 18 | 48.43 | 705 |

See Page 372 for Bell and Spigot Dimensions.



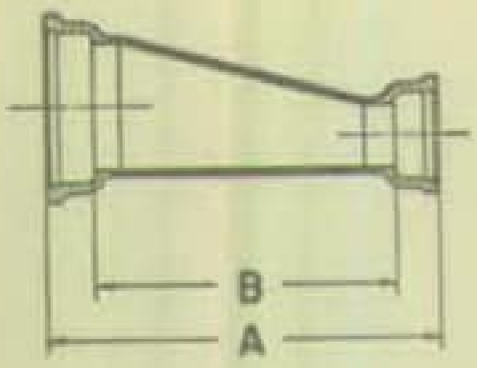

## Concentric Reducers

SMALL END BELL

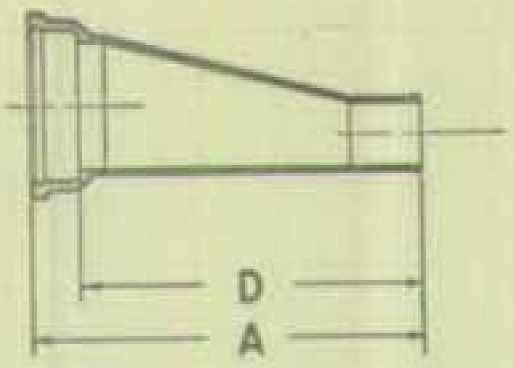
| Nominal Diameter, Inches | Dimensions in Inches A | Approximate Weight in Pounds |
|---|---|---|
| 14x 4 | 32.0 | 178 |
| 14x 6 | 32.0 | 198 |
| 18x 8 | 32.0 | 280 |
| 18x10 | 32.0 | 303 |
| 24x12 | 37.5 | 508 |
| 30x16 | 37.5 | 727 |
| 30x20 | 37.5 | 820 |
| 30x24 | 37.0 | 940 |
| 36x30 | 43.0 | 1418 |
| 42x36 | 43.0 | 1866 |
| 48x42 | 43.0 | 2475 |
| 54x48 | 43.0 | 3089 |

See Page 372 for Bell and Spigot Dimensions.

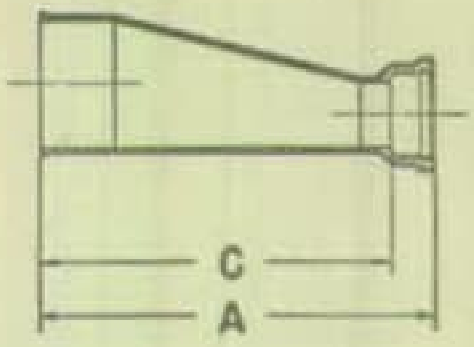
# Eccentric Reducers



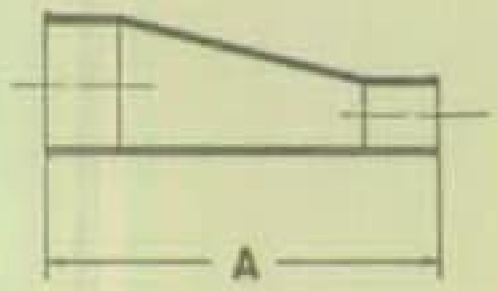

BELL AND BELL




LARGE END BELL



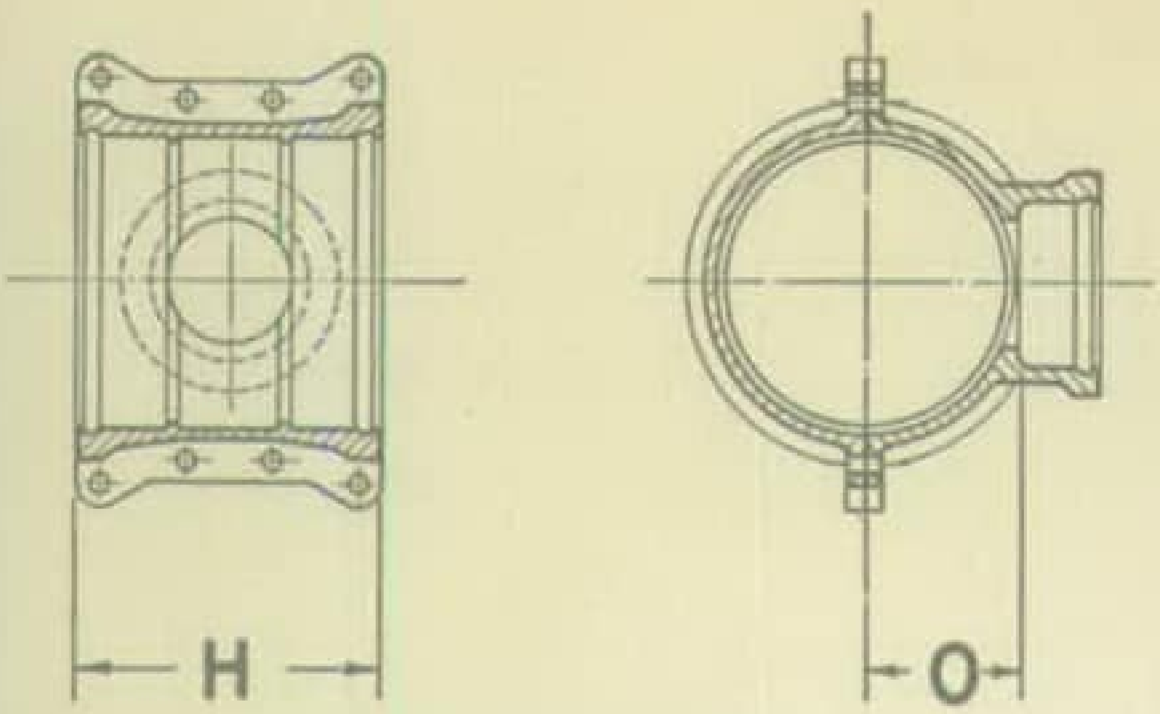

SMALL END BELL



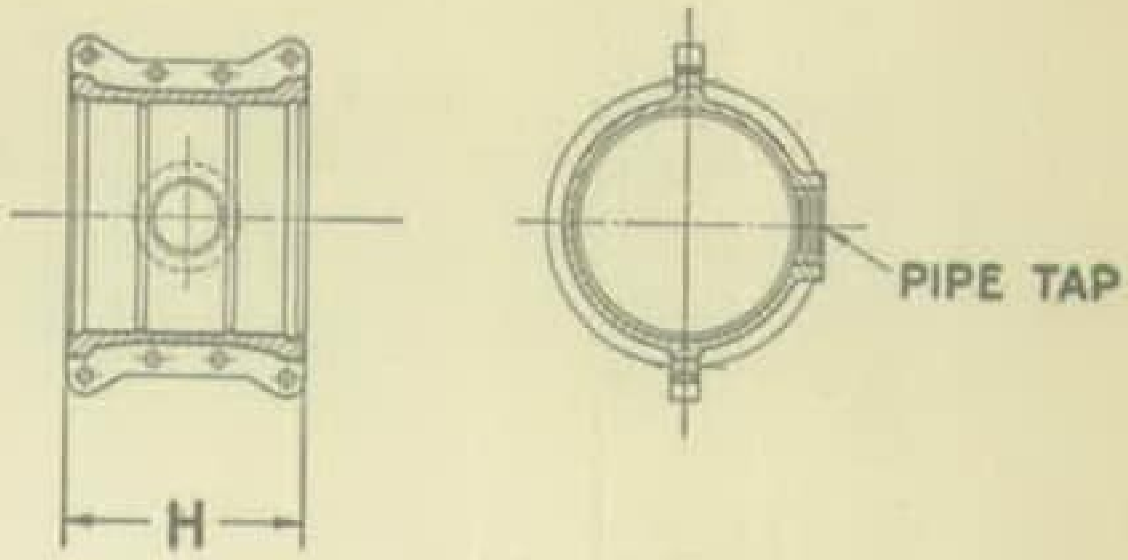

SPIGOT AND SPIGOT

| Nominal Diameter, Inches | | Dimensions in Inches | | | | Approximate Weight in Pounds | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | 2 Bells | Large Bell | Small Bell | 2 Spigots |
| 4 | 3 | 20.0 | 12.0 | 16.0 | 16.0 | 57 | 44 | 39 | 26 |
| 6 | 3 | 25.0 | 17.0 | 21.0 | 21.0 | 80 | 66 | 55 | 41 |
| 6 | 4 | 20.0 | 12.0 | 16.0 | 16.0 | 81 | 63 | 56 | 38 |
| 8 | 4 | 28.0 | 20.0 | 24.0 | 24.0 | 117 | 99 | 84 | 66 |
| 8 | 6 | 20.0 | 12.0 | 16.0 | 16.0 | 114 | 89 | 81 | 56 |
| 10 | 4 | 36.0 | 28.0 | 32.0 | 32.0 | 160 | 142 | 122 | 104 |
| 10 | 6 | 28.0 | 20.0 | 24.0 | 24.0 | 156 | 131 | 118 | 93 |
| 10 | 8 | 20.0 | 12.0 | 16.0 | 16.0 | 148 | 115 | 110 | 77 |
| 12 | 6 | 37.0 | 28.5 | 33.0 | 32.5 | 222 | 198 | 171 | 148 |
| 12 | 8 | 29.0 | 20.5 | 25.0 | 24.5 | 212 | 181 | 162 | 130 |
| 12 | 10 | 21.0 | 12.5 | 17.0 | 16.5 | 193 | 158 | 142 | 107 |
| 16 | 8 | 46.0 | 37.5 | 42.0 | 41.5 | 388 | 356 | 304 | 272 |
| 16 | 10 | 38.0 | 29.5 | 34.0 | 33.5 | 366 | 331 | 282 | 247 |
| 16 | 12 | 29.0 | 20.0 | 24.5 | 24.5 | 344 | 293 | 259 | 209 |
| 20 | 10 | 54.0 | 45.5 | 50.0 | 49.5 | 586 | 551 | 469 | 434 |
| 20 | 12 | 46.0 | 37.0 | 41.5 | 41.5 | 569 | 518 | 441 | 401 |
| 20 | 16 | 30.0 | 21.0 | 25.5 | 25.5 | 509 | 425 | 392 | 308 |
| 24 | 16 | 46.5 | 37.0 | 42.0 | 41.5 | 792 | 716 | 641 | 565 |
| 24 | 20 | 30.5 | 21.0 | 26.0 | 25.5 | 677 | 572 | 527 | 421 |
| 30 | 20 | 55.0 | 45.5 | 50.5 | 50.0 | 1226 | 1121 | 1023 | 917 |
| 30 | 24 | 40.0 | 30.0 | 35.0 | 35.0 | 1102 | 952 | 899 | 748 |
| 36 | 24 | 64 0 | 54.0 | 59.0 | 59.0 | 1843 | 1692 | 1576 | 1426 |
| 36 | 30 | 40.0 | 30.0 | 35.0 | 35.0 | 1484 | 1281 | 1217 | 1014 |
| 42 | 30 | 64.0 | 54.0 | 59.0 | 59.0 | 2465 | 2262 | 2108 | 1904 |
| 42 | 36 | 40.0 | 30.0 | 35.0 | 35.0 | 1965 | 1698 | 1607 | 1341 |
| 48 | 36 | 64.0 | 54.0 | 59.0 | 59.0 | 3247 | 2980 | 2821 | 2554 |
| 48 | 42 | 40.0 | 30.0 | 35.0 | 35.0 | 2566 | 2208 | 2139 | 1782 |

See Page 372 for Bell and Spigot Dimensions.




HUB SLEEVE




SERVICE SLEEVE

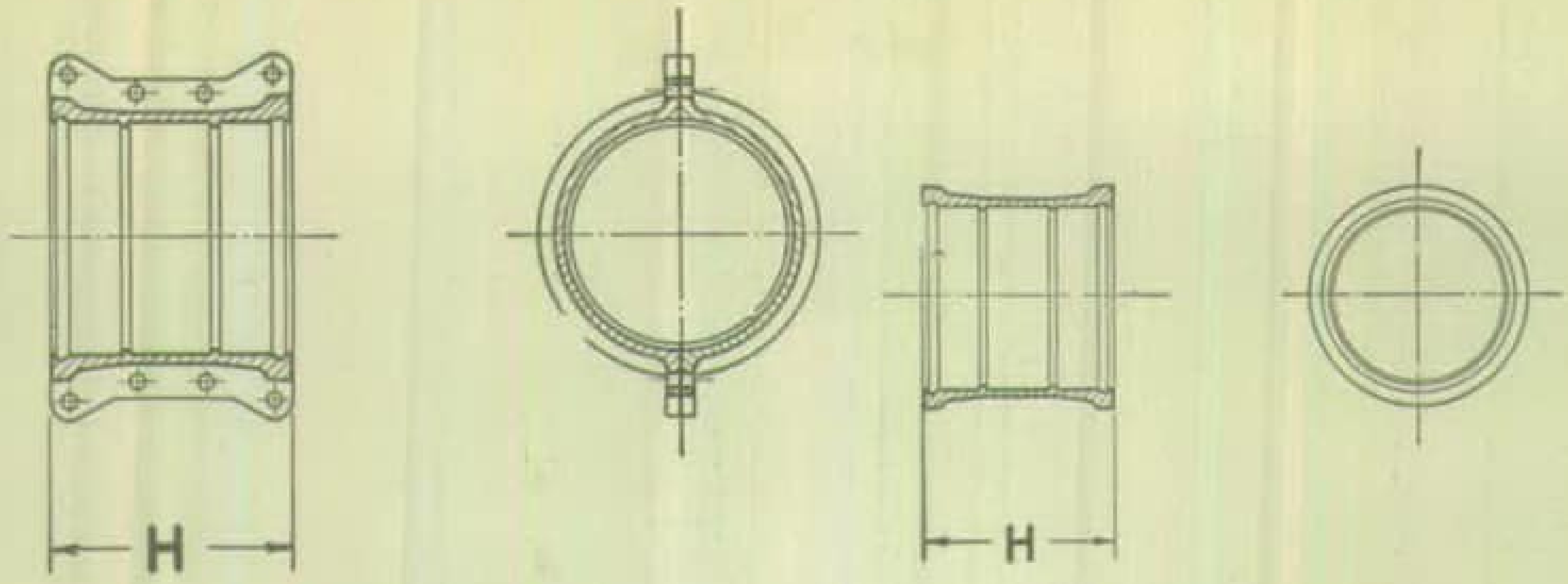
HUB SLEEVES

| Nominal Diameter, Inches | Dimensions in Inches | | Approximate Weight in Pounds |
|---|---|---|---|
| | H | O | |
| 10x 4 | 15 | 6.54 | 170 |
| 10x 6 | 15 | 6.54 | 196 |
| 12x 4 | 15 | 7.64 | 208 |
| 12x 6 | 15 | 7.64 | 238 |
| 16x 6 | 18 | 9.82 | 343 |
| 16x 8 | 18 | 9.82 | 352 |
| 20x 6 | 18 | 12.10 | 441 |
| 20x 8 | 18 | 12.10 | 448 |
| 20x10 | 18 | 12.10 | 451 |

See Page 372 for Bell and Spigot Dimensions.

SERVICE SLEEVES

| Nominal Diameter, Inches | Dimensions in Inches | Maximum Pipe Tap, Inches | Approximate Weight in Pounds |
|---|---|---|---|
| | H | | |
| 2 | 8 | 1.50 | 38 |
| 3 | 12 | 3.00 | 57 |
| 4 | 12 | 3.00 | 69 |
| 6 | 12 | 3.00 | 94 |
| 8 | 15 | 3.00 | 133 |
| 10 | 15 | 3.00 | 158 |
| 12 | 15 | 4.00 | 201 |
| 16 | 18 | 4.00 | 323 |

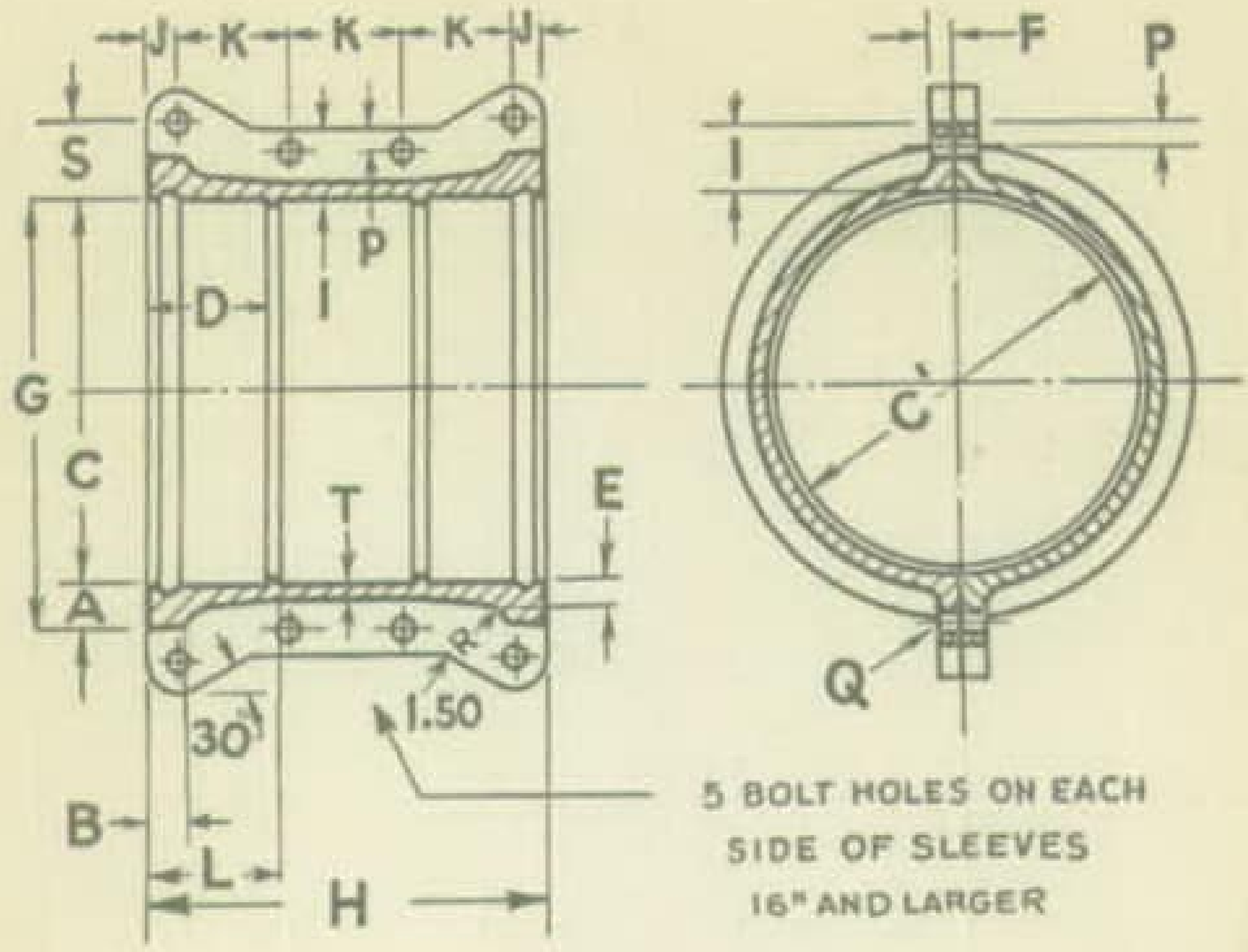



SPLIT SLEEVE SOLID SLEEVE

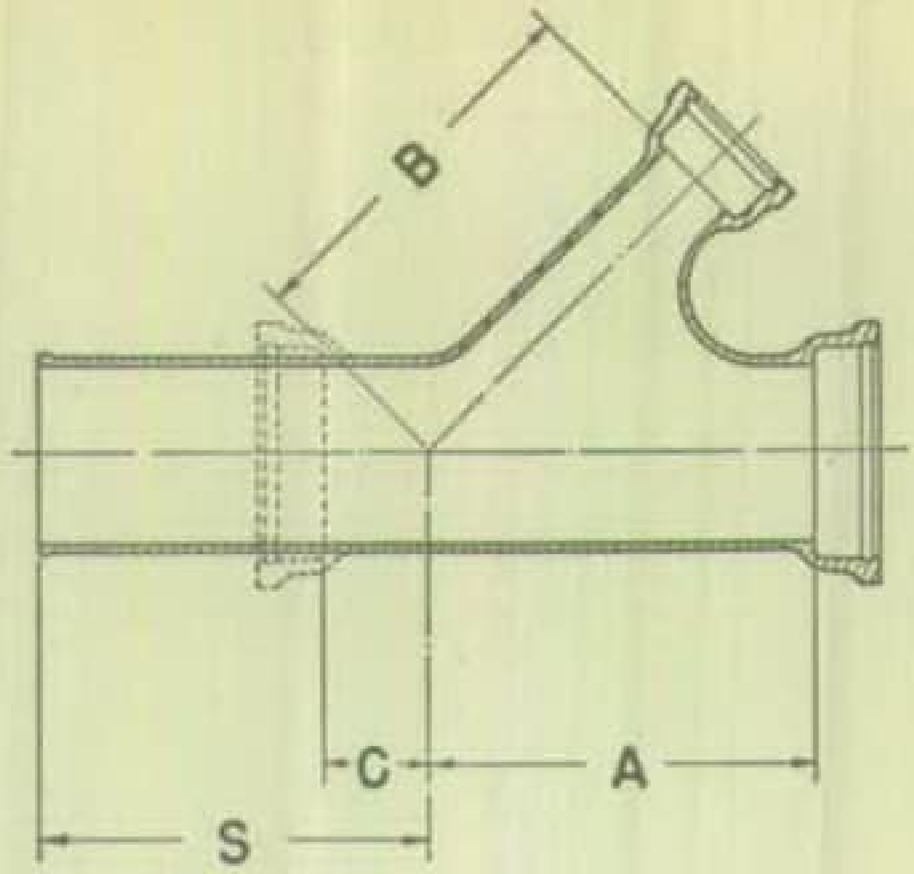
SPLIT AND SOLID SLEEVES

| Nominal Diameter, Inches | Dimensions in Inches | Approximate Weight in Pounds | |
|---|---|---|---|
| | H | Split Sleeve | Solid Sleeve |
| 2 | 8 | 37 | 20 |
| 3 | 12 | 56 | 38 |
| 4 | 12 | 67 | 47 |
| 6 | 12 | 87 | 65 |
| 8 | 15 | 127 | 100 |
| 10 | 15 | 151 | 122 |
| 12 | 15 | 191 | 160 |
| 16 | 18 | 314 | 269 |
| 20 | 18 | 420 | 372 |
| 24 | 18 | 552 | 500 |
| 30 | 18 | 729 | 676 |
| 36 | 18 | 939 | 871 |
| 42 | 18 | 1204 | 1133 |
| 48 | 18 | 1507 | 1421 |

## Split Sleeves




| Nominal Diameter, Inches | Dimensions in Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | C′ | D | E | F | G | H |
| 2 | 1.12 | 1.25 | 3.38 | 3.08 | 2.00 | .56 | .75 | 5.62 | 8 |
| 3 | 1.30 | 1.25 | 4.80 | 4.50 | 4.00 | .56 | .75 | 7.40 | 12 |
| 4 | 1.30 | 1.50 | 5.80 | 5.43 | 4.00 | .68 | .75 | 8.40 | 12 |
| 6 | 1.40 | 1.50 | 7.90 | 7.53 | 4.00 | .75 | .81 | 10.70 | 12 |
| 8 | 1.50 | 1.50 | 10.05 | 9.80 | 4.00 | .81 | .81 | 13.05 | 15 |
| 10 | 1.50 | 1.50 | 12.10 | 11.85 | 4.00 | .81 | .87 | 15.10 | 15 |
| 12 | 1.60 | 1.50 | 14.20 | 13.95 | 4.50 | .93 | .94 | 17.40 | 15 |
| 16 | 1.80 | 1.75 | 18.40 | 18.15 | 4.50 | 1.06 | 1.06 | 22.00 | 18 |
| 20 | 2.00 | 1.75 | 22.85 | 22.45 | 4.50 | 1.12 | 1.12 | 26.85 | 18 |
| 24 | 2.10 | 2.00 | 27.05 | 26.65 | 5.00 | 1.31 | 1.25 | 31.25 | 18 |
| 30 | 2.30 | 2.00 | 32.99 | 32.59 | 5.00 | 1.43 | 1.31 | 37.59 | 18 |
| 36 | 2.50 | 2.00 | 39.21 | 38.81 | 5.00 | 1.50 | 1.43 | 44.21 | 18 |
| 42 | 2.80 | 2.00 | 45.45 | 45.05 | 5.00 | 1.68 | 1.56 | 51.05 | 18 |
| 48 | 3.00 | 2.00 | 51.75 | 51.35 | 5.00 | 1.75 | 1.75 | 57.75 | 18 |




## Y – BRANCHES

| Nominal Diameter, Inches | Dimensions in Inches | | | | Approximate Weight in Pounds | |
|---|---|---|---|---|---|---|
| | A | B | C | S | 3 Bells | 2 Bells |
| 4x 4 | 11.15 | 11.15 | 3.16 | 23 | 105 | 109 |
| 6x 4 | 15.50 | 15.25 | 4.25 | 23 | 154 | 161 |
| 6x 6 | 15.50 | 15.50 | 4.25 | 23 | 171 | 178 |
| 8x 4 | 19.30 | 18.80 | 5.31 | 23 | 215 | 224 |
| 8x 6 | 19.30 | 19.05 | 5.31 | 23 | 234 | 243 |
| 8x 8 | 19.30 | 19.30 | 5.31 | 23 | 254 | 263 |
| 10x 4 | 22.75 | 22.00 | 6.75 | 23 | 285 | 297 |
| 10x 6 | 22.75 | 22.25 | 6.75 | 23 | 305 | 317 |
| 10x 8 | 22.75 | 22.50 | 6.75 | 23 | 327 | 339 |
| 10x10 | 22.75 | 22.75 | 6.75 | 23 | 347 | 360 |
| 12x 4 | 26.75 | 26.00 | 7.25 | 23 | 396 | 406 |
| 12x 6 | 26.75 | 26.25 | 7.25 | 23 | 418 | 428 |
| 12x 8 | 26.75 | 26.50 | 7.25 | 23 | 442 | 453 |
| 12x10 | 26.75 | 26.75 | 7.25 | 23 | 466 | 476 |
| 12x12 | 26.75 | 26.75 | 7.25 | 23 | 502 | 512 |
| 16x16 | 33.13 | 33.13 | 9.12 | 23 | 864 | 859 |
| 20x20 | 38.53 | 38.53 | 11.03 | 23 | 1271 | 1245 |
| 24x24 | 43.00 | 43.00 | 13.00 | 23 | 1828 | 1753 |
| 30x30 | 52.50 | 52.50 | 13.75 | 23 | 2784 | 2672 |
| 36x36 | 60.38 | 60.38 | 18.37 | 23 | 4090 | 3818 |
| 42x42 | 70.00 | 70.00 | 22.00 | 23 | 5981 | 5489 |
| 48x48 | 80.00 | 80.00 | 25.00 | 23 | 8677 | 7926 |

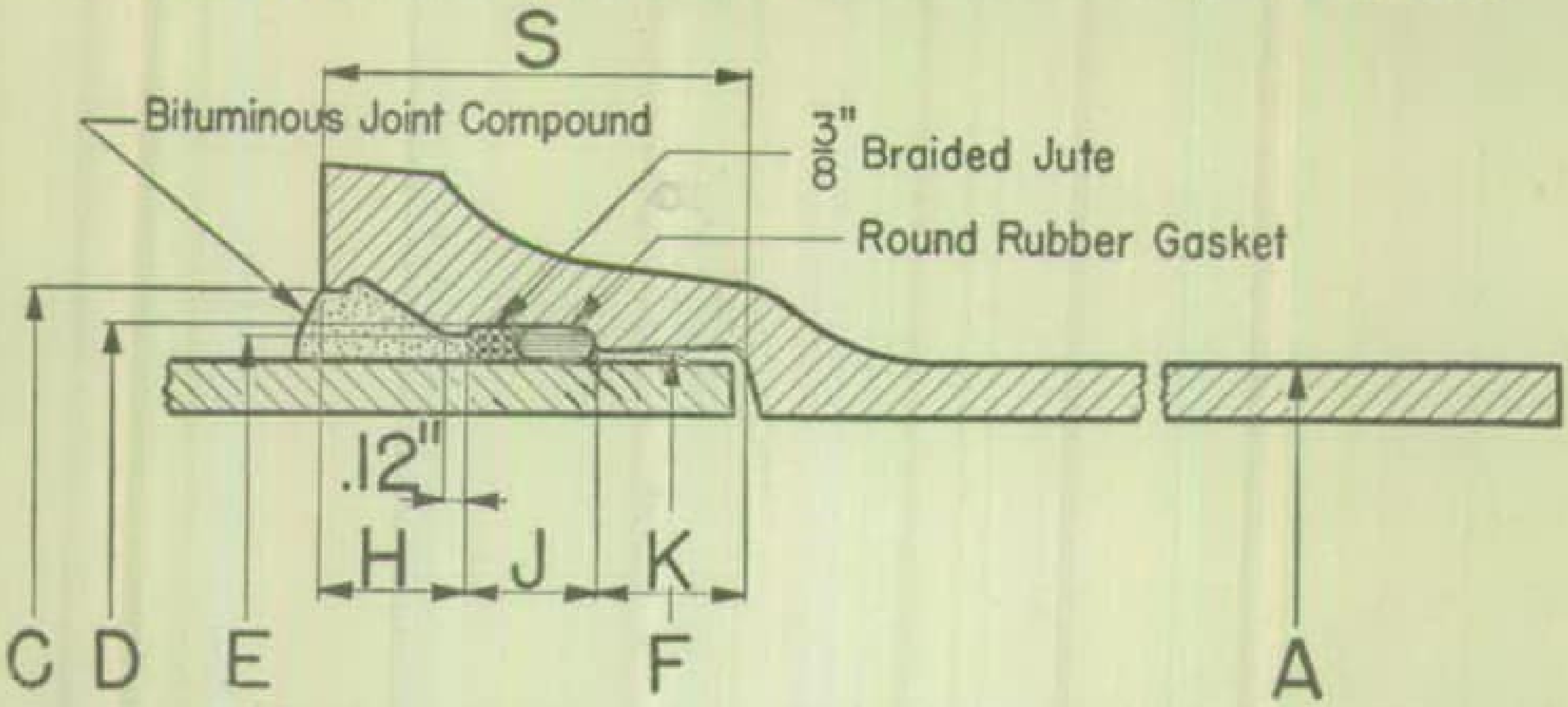
See Page 372 for Bell and Spigot Dimensions.

# SECTION 16

## Special Types of Pipe and Fittings

## Roll-On Joint Pipe

**Standard Dimensions, Thicknesses and Weights of Cast Iron Roll-On Joint Pipe for Water or Other Liquids. For 150 PSI pressure, laid without blocks on flat bottomed trench with tamped backfill under 5 feet of cover.**

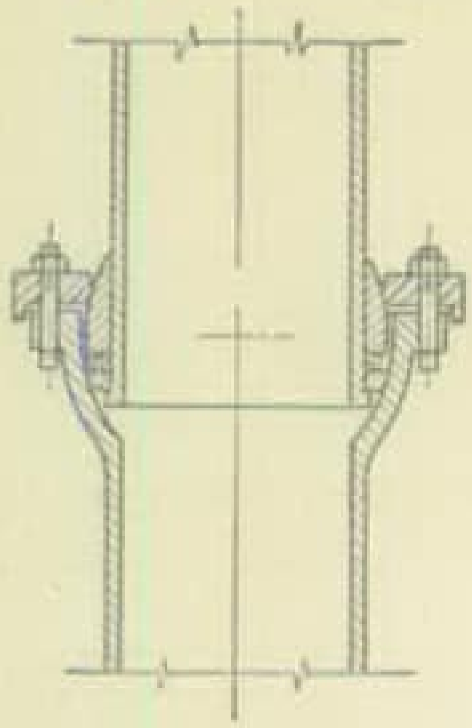



| Size | A | C | D | E | F | H | J | K | Round Rubber Gasket I. D. | Round Rubber Gasket Thickness | S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 3.96 | 4.93 | 4.43 | 4.31 | 4.05 | 1.06 | 1.13 | 1.31 | 3.17 | 0.47 | 3.50 |
| 4 | 4.80 | 6.00 | 5.35 | 5.23 | 4.89 | 1.31 | 1.25 | 1.44 | 3.81 | 0.55 | 4.00 |
| 6 | 6.90 | 8.10 | 7.45 | 7.33 | 6.99 | 1.31 | 1.25 | 1.44 | 5.50 | 0.55 | 4.00 |
| 8 | 9.05 | 10.25 | 9.60 | 9.48 | 9.14 | 1.31 | 1.25 | 1.44 | 7.25 | 0.55 | 4.00 |
| 10 | 11.10 | 12.30 | 11.65 | 11.53 | 11.20 | 1.31 | 1.25 | 1.44 | 8.88 | 0.55 | 4.00 |
| 12 | 13.20 | 14.40 | 13.75 | 13.63 | 13.30 | 1.31 | 1.38 | 1.56 | 10.56 | 0.55 | 4.25 |

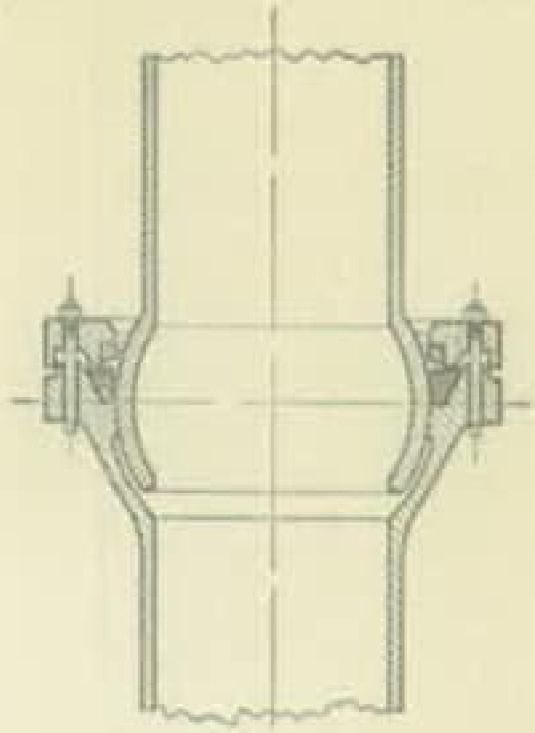
| | Pit Cast ASA A21.2 | | | Centrifugally Cast in Metal Molds ASA A21.6 | | | | | Centrifugally Cast in Sand Lined Molds ASA A21.8 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 12 ft. lgth. | | | 12 ft. lgth. | | 18 ft. lgth. | | | 16 ft. lgth. | | 16½ ft. lgth. | | 20 ft. lgth. | |
| Size | Thickness, Inches | Avg. per ft.† | Avg. per lgth.* | Thickness, Inches | Avg. per ft.† | Avg. per lgth.* | Avg. per ft.† | Avg. per lgth.* | Thickness, Inches | Avg. per ft.† | Avg. per lgth.* | Avg. per ft.† | Avg. per lgth.* | Avg. per ft.† | Avg. per lgth.* |
| 3 | 0.37 | 14.2 | 170 | 0.32 | 12.5 | 150 | 12.0 | 215 | 0.32 | 12.4 | 195 | 12.3 | 205 | ..... | ..... |
| 4 | 0.40 | 19.2 | 230 | 0.35 | 16.6 | 200 | 16.1 | 290 | 0.35 | 16.5 | 265 | 16.4 | 270 | ..... | ..... |
| 6 | 0.43 | 30.0 | 360 | 0.38 | 26.4 | 315 | 25.6 | 460 | 0.38 | 25.9 | 415 | 25.8 | 425 | ..... | ..... |
| 8 | 0.46 | 42.9 | 515 | 0.41 | 38.1 | 455 | 36.9 | 665 | 0.41 | 37.0 | 590 | 36.9 | 610 | ..... | ..... |
| 10 | 0.54 | 60.8 | 730 | 0.44 | 50.5 | 605 | 49.0 | 880 | 0.44 | 49.1 | 785 | 49.0 | 810 | ..... | ..... |
| 12 | 0.58 | 77.9 | 935 | 0.48 | 65.3 | 785 | 63.4 | 1140 | 0.48 | 63.7 | 1020 | 63.6 | 1050 | 63.0 | 1260 |

*Including bell. Calculated weight of pipe rounded off to nearest 5 lb.
†Average weight per foot based on calculated weight of pipe before rounding.
Dimensions in inches.

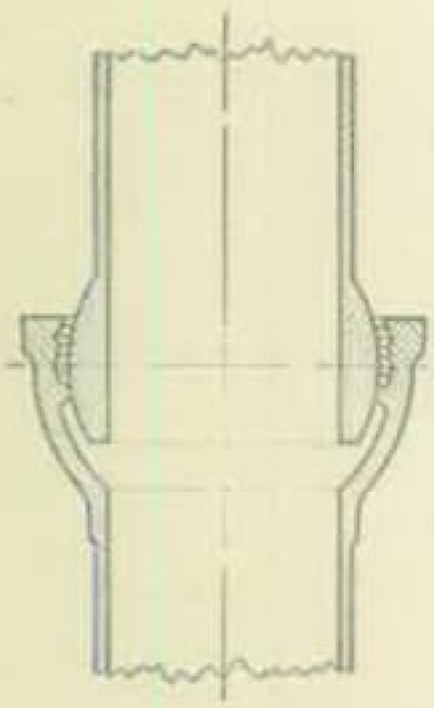
## SUBMARINE AND LOCK TYPE MECHANICAL JOINTS



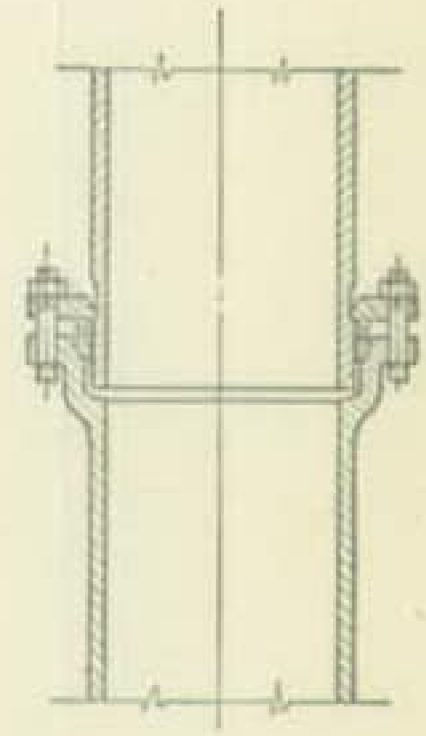
MECHANICAL FLEXIBLE
JOINT PIPE
"MOLOX" TYPE



MECHANICAL FLEXIBLE JOINT PIPE
"USIFLEX" TYPE



TYPE-2 METROPOLITAN
JOINT FOR
FLEXIBLE JOINT PIPE



LOCK TYPE MECHANICAL JOINT

# Weights and Dimensions of Plain End Iron Pipe Size Pipe

A.S.A. CLASS 23

| Size | O.D. | Thick-ness | I.D. | Barrel Wt. Ft. | Weight per Length* | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 12 Ft. | 16 Ft. | 16½ Ft. | 18 Ft. |
| 3 | 3.50 | 0.35** | 2.80 | 10.8 | 130 | 175 | ........ | ........ |
| 4 | 4.50 | 0.38 | 3.74 | 15.3 | 185 | 245 | 250 | 275 |
| 6 | 6.62 | 0.41 | 5.80 | 25.0 | 300 | 400 | 410 | 450 |
| 8 | 8.62 | 0.44 | 7.74 | 35.3 | 425 | 565 | 580 | 635 |
| 10 | 10.75 | 0.48 | 9.79 | 48.3 | 580 | 775 | 795 | 870 |
| 12 | 12.75 | 0.52 | 11.71 | 62.3 | 750 | 995 | 1030 | 1120 |

A.S.A. CLASS 25

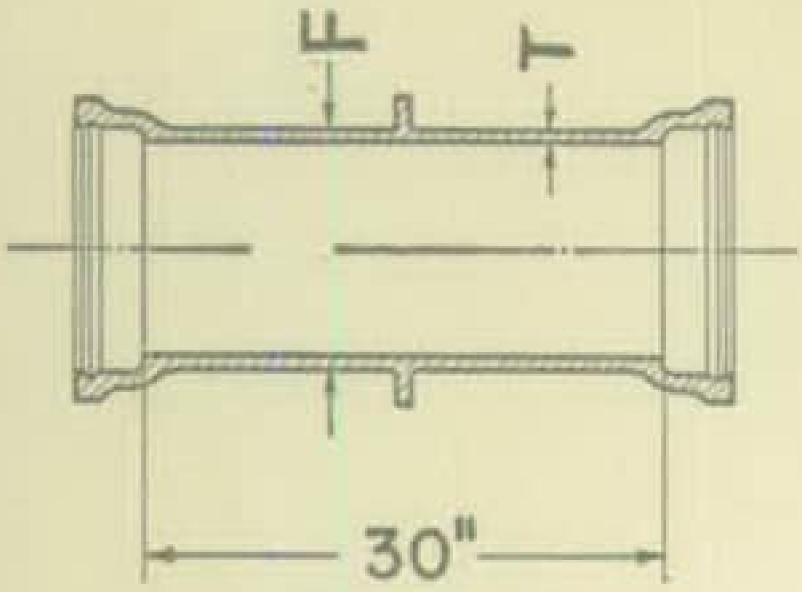
| Size | O.D. | Thick-ness | I.D. | Barrel Wt. Ft. | Weight per Length* | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 12 Ft. | 16 Ft. | 16½ Ft. | 18 Ft. |
| 3 | 3.50 | 0.41 | 2.68 | 12.4 | 150 | 200 | ........ | ........ |
| 4 | 4.50 | 0.44 | 3.62 | 17.5 | 210 | 280 | 290 | 315 |
| 6 | 6.62 | 0.48 | 5.66 | 28.9 | 345 | 460 | 475 | 520 |
| 8 | 8.62 | 0.52 | 7.58 | 41.3 | 495 | 660 | 680 | 745 |
| 10 | 10.75 | 0.56 | 9.63 | 55.9 | 670 | 895 | 920 | 1005 |
| 12 | 12.75 | 0.60 | 11.55 | 71.5 | 860 | 1145 | 1180 | 1285 |

A.S.A. CLASS 27

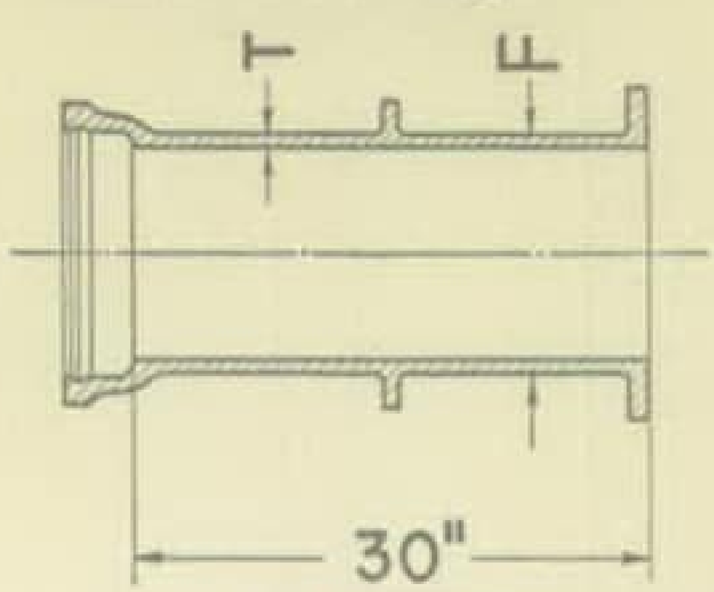
| Size | O.D. | Thick-ness | I.D. | Barrel Wt. Ft. | Weight per Length* | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 12 Ft. | 16 Ft. | 16½ Ft. | 18 Ft. |
| 3 | 3.50 | 0.48 | 2.54 | 14.2 | 170 | 225 | ........ | ........ |
| 4 | 4.50 | 0.52 | 3.46 | 20.3 | 245 | 325 | 335 | 365 |
| 6 | 6.62 | 0.56 | 5.50 | 33.3 | 400 | 535 | 550 | 600 |
| 8 | 8.62 | 0.60 | 7.42 | 47.2 | 565 | 755 | 780 | 850 |
| 10 | 10.75 | 0.65 | 9.45 | 64.3 | 770 | 1030 | 1060 | 1155 |
| 12 | 12.75 | 0.70 | 11.35 | 82.7 | 990 | 1325 | 1365 | 1490 |

All dimensions given in inches.
*Calculated weights rounded to nearest 5 pounds.
** .38" is minimum thickness of Cast Iron Pressure pipe recommended for threading.

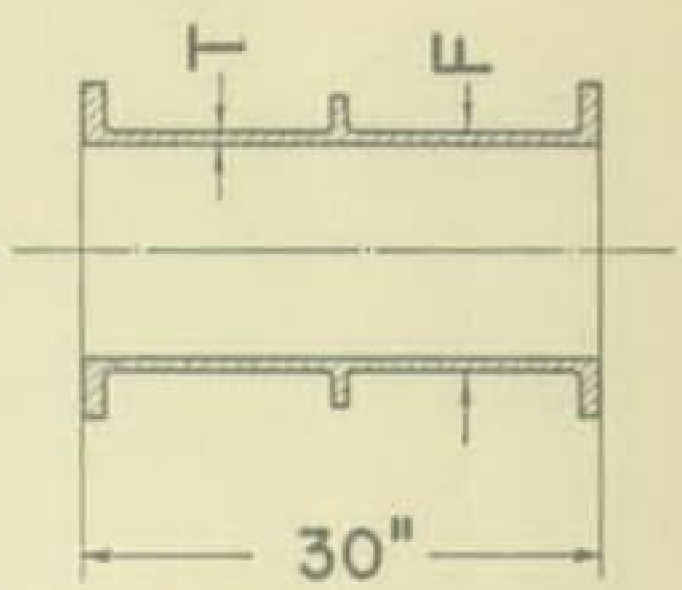
# Laying Dimensions and Weights of Standard Wall Castings



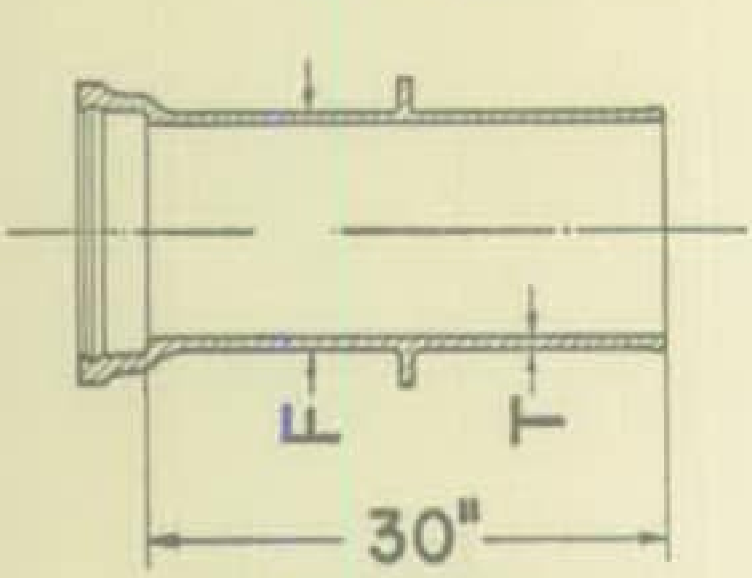

Bell and Bell



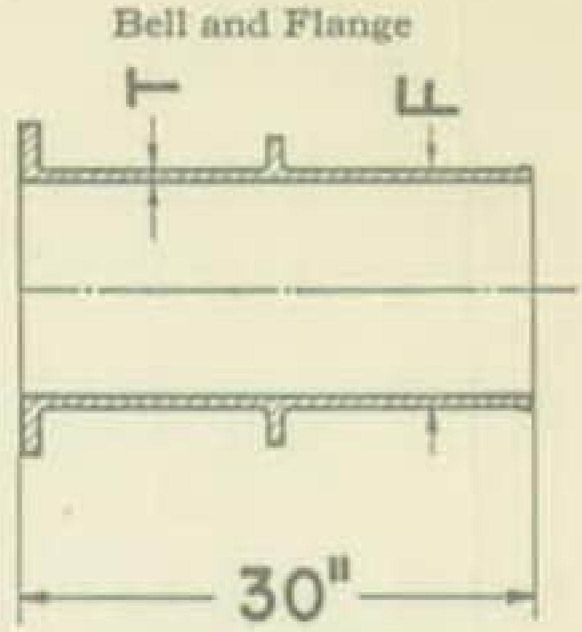

Bell and Flange



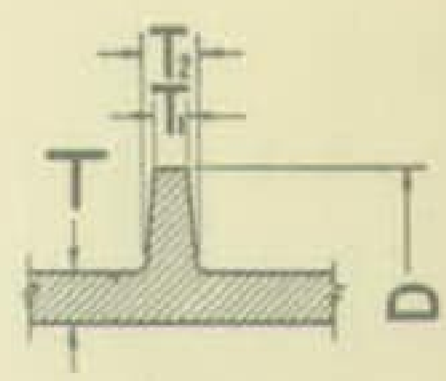

Flange and Flange




Bell and Spigot




Flange and Spigot

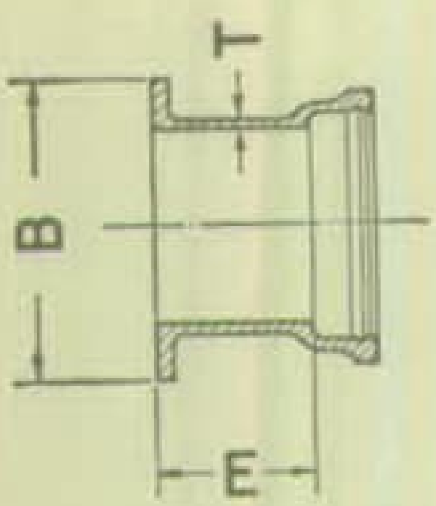



Detail Intermediate Flange

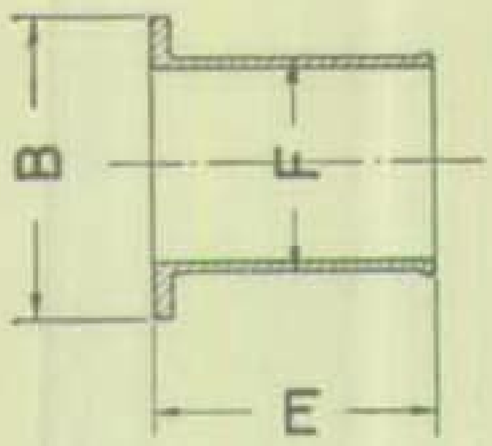
| Nom. Diam. | Class | T | F | Intermediate Flange | | | | Wall Pipe Weights | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $T_2$ | $T_1$ | D | Int. Flg. Wt. | Bell & Bell | Bell & Flange | Flange & Flange | Bell & Spigot | Flange & Spigot |
| 3 | D | 0.48 | 3.96 | 0.75 | 0.50 | 7.00 | 4 | 85 | 70 | 55 | 65 | 50 |
| 4 | D | 0.52 | 5.00 | 0.75 | 0.50 | 8.00 | 5 | 110 | 95 | 85 | 85 | 75 |
| 6 | D | 0.55 | 7.10 | 0.75 | 0.50 | 10.00 | 6 | 165 | 140 | 120 | 130 | 105 |
| 8 | D | 0.60 | 9.30 | 0.75 | 0.50 | 12.50 | 9 | 235 | 205 | 180 | 185 | 155 |
| 10 | D | 0.68 | 11.40 | 0.75 | 0.50 | 14.50 | 10 | 315 | 280 | 245 | 245 | 215 |
| 12 | D | 0.75 | 13.50 | 0.75 | 0.50 | 16.50 | 12 | 395 | 365 | 330 | 320 | 285 |
| 14 | B | 0.66 | 15.30 | 1.00 | 0.75 | 19.50 | 26 | 440 | 405 | 370 | 355 | 320 |
| 14 | D | 9.82 | 15.65 | 1.00 | 0.75 | 19.50 | 24 | 515 | 470 | 425 | 420 | 375 |
| 16 | B | 0.70 | 17.40 | 1.00 | 0.75 | 21.75 | 30 | 545 | 500 | 450 | 435 | 385 |
| 16 | D | 0.89 | 17.80 | 1.00 | 0.75 | 21.75 | 28 | 655 | 590 | 525 | 525 | 460 |
| 18 | B | 0.75 | 19.50 | 1.00 | 0.75 | 23.75 | 33 | 645 | 580 | 520 | 515 | 450 |
| 18 | D | 0.96 | 19.92 | 1.00 | 0.75 | 23.75 | 30 | 785 | 695 | 605 | 635 | 545 |
| 20 | B | 0.80 | 21.60 | 1.00 | 0.75 | 25.75 | 35 | 755 | 690 | 620 | 600 | 535 |
| 20 | D | 1.03 | 22.06 | 1.00 | 0.75 | 25.75 | 32 | 940 | 835 | 725 | 755 | 645 |
| 24 | B | 0.89 | 25.80 | 1.00 | 0.75 | 30.25 | 45 | 985 | 910 | 835 | 790 | 715 |
| 24 | D | 1.16 | 26.32 | 1.00 | 0.75 | 30.25 | 40 | 1255 | 1115 | 980 | 1010 | 870 |
| 30 | B | 1.03 | 32.00 | 1.25 | 1.00 | 36.50 | 70 | 1450 | 1335 | 1220 | 1155 | 1040 |
| 30 | D | 1.37 | 32.74 | 1.25 | 1.00 | 36.50 | 60 | 1945 | 1695 | 1440 | 1535 | 1280 |
| 36 | B | 1.15 | 38.30 | 1.25 | 1.00 | 43.00 | 88 | 2025 | 1855 | 1685 | 1585 | 1415 |
| 36 | D | 1.58 | 39.16 | 1.25 | 1.00 | 43.00 | 72 | 2700 | 2355 | 2010 | 2115 | 1775 |
| 42 | B | 1.28 | 44.50 | 1.50 | 1.25 | 49.50 | 130 | 2660 | 2465 | 2275 | 2080 | 1885 |
| 42 | D | 1.78 | 45.58 | 1.50 | 1.25 | 49.50 | 105 | 3625 | 3160 | 2700 | 2825 | 2360 |
| 48 | B | 1.42 | 50.80 | 1.50 | 1.25 | 56.50 | 172 | 3380 | 3110 | 2835 | 2640 | 2370 |
| 48 | D | 1.96 | 51.98 | 1.50 | 1.25 | 56.50 | 138 | 4630 | 3990 | 3350 | 3590 | 2950 |

Dimensions in inches.
Fittings can be furnished in lengths other than 30".
A.S.A. Class 125 Standard Flanges used, see page 345 for dimensions.
Wall Flange in center of laying length unless otherwise specified.

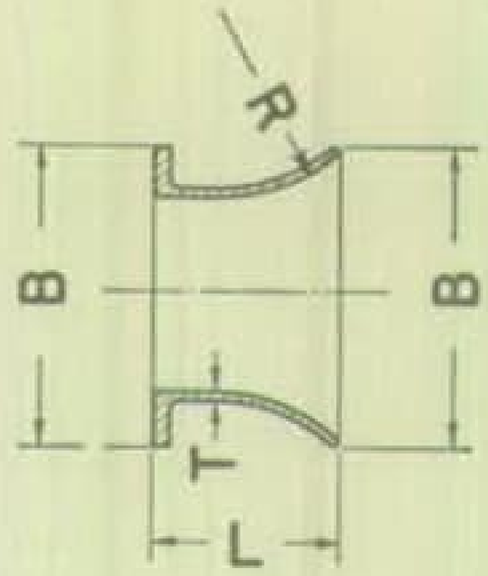
## Laying Dimensions and Weights of Standard Fittings



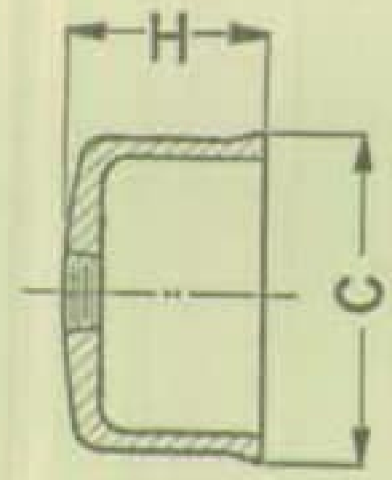

Flange and Bell




Flange and Spigot




Flange and Flare



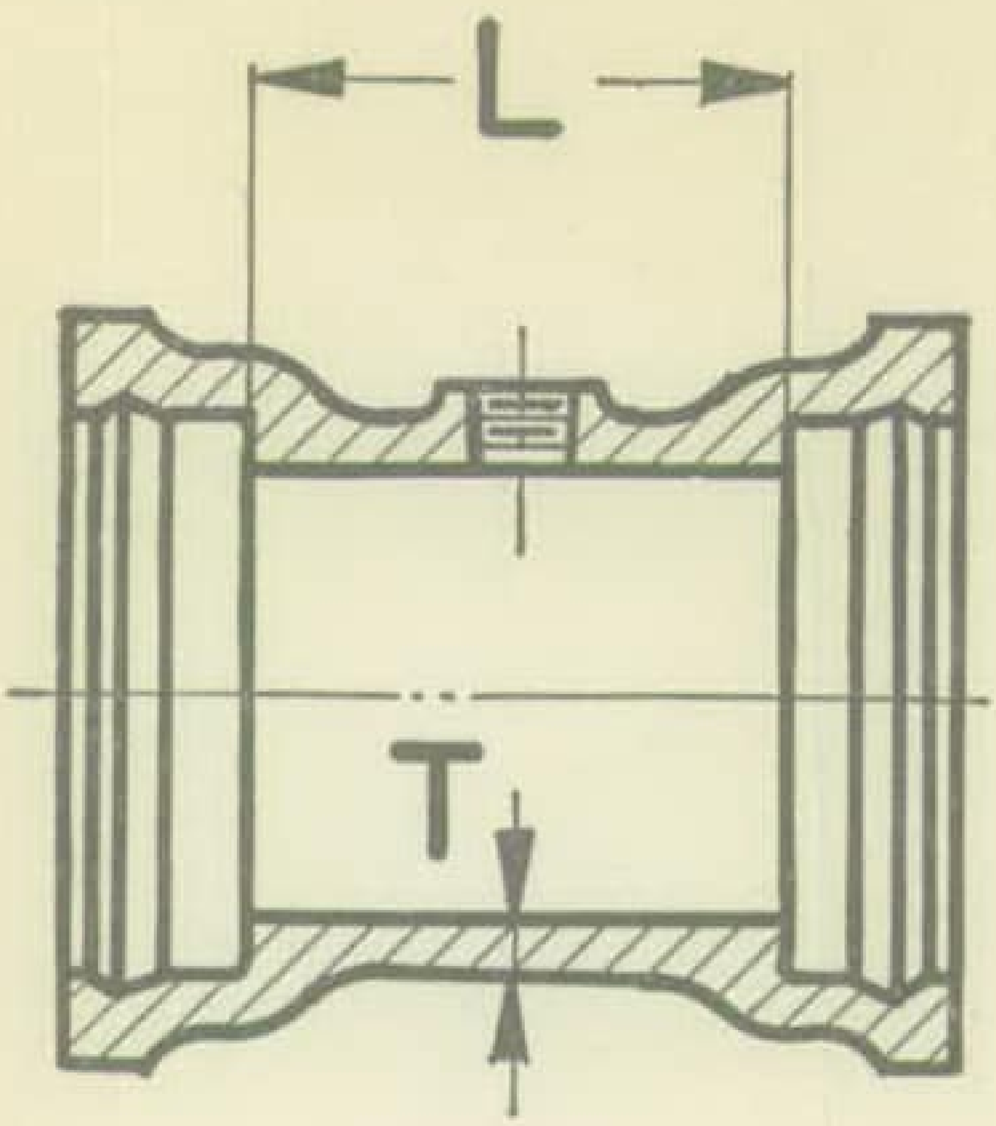

Round Nose Plug

E—To Be Specified by Purchaser

| Size | Class | Data for Flange & Bell or Flange & Spigot | | | | | | Flange & Flare | | | Round Nose Plugs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T | F. O.D. | Wt. of Bell | Wt. of Bead | Wt. Single Flange | Wt. per Ft. of Bbl. | R | L | Wt. | C | H | Wt. Not Tapped | Max. Tap Size |
| 3 | D | 0.48 | 3.96 | 20 | 0.3 | 6 | 16.4 | 6 | 8 | 20 | 4.34 | 5.50 | 10 | 2 |
| 4 | D | 0.52 | 5.00 | 25 | 0.4 | 10 | 22.8 | 6 | 8 | 30 | 5.28 | 6.00 | 15 | 2½ |
| 6 | D | 0.55 | 7.10 | 35 | 0.5 | 13 | 35.3 | 6 | 8 | 40 | 7.38 | 6.00 | 25 | 4 |
| 8 | D | 0.60 | 9.30 | 49 | 1.2 | 21 | 51.2 | 8 | 10 | 70 | 9.56 | 6.00 | 40 | 4 |
| 10 | D | 0.68 | 11.40 | 62 | 1.4 | 28 | 71.5 | 10 | 10 | 95 | 11.63 | 6.00 | 55 | 4 |
| 12 | D | 0.75 | 13.50 | 76 | 1.7 | 43 | 93.7 | 12 | 12 | 155 | 13.73 | 6.00 | 70 | 4 |
| 14 | B | 0.66 | 15.30 | 88 | 1.9 | 54 | 94.7 | 14 | 12 | 165 | ..... | .... | ........ | ...... |
| 14 | D | 0.82 | 15.65 | 96 | 1.9 | 51 | 119.2 | 14 | 12 | 190 | ..... | .... | ........ | ...... |
| 16 | B | 0.70 | 17.40 | 114 | 2.1 | 67 | 114.6 | 16 | 16 | 240 | ..... | .... | ........ | ...... |
| 16 | D | 0.89 | 17.80 | 128 | 2.2 | 63 | 147.5 | 16 | 16 | 280 | ..... | .... | ........ | ...... |
| 18 | B | 0.75 | 19.50 | 133 | 2.4 | 70 | 137.8 | 18 | 16 | 275 | ..... | .... | ........ | ...... |
| 18 | D | 0.96 | 19.92 | 154 | 2.4 | 65 | 178.4 | 18 | 16 | 320 | ..... | .... | ........ | ...... |
| 20 | B | 0.80 | 21.60 | 156 | 2.6 | 89 | 163.1 | 20 | 18 | 355 | ..... | .... | ........ | ...... |
| 20 | D | 1.03 | 22.06 | 189 | 2.7 | 82 | 212.3 | 20 | 18 | 425 | ..... | .... | ........ | ...... |
| 24 | B | 0.89 | 25.80 | 199 | 3.2 | 123 | 217.3 | 24 | 18 | 480 | ..... | .... | ........ | ...... |
| 24 | D | 1.16 | 26.32 | 250 | 3.2 | 112 | 286.1 | 24 | 18 | 570 | ..... | .... | ........ | ...... |
| 30 | B | 1.03 | 32.00 | 298 | 3.9 | 184 | 312.7 | ... | ... | .... | ..... | .... | ........ | ...... |
| 30 | D | 1.37 | 32.74 | 416 | 4.0 | 163 | 421.3 | ... | ... | .... | ..... | .... | ........ | ...... |
| 36 | B | 1.15 | 38.30 | 446 | 4.7 | 274 | 418.8 | ... | ... | .... | ..... | .... | ........ | ...... |
| 36 | D | 1.58 | 39.16 | 586 | 4.8 | 242 | 582.0 | ... | ... | .... | ..... | .... | ........ | ...... |
| 42 | B | 1.28 | 44.50 | 586 | 5.4 | 393 | 542.3 | ... | ... | .... | ..... | .... | ........ | ...... |
| 42 | D | 1.78 | 45.58 | 805 | 5.8 | 341 | 764.2 | ... | ... | .... | ..... | .... | ........ | ...... |
| 48 | B | 1.42 | 50.80 | 745 | 6.2 | 474 | 687.3 | ... | ... | .... | ..... | .... | ........ | ...... |
| 48 | D | 1.96 | 51.98 | 1046 | 6.3 | 406 | 961.0 | ... | ... | .... | ..... | .... | ........ | ...... |

Dimensions in inches.
B is 125 Std. Flange O.D.

## Dimensions and Weights—Tapped Tee



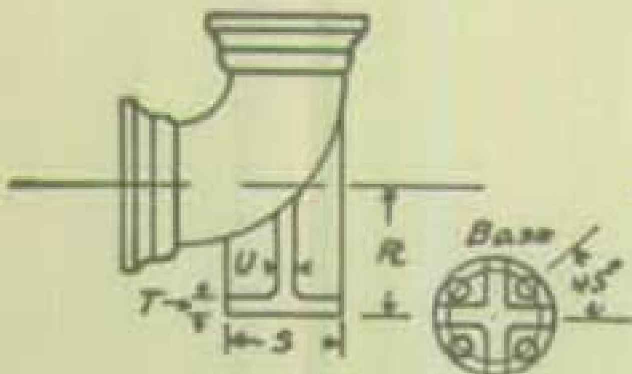

TAPPED TEE

| Size | Class | Dimensions in Inches | | Weight Pounds |
|---|---|---|---|---|
| | | T | L | |
| 3 | D | .48 | 12 | 55 |
| 4 | D | .52 | 12 | 75 |
| 6 | D | .55 | 12 | 105 |
| 8 | D | .60 | 12 | 150 |
| 10 | D | .68 | 12 | 195 |
| 12 | D | .75 | 12 | 245 |

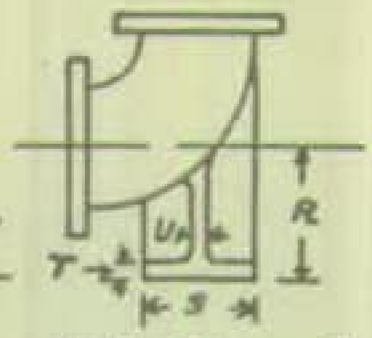
When ordering specify size of tap.
Tapped crosses can be furnished by the addition of another tapped boss.

# Weights and Dimensions of Standard Bases for Fittings

**Bases can be furnished for Tees and Bends as follows**
**125# Flanged—Mech-Joint—Short Body—A.W.W.A. B. & S.**

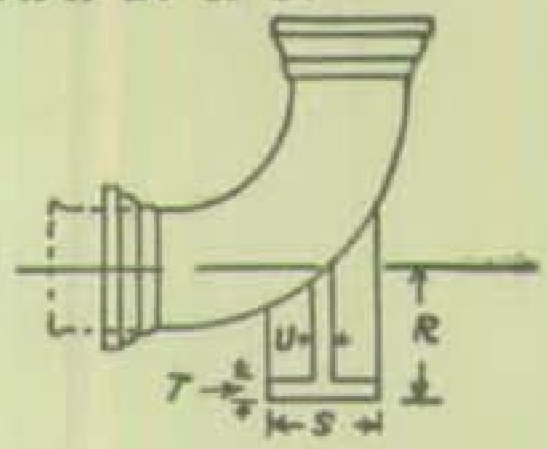


Short Body

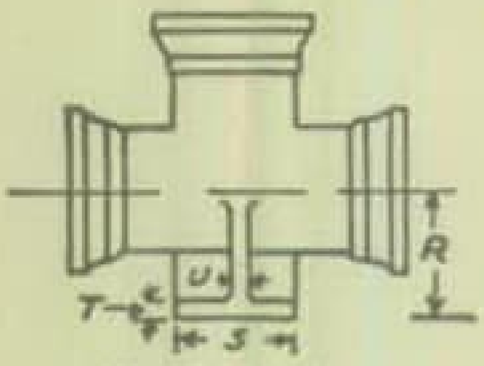


125# Flanged

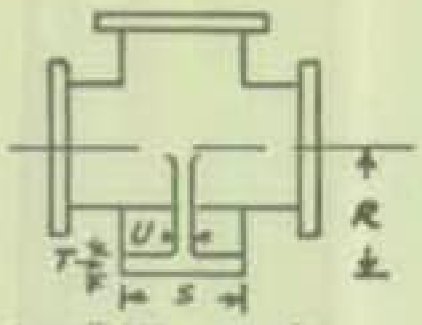
Mechanical Joint



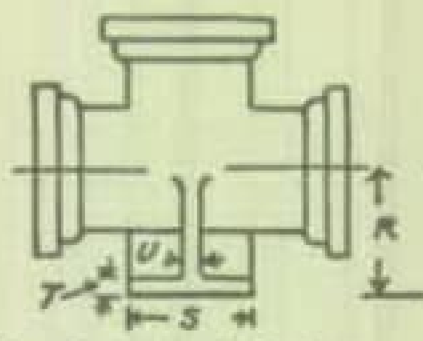
A.W.W.A.



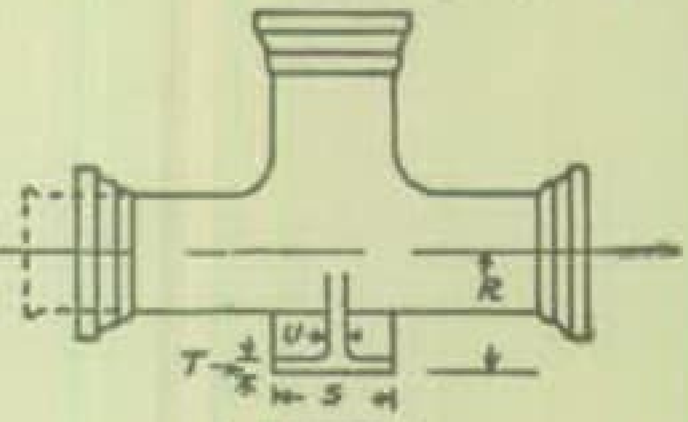
Short Body



125# Flanged



Mechanical Joint

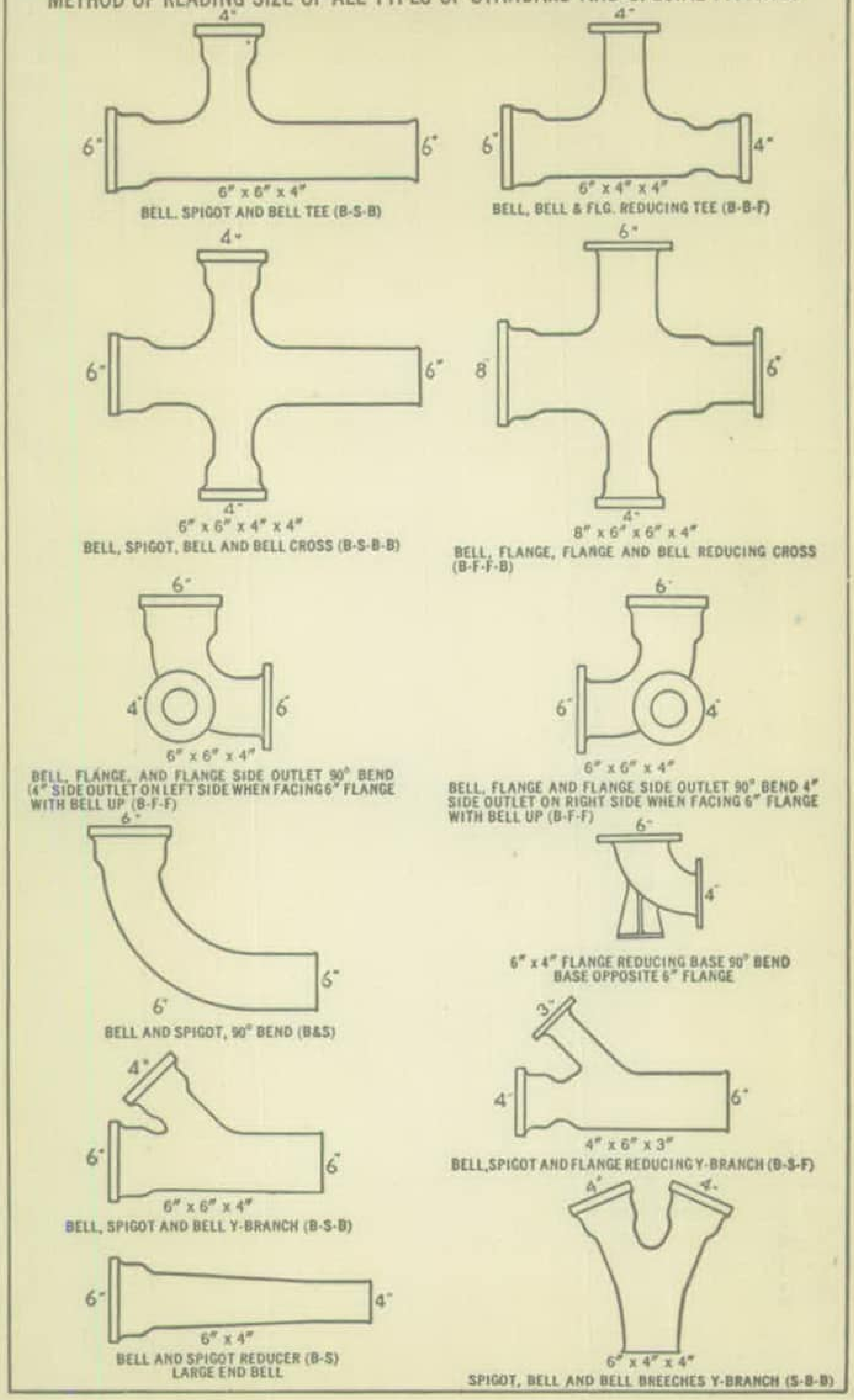


A.W.W.A.

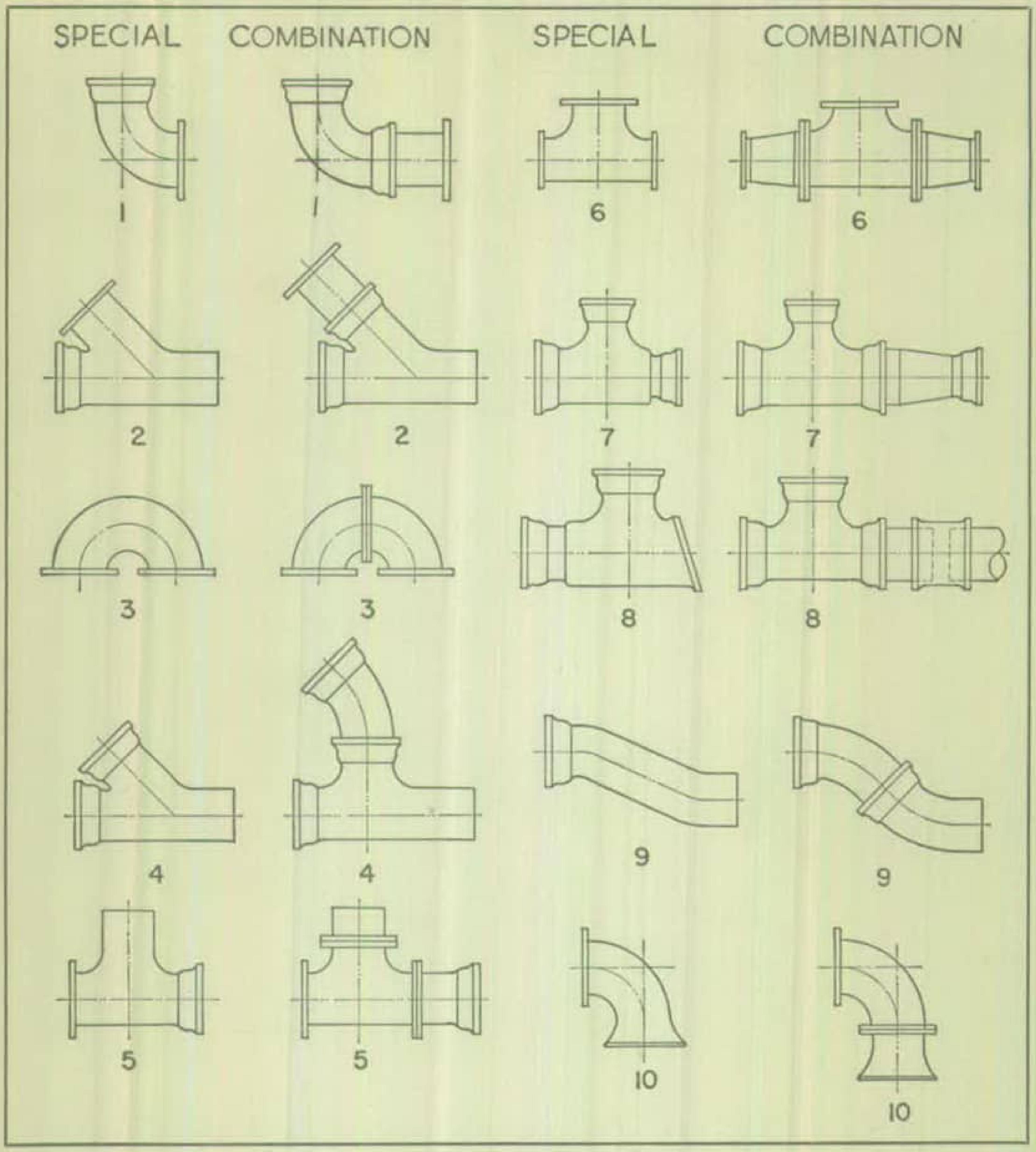
| Size | Center to Base R | Diam. of Base S | Thick. of Base T | Thick. of Rib U | Diam. of B.C. of Base | Size of Holes in Base | No. of Holes in Base | Supporting Pipe Size | Wt. of Base, Lbs. Tees | Bends A.W.W.A. | Bends 125 Lb. Flg. & Mech. Joint | Bends Short Body |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 4.88 | 5.00 | 0.56 | 0.50 | 3.88 | ⅝ | 4 | 1½ | 5 | 20 | 10 | 10 |
| 4 | 5.50 | 6.00 | 0.62 | 0.50 | 4.75 | ¾ | 4 | 2 | 10 | 25 | 10 | 10 |
| 6 | 7.00 | 7.00 | 0.69 | 0.62 | 5.50 | ¾ | 4 | 2½ | 15 | 35 | 20 | 20 |
| 8 | 8.38 | 9.00 | 0.94 | 0.88 | 7.50 | ¾ | 4 | 4 | 30 | 60 | 40 | 40 |
| 10 | 9.75 | 9.00 | 0.94 | 0.88 | 7.50 | ¾ | 4 | 4 | 30 | 65 | 45 | 45 |
| 12 | 11.25 | 11.00 | 1.00 | 1.00 | 9.50 | ⅞ | 4 | 6 | 45 | 85 | 65 | 65 |
| 14 | 12.50 | 11.00 | 1.00 | 1.00 | 9.50 | ⅞ | 4 | 6 | 50 | 95 | 70 | ..... |
| 16 | 13.75 | 11.00 | 1.00 | 1.00 | 9.50 | ⅞ | 4 | 6 | 50 | 110 | 75 | ..... |
| 18 | 15.00 | 13.50 | 1.12 | 1.12 | 11.75 | ⅞ | 4 | 8 | 75 | 155 | 115 | ..... |
| 20 | 16.00 | 13.50 | 1.12 | 1.12 | 11.75 | ⅞ | 4 | 8 | 75 | 160 | 120 | ..... |
| 24 | 18.50 | 13.50 | 1.12 | 1.12 | 11.75 | ⅞ | 4 | 8 | 80 | 175 | 130 | ..... |
| 30 | 23.00 | 16.00 | 1.19 | 1.15 | 14.25 | 1 | 4 | 10 | 120 | 260 | 190 | ..... |
| 36 | 26.00 | 19.00 | 1.25 | 1.15 | 17.00 | 1 | 4 | 12 | 160 | 390 | 250 | ..... |
| 42 | 30.00 | 23.50 | 1.44 | 1.28 | 21.25 | 1⅛ | 4 | 16 | 270 | 575 | 410 | ..... |
| 48 | 34.00 | 25.00 | 1.56 | 1.42 | 22.75 | 1¼ | 4 | 18 | 335 | 740 | 515 | ..... |
| 54 | 38.00 | 27.50 | 1.69 | 1.55 | 25.00 | 1¼ | 4 | 20 | ..... | ..... | ..... | ..... |
| 60 | 42.00 | 32.00 | 1.88 | 1.67 | 29.50 | 1⅜ | 4 | 24 | ..... | ..... | ..... | ..... |

Dimensions in inches.
Bases are not faced nor drilled unless specified.
Dimension "R" is a finished dimension, unfinished bases will be ⅛" longer.

METHOD OF READING SIZE OF ALL TYPES OF STANDARD AND SPECIAL FITTINGS



## Combination of Standard Fittings That May Be Used in Place of Special Fittings

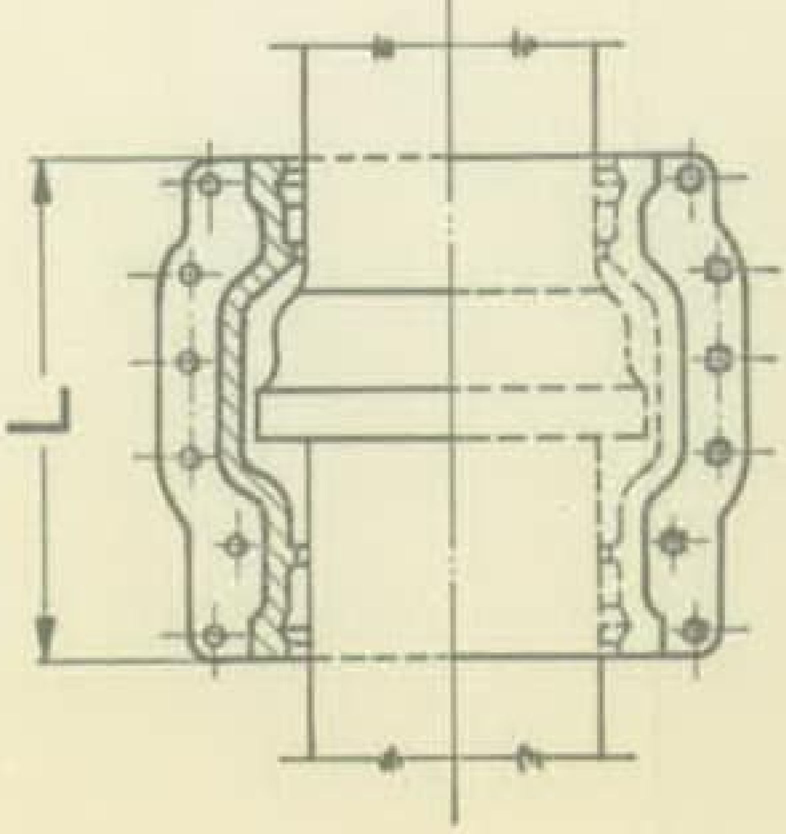



The illustrations in the "SPECIAL" columns on this page indicate typical fittings that are often required with a combination of bell, spigot, and flange outlets. The laying dimensions of these fittings are not covered by any standard and they are therefore usually named "SPECIAL" inasmuch as they are made to order to suit certain conditions in piping installations.

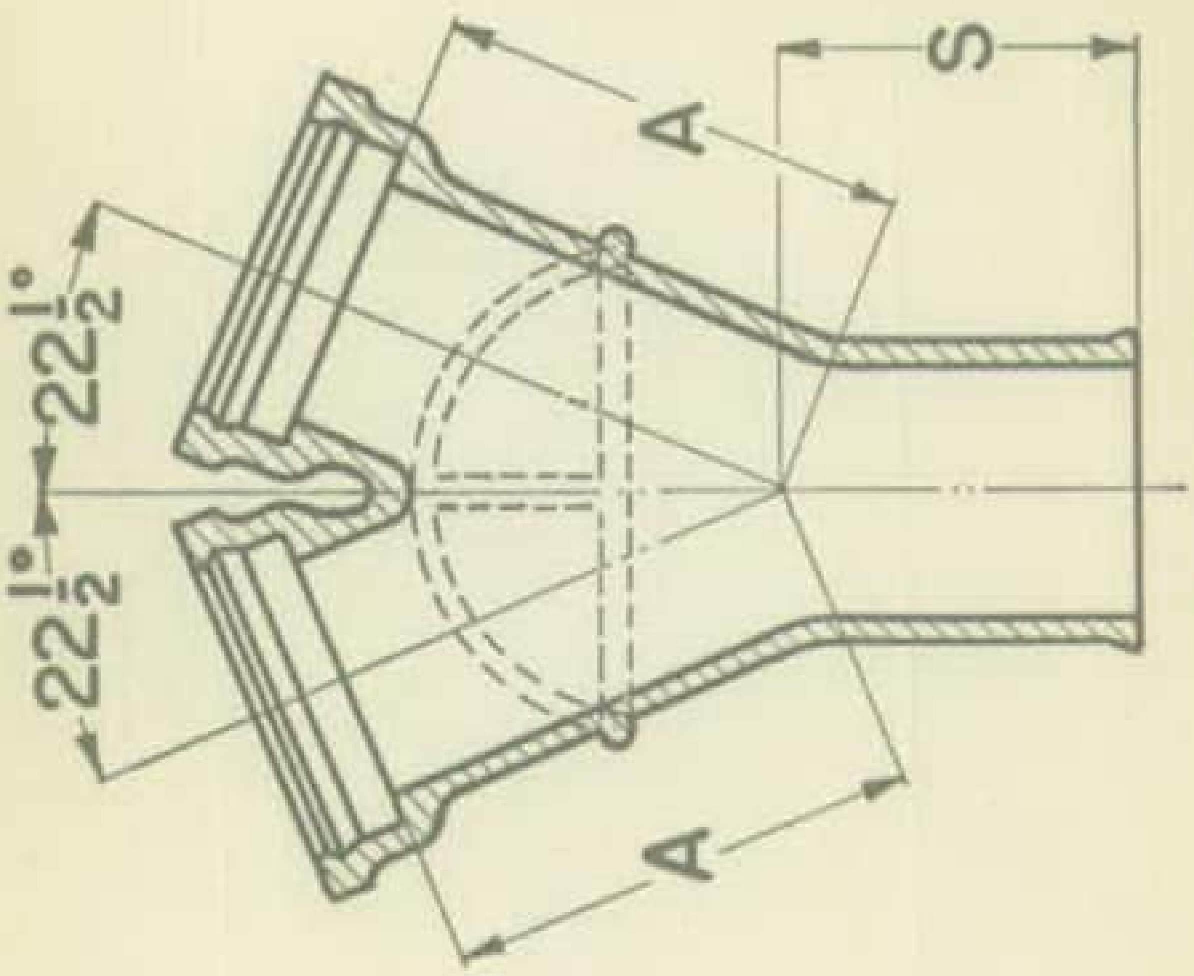
To the right of each "SPECIAL" fitting is shown a combination of Standard fittings that can be used to obtain the same outlet effects as the Specials. The laying dimensions may not be interchangeable since the dimensions of the Standard fittings are fixed whereas the Specials can be made to any desired lengths.

The use of Standard fittings wherever possible is always recommended as the most economical and such fittings can usually be shipped out of stock. In sending inquiries for fittings of dimensions deviating from the Standard, state specifically the type of outlets wanted, reading, size, etc., as shown on page 399, and give exact dimension from center line to outlet.

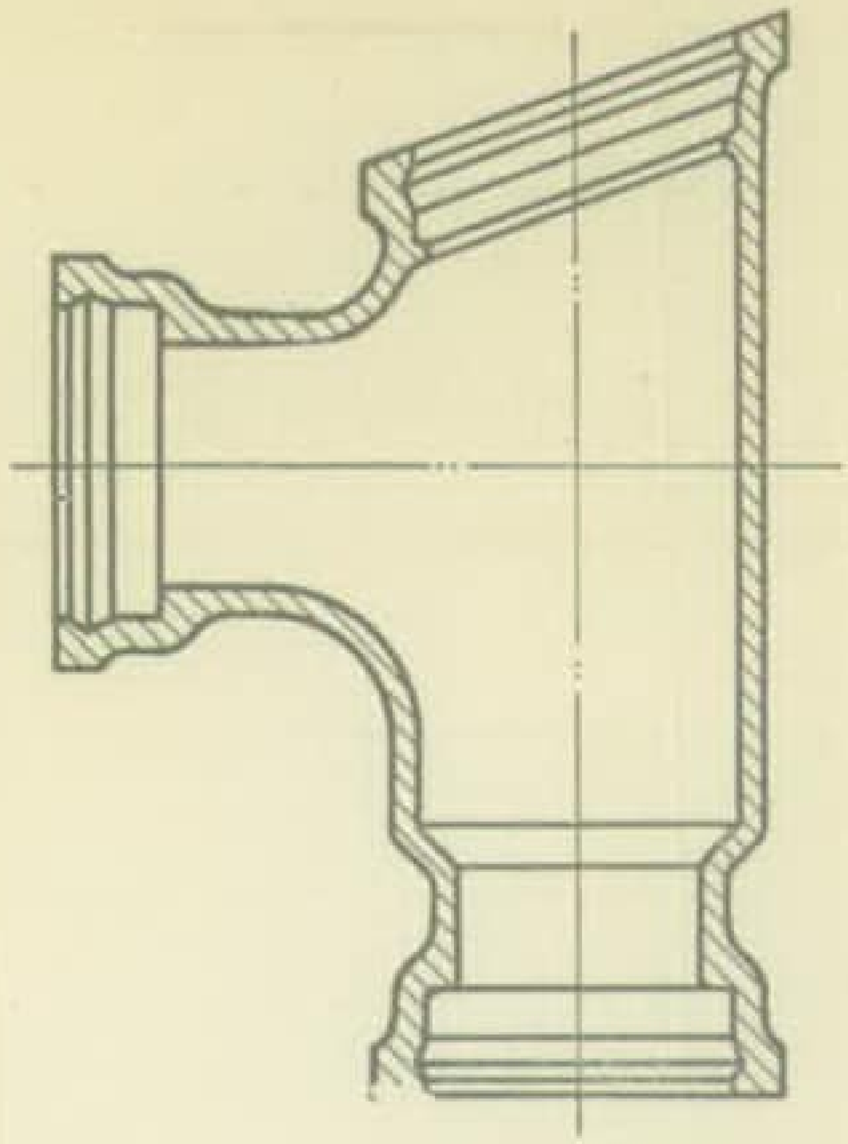
## Non-Standard Fittings




Bell Split Sleeve



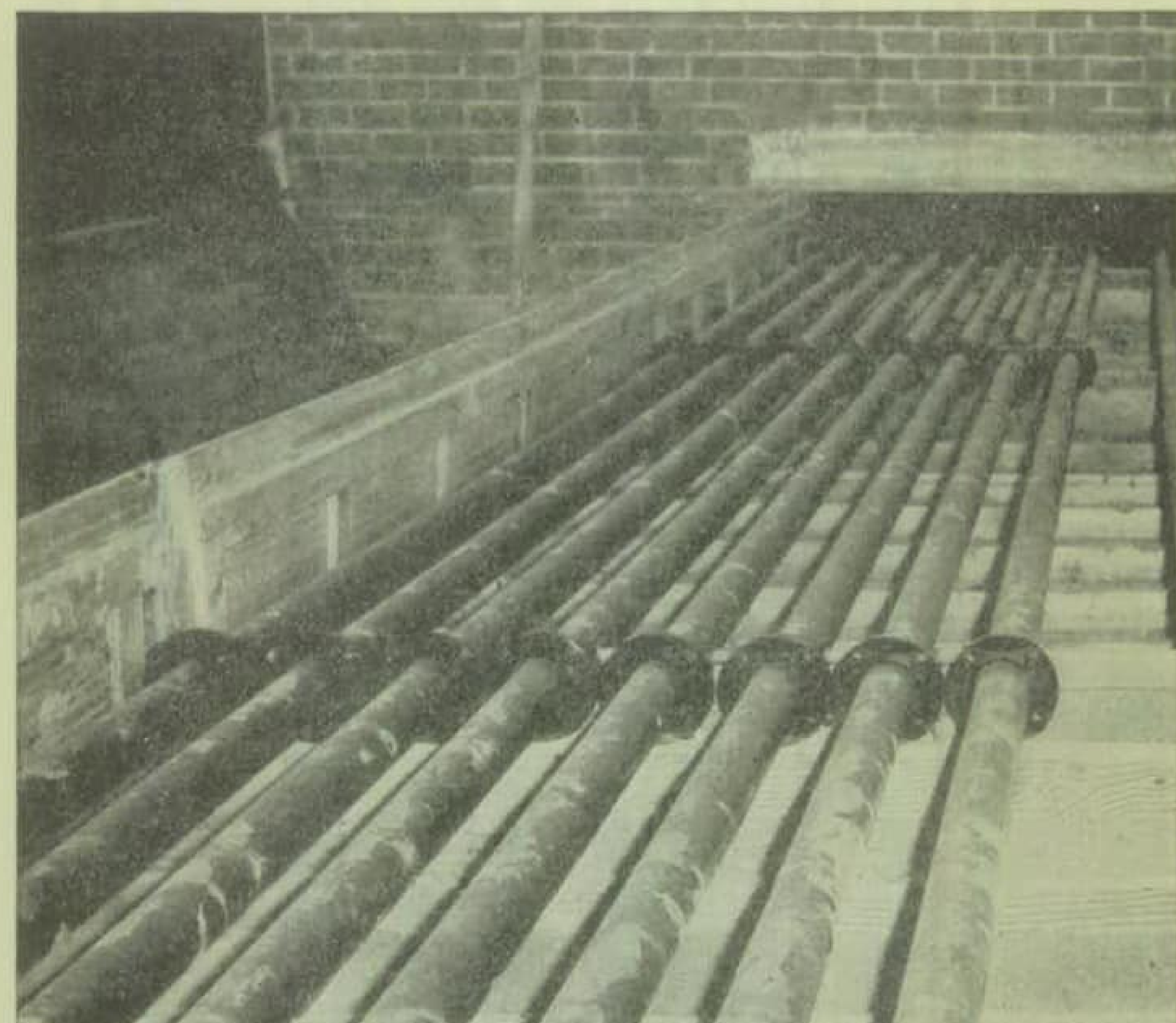

Type 1 Y Branch



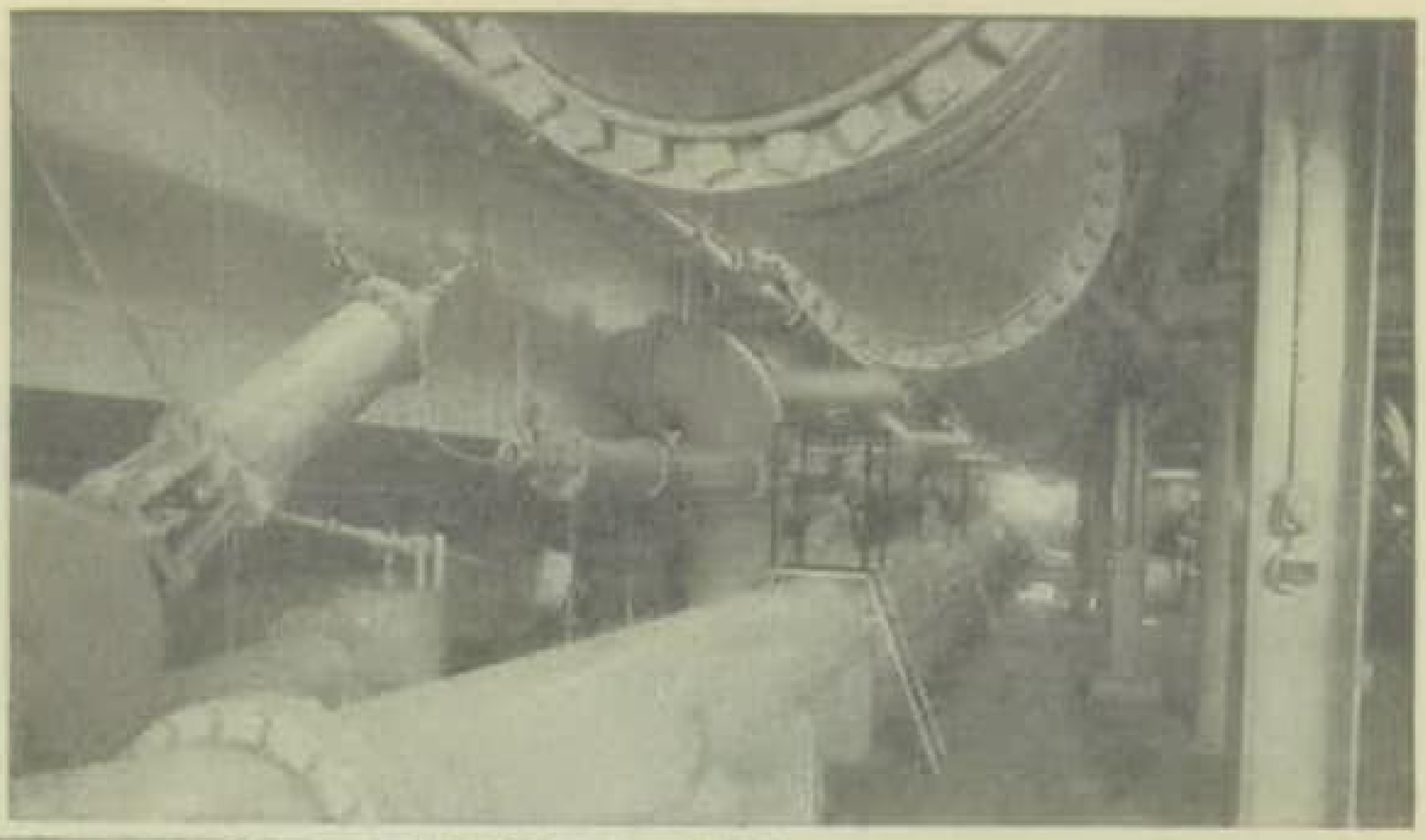
Cutting-in Tee

# SECTION 17

## Industrial Uses



*Cast iron pipe carries hot corrosive liquid in chemical plant*



**Paper Mills**
*Installation of cast iron pipe for supply and backwash lines in filtration plant.*

**Rayon Plants**
*Cast iron pipe is widely used for water supply in rayon and other process industries.*

**Coal Mines**
*Cast iron pipe in mine refuse disposal system.*

***Steam Generating Plants***
***Cast iron pipe carries over 40 tons of ash daily in ash removal system.***


***Railroads***
***Cast iron water line from pumping station to water tank.***

***Oil Refineries***
***Cast iron pipe installed for cooling coil.***

# SECTION 18

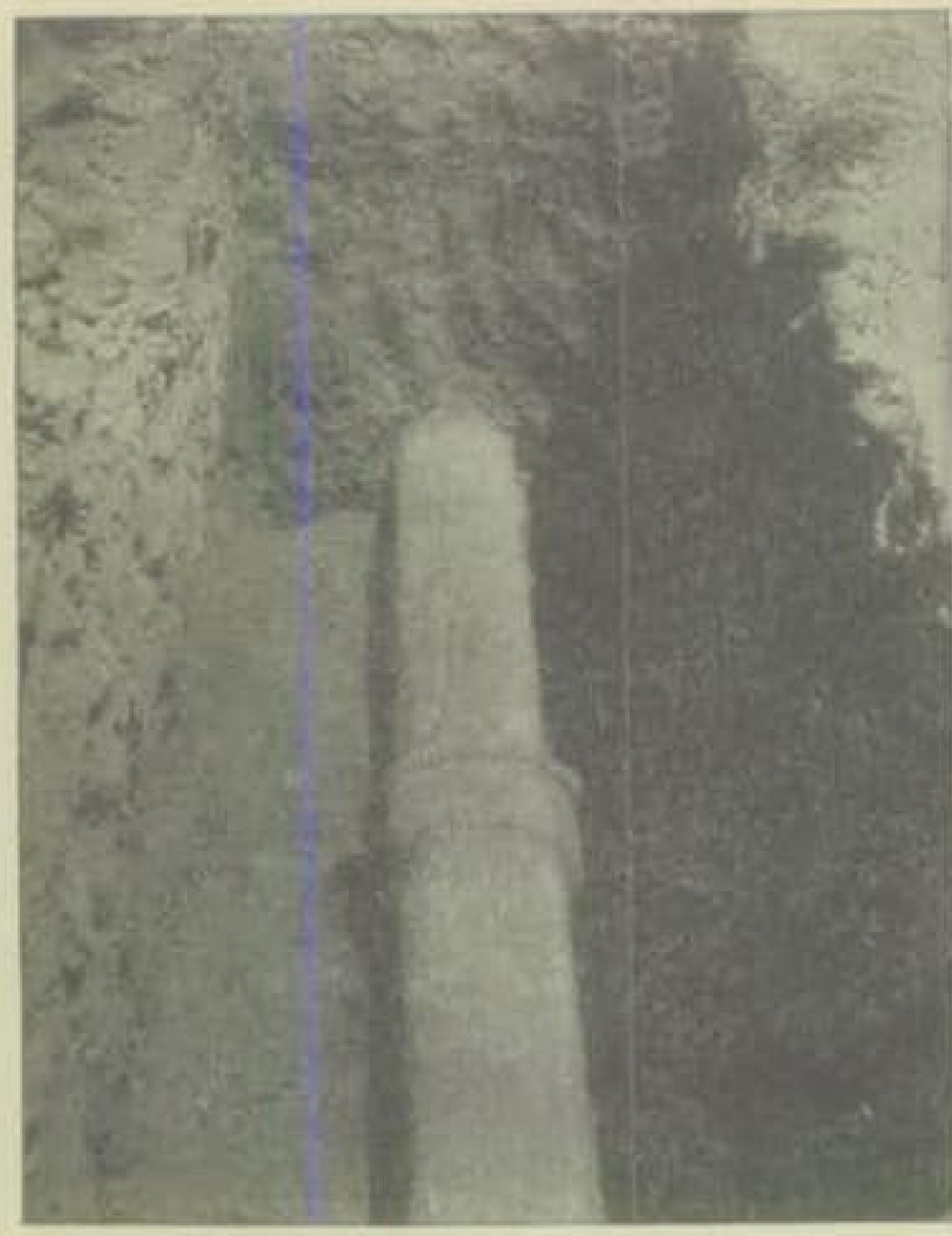
## Salvaging and Re-Using Cast Iron Pipe

**It is impossible to foretell future requirements or population shifts in cities, large or small, but any public official can be sure that, when water, gas or sewer mains must be abandoned, rerouted, or replaced by larger sizes, the pipe can be salvaged, or reused, if it is cast iron pipe.**

*Springfield, Missouri. In connection with changes at a pumping station, part of a 50-year-old 18-inch cast iron water main was recently taken up and relaid in another part of the city. Note cast marks and date clearly discernible on pipe in right center.*

*San Francisco, Cal. A 12-inch cast iron line, originally laid in 1892 by the Spring Valley Water Co., subsequently taken over by the San Francisco Water Department, was removed after more than 40 years of service. In excellent condition it was relaid elsewhere in the city, saving a substantial sum to the taxpayers.*

*Columbus, Ohio. Recent completion of a new sewage treatment plant and intercepting sewer resulted in the abandonment of a 48-inch cast iron force main. After 37 years' service, without any maintenance cost, the pipe was taken up and sold by the city for a substantial price per ton, over and above all removal expense.*



Richmond, Va. *A section of a cast iron water main, salvaged and relaid at 88 years of age, uncovered for inspection in its 113th year of service to the taxpayers of Richmond, Va.*

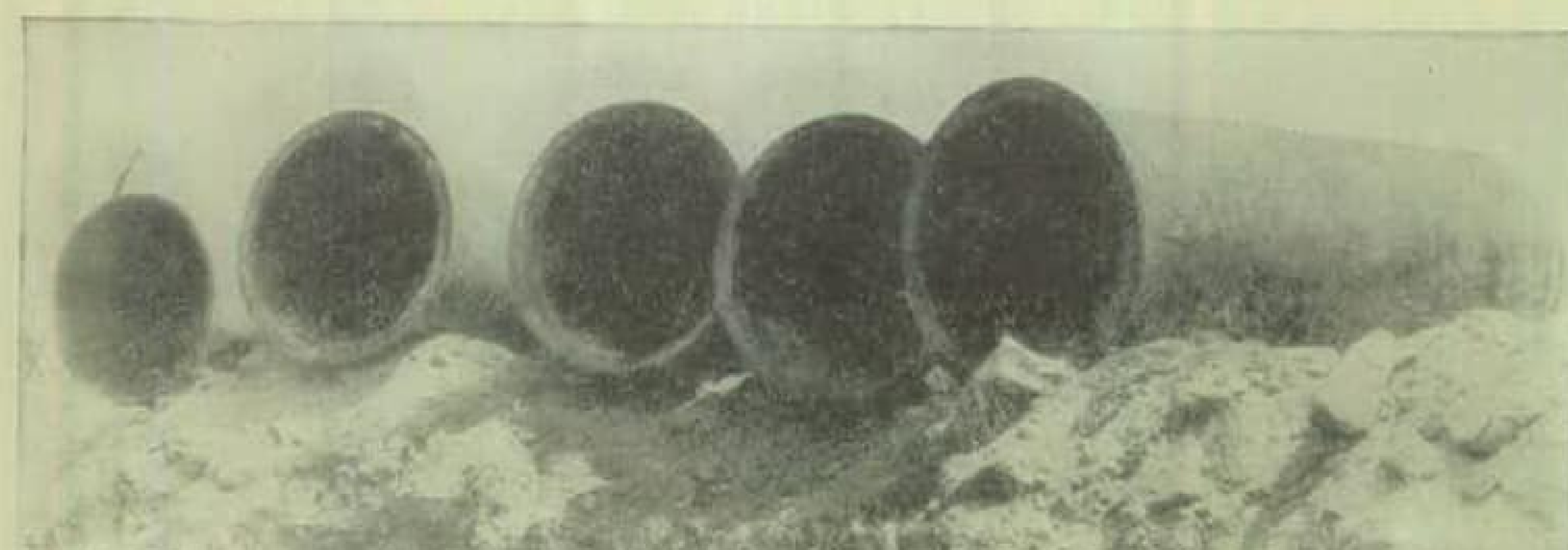
Kenosha, Wis. *Removing a 14-inch cast iron water main for replacement with new 24-inch cast iron pipe. After 43 years' service, the old 14-inch pipe proved to be in excellent condition and was relaid in another section of the city.*

Chicago, Ill. *Note the fine condition of this 36-inch cast iron pipe, both interior and exterior, after 70 years of service in its original location in Chicago's water supply system. The maker's stencil is clearly legible. Naturally, this pipe was salvaged and relaid elsewhere, at a considerable saving to the city.*

*Ft. Worth, Texas.* This city was recently required by the State Highway Department to relocate a 36-inch cast iron water main which had been in service for 46 years. When taken up the pipe was found in fine condition (interiors almost literally "as clean as a whistle"), moved to a new location and relaid.

*Nashua, N. H.* Eighty-year-old cast iron pipe recently removed from the system, being cleaned and redipped for relaying in other sections of the distribution system.

*Glendale, Cal.* Installing a 48-inch bell and spigot cast iron intercepting sewer crossing under Los Angeles River. This is the third location for the pipe. It was first used in Philadelphia from 1901 to 1923 then reconditioned and installed at Glendale in 1925 and relocated at Glendale in 1938.



*Escanaba, Mich. This 16-inch cast iron pipe, after nearly half a century of service in the water supply system of Iron Mountain, Michigan, was taken up and relaid in Escanaba, about fifty miles away.*

*New York, N. Y. Removing a 36-inch cast iron water main from tunnel in Highbridge. Installed in 1848 to carry water from Croton Aqueduct across Harlem River and abandoned when bridge was reconstructed. Sold as scrap.*

# SECTION 19

## Useful Tables

**Please note that while all tables and formulas contained in the following pages have been carefully checked and every precaution taken in proofreading, we do not assume responsibility for their accuracy.**

## Pressures in Pounds per Square Inch, Corresponding to Heads of Water in Feet

| Head Ft. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ........ | 0.433 | 0.866 | 1.299 | 1.732 | 2.165 | 2.598 | 3.031 | 3.464 | 3.987 |
| 10 | 4.330 | 4.763 | 5.196 | 5.629 | 6.062 | 6.495 | 6.928 | 7.361 | 7.794 | 8.277 |
| 20 | 8.660 | 9.093 | 9.526 | 9.959 | 10.392 | 10.825 | 11.258 | 11.691 | 12.124 | 12.557 |
| 30 | 12.990 | 13.423 | 13.856 | 14.289 | 14.722 | 15.155 | 15.588 | 16.021 | 16.454 | 16.887 |
| 40 | 17.320 | 17.753 | 18.186 | 18.619 | 19.052 | 19.485 | 19.918 | 20.351 | 20.784 | 21.217 |
| 50 | 21.650 | 22.083 | 22.516 | 22.949 | 23.382 | 23.815 | 24.248 | 24.681 | 25.114 | 25.547 |
| 60 | 25.980 | 26.413 | 26.846 | 27.279 | 27.712 | 28.145 | 28.578 | 29.011 | 29.444 | 29.877 |
| 70 | 30.310 | 30.743 | 31.176 | 31.609 | 32.042 | 32.475 | 32.908 | 33.341 | 33.774 | 34.207 |
| 80 | 34.640 | 35.073 | 35.506 | 35.939 | 36.372 | 36.805 | 37.238 | 37.671 | 38.104 | 38.537 |
| 90 | 38.970 | 39.403 | 39.836 | 40.269 | 40.702 | 41.135 | 41.568 | 42.001 | 42.436 | 42.867 |

## Heads of Water in Feet, Corresponding to Pressures in Pounds per Square Inch

| Pressure Lbs. per Sq. In. | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | ............... | 2.309 | 4.619 | 6.928 | 9.238 |
| 10 | 23.095 | 25.404 | 27.714 | 30.023 | 32.333 |
| 20 | 46.189 | 48.499 | 50.808 | 53.118 | 55.427 |
| 30 | 69.284 | 71.594 | 73.903 | 76.213 | 78.522 |
| 40 | 92.379 | 94.688 | 96.998 | 99.307 | 101.62 |
| 50 | 115.47 | 117.78 | 120.09 | 122.40 | 124.71 |
| 60 | 138.57 | 140.88 | 143.19 | 145.50 | 147.81 |
| 70 | 161.66 | 163.97 | 166.28 | 168.59 | 170.90 |
| 80 | 184.76 | 187.07 | 189.38 | 191.69 | 194.00 |
| 90 | 207.85 | 210.16 | 212.47 | 214.78 | 217.09 |
| | 5 | 6 | 7 | 8 | 9 |
| 0 | 11.547 | 13.857 | 16.166 | 18.476 | 20.785 |
| 10 | 34.642 | 36.952 | 39.261 | 41.570 | 43.880 |
| 20 | 57.737 | 60.046 | 62.356 | 64.665 | 66.975 |
| 30 | 80.831 | 83.141 | 85.450 | 87.760 | 90.069 |
| 40 | 103.93 | 106.24 | 108.55 | 110.85 | 113.16 |
| 50 | 127.02 | 129.33 | 131.64 | 133.95 | 136.26 |
| 60 | 150.12 | 152.42 | 154.73 | 157.04 | 159.35 |
| 70 | 173.21 | 175.52 | 177.83 | 180.14 | 182.45 |
| 80 | 196.31 | 198.61 | 200.92 | 203.23 | 205.54 |
| 90 | 219.40 | 221.71 | 224.02 | 226.33 | 228.64 |

At 62° F., 1 foot head = 0.433 lb. per square inch; 0.433 × 144 = 62.355 lbs. per cubic foot. 1 lb. per square inch = 2.30947 feet head. 1 atmosphere = 14.7 lbs. per square inch = 33.94 feet head.

## Linear Expansion of Cast Iron Pipe

The coefficient of linear expansion of cast iron may be taken as 0.0000058 per degree Fahrenheit. The expansion or contraction in *inches* that will take place in a line of given length with various temperature changes is shown in the following table:

| Temp. Difference °F | Length of Line in Feet | | | |
|---|---|---|---|---|
| | 100 | 500 | 1000 | 5280 |
| 5 | 0.035 | 0.17 | 0.35 | 1.83 |
| 10 | 0.070 | 0.35 | 0.70 | 3.67 |
| 20 | 0.139 | 0.70 | 1.39 | 7.34 |
| 30 | 0.209 | 1.04 | 2.09 | 11.01 |
| 40 | 0.278 | 1.39 | 2.78 | 14.70 |
| 50 | 0.348 | 1.74 | 3.48 | 18.35 |
| 60 | 0.418 | 2.09 | 4.18 | 22.04 |
| 70 | 0.487 | 2.44 | 4.87 | 25.72 |
| 80 | 0.557 | 2.79 | 5.57 | 29.39 |
| 90 | 0.626 | 3.13 | 6.26 | 33.05 |
| 100 | 0.696 | 3.48 | 6.96 | 36.71 |
| 120 | 0.835 | 4.17 | 8.35 | 44.10 |
| 150 | 1.043 | 5.22 | 10.43 | 55.10 |

## Weight of Lead and Jute per Joint

| Nominal Dia. of Pipe, Inches | 3 | 4 | 6 | 8 | 10 | 12 | 14 |
|---|---|---|---|---|---|---|---|
| Approx. Pounds of Lead Required per Joint........... | 6.50 | 8.00 | 11.25 | 14.50 | 17.50 | 20.50 | 24.00 |
| Approx. Pounds of Jute Required per Joint........... | 0.18 | 0.21 | 0.31 | 0.44 | 0.53 | 0.61 | 0.81 |

| Nominal Dia. of Pipe Inches | 16 | 18 | 20 | 24 | 30 | 36 | 42 | 48 |
|---|---|---|---|---|---|---|---|---|
| Approx. Pounds of Lead Required per Joint.. | 33.0 | 36.90 | 40.50 | 52.50 | 64.75 | 77.25 | 104.25 | 119.00 |
| Approx. Pounds of Jute Required per Joint.. | 0.94 | 1.00 | 1.25 | 1.50 | 2.06 | 3.00 | 3.50 | 4.00 |

The weight of lead per joint is based on the depth of lead required by A.W.W.A. laying specifications plus an allowance of .25" projection beyond the bell face for calking.

# Maximum Deflection Full Length Pipe

## BELL AND SPIGOT PIPE*

| Nom. Pipe Diam. | Joint Opening | Max. Deflection With Pipe Length of: | | | | Approx. Radius of Curve Produced by Succession of Joints With Pipe Lengths of: | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 12 ft. | 16 ft. | 18 ft. | 20 ft. | 12 ft. | 16 ft. | 18 ft. | 20 ft. |
| | | *in.* | | | | *ft.* | | | |
| 2 | 0.41 | 23.6 | 31.5 | 35.4 | 39.4 | 73 | 98 | 110 | 122 |
| 3 | 0.43 | 14.8 | 19.7 | 22.2 | 24.7 | 112 | 149 | 168 | 186 |
| 4 | 0.41 | 11.1 | 14.8 | 16.7 | 18.5 | 156 | 208 | 234 | 260 |
| 6 | 0.58 | 11.1 | 14.8 | 16.7 | 18.5 | 156 | 208 | 234 | 260 |
| 8 | 0.65 | 9.7 | 12.9 | 14.6 | 16.2 | 178 | 238 | 268 | 297 |
| 10 | 0.75 | 9.3 | 12.4 | 14.0 | 15.5 | 186 | 248 | 279 | 310 |
| 12 | 0.75 | 7.9 | 10.5 | 11.9 | 13.2 | 218 | 292 | 327 | 363 |
| 14 | 0.75 | 6.7 | 8.9 | 10.1 | 11.2 | 258 | 345 | 387 | 430 |
| 16 | 0.75 | 5.9 | 7.9 | 8.8 | 9.7 | 293 | 390 | 440 | 488 |
| 18 | 0.75 | 5.3 | 7.1 | 8.0 | 8.8 | 326 | 434 | 489 | 543 |
| 20 | 0.75 | 4.8 | 6.4 | 7.2 | 8.0 | 360 | 480 | 540 | 600 |
| 24 | 0.75 | 4.0 | 5.3 | 6.0 | 6.7 | 432 | 577 | 648 | 720 |
| 30 | 0.75 | 3.3 | 4.4 | 5.0 | 5.5 | 524 | 699 | 786 | 873 |
| 36 | 0.75 | 2.8 | 3.7 | 4.2 | 4.7 | 617 | 824 | 926 | 1,028 |
| 42 | 0.75 | 2.4 | 3.2 | 3.6 | 4.0 | 720 | 960 | 1,080 | 1,200 |
| 48 | 0.75 | 2.1 | 2.8 | 3.2 | 3.5 | 823 | 1,097 | 1,234 | 1,371 |
| 54 | 0.75 | 1.9 | 2.5 | 2.9 | 3.2 | 909 | 1,211 | 1,364 | 1,515 |
| 60 | 0.75 | 1.7 | 2.3 | 2.6 | 2.8 | 1,016 | 1,355 | 1,524 | 1,695 |

* Limiting factors: (1) joint opening not to exceed 0.75 in.; (2) calking space at face of bell to be not less than 0.25 in. in width.

## MECHANICAL JOINT PIPE

| Size of Pipe | Bend in One Joint Angle | Deflection in Inches | | | | Approximate Radius in feet of Curve Produced by Succession of Joints | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 12 ft. length | 16 ft. length | 18 ft. length | 20 ft. length | 12 ft. length | 16 ft. length | 18 ft. length | 20 ft. length |
| 3 | 8°–18′ | 21 | 28 | 31 | — | 85 | 110 | 125 | — |
| 4 | 8°–18′ | 21 | 28 | 31 | — | 85 | 110 | 125 | — |
| 6 | 7°– 7′ | 18 | 24 | 27 | — | 100 | 130 | 145 | — |
| 8 | 5°–21′ | 13 | 18 | 20 | — | 130 | 170 | 195 | — |
| 10 | 5°–21′ | 13 | 18 | 20 | — | 130 | 170 | 195 | — |
| 12 | 5°–21′ | 13 | 18 | 20 | 22 | 130 | 170 | 195 | 220 |
| 14 | 3°–35′ | 9 | 12 | 13½ | 15 | 190 | 250 | 285 | 320 |
| 16 | 3°–35′ | 9 | 12 | 13½ | 15 | 190 | 250 | 285 | 320 |
| 18 | 3°– 0′ | 7½ | 10 | 11 | 12 | 230 | 300 | 340 | 380 |
| 20 | 3°– 0′ | 7½ | 10 | 11 | 12 | 230 | 300 | 340 | 380 |
| 24 | 2°–23′ | 6 | 8 | 9 | 10 | 300 | 400 | 450 | 500 |
| 30 | 2°–23′ | 6 | 8 | 9 | 10 | 300 | 400 | 450 | 500 |
| 36 | 2°– 5′ | 5 | 7 | 8 | — | 330 | 440 | 500 | — |
| 42 | 2°– 0′ | 5 | 6 | 7½ | — | 340 | 450 | 510 | — |
| 48 | 2°– 0′ | 5 | 6 | 7½ | — | 340 | 450 | 510 | — |

## Equivalents of Fractions of an Inch

| Fractions | | | Decimals | Milli-meters | Fractions | | | Decimals | Milli-meters |
|---|---|---|---|---|---|---|---|---|---|
| | | 1/64 | 0.015625 | .3969 | | | 33/64 | 0.515625 | 13.0966 |
| | 1/32 | | 0.03125 | .7937 | | 17/32 | | 0.53125 | 13.4935 |
| | | 3/64 | 0.046875 | 1.1906 | | | 35/64 | 0.546875 | 13.8904 |
| 1/16 | | | 0.0625 | 1.5875 | 9/16 | | | 0.5625 | 14.2872 |
| | | 5/64 | 0.078125 | 1.9843 | | | 37/64 | 0.578125 | 14.6841 |
| | 3/32 | | 0.09375 | 2.3812 | | 19/32 | | 0.59375 | 15.0810 |
| | | 7/64 | 0.109375 | 2.7781 | | | 39/64 | 0.609375 | 15.4778 |
| 1/8 | | | 0.125 | 3.1749 | 5/8 | | | 0.625 | 15.8747 |
| | | 9/64 | 0.140625 | 3.5718 | | | 41/64 | 0.640625 | 16.2716 |
| | 5/32 | | 0.15625 | 3.9687 | | 21/32 | | 0.65625 | 16.6684 |
| | | 11/64 | 0.171875 | 4.3655 | | | 43/64 | 0.671875 | 17.0653 |
| 3/16 | | | 0.1875 | 4.7624 | 11/16 | | | 0.6875 | 17.4622 |
| | | 13/64 | 0.203125 | 5.1593 | | | 45/64 | 0.703125 | 17.8591 |
| | 7/32 | | 0.21875 | 5.5561 | | 23/32 | | 0.71875 | 18.2559 |
| | | 15/64 | 0.234375 | 5.9530 | | | 47/64 | 0.734375 | 18.6528 |
| 1/4 | | | 0.25 | 6.3499 | 3/4 | | | 0.75 | 19.0497 |
| | | 17/64 | 0.265625 | 6.7468 | | | 49/64 | 0.765625 | 19.4465 |
| | 9/32 | | 0.28125 | 7.1436 | | 25/32 | | 0.78125 | 19.8434 |
| | | 19/64 | 0.296875 | 7.5405 | | | 51/64 | 0.796875 | 20.2403 |
| 5/16 | | | 0.3125 | 7.9374 | 13/16 | | | 0.8125 | 20.6371 |
| | | 21/64 | 0.328125 | 8.3342 | | | 53/64 | 0.828125 | 21.0340 |
| | 11/32 | | 0.34375 | 8.7311 | | 27/32 | | 0.84375 | 21.4309 |
| | | 23/64 | 0.359375 | 9.1280 | | | 55/64 | 0.859375 | 21.8277 |
| 3/8 | | | 0.375 | 9.5248 | 7/8 | | | 0.875 | 22.2246 |
| | | 25/64 | 0.390625 | 9.9217 | | | 57/64 | 0.890625 | 22.6215 |
| | 13/32 | | 0.40625 | 10.3186 | | 29/32 | | 0.90625 | 23.0183 |
| | | 27/64 | 0.421875 | 10.7154 | | | 59/64 | 0.921875 | 23.4152 |
| 7/16 | | | 0.4375 | 11.1123 | 15/16 | | | 0.9375 | 23.8121 |
| | | 29/64 | 0.453125 | 11.5092 | | | 61/64 | 0.953125 | 24.2089 |
| | 15/32 | | 0.46875 | 11.9060 | | 31/32 | | 0.96875 | 24.6058 |
| | | 31/64 | 0.484375 | 12.3029 | | | 63/64 | 0.984375 | 25.0027 |
| 1/2 | | | 0.50 | 12.6998 | 1 | | | 1.00 | 25.3995 |

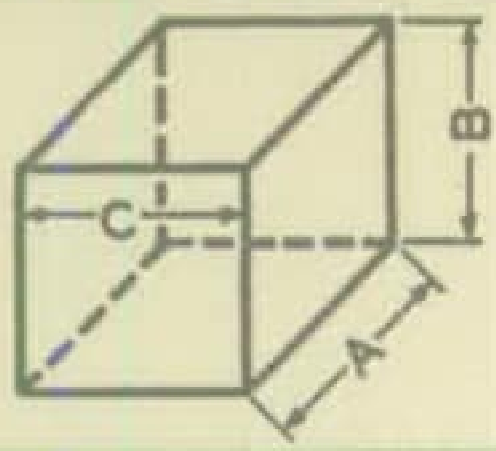
## Circumferences and Areas of Circles

| Diam. | Circum. | Area | Diam. | Circum. | Area | Diam. | Circum. | Area |
|---|---|---|---|---|---|---|---|---|
| 1/64 | 0.04909 | 0.00019 | 2 11/16 | 8.4430 | 5.6727 | 7 | 21.991 | 38.485 |
| 1/32 | 0.09818 | 0.00077 | 3/4 | 8.6394 | 5.9396 | 1/8 | 22.384 | 39.871 |
| 3/64 | 0.14726 | 0.00173 | 13/16 | 8.8357 | 6.2126 | 1/4 | 22.776 | 41.282 |
| 1/16 | 0.19635 | 0.00307 | 7/8 | 9.0321 | 6.4918 | 3/8 | 23.169 | 42.718 |
| 3/32 | 0.29452 | 0.00690 | 15/16 | 9.2284 | 6.7771 | 1/2 | 23.562 | 44.179 |
| 1/8 | 0.39270 | 0.01227 | 3 | 9.4248 | 7.0686 | 5/8 | 23.955 | 45.664 |
| 5/32 | 0.49087 | 0.01917 | 1/16 | 9.6211 | 7.3662 | 3/4 | 24.347 | 47.173 |
| 3/16 | 0.58905 | 0.02761 | 1/8 | 9.8175 | 7.6699 | 7/8 | 24.740 | 48.707 |
| 7/32 | 0.68722 | 0.03758 | 3/16 | 10.014 | 7.9798 | 8 | 25.133 | 50.265 |
| 1/4 | 0.78540 | 0.04909 | 1/4 | 10.210 | 8.2958 | 1/8 | 25.525 | 51.849 |
| 9/32 | 0.88357 | 0.06213 | 5/16 | 10.407 | 8.6179 | 1/4 | 25.918 | 53.456 |
| 5/16 | 0.98175 | 0.07670 | 3/8 | 10.603 | 8.9462 | 3/8 | 26.311 | 55.088 |
| 11/32 | 1.0799 | 0.09281 | 7/16 | 10.799 | 9.2806 | 1/2 | 26.704 | 56.745 |
| 3/8 | 1.1781 | 0.11045 | 1/2 | 10.996 | 9.6211 | 5/8 | 27.096 | 58.426 |
| 13/32 | 1.2763 | 0.12962 | 9/16 | 11.192 | 9.9678 | 3/4 | 27.489 | 60.132 |
| 7/16 | 1.3744 | 0.15033 | 5/8 | 11.388 | 10.321 | 7/8 | 27.882 | 61.862 |
| 15/32 | 1.4726 | 0.17257 | 11/16 | 11.585 | 10.680 | 9 | 28.274 | 63.617 |
| 1/2 | 1.5708 | 0.19635 | 3/4 | 11.781 | 11.045 | 1/8 | 28.667 | 65.397 |
| 17/32 | 1.6690 | 0.22166 | 13/16 | 11.977 | 11.416 | 1/4 | 29.060 | 67.201 |
| 9/16 | 1.7671 | 0.24850 | 7/8 | 12.174 | 11.793 | 3/8 | 29.452 | 69.029 |
| 19/32 | 1.8653 | 0.27688 | 15/16 | 12.370 | 12.177 | 1/2 | 29.845 | 70.882 |
| 5/8 | 1.9635 | 0.30680 | 4 | 12.566 | 12.566 | 5/8 | 30.238 | 72.760 |
| 21/32 | 2.0617 | 0.33824 | 1/16 | 12.763 | 12.962 | 3/4 | 30.631 | 74.662 |
| 11/16 | 2.1598 | 0.37122 | 1/8 | 12.959 | 13.364 | 7/8 | 31.023 | 76.589 |
| 23/32 | 2.2580 | 0.40574 | 3/16 | 13.155 | 13.772 | 10 | 31.416 | 78.540 |
| 3/4 | 2.3562 | 0.44179 | 1/4 | 13.352 | 14.186 | 1/4 | 32.201 | 82.516 |
| 25/32 | 2.4544 | 0.47937 | 5/16 | 13.548 | 14.607 | 1/2 | 32.987 | 86.590 |
| 13/16 | 2.5525 | 0.51849 | 3/8 | 13.744 | 15.033 | 3/4 | 33.772 | 90.763 |
| 27/32 | 2.6507 | 0.55914 | 7/16 | 13.941 | 15.466 | 11 | 34.558 | 95.033 |
| 7/8 | 2.7489 | 0.60132 | 1/2 | 14.137 | 15.904 | 1/4 | 35.343 | 99.402 |
| 29/32 | 2.8471 | 0.64504 | 9/16 | 14.334 | 16.349 | 1/2 | 36.128 | 103.87 |
| 15/16 | 2.9452 | 0.69029 | 5/8 | 14.530 | 16.800 | 3/4 | 36.914 | 108.43 |
| 31/32 | 3.0434 | 0.73708 | 11/16 | 14.726 | 17.257 | 12 | 37.699 | 113.10 |
| 1 | 3.1416 | 0.7854 | 3/4 | 14.923 | 17.721 | 1/4 | 38.485 | 117.86 |
| 1/16 | 3.3379 | 0.8866 | 13/16 | 15.119 | 18.190 | 1/2 | 39.270 | 122.72 |
| 1/8 | 3.5343 | 0.9940 | 7/8 | 15.315 | 18.665 | 3/4 | 40.055 | 127.68 |
| 3/16 | 3.7306 | 1.1075 | 15/16 | 15.512 | 19.147 | 13 | 40.841 | 132.73 |
| 1/4 | 3.9270 | 1.2272 | 5 | 15.708 | 19.635 | 1/4 | 41.626 | 137.89 |
| 5/16 | 4.1233 | 1.3530 | 1/16 | 15.904 | 20.129 | 1/2 | 42.412 | 143.14 |
| 3/8 | 4.3197 | 1.4849 | 1/8 | 16.101 | 20.629 | 3/4 | 43.197 | 148.49 |
| 7/16 | 4.5160 | 1.6230 | 3/16 | 16.297 | 21.135 | 14 | 43.982 | 153.94 |
| 1/2 | 4.7124 | 1.7671 | 1/4 | 16.493 | 21.648 | 1/4 | 44.768 | 159.48 |
| 9/16 | 4.9087 | 1.9175 | 5/16 | 16.690 | 22.166 | 1/2 | 45.553 | 165.13 |
| 5/8 | 5.1051 | 2.0739 | 3/8 | 16.886 | 22.691 | 3/4 | 46.338 | 170.87 |
| 11/16 | 5.3014 | 2.2365 | 7/16 | 17.082 | 23.221 | 15 | 47.124 | 176.71 |
| 3/4 | 5.4978 | 2.4053 | 1/2 | 17.279 | 23.758 | 1/4 | 47.909 | 182.65 |
| 13/16 | 5.6941 | 2.5802 | 9/16 | 17.475 | 24.301 | 1/2 | 48.695 | 188.69 |
| 7/8 | 5.8905 | 2.7612 | 5/8 | 17.671 | 24.850 | 3/4 | 49.480 | 194.83 |
| 15/16 | 6.0868 | 2.9483 | 11/16 | 17.868 | 25.406 | 16 | 50.265 | 201.06 |
| 2 | 6.2832 | 3.1416 | 3/4 | 18.064 | 25.967 | 1/4 | 51.051 | 207.39 |
| 1/16 | 6.4795 | 3.3410 | 13/16 | 18.261 | 26.535 | 1/2 | 51.836 | 213.82 |
| 1/8 | 6.6759 | 3.5466 | 7/8 | 18.457 | 27.109 | 3/4 | 52.622 | 220.35 |
| 3/16 | 6.8722 | 3.7583 | 15/16 | 18.653 | 27.688 | 17 | 53.407 | 226.98 |
| 1/4 | 7.0686 | 3.9761 | 6 | 18.850 | 28.274 | 1/4 | 54.192 | 233.71 |
| 5/16 | 7.2649 | 4.2000 | 1/8 | 19.242 | 29.465 | 1/2 | 54.978 | 240.53 |
| 3/8 | 7.4613 | 4.4301 | 1/4 | 19.635 | 30.680 | 3/4 | 55.763 | 247.45 |
| 7/16 | 7.6576 | 4.6664 | 3/8 | 20.028 | 31.919 | 18 | 56.549 | 254.47 |
| 1/2 | 7.8540 | 4.9087 | 1/2 | 20.420 | 33.183 | 1/4 | 57.334 | 261.59 |
| 9/16 | 8.0503 | 5.1572 | 5/8 | 20.813 | 34.472 | 1/2 | 58.119 | 268.80 |
| 5/8 | 8.2467 | 5.4119 | 3/4 | 21.206 | 35.785 | 3/4 | 58.905 | 276.12 |
| | | | 7/8 | 21.598 | 37.122 | | | |

# Circumferences and Areas of Circles

| Diam. | Circum. | Area | Diam. | Circum. | Area | Diam. | Circum. | Area |
|---|---|---|---|---|---|---|---|---|
| 19 | 59.690 | 283.53 | 34½ | 108.385 | 934.82 | 50 | 157.080 | 1963.5 |
| ¼ | 60.476 | 291.04 | ¾ | 109.170 | 948.42 | 51 | 160.221 | 2042.8 |
| ½ | 61.261 | 298.65 | 35 | 109.956 | 962.11 | 52 | 163.363 | 2123.7 |
| ¾ | 62.046 | 306.35 | ¼ | 110.741 | 975.91 | 53 | 166.504 | 2206.2 |
| 20 | 62.832 | 314.16 | ½ | 111.527 | 989.8 | 54 | 169.646 | 2290.2 |
| ¼ | 63.617 | 322.06 | ¾ | 112.312 | 1003.8 | 55 | 172.788 | 2375.8 |
| ½ | 64.403 | 330.06 | 36 | 113.097 | 1017.9 | 56 | 175.929 | 2463.0 |
| ¾ | 65.188 | 338.16 | ¼ | 113.883 | 1032.1 | 57 | 179.071 | 2551.8 |
| 21 | 65.973 | 346.36 | ½ | 114.668 | 1046.3 | 58 | 182.212 | 2642.1 |
| ¼ | 66.759 | 354.66 | ¾ | 115.454 | 1060.7 | 59 | 185.354 | 2734.0 |
| ½ | 67.544 | 363.05 | 37 | 116.239 | 1075.2 | 60 | 188.496 | 2827.4 |
| ¾ | 68.330 | 371.54 | ¼ | 117.024 | 1089.8 | 61 | 191.637 | 2922.5 |
| 22 | 69.115 | 380.13 | ½ | 117.810 | 1104.5 | 62 | 194.779 | 3019.1 |
| ¼ | 69.900 | 388.82 | ¾ | 118.596 | 1119.2 | 63 | 197.920 | 3117.2 |
| ½ | 70.686 | 397.61 | 38 | 119.381 | 1134.1 | 64 | 201.062 | 3217.0 |
| ¾ | 71.471 | 406.49 | ¼ | 120.166 | 1149.1 | 65 | 204.204 | 3318.3 |
| 23 | 72.257 | 415.48 | ½ | 120.951 | 1164.2 | 66 | 207.345 | 3421.2 |
| ¼ | 73.042 | 424.56 | ¾ | 121.737 | 1179.3 | 67 | 210.487 | 3525.7 |
| ½ | 73.827 | 433.74 | 39 | 122.522 | 1194.6 | 68 | 213.628 | 3631.7 |
| ¾ | 74.613 | 443.01 | ¼ | 123.308 | 1210.0 | 69 | 216.770 | 3739.3 |
| 24 | 75.398 | 452.39 | ½ | 124.093 | 1225.4 | 70 | 219.911 | 3848.5 |
| ¼ | 76.184 | 461.86 | ¾ | 124.878 | 1241.0 | 71 | 223.053 | 3959.2 |
| ½ | 76.969 | 471.44 | 40 | 125.664 | 1256.6 | 72 | 226.195 | 4071.5 |
| ¾ | 77.754 | 481.11 | ¼ | 126.449 | 1272.4 | 73 | 229.336 | 4185.4 |
| 25 | 78.540 | 490.87 | ½ | 127.235 | 1288.2 | 74 | 232.478 | 4300.8 |
| ¼ | 79.325 | 500.74 | ¾ | 128.020 | 1304.2 | 75 | 235.619 | 4417.9 |
| ½ | 80.111 | 510.71 | 41 | 128.805 | 1320.3 | 76 | 238.761 | 4536.5 |
| ¾ | 80.896 | 520.77 | ¼ | 129.591 | 1336.4 | 77 | 241.903 | 4656.6 |
| 26 | 81.681 | 530.93 | ½ | 130.376 | 1352.7 | 78 | 245.044 | 4778.4 |
| ¼ | 82.467 | 541.19 | ¾ | 131.161 | 1369.0 | 79 | 248.186 | 4901.7 |
| ½ | 83.252 | 551.55 | 42 | 131.947 | 1385.4 | 80 | 251.327 | 5026.5 |
| ¾ | 84.038 | 562.00 | ¼ | 132.732 | 1402.0 | 81 | 254.469 | 5153.0 |
| 27 | 84.823 | 572.56 | ½ | 133.518 | 1418.6 | 82 | 257.611 | 5281.0 |
| ¼ | 85.608 | 583.21 | ¾ | 134.303 | 1435.4 | 83 | 260.752 | 5410.6 |
| ½ | 86.394 | 593.96 | 43 | 135.088 | 1452.2 | 84 | 263.894 | 5541.8 |
| ¾ | 87.179 | 604.81 | ¼ | 135.874 | 1469.1 | 85 | 267.035 | 5674.5 |
| 28 | 87.965 | 615.75 | ½ | 136.659 | 1486.2 | 86 | 270.177 | 5808.8 |
| ¼ | 88.750 | 626.80 | ¾ | 137.445 | 1503.3 | 87 | 273.319 | 5944.7 |
| ½ | 89.535 | 637.94 | 44 | 138.230 | 1520.5 | 88 | 276.460 | 6082.1 |
| ¾ | 90.321 | 649.18 | ¼ | 139.015 | 1537.9 | 89 | 279.602 | 6221.1 |
| 29 | 91.106 | 660.52 | ½ | 139.801 | 1555.3 | 90 | 282.743 | 6361.7 |
| ¼ | 91.892 | 671.96 | ¾ | 140.586 | 1572.8 | 91 | 285.885 | 6503.9 |
| ½ | 92.677 | 683.49 | 45 | 141.372 | 1590.4 | 92 | 289.027 | 6647.6 |
| ¾ | 93.462 | 695.13 | ¼ | 142.157 | 1608.2 | 93 | 292.168 | 6792.9 |
| 30 | 94.248 | 706.86 | ½ | 142.942 | 1626.0 | 94 | 295.310 | 6939.8 |
| ¼ | 95.033 | 718.69 | ¾ | 143.728 | 1643.9 | 95 | 298.451 | 7088.2 |
| ½ | 95.819 | 730.62 | 46 | 144.513 | 1661.9 | 96 | 301.593 | 7238.2 |
| ¾ | 96.604 | 742.64 | ¼ | 145.299 | 1680.0 | 97 | 304.734 | 7389.8 |
| 31 | 97.389 | 754.77 | ½ | 146.084 | 1698.2 | 98 | 307.876 | 7543.0 |
| ¼ | 98.175 | 766.99 | ¾ | 146.869 | 1716.5 | 99 | 311.018 | 7697.7 |
| ½ | 98.960 | 779.31 | 47 | 147.655 | 1734.9 | 100 | 314.159 | 7854.0 |
| ¾ | 99.746 | 791.73 | ¼ | 148.440 | 1753.5 | 101 | 317.30 | 8011.85 |
| 32 | 100.531 | 804.25 | ½ | 149.226 | 1772.1 | 102 | 320.44 | 8171.28 |
| ¼ | 101.316 | 816.86 | ¾ | 150.011 | 1790.8 | 103 | 323.58 | 8332.29 |
| ½ | 102.102 | 829.58 | 48 | 150.796 | 1809.6 | 104 | 326.73 | 8494.87 |
| ¾ | 102.887 | 842.39 | ¼ | 151.582 | 1828.5 | 105 | 329.87 | 8659.01 |
| 33 | 103.673 | 855.30 | ½ | 152.367 | 1847.5 | 106 | 333.01 | 8824.73 |
| ¼ | 104.458 | 868.31 | ¾ | 153.153 | 1866.5 | 107 | 336.15 | 8992.02 |
| ½ | 105.243 | 881.41 | 49 | 153.938 | 1885.7 | 108 | 339.29 | 9160.88 |
| ¾ | 106.029 | 894.62 | ¼ | 154.723 | 1905.0 | 109 | 342.43 | 9331.32 |
| 34 | 106.814 | 907.92 | ½ | 155.509 | 1924.4 | 110 | 345.58 | 9503.32 |
| ¼ | 107.600 | 921.32 | ¾ | 156.294 | 1943.9 | | | |

# USEFUL FORMULAE FOR ESTIMATING WEIGHTS OF CAST IRON PIPE AND FITTINGS




## PARALLELEPIPEDS

VOLUME IN CUB. INCHES = A X B X C

WEIGHT IN POUNDS = VOLUME X .26


## CIRCLE

R = RADIUS; D = DIAMETER

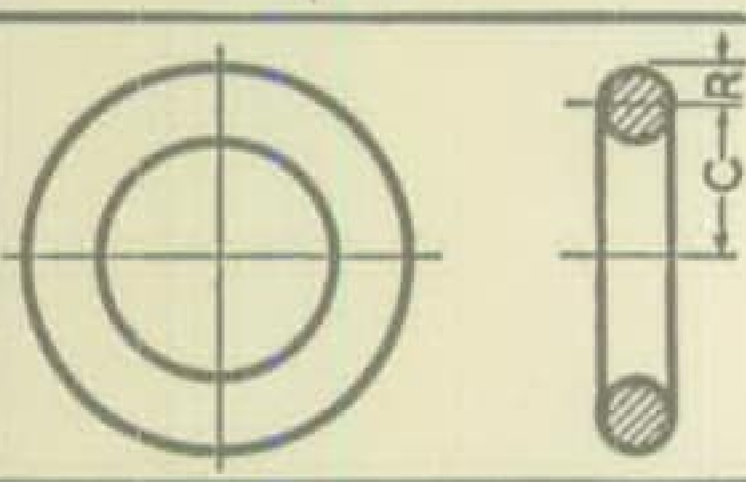
CIRCUMFERENCE = 3.14 X D

AREA = $3.14 \times R^2$

## SPHERE

AREA = $3.14 \times D^2$ VOLUME = $\frac{3.14 \times D^3}{6}$

WEIGHT IN POUNDS = VOLUME X .26



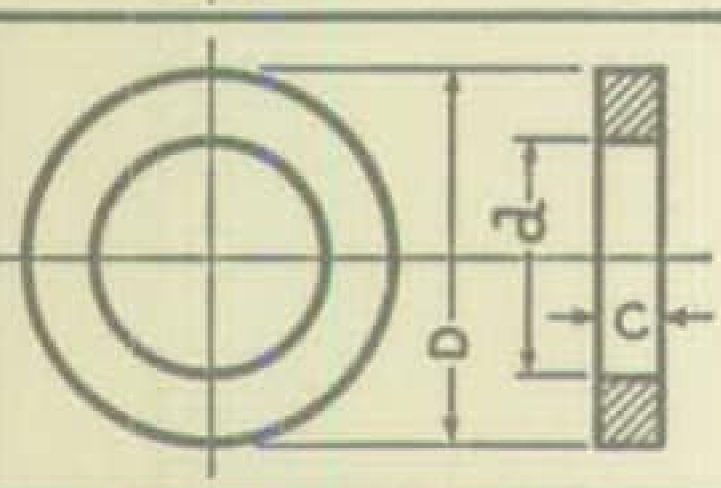

## TORUS

VOLUME IN CUB. INCHES =

$2 \times 3.14^2 \times C \times R^2 =$

$19.72 \times C \times R^2$

WEIGHT IN POUNDS = VOLUME X .26

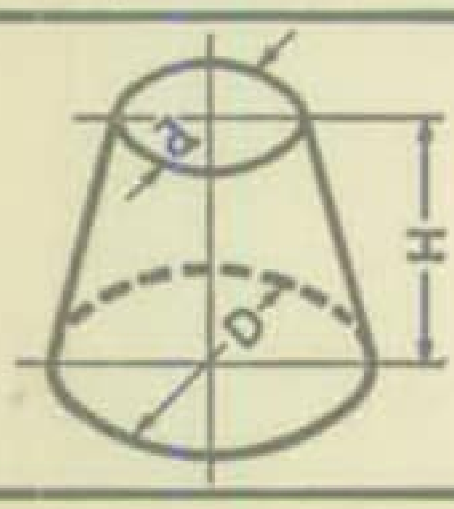



## CIRCULAR RING

VOLUME IN CUB. INCHES =

(AREA D − AREA d) X C

WEIGHT IN POUNDS = VOLUME X .26




## FRUSTUM OF CONE

VOLUME = $\frac{H}{3} \times \left(\text{AREA [d]} + \text{AREA [D]} + \sqrt{\text{AREA [d]} \times \text{AREA [D]}}\right)$

WEIGHT IN POUNDS = VOLUME X .26

ONE CUB. INCH OF IRON WEIGHS 0.26 POUNDS
ONE CUB. FOOT OF IRON WEIGHS 450 POUNDS

# Specific Gravities and Weights

| Substance | Specific Gravity | Weight, Pounds per Cu. Ft. |
|---|---|---|
| **Ashlar Masonry** | | |
| Granite, syenite, gneiss | 2.3–3.0 | 165 |
| Limestone, marble | 2.3–2.8 | 160 |
| Sandstone, bluestone | 2.1–2.4 | 140 |
| **Mortar Rubble Masonry** | | |
| Granite, syenite, gneiss | 2.2–2.8 | 155 |
| Limestone, marble | 2.2–2.6 | 150 |
| Sandstone, bluestone | 2.0–2.2 | 130 |
| **Dry Rubble Masonry** | | |
| Granite, syenite, gneiss | 1.9–2.3 | 130 |
| Limestone, marble | 1.9–2.1 | 125 |
| Sandstone, bluestone | 1.8–1.9 | 110 |
| **Brick Masonry** | | |
| Pressed brick | 2.2–2.3 | 140 |
| Common brick | 1.8–2.0 | 120 |
| Soft brick | 1.5–1.7 | 100 |
| **Concrete Masonry** | | |
| Cement, stone, sand | 2.2–2.4 | 144 |
| Cement, slag, etc. | 1.9–2.3 | 130 |
| Cement, cinder, etc. | 1.5–1.7 | 100 |
| **Various Building Mat'l** | | |
| Ashes, cinders | | 40–45 |
| Cement, portland, loose | | 90 |
| Cement, portland, set | 2.7–3.2 | 183 |
| Lime, gypsum, loose | | 53–64 |
| Mortar, set | 1.4–1.9 | 103 |
| Slags, bank slag | | 67–72 |
| Slags, bank screenings | | 98–117 |
| Slags, machine slag | | 96 |
| Slags, slag sand | | 49–55 |
| **Earth, etc., Excavated** | | |
| Clay, dry | | 63 |
| Clay, damp, plastic | | 110 |
| Clay and gravel, dry | | 100 |
| Earth, dry, loose | | 76 |
| Earth, dry, packed | | 95 |
| Earth, moist, loose | | 78 |
| Earth, moist, packed | | 96 |
| Earth, mud, flowing | | 108 |
| Earth, mud, packed | | 115 |
| Riprap, limestone | | 80–85 |
| Riprap, sandstone | | 90 |
| Riprap, shale | | 105 |
| Sand, gravel, dry, loose | | 90–105 |
| Sand, gravel, dry, packed | | 100–120 |
| Sand, gravel, dry, wet | | 118–120 |
| **Excavations in Water** | | |
| Sand or gravel | | 60 |
| Sand or gravel and clay | | 65 |
| Clay | | 80 |
| River mud | | 90 |
| Soil | | 70 |
| Stone riprap | | 65 |

| Substance | Specific Gravity | Weight, Pounds per Cu. Ft. |
|---|---|---|
| **Minerals** | | |
| Asbestos | 2.1–2.8 | 153 |
| Barytes | 4.50 | 281 |
| Basalt | 2.7–3.2 | 184 |
| Bauxite | 2.55 | 159 |
| Borax | 1.7–1.8 | 109 |
| Chalk | 1.8–2.6 | 137 |
| Clay, marl | 1.8–2.6 | 137 |
| Dolomite | 2.9 | 181 |
| Feldspar, orthoclase | 2.5–2.6 | 159 |
| Gneiss, serpentine | 2.4–2.7 | 159 |
| Granite, syenite | 2.5–3.1 | 175 |
| Greenstone, trap | 2.8–3.2 | 187 |
| Gypsum, alabaster | 2.3–2.8 | 159 |
| Hornblende | 3.0 | 187 |
| Limestone, marble | 2.5–2.8 | 165 |
| Magnesite | 3.0 | 187 |
| Phosphate rock, apatite | 3.2 | 200 |
| Porphyry | 2.6–2.9 | 172 |
| Pumice, natural | 0.37–0.90 | 40 |
| Quartz, flint | 2.5–2.8 | 165 |
| Sandstone, bluestone | 2.2–2.5 | 147 |
| Shale, slate | 2.7–2.9 | 175 |
| Soapstone, talc | 2.6–2.8 | 169 |
| **Stone, Quarried, Piled** | | |
| Basalt, granite, gneiss | | 96 |
| Limestone, marble, quartz | | 95 |
| Sandstone | | 82 |
| Shale | | 92 |
| Greenstone, hornblende | | 107 |
| **Bituminous Substances** | | |
| Asphaltum | 1.1–1.5 | 81 |
| Coal, anthracite | 1.4–1.7 | 97 |
| Coal, bituminous | 1.2–1.5 | 84 |
| Coal, lignite | 1.1–1.4 | 78 |
| Coal, peat, turf, dry | 0.65–0.85 | 47 |
| Coal, charcoal, pine | 0.28–0.44 | 23 |
| Coal, charcoal, oak | 0.47–0.57 | 33 |
| Coal, coke | 1.0–1.4 | 75 |
| Graphite | 1.9–2.3 | 131 |
| Paraffine | 0.87–0.91 | 56 |
| Petroleum | 0.87 | 54 |
| Petroleum, refined | 0.79–0.82 | 50 |
| Petroleum, benzine | 0.73–0.75 | 46 |
| Petroleum, gasoline | 0.66–0.69 | 42 |
| Pitch | 1.07–1.15 | 69 |
| Tar, bituminous | 1.20 | 75 |
| **Coal and Coke, Piled** | | |
| Coal, anthracite | | 47–58 |
| Coal, bituminous, lignite | | 40–54 |
| Coal, peat, turf | | 20–26 |
| Coal, charcoal | | 10–14 |
| Coal, coke | | 23–32 |

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

# Specific Gravities and Weights

| Substance | Specific Gravity | Weight, Pounds per Cu. Ft. |
|---|---|---|
| **Metals, Alloys, Ores** | | |
| Aluminum, cast-hammered | 2.55–2.75 | 165 |
| Aluminum, bronze | 7.7 | 481 |
| Brass, cast-rolled | 8.4–8.7 | 534 |
| Bronze, 7.9 to 14% Sn. | 7.4–8.9 | 509 |
| Copper, cast-rolled | 8.8–9.0 | 556 |
| Copper, ore, pyrites | 4.1–4.3 | 262 |
| Gold, cast-hammered | 19.25–19.3 | 1205 |
| Iron, cast, pig | 7.2 | 450 |
| Iron, wrought | 7.6–7.9 | 485 |
| Iron, steel | 7.8–7.9 | 490 |
| Iron, spiegel-eisen | 7.5 | 468 |
| Iron, ferro-silicon | 6.7–7.3 | 437 |
| Iron ore, hematite | 5.2 | 325 |
| Iron ore, hematite in bank | | 160–180 |
| Iron ore, hematite, loose | | 130–160 |
| Iron ore, limonite | 3.6–4.0 | 237 |
| Iron ore, magnetite | 4.9–5.2 | 315 |
| Iron, slag | 2.5–3.0 | 172 |
| Lead | 11.37 | 710 |
| Lead ore, galena | 7.3–7.6 | 475 |
| Manganese | 7.2–8.0 | 500 |
| Manganese ore, pyrolusite | 3.7–4.6 | 259 |
| Mercury | 13.6 | 849 |
| Nickel | 8.9–9.2 | 565 |
| Nickel, monel metal | 8.8–9.0 | 556 |
| Platinum, cast-hammered | 21.1–21.5 | 1330 |
| Silver, cast-hammered | 10.4–10.6 | 656 |
| Tin, cast-hammered | 7.2–7.5 | 459 |
| Tin, ore, cassiterite | 6.4–7.0 | 418 |
| Zinc, cast-rolled | 6.9–7.2 | 440 |
| Zinc, ore, blende | 3.9–4.2 | 253 |
| **Various Solids** | | |
| Cereals, oats, bulk | | 32 |
| Cereals, barley, bulk | | 99 |
| Cereals, corn, rye, bulk | | 48 |
| Cereals, wheat, bulk | | 48 |
| Hay and Straw, bales | | 20 |
| Cotton, flax, hemp | 1.47–1.50 | 93 |
| Fats | 0.90–0.97 | 58 |
| Flour, loose | 0.40–0.50 | 28 |
| Flour, pressed | 0.70–0.80 | 47 |
| Glass, common | 2.40–2.60 | 156 |
| Glass, plate or crown | 2.45–2.72 | 161 |
| Glass, crystal | 2.90–3.00 | 184 |
| Leather | 0.86–1.02 | 59 |
| Paper | 0.70–1.15 | 58 |
| Potatoes, piled | | 42 |
| Rubber, caoutchouc | 0.92–0.96 | 59 |
| Rubber goods | 1.0–2.0 | 94 |
| Salt, granulated, piled | | 48 |
| Saltpeter | | 67 |
| Starch | 1.53 | 96 |
| Sulphur | 1.93–2.07 | 125 |
| Wool | 1.32 | 82 |

| Substance | Specific Gravity | Weight, Pounds per Cu. Ft. |
|---|---|---|
| **Timber, U. S. Seasoned** | | |
| Ash, white-red | 0.62–0.65 | 40 |
| Cedar, white-red | 0.32–0.38 | 22 |
| Chestnut | 0.66 | 41 |
| Cypress | 0.48 | 30 |
| Fir, Douglas spruce | 0.51 | 32 |
| Fir, eastern | 0.40 | 25 |
| Elm, white | 0.72 | 45 |
| Hemlock | 0.42–0.52 | 29 |
| Hickory | 0.74–0.84 | 49 |
| Locust | 0.73 | 46 |
| Maple, hard | 0.68 | 43 |
| Maple, white | 0.53 | 33 |
| Oak, chestnut | 0.86 | 54 |
| Oak, live | 0.95 | 59 |
| Oak, red, black | 0.65 | 41 |
| Oak, white | 0.74 | 46 |
| Pine, Oregon | 0.51 | 32 |
| Pine, red | 0.48 | 30 |
| Pine, white | 0.41 | 26 |
| Pine, yellow, long-leaf | 0.70 | 44 |
| Pine, yellow, short-leaf | 0.61 | 38 |
| Poplar | 0.48 | 30 |
| Redwood, California | 0.42 | 26 |
| Spruce, white, black | 0.40–0.46 | 27 |
| Walnut, black | 0.61 | 38 |
| Walnut, white | 0.41 | 26 |
| Moisture Contents: | | |
| Seasoned timber 15 to 20% | | |
| Green timber up to 50% | | |
| **Various Liquids** | | |
| Alcohol, 100% | 0.79 | 49 |
| Acids, muriatic, 40% | 1.20 | 75 |
| Acids, nitric, 91% | 1.50 | 94 |
| Acids, sulphuric, 87% | 1.80 | 112 |
| Lye, soda, 66% | 1.70 | 106 |
| Oils, vegetable | 0.91–0.94 | 58 |
| Oils, mineral, lubricants | 0.90–0.93 | 57 |
| Water, 4°C., max. density | 1.0 | 62.428 |
| Water, 100°C | 0.9584 | 59.830 |
| Water, ice | 0.88–0.92 | 56 |
| Water, snow, fresh fallen | .125 | 8 |
| Water, sea water | 1.02–1.03 | 64 |
| **Gases, Air = 1** | | |
| Air, 0°C., 760 mm | 1.0 | .08071 |
| Ammonia | 0.5920 | .0478 |
| Carbon dioxide | 1.5291 | .1234 |
| Carbon monoxide | 0.9673 | .0781 |
| Gas, illuminating | 0.35–0.45 | .028–.036 |
| Gas, natural | 0.47–0.48 | .038–.039 |
| Hydrogen | 0.0693 | .00559 |
| Nitrogen | 0.9714 | .0784 |
| Oxygen | 1.1056 | .0892 |

The specific gravities of solids and liquids refer to water at 4°C., those of gases to air at 0°C. and 760 mm pressure. The weights per cubic foot are derived from average specific gravities, except where stated that weights are for bulk, heaped or loose material, etc.

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# A Table of Constants for Certain Gases and Vapors

| Name of Gas or Vapor | | Formula | Molecular Weight | Specific Gravity Gas or Vapor at 60° F. 30" Hg. Pres. Air = 1.0 | Boiling Point ° Fahr. | Specific Gravity Liquid at 60° F. Water = 1.0 |
|---|---|---|---|---|---|---|
| Carbon (to CO) | | C | 12.010 | ........ | ........ | ........ |
| Carbon (to $CO_2$) | | C | 12.010 | ........ | ........ | ........ |
| Carbon Monoxide | | CO | 28.010 | 0.9672 | −313.6 | ........ |
| Carbon Dioxide | | $CO_2$ | 44.010 | 1.5291 | −109.3 | ........ |
| Hydrogen | | $H_2$ | 2.0160 | 0.06952 | −423.0 | ........ |
| Methane | Paraffin Series $C_nH_{2n+2}$ | $CH_4$ | 16.042 | 0.5545 | −258.5 | ........ |
| Ethane | | $C_2H_6$ | 30.068 | 1.0493 | −127.5 | ........ |
| Propane | | $C_3H_8$ | 44.094 | 1.562 | − 43.9 | 0.509* |
| n-Butane | | $C_4H_{10}$ | 58.120 | 2.086 | 31.5 | 0.585* |
| Iso-Butane | | $C_4H_{10}$ | 58.120 | 2.068 | 13.6 | 0.565* |
| n-Pentane | | $C_5H_{12}$ | 72.146 | 2.49* | 97.2 | 0.631 |
| n-Hexane | | $C_6H_{14}$ | 86.172 | 2.97* | 156.2 | 0.664 |
| Ethylene | Olefin Series $C_nH_{2n}$ | $C_2H_4$ | 28.052 | 0.9748 | −155.0 | ........ |
| Propylene | | $C_3H_6$ | 42.078 | 1.481 | − 52.6 | ........ |
| Butylene | | $C_4H_8$ | 56.104 | 1.935 | 23.0 | 0.630* |
| Benzene | Aromatic Series $C_nH_{2n-6}$ | $C_6H_6$ | 78.108 | 2.712* | 176.2 | 0.884 |
| Toluene | | $C_7H_8$ | 92.134 | 3.178* | 231.3 | 0.871 |
| Xylene | | $C_8H_{10}$ | 106.160 | 3.662* | 282.2 | 0.870 |
| Acetylene | | $C_2H_2$ | 26.036 | 0.9073 | −118.5 | ........ |
| Naphthalene | | $C_{10}H_8$ | 128.164 | ........ | 424.2 | 1.145‡ |
| Ammonia | | $NH_3$ | 17.032 | 0.5963 | − 28.0 | ........ |
| Nitrous Oxide | | $N_2O$ | 44.016 | 1.530 | −129.1 | ........ |
| Nitric Oxide | | NO | 30.008 | 1.0367 | −241.2 | ........ |
| Hydrogen Sulphide | | $H_2S$ | 34.076 | 1.194 | − 79.2 | ........ |
| Sulphur Dioxide | | $SO_2$ | 64.060 | 2.2637 | 14.0 | ........ |
| Water Vapor | | $H_2O$ | 18.016 | 0.6221* | 212.0 | .999041 |
| Oxygen | | $O_2$ | 32.0000 | 1.1053 | −297.4 | ........ |
| Nitrogen | | $N_2$ | 28.016 | 0.9673 | −320.4 | ........ |
| Nitrogen "Atmospheric" | | † | 28.161 | 0.9721 | ........ | ........ |
| Air | | ........ | ........ | 1.0000 | −317.6 | ........ |

* Theoretical or calculated data. The substance does not exist as a gas at 60° F. and 30 inches of mercury pressure.

† Consists of Nitrogen together with 0.94% of Argon by volume, about 0.03% of Carbon Dioxide and a trace of Hydrogen.

‡ Solid.

# A Table of Constants for Certain Gases and Vapors

| 60°F.—30"Hg. Pres. | | Specific Heat Const. Pres. Btu./lb./°F. at 60° F. Water = 1.0 | Ratio Specific Heat Const. Pres. to Specific Heat Const. Volume | Heat of Combustion—Dry Gas at 60° F. and 30" Hg. Pressure | | | |
|---|---|---|---|---|---|---|---|
| | | | | B.t.u. per Cu. Ft. | | B.t.u. per Lb. | |
| Lbs. per Cu. Ft. | Cu. Ft. per Lb. | | | Gross | Net | Gross | Net |
| ... | ... | ... | ... | ... | ... | 3,958 | 3,958 |
| ... | ... | ... | ... | ... | ... | 14,092 | 14,092 |
| .07405 | 13.504 | 0.2478 | 1.404 | 321.7 | 321.7 | 4,345 | 4,345 |
| .11707 | 8.542 | 0.1989 | 1.304 | ... | ... | ... | ... |
| .005323 | 187.874 | 3.3890 | 1.410 | 325.0 | 274.6 | 61,061 | 51,589 |
| .04245 | 23.557 | .5284 | 1.310 | 1014.4 | 913.3 | 23,896 | 21,515 |
| .08034 | 12.447 | .3861 | 1.220 | 1794 | 1641 | 22,330 | 20,430 |
| .11962 | 8.360 | .3650 | 1.150 | 2593 | 2386 | 21,675 | 19,942 |
| .1597 | 6.263 | .3510 | 1.108 | 3405 | 3142 | 21,321 | 19,678 |
| .15833 | 6.316 | .3510 | 1.108 | 3368 | 3108 | 21,271 | 19,628 |
| .1907* | 5.245* | ... | ... | 4023* | 3720* | 21,101 | 19,513 |
| .2277* | 4.392* | ... | ... | 4771* | 4418* | 20,954 | 19,402 |
| .07464 | 13.398 | .3592 | 1.255 | 1615 | 1513 | 21,638 | 20,277 |
| .11339 | 8.819 | ... | ... | 2380 | 2226 | 20,990 | 19,629 |
| .14815 | 6.750 | ... | ... | 3079 | 2877 | 20,780 | 19,419 |
| .2076* | 4.816* | ... | ... | 3758* | 3606* | 18,100§ | 17,367§ |
| .2433* | 4.110* | ... | ... | 4453* | 4251* | 18,300§ | 17,471§ |
| .2803* | 3.567* | ... | ... | 5189* | 4937* | 18,510§ | 17,610§ |
| .06947 | 14.395 | .3832 | 1.260 | 1491 | 1440 | 21,460 | 20,727 |
| ... | ... | ... | ... | ... | ... | 17,280‡ | 16,684‡ |
| .04566 | 21.903 | .5232 | 1.310 | 442 | 365 | 9,678 | 7,996 |
| .11716 | 8.536 | .2004 | ... | ... | ... | ... | ... |
| .07937 | 12.599 | .2329 | ... | ... | ... | ... | ... |
| .0914 | 10.972 | .2430 | ... | 649 | 598 | 7,100 | 6,539 |
| .17331 | 5.770 | .1516 | ... | ... | ... | ... | ... |
| .04763* | 20.995* | .4820 | 1.324 | | | | |
| .08463 | 11.817 | .2178 | 1.401 | | | | |
| .07406 | 13.503 | .2477 | 1.404 | | | | |
| .07443 | 13.436 | .2460 | ... | | | | |
| .07656 | 13.061 | .2400 | 1.403 | | | | |

| Atmosphere | By Volume | By Weight |
|---|---|---|
| $O_2$ | 20.99% | 23.20% |
| $N_2$, etc. | 79.01% | 76.80% |

* Theoretical or calculated data. The substance does not exist as a gas at 60° F. and 30 inches of mercury pressure.

‡ Solid. § Liquid.

# Gas Volume Correction Factors

The observed volume of saturated gas is multiplied by the factor taken from this table for correcting to the volume of saturated gas under the "standard conditions" of 30 inches of mercury pressure and 60 deg. Fahrenheit.

| Temp. (°F.) | Total Gas Pressure—Inches of Mercury | | | | | | | | | | | | | | | | | | | | Temp. (°F.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 28.6 | 28.7 | 28.8 | 28.9 | 29.0 | 29.1 | 29.2 | 29.3 | 29.4 | 29.5 | 29.6 | 29.7 | 29.8 | 29.9 | 30.0 | 30.1 | 30.2 | 30.3 | 30.4 | 30.5 | |
| 32 | 1.019 | 1.023 | 1.026 | 1.030 | 1.033 | 1.037 | 1.041 | 1.044 | 1.048 | 1.051 | 1.055 | 1.059 | 1.062 | 1.066 | 1.069 | 1.073 | 1.076 | 1.080 | 1.084 | 1.087 | 32 |
| 33 | 1.017 | 1.020 | 1.024 | 1.027 | 1.031 | 1.035 | 1.038 | 1.042 | 1.045 | 1.049 | 1.052 | 1.056 | 1.060 | 1.063 | 1.067 | 1.070 | 1.074 | 1.078 | 1.081 | 1.085 | 33 |
| 34 | 1.014 | 1.018 | 1.022 | 1.025 | 1.029 | 1.032 | 1.036 | 1.039 | 1.043 | 1.047 | 1.050 | 1.054 | 1.057 | 1.061 | 1.064 | 1.068 | 1.072 | 1.075 | 1.079 | 1.082 | 34 |
| 35 | 1.012 | 1.016 | 1.019 | 1.023 | 1.026 | 1.030 | 1.033 | 1.037 | 1.041 | 1.044 | 1.048 | 1.051 | 1.055 | 1.058 | 1.062 | 1.065 | 1.069 | 1.073 | 1.076 | 1.080 | 35 |
| 36 | 1.010 | 1.013 | 1.017 | 1.020 | 1.024 | 1.028 | 1.031 | 1.035 | 1.038 | 1.042 | 1.045 | 1.049 | 1.052 | 1.056 | 1.060 | 1.063 | 1.067 | 1.070 | 1.074 | 1.077 | 36 |
| 37 | 1.007 | 1.011 | 1.014 | 1.018 | 1.022 | 1.025 | 1.029 | 1.032 | 1.036 | 1.039 | 1.043 | 1.046 | 1.050 | 1.054 | 1.057 | 1.061 | 1.064 | 1.068 | 1.071 | 1.075 | 37 |
| 38 | 1.005 | 1.009 | 1.012 | 1.016 | 1.019 | 1.023 | 1.026 | 1.030 | 1.033 | 1.037 | 1.040 | 1.044 | 1.048 | 1.051 | 1.055 | 1.058 | 1.062 | 1.065 | 1.069 | 1.072 | 38 |
| 39 | 1.003 | 1.006 | 1.010 | 1.013 | 1.017 | 1.020 | 1.024 | 1.027 | 1.031 | 1.035 | 1.038 | 1.042 | 1.045 | 1.049 | 1.052 | 1.056 | 1.059 | 1.063 | 1.066 | 1.070 | 39 |
| 40 | 1.000 | 1.004 | 1.007 | 1.011 | 1.014 | 1.018 | 1.022 | 1.025 | 1.029 | 1.032 | 1.036 | 1.039 | 1.043 | 1.046 | 1.050 | 1.053 | 1.057 | 1.060 | 1.064 | 1.067 | 40 |
| 41 | .998 | 1.002 | 1.005 | 1.009 | 1.012 | 1.016 | 1.019 | 1.023 | 1.026 | 1.030 | 1.033 | 1.037 | 1.040 | 1.044 | 1.047 | 1.051 | 1.054 | 1.058 | 1.061 | 1.065 | 41 |
| 42 | .996 | .999 | 1.003 | 1.006 | 1.010 | 1.013 | 1.017 | 1.020 | 1.024 | 1.027 | 1.031 | 1.034 | 1.038 | 1.041 | 1.045 | 1.048 | 1.052 | 1.055 | 1.059 | 1.062 | 42 |
| 43 | .993 | .997 | 1.000 | 1.004 | 1.007 | 1.011 | 1.014 | 1.018 | 1.021 | 1.025 | 1.028 | 1.032 | 1.035 | 1.039 | 1.042 | 1.046 | 1.049 | 1.053 | 1.056 | 1.060 | 43 |
| 44 | .991 | .994 | .998 | 1.001 | 1.005 | 1.008 | 1.012 | 1.015 | 1.019 | 1.022 | 1.026 | 1.029 | 1.033 | 1.036 | 1.040 | 1.043 | 1.047 | 1.050 | 1.054 | 1.057 | 44 |
| 45 | .989 | .992 | .996 | .999 | 1.003 | 1.006 | 1.010 | 1.013 | 1.017 | 1.020 | 1.024 | 1.027 | 1.031 | 1.034 | 1.037 | 1.041 | 1.044 | 1.048 | 1.051 | 1.055 | 45 |
| 46 | .986 | .990 | .993 | .997 | 1.000 | 1.004 | 1.007 | 1.011 | 1.014 | 1.018 | 1.021 | 1.025 | 1.028 | 1.032 | 1.035 | 1.039 | 1.042 | 1.046 | 1.049 | 1.052 | 46 |
| 47 | .984 | .987 | .991 | .994 | .998 | 1.001 | 1.005 | 1.008 | 1.012 | 1.015 | 1.019 | 1.022 | 1.026 | 1.029 | 1.033 | 1.036 | 1.040 | 1.043 | 1.046 | 1.050 | 47 |
| 48 | .982 | .985 | .988 | .992 | .995 | .999 | 1.002 | 1.006 | 1.009 | 1.013 | 1.016 | 1.020 | 1.023 | 1.027 | 1.030 | 1.034 | 1.037 | 1.041 | 1.044 | 1.047 | 48 |
| 49 | .979 | .983 | .986 | .990 | .993 | .996 | 1.000 | 1.003 | 1.007 | 1.010 | 1.014 | 1.017 | 1.021 | 1.024 | 1.028 | 1.031 | 1.035 | 1.038 | 1.041 | 1.045 | 49 |
| 50 | .977 | .980 | .984 | .987 | .991 | .994 | .998 | 1.001 | 1.004 | 1.008 | 1.011 | 1.015 | 1.018 | 1.022 | 1.025 | 1.029 | 1.032 | 1.036 | 1.039 | 1.042 | 50 |
| 51 | .974 | .978 | .981 | .985 | .988 | .992 | .995 | .998 | 1.002 | 1.005 | 1.009 | 1.012 | 1.016 | 1.019 | 1.023 | 1.026 | 1.030 | 1.033 | 1.036 | 1.040 | 51 |
| 52 | .972 | .975 | .979 | .982 | .986 | .989 | .993 | .996 | 1.000 | 1.003 | 1.006 | 1.010 | 1.013 | 1.017 | 1.020 | 1.024 | 1.027 | 1.031 | 1.034 | 1.037 | 52 |
| 53 | .970 | .973 | .976 | .980 | .983 | .987 | .990 | .994 | .997 | 1.000 | 1.004 | 1.007 | 1.011 | 1.014 | 1.018 | 1.021 | 1.025 | 1.028 | 1.031 | 1.035 | 53 |
| 54 | .967 | .971 | .974 | .977 | .981 | .984 | .988 | .991 | .995 | .998 | 1.001 | 1.005 | 1.008 | 1.012 | 1.015 | 1.019 | 1.022 | 1.025 | 1.029 | 1.032 | 54 |
| 55 | .965 | .968 | .972 | .975 | .978 | .982 | .985 | .989 | .992 | .996 | .999 | 1.002 | 1.006 | 1.009 | 1.013 | 1.016 | 1.020 | 1.023 | 1.026 | 1.030 | 55 |
| 56 | .962 | .966 | .969 | .973 | .976 | .979 | .983 | .986 | .990 | .993 | .997 | 1.000 | 1.003 | 1.007 | 1.010 | 1.014 | 1.017 | 1.020 | 1.024 | 1.027 | 56 |
| 57 | .960 | .963 | .967 | .970 | .974 | .977 | .980 | .984 | .987 | .991 | .994 | .997 | 1.001 | 1.004 | 1.008 | 1.011 | 1.015 | 1.018 | 1.021 | 1.025 | 57 |
| 58 | .957 | .961 | .964 | .968 | .971 | .975 | .978 | .981 | .985 | .988 | .992 | .995 | .998 | 1.002 | 1.005 | 1.009 | 1.012 | 1.015 | 1.019 | 1.022 | 58 |
| 59 | .955 | .958 | .962 | .965 | .969 | .972 | .975 | .979 | .982 | .986 | .989 | .992 | .996 | .999 | 1.003 | 1.006 | 1.009 | 1.013 | 1.016 | 1.020 | 59 |
| 60 | .953 | .956 | .959 | .963 | .966 | .970 | .973 | .976 | .980 | .983 | .986 | .990 | .993 | .997 | 1.000 | 1.003 | 1.007 | 1.010 | 1.014 | 1.017 | 60 |
| 61 | .950 | .953 | .957 | .960 | .964 | .967 | .970 | .974 | .977 | .981 | .984 | .987 | .991 | .994 | .998 | 1.001 | 1.004 | 1.008 | 1.011 | 1.014 | 61 |
| 62 | .948 | .951 | .954 | .958 | .961 | .964 | .968 | .971 | .975 | .978 | .981 | .985 | .988 | .992 | .995 | .998 | 1.002 | 1.005 | 1.008 | 1.012 | 62 |
| 63 | .945 | .949 | .952 | .955 | .959 | .962 | .965 | .969 | .972 | .975 | .979 | .982 | .986 | .989 | .992 | .996 | .999 | 1.002 | 1.006 | 1.009 | 63 |
| 64 | .943 | .946 | .949 | .953 | .956 | .959 | .963 | .966 | .970 | .973 | .976 | .980 | .983 | .986 | .990 | .993 | .996 | 1.000 | 1.003 | 1.007 | 64 |
| 65 | .940 | .943 | .947 | .950 | .954 | .957 | .960 | .964 | .967 | .970 | .974 | .977 | .980 | .984 | .987 | .991 | .994 | .997 | 1.001 | 1.004 | 65 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 66 | .938 | .941 | .944 | .948 | .951 | .954 | .958 | .961 | .964 | .968 | .971 | .974 | .978 | .981 | .985 | .988 | .991 | .995 | .998 | 1.001 | 66 |
| 67 | .935 | .938 | .942 | .945 | .949 | .952 | .955 | .958 | .962 | .965 | .969 | .972 | .975 | .979 | .982 | .985 | .989 | .992 | .995 | .999 | 67 |
| 68 | .932 | .936 | .939 | .942 | .946 | .949 | .952 | .956 | .959 | .963 | .966 | .969 | .973 | .976 | .979 | .983 | .986 | .989 | .993 | .996 | 68 |
| 69 | .930 | .933 | .937 | .940 | .943 | .947 | .950 | .953 | .957 | .960 | .963 | .967 | .970 | .973 | .977 | .980 | .983 | .987 | .990 | .993 | 69 |
| 70 | .927 | .931 | .934 | .937 | .941 | .944 | .947 | .951 | .954 | .957 | .961 | .964 | .967 | .971 | .974 | .977 | .981 | .984 | .987 | .991 | 70 |
| 71 | .925 | .928 | .931 | .935 | .938 | .941 | .945 | .948 | .951 | .955 | .958 | .961 | .965 | .968 | .971 | .975 | .978 | .981 | .985 | .988 | 71 |
| 72 | .922 | .925 | .929 | .932 | .935 | .939 | .942 | .945 | .949 | .952 | .955 | .959 | .962 | .965 | .969 | .972 | .975 | .978 | .982 | .985 | 72 |
| 73 | .919 | .923 | .926 | .929 | .933 | .936 | .939 | .943 | .946 | .949 | .953 | .956 | .959 | .963 | .966 | .969 | .972 | .976 | .979 | .982 | 73 |
| 74 | .917 | .920 | .923 | .927 | .930 | .933 | .937 | .940 | .943 | .947 | .950 | .953 | .956 | .960 | .963 | .966 | .970 | .973 | .976 | .980 | 74 |
| 75 | .914 | .917 | .921 | .924 | .927 | .931 | .934 | .937 | .941 | .944 | .947 | .950 | .954 | .957 | .960 | .964 | .967 | .970 | .974 | .977 | 75 |
| 76 | .911 | .915 | .918 | .921 | .925 | .928 | .931 | .935 | .938 | .941 | .944 | .948 | .951 | .954 | .958 | .961 | .964 | .967 | .971 | .974 | 76 |
| 77 | .909 | .912 | .915 | .919 | .922 | .925 | .929 | .932 | .935 | .938 | .942 | .945 | .948 | .952 | .955 | .958 | .961 | .965 | .968 | .971 | 77 |
| 78 | .906 | .909 | .913 | .916 | .919 | .923 | .926 | .929 | .932 | .936 | .939 | .942 | .945 | .949 | .952 | .955 | .959 | .962 | .965 | .968 | 78 |
| 79 | .903 | .907 | .910 | .913 | .916 | .920 | .923 | .926 | .930 | .933 | .936 | .939 | .943 | .946 | .949 | .952 | .956 | .959 | .962 | .966 | 79 |
| 80 | .901 | .904 | .907 | .910 | .914 | .917 | .920 | .923 | .927 | .930 | .933 | .937 | .940 | .943 | .946 | .950 | .953 | .956 | .959 | .963 | 80 |
| 81 | .898 | .901 | .904 | .908 | .911 | .914 | .917 | .921 | .924 | .927 | .930 | .934 | .937 | .940 | .943 | .947 | .950 | .953 | .956 | .960 | 81 |
| 82 | .895 | .898 | .902 | .905 | .908 | .911 | .915 | .918 | .921 | .924 | .928 | .931 | .934 | .937 | .941 | .944 | .947 | .950 | .954 | .957 | 82 |
| 83 | .892 | .895 | .899 | .902 | .905 | .908 | .912 | .915 | .918 | .921 | .925 | .928 | .931 | .934 | .938 | .941 | .944 | .947 | .951 | .954 | 83 |
| 84 | .889 | .893 | .896 | .899 | .902 | .906 | .909 | .912 | .915 | .919 | .922 | .925 | .928 | .932 | .935 | .938 | .941 | .944 | .948 | .951 | 84 |
| 85 | .886 | .890 | .893 | .896 | .899 | .903 | .906 | .909 | .912 | .916 | .919 | .922 | .925 | .929 | .932 | .935 | .938 | .941 | .945 | .948 | 85 |
| 86 | .884 | .887 | .890 | .893 | .897 | .900 | .903 | .906 | .909 | .913 | .916 | .919 | .922 | .926 | .929 | .932 | .935 | .939 | .942 | .945 | 86 |
| 87 | .881 | .884 | .887 | .890 | .894 | .897 | .900 | .903 | .906 | .910 | .913 | .916 | .919 | .923 | .926 | .929 | .932 | .935 | .939 | .942 | 87 |
| 88 | .878 | .881 | .884 | .887 | .891 | .894 | .897 | .900 | .903 | .907 | .910 | .913 | .916 | .920 | .923 | .926 | .929 | .932 | .936 | .939 | 88 |
| 89 | .875 | .878 | .881 | .884 | .888 | .891 | .894 | .897 | .900 | .904 | .907 | .910 | .913 | .916 | .920 | .923 | .926 | .929 | .933 | .936 | 89 |
| 90 | .872 | .875 | .878 | .881 | .885 | .888 | .891 | .894 | .897 | .901 | .904 | .907 | .910 | .913 | .917 | .920 | .923 | .926 | .929 | .933 | 90 |
| 91 | .869 | .872 | .875 | .878 | .881 | .885 | .888 | .891 | .894 | .897 | .901 | .904 | .907 | .910 | .913 | .917 | .920 | .923 | .926 | .929 | 91 |
| 92 | .866 | .869 | .872 | .875 | .878 | .882 | .885 | .888 | .891 | .894 | .898 | .901 | .904 | .907 | .910 | .914 | .917 | .920 | .923 | .926 | 92 |
| 93 | .863 | .866 | .869 | .872 | .875 | .878 | .882 | .885 | .888 | .891 | .894 | .898 | .901 | .904 | .907 | .910 | .914 | .917 | .920 | .923 | 93 |
| 94 | .859 | .863 | .866 | .869 | .872 | .875 | .879 | .882 | .885 | .888 | .891 | .894 | .898 | .901 | .904 | .907 | .910 | .914 | .917 | .920 | 94 |
| 95 | .856 | .859 | .863 | .866 | .869 | .872 | .875 | .878 | .882 | .885 | .888 | .891 | .894 | .898 | .901 | .904 | .907 | .910 | .913 | .917 | 95 |
| 96 | .853 | .856 | .859 | .863 | .866 | .869 | .872 | .875 | .878 | .882 | .885 | .888 | .891 | .894 | .898 | .901 | .904 | .907 | .910 | .913 | 96 |
| 97 | .850 | .853 | .856 | .859 | .863 | .866 | .869 | .872 | .875 | .878 | .882 | .885 | .888 | .891 | .894 | .897 | .901 | .904 | .907 | .910 | 97 |
| 98 | .847 | .850 | .853 | .856 | .859 | .862 | .866 | .869 | .872 | .875 | .878 | .881 | .885 | .888 | .891 | .894 | .897 | .900 | .904 | .907 | 98 |
| 99 | .843 | .846 | .850 | .853 | .856 | .859 | .862 | .865 | .869 | .872 | .875 | .878 | .881 | .884 | .887 | .891 | .894 | .897 | .900 | .903 | 99 |
| 100 | .840 | .843 | .846 | .850 | .853 | .856 | .859 | .862 | .865 | .868 | .872 | .875 | .878 | .881 | .884 | .887 | .890 | .894 | .897 | .900 | 100 |
| 101 | .837 | .840 | .843 | .846 | .849 | .852 | .856 | .859 | .862 | .865 | .868 | .871 | .874 | .878 | .881 | .884 | .887 | .890 | .893 | .896 | 101 |
| 102 | .833 | .836 | .840 | .843 | .846 | .849 | .852 | .855 | .858 | .862 | .865 | .868 | .871 | .874 | .877 | .880 | .884 | .887 | .890 | .893 | 102 |
| 103 | .830 | .833 | .836 | .839 | .842 | .846 | .849 | .852 | .855 | .858 | .861 | .864 | .867 | .871 | .874 | .877 | .880 | .883 | .886 | .889 | 103 |
| 104 | .826 | .830 | .833 | .836 | .839 | .842 | .845 | .848 | .851 | .855 | .858 | .861 | .864 | .867 | .870 | .873 | .876 | .880 | .883 | .886 | 104 |
| 105 | .823 | .826 | .829 | .832 | .835 | .839 | .842 | .845 | .848 | .851 | .854 | .857 | .860 | .863 | .867 | .870 | .873 | .876 | .879 | .882 | 105 |
| 106 | .819 | .822 | .826 | .829 | .832 | .835 | .838 | .841 | .844 | .847 | .851 | .854 | .857 | .860 | .863 | .866 | .869 | .872 | .875 | .879 | 106 |
| 107 | .816 | .819 | .822 | .825 | .828 | .831 | .834 | .838 | .841 | .844 | .847 | .850 | .853 | .856 | .859 | .862 | .866 | .869 | .872 | .875 | 107 |
| 108 | .812 | .815 | .818 | .821 | .825 | .828 | .831 | .834 | .837 | .840 | .843 | .846 | .849 | .853 | .856 | .859 | .862 | .865 | .868 | .871 | 108 |
| 109 | .809 | .812 | .815 | .818 | .821 | .824 | .827 | .830 | .833 | .836 | .840 | .843 | .846 | .849 | .852 | .855 | .858 | .861 | .864 | .867 | 109 |
| 110 | .805 | .808 | .811 | .814 | .817 | .820 | .823 | .826 | .830 | .833 | .836 | .839 | .842 | .845 | .848 | .851 | .854 | .857 | .860 | .864 | 110 |

Formula used: Correction factor $= \frac{(H - W)\ (60 + 459.7)}{(T + 459.7)\ (30 - 0.5217)}$

H = total gas pressure. W = vapor pressure of water at T°.
T = temperature of gas (°F).

## Correcting Gas Volume

For temperatures and/or pressures not covered by the table "Gas Volume Correction Factors" the following formula may be used for correcting gas saturated with water vapor to standard conditions:

$$Q = 17.64V \times \frac{H - W}{460 + T}$$

Where Q = volume of gas corrected to 60° F., 30 inches of mercury pressure and saturated with water vapor.

V = volume as measured.

H = absolute pressure of the gas in inches of mercury.

T = temperature of the gas in degrees F.

W = vapor pressure of water at temperature T (see table below).

Where the gas is partly saturated, W in the above formula is equal to the vapor pressure of water at the dew point temperature of the gas (see table below). When the gas is dry W = 0. In each case Q is volume of gas at 60° F., 30 inches of mercury pressure and saturated with water vapor.

Natural gas is usually measured and corrected on a dry basis to a temperature of 60° F. and a specified pressure base. There is no uniformity in the pressure bases used. The more commonly used are: (1) Atmospheric pressure at point of measurement plus a small specified gauge pressure; (2) 14.65 pounds per square inch (14.4 lbs. + 4 oz.), and 14.73 pounds per square inch (30 inches of mercury), specified in California.

The formula for correcting a dry gas to 60° F. and any given pressure base is as follows:

$$Q_d = V \times \frac{520}{460 + T} \times \frac{P}{P_s}$$

Where $Q_d$ = volume of gas corrected to 60° F. and the specified pressure base.

V = volume as measured.

T = temperature of the gas in degrees F.

P = absolute pressure of the gas in pounds per square inch.

$P_s$ = pressure base to which the gas is to be corrected—pounds per square inch absolute.

# Flow of Gas Through Pipes

## Low Pressures

The flow of gas through pipes under low pressures (up to about 1½ lbs. per sq. in.) may be computed by the use of the well known formula:

$$Q = c\sqrt{\frac{d^5\ (p_1 - p_2)}{G \times 1}} \qquad (1)$$

Where Q = flow in cubic feet per hour.
d = internal diameter of pipe in inches.
$p_1$ = initial pressure in inches of water.
$p_2$ = final pressure in inches of water.
G = specific gravity of the gas. (Air = 1.)
1 = length of pipe in yards.
c = a constant, given as 1000 by Molesworth and as 1350 by Pole.

Since the length of most low pressure mains is given in feet rather than yards, it is generally found more convenient to use the formula in the following revised form:

$$Q = C\sqrt{\frac{d^5\ (p_1 - p_2)}{G \times L}} \qquad (2)$$

Where C = $\sqrt{3}\ c$
L = length of pipe in feet.
All other symbols are as above.

The Spitzglass Formula, which is extensively used in low pressure gas flow calculations, is as follows:

$$Q = 3{,}550\sqrt{\frac{d^5\ (p_1 - p_2)}{G\ L\ (1 + 3.6/d + 0.03\ d)}} \qquad (3)$$

This is in effect Formula No. 2 with the constant

C equal to $\dfrac{3{,}550}{\sqrt{1 + 3.6/d + 0.03\ d}}$

In the following table are given for various pipe sizes:

Values of $\sqrt{d^5}$.

Values of C recommended in the American Gas Handbook, but revised for use in Formula No. 2.

Values of $\dfrac{3{,}550}{\sqrt{1 + 3.6/d + 0.03\ d}}$ designated in the table as $C_s$.

These constants, substituted in Formula No. 2, will enable the same answers to be obtained as with the Spitzglass Formula.

Constants for use in Formula No. 2

| Diameter (d) Inches (Internal) | $\sqrt{d^5}$ | C | Cs |
|---|---|---|---|
| 0.75 | 0.4871 | 1732 | 1471 |
| 0.824 (3/4" Pipe) | 0.6163 | 1732 | 1528 |
| 1.000 | 1.000 | 1732 | 1650 |
| 1.049 (1" Pipe) | 1.127 | 1732 | 1680 |
| 1.38 (1¼" Pipe) | 2.237 | 1905 | 1859 |
| 1.50 | 2.756 | 1905 | 1913 |
| 1.61 (1½" Pipe) | 3.289 | 1905 | 1959 |
| 2.00 | 5.657 | 2078 | 2100 |
| 2.067 (2" Pipe) | 6.143 | 2078 | 2119 |
| 2.469 (2½" Pipe) | 9.579 | 2078 | 2231 |
| 3.00 | 15.59 | 2252 | 2346 |
| 3.068 | 16.49 | 2252 | 2359 |
| 4.00 | 32.00 | 2338 | 2498 |
| 4.026 | 32.52 | 2338 | 2500 |
| 6.00 | 88.18 | 2338 | 2661 |
| 8.00 | 181.0 | 2338 | 2731 |
| 10.00 | 316.2 | 2338 | 2756 |
| 12.00 | 498.8 | 2338 | 2756 |
| 16.00 | 1024 | 2338 | 2718 |
| 20.00 | 1789 | 2338 | 2661 |
| 24.00 | 2822 | 2338 | 2597 |
| 30.00 | 4930 | 2338 | 2498 |
| 36.00 | 7776 | 2338 | 2405 |

It will be noted that the constants recommended in the American Gas Handbook are slightly more conservative than those derived from the Spitzglass Formula for pipe sizes 1½" and larger.

## High Pressures

Actual tests on flow of natural gas through high pressure transmission lines conducted by the Bureau of Mines and the American Gas Association have indicated that the Weymouth formula is generally the most accurate for computing flows in pipes 6 inches and larger. The Weymouth formula is as follows:

$$Q = 18.062 \frac{T_0}{P_0}\left[\frac{(P_1^2 - P_2^2)d^{16/3}}{G\,T\,L}\right]^{1/2}$$

Where Q = cubic feet per hour at temperature and pressure bases $T_0$ and $P_0$.

d = inside diameter of pipe in inches.

G = specific gravity of gas. (Air = 1.)
L = length of pipe in miles.

| | |
|---|---|
| $P_0$ = base pressure<br>$P_1$ = initial pressure<br>$P_2$ = final pressure | Pounds per square inch absolute. (14.7 + gauge pressure in lbs. per sq. in.) |
| $T_0$ = base temperature<br>T = flowing temperature | ° F. absolute (459.7° + ° F. above zero.) |

If the base and flowing temperatures are 519.7° (60° F. above zero) and the base pressure is 30 inches of mercury (14.73 lbs. per sq. in.) the formula becomes:

$$Q = 27.95\sqrt{\frac{(P_1^2 - P_2^2)\, d^{16/3}}{G\,L}}$$

Other commonly used formulae are:

The Pittsburgh Formula:

$$Q = 36.78\sqrt{\frac{(P_1^2 - P_2^2)\, d^5}{G\,L}}$$

The Cox Formula:

$$G = 33.3\sqrt{\frac{(P_1^2 - P_2^2)\, d^5}{G\,L}}$$

The Oliphant Formula:

$$Q = 42\,a\sqrt{\frac{P_1^2 - P_2^2}{L}}$$

$$\text{where } a = \sqrt{d^5} + \frac{d^3}{30}$$

For pipes 4″ or under there are some indications that the Pittsburgh or Cox formulae are most applicable.

## Values of $(d)^{8/3}$ and $(d)^{16/3}$

(Note — $d^{8/3} = \sqrt{d^{16/3}}$)

| Diameter (d), Inches | | $(d)^{8/3}$ | $(d)^{16/3}$ |
|---|---|---|---|
| External | Internal | | |
| 2.375 | 2.067 | 6.933 | 48.063 |
| 3.500 | 3.068 | 19.87 | 394.99 |
| 4.500 | 4.026 | 41.02 | 1,682.6 |
| 6.625 | 6.040 | 121.0 | 14,640 |
| 6.625 | 6.125 | 125.6 | 15,773 |
| 6.625 | 6.250 | 132.5 | 17,567 |
| 8.625 | 8.071 | 262.1 | 68,700 |
| 8.625 | 8.125 | 266.8 | 71,182 |
| 8.625 | 8.185 | 272.1 | 74,035 |
| 10.000 | 9.625 | 419.2 | 175,710 |
| 10.750 | 10.192 | 488.3 | 238,440 |
| 10.750 | 10.250 | 495.7 | 245,760 |
| 12.750 | 12.090 | 770.0 | 592,870 |
| 12.750 | 12.188 | 786.7 | 618,920 |
| 12.750 | 12.250 | 797.5 | 635,930 |
| 14.000 | 13.500 | 1033.3 | 1,067,600 |
| 15.000 | 14.500 | 1250.2 | 1,563,000 |
| 16.000 | 15.250 | 1430.2 | 2,045,400 |
| 16.000 | 15.375 | 1461.7 | 2,136,500 |
| 16.000 | 15.500 | 1493.5 | 2,230,600 |
| 18.000 | 17.250 | 1986.6 | 3,946,500 |
| 18.000 | 17.375 | 2025.3 | 4,101,600 |
| 18.000 | 17.500 | 2064.3 | 4,261,400 |
| 20.000 | 19.250 | 2661.6 | 7,084,200 |
| 20.000 | 19.375 | 2707.9 | 7,333,000 |
| 20.000 | 19.432 | 2729.3 | 7,449,200 |
| 22.000 | 21.125 | 3410.4 | 11,631,000 |
| 22.000 | 21.375 | 3519.1 | 12,384,000 |
| 22.000 | 21.500 | 3574.1 | 12,775,000 |
| 24.000 | 23.125 | 4340.8 | 18,843,000 |
| 24.000 | 23.375 | 4466.8 | 19,953,000 |
| 24.000 | 23.500 | 4531.0 | 20,529,000 |
| 26.000 | 25.125 | 5415.4 | 29,326,000 |
| 26.000 | 25.500 | 5633.4 | 31,736,000 |
| 28.000 | 27.125 | 6642.3 | 44,120,000 |
| 28.000 | 27.500 | 6889.8 | 47,471,000 |
| 30.000 | 29.125 | 8030.0 | 64,482,000 |
| 30.000 | 29.500 | 8308.3 | 69,030,000 |

# Flow of Gas Through Pipes of Varying Dimensions

*Actual Determinations*

The data given in these tables show the rates of flow of 0.6 specific gravity gas (in cu. ft. per hour) for different pressure drops (in 10ths inches of water column) in different sizes and varying lengths of pipe. For gas of any specific gravity other than 0.6, multiply the flow figures in the table by $\sqrt{\frac{0.6}{\text{sp. gr. of gas}}}$

**LENGTH OF STRAIGHT PIPE IN FEET**

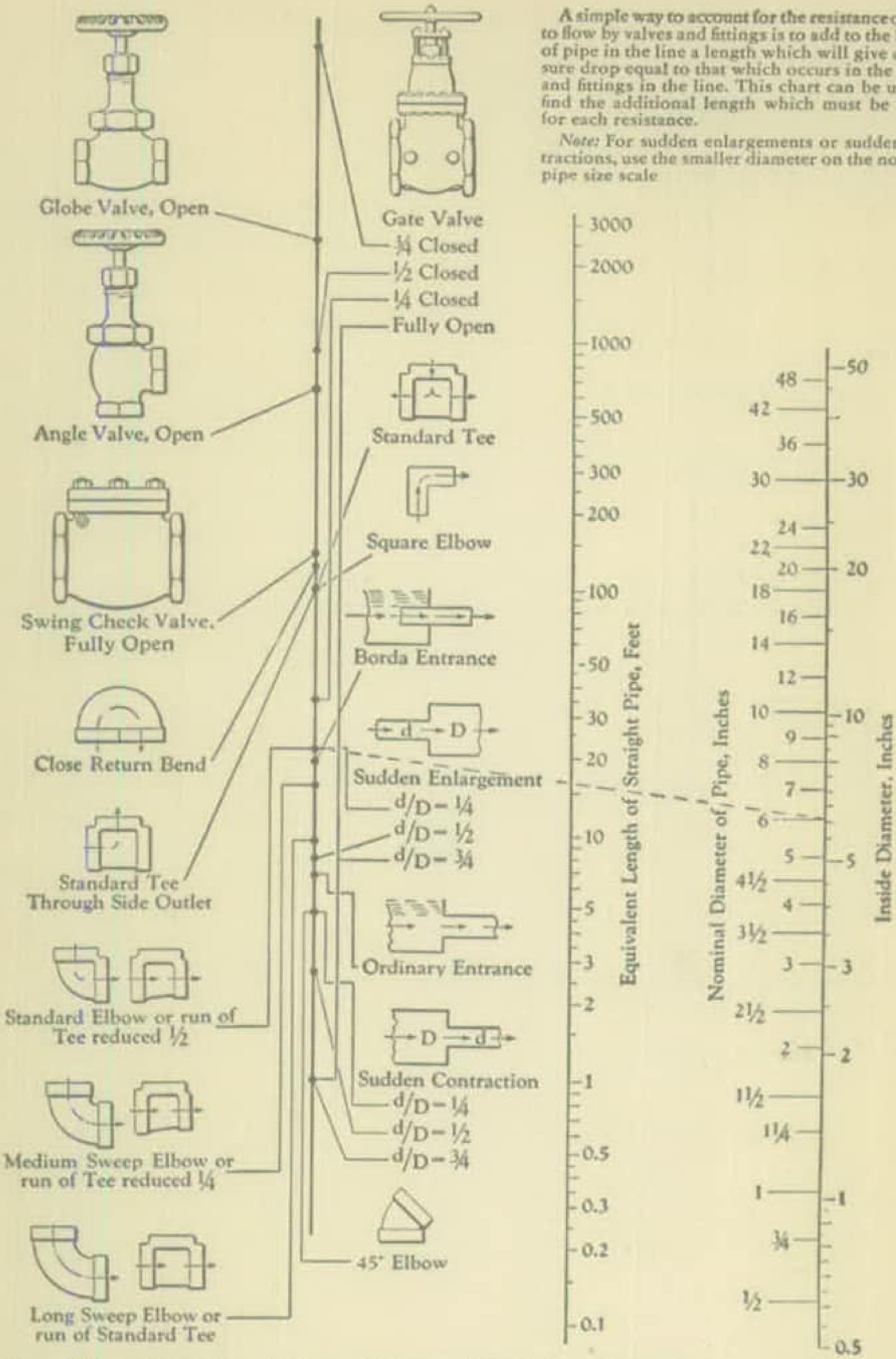
| Size Pipe Inches | Press. Drop 10th Ins. | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 415 | 300 | 240 | 210 | 190 | 170 | 160 | 150 | 142 | 135 | 125 | 112 | 100 | 90 | 75 | 62 | 50 | 45 | 40 | 35 | No | 30 |
| | 5 | 540 | 440 | 325 | 285 | 250 | 225 | 215 | 195 | 185 | 177 | 155 | 140 | 130 | 120 | 100 | 80 | 70 | 65 | 57 | 48 | Tests | 40 |
| | 10 | ..... | 560 | 440 | 400 | 360 | 335 | 310 | 290 | 270 | 260 | 235 | 215 | 195 | 180 | 145 | 125 | 110 | 100 | 90 | 80 | Made | 70 |
| | 15 | ..... | ..... | 565 | 510 | 440 | 410 | 380 | 355 | 340 | 325 | 295 | 265 | 240 | 225 | 180 | 155 | 135 | 125 | 110 | 105 | with | 90 |
| | 20 | ..... | ..... | ..... | 570 | 510 | 465 | 440 | 410 | 395 | 380 | 345 | 310 | 285 | 265 | 215 | 185 | 160 | 145 | 135 | 125 | This | 105 |
| | 30 | ..... | ..... | ..... | ..... | ..... | 580 | 540 | 505 | 480 | 465 | 420 | 380 | 350 | 330 | 265 | 225 | 200 | 180 | 165 | 155 | Lgt. | 135 |
| 1¼ | 3 | 850 | 610 | 505 | 430 | 390 | 360 | 340 | 310 | 295 | 285 | 200 | 230 | 210 | 195 | 155 | 135 | 115 | 100 | 90 | 85 | No | 75 |
| | 5 | 1125 | 790 | 660 | 570 | 510 | 465 | 440 | 410 | 390 | 375 | 335 | 305 | 280 | 260 | 205 | 180 | 165 | 140 | 125 | 115 | Tests | 100 |
| | 10 | ..... | 1135 | 940 | 810 | 725 | 670 | 630 | 590 | 560 | 545 | 485 | 440 | 410 | 380 | 305 | 260 | 230 | 205 | 190 | 175 | Made | 155 |
| | 15 | ..... | ..... | 1155 | 1000 | 890 | 820 | 770 | 725 | 685 | 670 | 600 | 525 | 450 | 435 | 375 | 325 | 285 | 260 | 235 | 225 | with | 195 |
| | 20 | ..... | ..... | ..... | 1150 | 1020 | 960 | 895 | 835 | 800 | 770 | 700 | 630 | 585 | 545 | 440 | 380 | 335 | 305 | 280 | 260 | This | 230 |
| | 30 | ..... | ..... | ..... | ..... | ..... | 1175 | 1100 | 1030 | 980 | 940 | 860 | 780 | 720 | 670 | 545 | 470 | 420 | 380 | 350 | 325 | Lgt. | 285 |
| 1½ | 3 | 1325 | 940 | 770 | 680 | 600 | 550 | 510 | 475 | 450 | 440 | 395 | 350 | 325 | 300 | 240 | 205 | 175 | 160 | 140 | 130 | No | 120 |
| | 5 | 1700 | 1200 | 1000 | 865 | 780 | 720 | 670 | 620 | 600 | 570 | 510 | 455 | 430 | 400 | 315 | 265 | 240 | 215 | 195 | 180 | Tests | 150 |
| | 10 | ..... | 1925 | 1450 | 1230 | 1120 | 1040 | 960 | 900 | 855 | 830 | 745 | 670 | 620 | 580 | 465 | 400 | 350 | 315 | 290 | 270 | Made | 240 |
| | 15 | ..... | ..... | 1770 | 1550 | 1375 | 1275 | 1175 | 1100 | 1050 | 1015 | 910 | 830 | 770 | 720 | 580 | 490 | 440 | 395 | 360 | 340 | with | 300 |
| | 20 | ..... | ..... | ..... | 1760 | 1575 | 1470 | 1370 | 1275 | 1225 | 1170 | 1075 | 950 | 895 | 830 | 670 | 590 | 510 | 460 | 430 | 400 | This | 350 |
| | 30 | ..... | ..... | ..... | ..... | ..... | 1805 | 1675 | 1575 | 1495 | 1450 | 1320 | 1180 | 1100 | 925 | 875 | 720 | 640 | 565 | 520 | 490 | Lgt. | 430 |
| 2 | 3 | 2420 | 1725 | 1430 | 1225 | 1115 | 1025 | 960 | 900 | 850 | 830 | 750 | 670 | 625 | 580 | 470 | 410 | 360 | 320 | 300 | 280 | No | 250 |
| | 5 | 3100 | 2225 | 1855 | 1600 | 1450 | 1375 | 1250 | 1175 | 1120 | 1075 | 970 | 880 | 820 | 760 | 610 | 530 | 470 | 420 | 390 | 365 | Tests | 320 |
| | 10 | ..... | 3160 | 2635 | 2275 | 2055 | 1900 | 1775 | 1675 | 1575 | 1545 | 1380 | 1270 | 1175 | 1085 | 870 | 760 | 670 | 610 | 560 | 525 | Made | 470 |
| | 15 | ..... | ..... | 3210 | 2790 | 2500 | 2325 | 2170 | 2025 | 1950 | 1825 | 1685 | 1545 | 1425 | 1335 | 1075 | 930 | 825 | 760 | 700 | 655 | with | 590 |
| | 20 | ..... | ..... | ..... | 3220 | 2925 | 2690 | 2500 | 2360 | 2250 | 2160 | 1980 | 1770 | 1650 | 1550 | 1255 | 1095 | 970 | 880 | 805 | 760 | This | 670 |
| | 30 | ..... | ..... | ..... | ..... | ..... | 3300 | 3080 | 2885 | 2745 | 2650 | 2415 | 2200 | 2000 | 1890 | 1550 | 1345 | 1200 | 1075 | 1000 | 940 | Lgt. | 825 |
| 2½ | 3 | 3900 | 2800 | 2320 | 2000 | 1800 | 1670 | 1550 | 1450 | 1380 | 1335 | 1225 | 1080 | 1000 | 940 | 735 | 645 | 570 | 500 | 465 | 430 | No | 385 |
| | 5 | 5040 | 3625 | 3000 | 2600 | 2350 | 2175 | 2025 | 1890 | 1810 | 1745 | 1570 | 1420 | 1315 | 1225 | 995 | 845 | 740 | 660 | 620 | 570 | Tests | 500 |
| | 10 | ..... | 5150 | 4285 | 3695 | 3340 | 3100 | 2880 | 2700 | 2570 | 2480 | 2240 | 2025 | 1890 | 1760 | 1415 | 1225 | 1085 | 990 | 910 | 850 | Made | 740 |
| | 15 | ..... | ..... | 5220 | 4550 | 4050 | 3780 | 3520 | 3300 | 3150 | 3050 | 2750 | 2500 | 2310 | 2155 | 1750 | 1500 | 1340 | 1225 | 1120 | 1020 | with | 950 |
| | 20 | ..... | ..... | ..... | 5240 | 4735 | 4400 | 4080 | 3800 | 3650 | 3510 | 3200 | 2900 | 2680 | 2500 | 2030 | 1775 | 1570 | 1410 | 1310 | 1225 | This | 1070 |
| | 30 | ..... | ..... | ..... | ..... | ..... | 5150 | 5000 | 4690 | 4475 | 4310 | 3910 | 3565 | 3290 | 3080 | 2500 | 2180 | 1925 | 1750 | 1600 | 1525 | Lgt. | 1340 |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 3 | 7000 | 5610 | 4400 | 3490 | 3145 | 2875 | 2670 | 2480 | 2360 | 2280 | 2040 | 1810 | 1665 | 1540 | 1220 | 1025 | 870 | 755 | 665 | 625 | No | 530 |
| | 5 | 9100 | 6500 | 5300 | 4600 | 4435 | 3780 | 3530 | 3290 | 3140 | 3020 | 2905 | 2840 | 2450 | 2140 | 1640 | 1385 | 1210 | 1085 | 980 | 900 | Tests | 760 |
| | 10 | ..... | 9300 | 7650 | 6600 | 5900 | 5500 | 5100 | 4800 | 4600 | 4400 | 3900 | 3600 | 3250 | 3000 | 2840 | 2140 | 1820 | 1640 | 1500 | 1390 | Made | 1225 |
| | 15 | ..... | ..... | 9380 | 8150 | 7300 | 6780 | 6290 | 5860 | 5600 | 5410 | 4880 | 4400 | 4050 | 3800 | 3050 | 2600 | 2290 | 2075 | 1895 | 1770 | with | 1600 |
| | 20 | ..... | ..... | ..... | 9380 | 8500 | 7860 | 7300 | 6835 | 6480 | 6290 | 5640 | 5140 | 4740 | 4410 | 3560 | 3050 | 2700 | 2440 | 2240 | 2080 | This | 1820 |
| | 30 | ..... | ..... | ..... | ..... | ..... | 9650 | 8990 | 8410 | 8000 | 7740 | 6990 | 6350 | 5850 | 5450 | 4410 | 3800 | 3380 | 3050 | 2790 | 2630 | Lgt. | 2290 |
| 3½ | 3 | 10350 | 7340 | 6050 | 5190 | 4690 | 4320 | 4035 | 3750 | 3565 | 3445 | 3115 | 2770 | 2575 | 2375 | 1890 | 1605 | 1400 | 1245 | 1130 | 1050 | No | 905 |
| | 5 | ..... | 9500 | 7880 | 6780 | 6140 | 5670 | 5280 | 4940 | 4685 | 4500 | 4000 | 3660 | 3380 | 3185 | 2500 | 2300 | 1890 | 1690 | 1545 | 1445 | Tests | 1245 |
| | 10 | ..... | ..... | ..... | 9740 | 8755 | 8080 | 7540 | 7080 | 6710 | 6510 | 5815 | 5280 | 4900 | 4550 | 3650 | 3160 | 2780 | 2500 | 2335 | 2150 | Made | 1885 |
| | 15 | ..... | ..... | ..... | ..... | ..... | 9945 | 9245 | 8650 | 8260 | 7960 | 7190 | 6500 | 6000 | 5620 | 4500 | 3910 | 3500 | 3150 | 2850 | 2700 | with | 2350 |
| | 20 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 10050 | 9580 | 9250 | 8350 | 7550 | 7000 | 6540 | 5290 | 4580 | 4020 | 3660 | 3400 | 3150 | This | 2775 |
| | 30 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9335 | 8610 | 8050 | 6550 | 5660 | 5000 | 4500 | 4195 | 3955 | Lgt. | 3450 |
| 4 | 3 | ..... | 10200 | 8420 | 7280 | 6580 | 6050 | 5635 | 5250 | 5000 | 4840 | 4355 | 3905 | 3610 | 3385 | 2720 | 2285 | 2000 | 1790 | 1655 | 1560 | No | 1350 |
| | 5 | ..... | ..... | ..... | 9450 | 8500 | 7880 | 7325 | 6870 | 6550 | 6300 | 5600 | 5125 | 4760 | 4400 | 3145 | 3010 | 2870 | 2670 | 2400 | 2100 | Tests | 1800 |
| | 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9800 | 9350 | 9040 | 8090 | 7380 | 6810 | 6350 | 5120 | 4400 | 3900 | 3550 | 3280 | 3050 | Made | 2690 |
| | 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9860 | 9080 | 8400 | 7860 | 6325 | 5450 | 4810 | 4360 | 4000 | 3740 | with | 3360 |
| | 20 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9700 | 9550 | 7375 | 6365 | 5610 | 5140 | 4750 | 4400 | This | 3880 |
| | 30 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 9050 | 7850 | 6990 | 6300 | 5820 | 5500 | Lgt. | 4820 |

| Size Pipe Inches | Press. Drop 10th Ins. | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 | 700 | 800 | 900 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 3 | 32000 | 22600 | 18500 | 16000 | 14400 | 13000 | 12100 | 11300 | 10100 | 9250 | 8550 | 8000 | 7550 | 7150 | 6500 | 6050 | 5650 | 5300 | 5100 |
| | 5 | 41500 | 29200 | 23800 | 20600 | 18500 | 16800 | 15600 | 14600 | 13000 | 11900 | 11000 | 10300 | 9750 | 9250 | 8400 | 7800 | 7400 | 6800 | 6500 |
| | 10 | 58100 | 41200 | 33800 | 29000 | 26000 | 23900 | 22000 | 20600 | 18400 | 16400 | 15500 | 14500 | 13700 | 13050 | 11900 | 11000 | 10300 | 9750 | 9250 |
| | 15 | 71500 | 50500 | 41300 | 35800 | 32100 | 29000 | 27000 | 25300 | 22600 | 20600 | 19200 | 17900 | 16800 | 15900 | 14600 | 13500 | 12600 | 11500 | 11200 |
| | 20 | 82500 | 58000 | 47800 | 41200 | 37000 | 33800 | 31000 | 29200 | 26000 | 23800 | 22000 | 20600 | 19400 | 18400 | 16800 | 15600 | 14500 | 13700 | 13000 |
| 8 | 3 | 65000 | 46000 | 37800 | 32600 | 29200 | 25800 | 24600 | 23000 | 20600 | 18700 | 17400 | 16300 | 15300 | 14500 | 13300 | 12300 | 11500 | 10800 | 10300 |
| | 5 | 84000 | 57500 | 48500 | 42000 | 37800 | 34400 | 31800 | 29800 | 26600 | 24000 | 22500 | 21000 | 19800 | 18800 | 17200 | 14900 | 14800 | 14000 | 13500 |
| | 10 | 118000 | 84000 | 68500 | 59500 | 53000 | 48500 | 45000 | 42000 | 37600 | 33200 | 31800 | 29600 | 28000 | 26600 | 24200 | 21900 | 21000 | 19800 | 18700 |
| | 15 | 145000 | 99500 | 84000 | 73000 | 65500 | 59500 | 55000 | 51500 | 46000 | 42000 | 39000 | 37400 | 34200 | 32500 | 29800 | 27500 | 25700 | 24200 | 23000 |
| | 20 | 168000 | 118000 | 97500 | 84000 | 75500 | 69000 | 63500 | 59500 | 53200 | 48500 | 45000 | 42000 | 39600 | 37500 | 34400 | 30800 | 29600 | 28000 | 26600 |
| 10 | 3 | 116000 | 82000 | 67500 | 58000 | 52000 | 47500 | 44000 | 41000 | 36800 | 33600 | 31000 | 29000 | 27400 | 26000 | 23700 | 21900 | 20300 | 19400 | 18400 |
| | 5 | 150000 | 106000 | 87000 | 75000 | 67500 | 61000 | 56800 | 53000 | 47500 | 46500 | 40000 | 37500 | 35500 | 33600 | 30600 | 28400 | 26600 | 25000 | 23600 |
| | 10 | 212000 | 150000 | 122000 | 105000 | 95000 | 87000 | 80000 | 75000 | 67000 | 60000 | 56500 | 53000 | 50000 | 47500 | 43300 | 40000 | 37500 | 35300 | 33600 |
| | 15 | 260000 | 184000 | 150000 | 130000 | 117000 | 105000 | 97000 | 95000 | 82000 | 75000 | 70000 | 65000 | 61500 | 58000 | 53000 | 49000 | 46000 | 42000 | 41000 |
| | 20 | 300000 | 212000 | 174000 | 150000 | 134000 | 122000 | 113000 | 105000 | 95000 | 87000 | 80500 | 75000 | 70500 | 67000 | 61000 | 57000 | 53000 | 50000 | 47500 |
| 12 | 3 | 183000 | 128000 | 105000 | 91500 | 82000 | 74500 | 69000 | 64500 | 57700 | 52500 | 48500 | 45500 | 43000 | 40700 | 37200 | 34400 | 32300 | 30400 | 28800 |
| | 5 | 234000 | 166000 | 135000 | 117500 | 110000 | 96000 | 89000 | 83500 | 74500 | 67000 | 63000 | 59000 | 55500 | 52700 | 48000 | 44500 | 41500 | 39200 | 37200 |
| | 10 | 331000 | 235000 | 192000 | 166000 | 148000 | 136000 | 125000 | 117000 | 105000 | 94000 | 89000 | 83000 | 78500 | 74500 | 68000 | 63000 | 58800 | 55500 | 52500 |
| | 15 | 406000 | 288000 | 236000 | 204000 | 184000 | 166000 | 154000 | 144000 | 128000 | 117000 | 109000 | 102000 | 96500 | 91000 | 83500 | 77000 | 72000 | 68000 | 64500 |
| | 20 | 470000 | 334000 | 272000 | 236000 | 210000 | 192000 | 177000 | 166000 | 148000 | 135000 | 125000 | 117000 | 110000 | 105000 | 96000 | 89000 | 83000 | 78800 | 74500 |

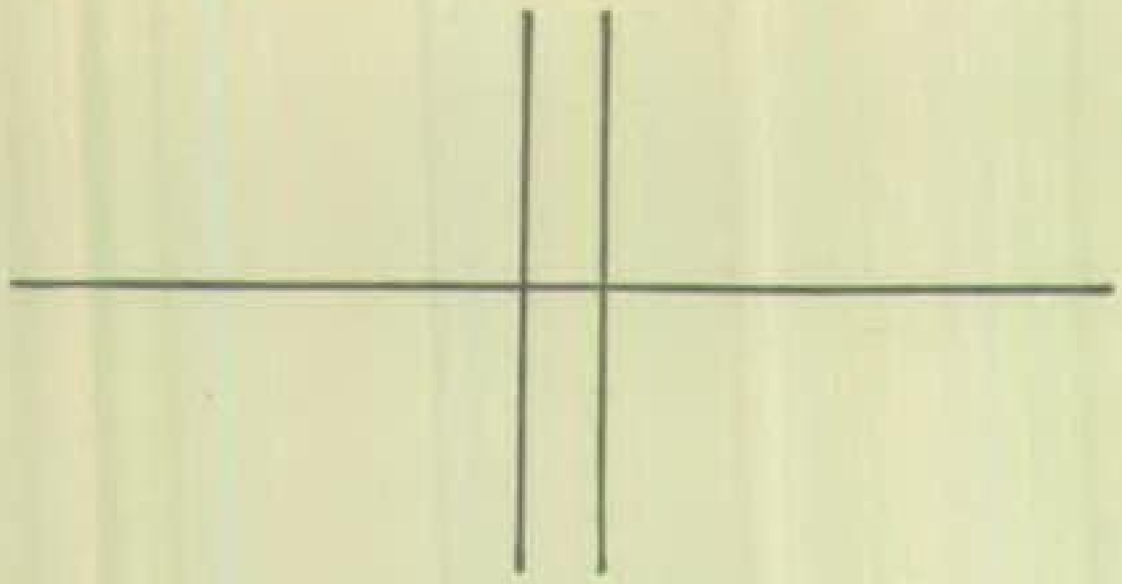
A simple way to account for the resistance offered to flow by valves and fittings is to add to the length of pipe in the line a length which will give a pressure drop equal to that which occurs in the valves and fittings in the line. This chart can be used to find the additional length which must be added for each resistance.

*Note:* For sudden enlargements or sudden contractions, use the smaller diameter on the nominal pipe size scale

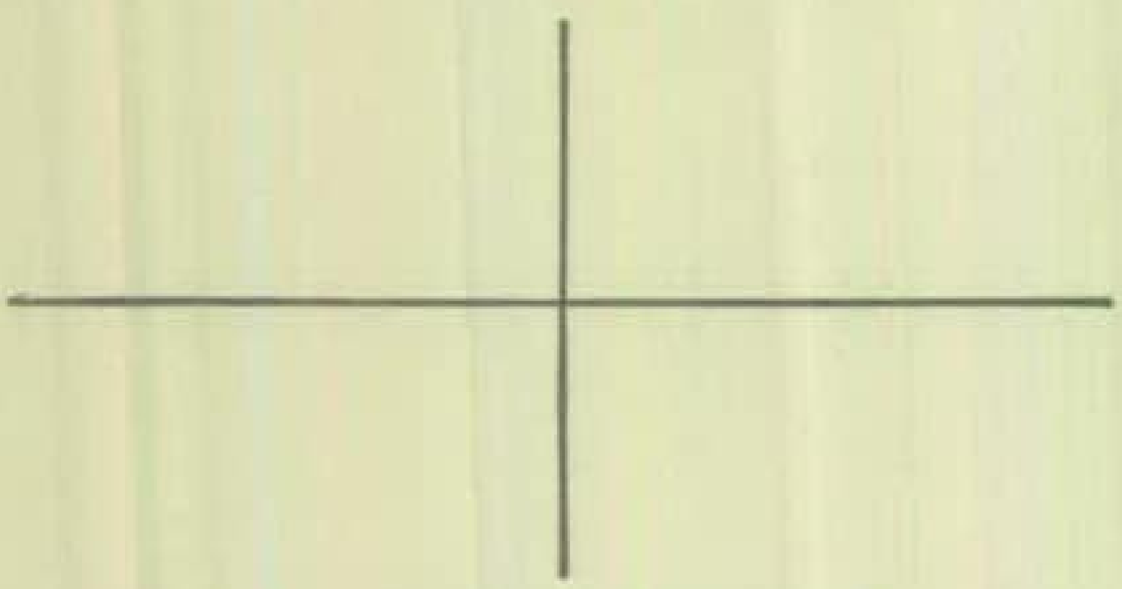



*From "Flow of Fluids through Valves, Fittings and Pipe." Copyright 1942 by Crane Company.*

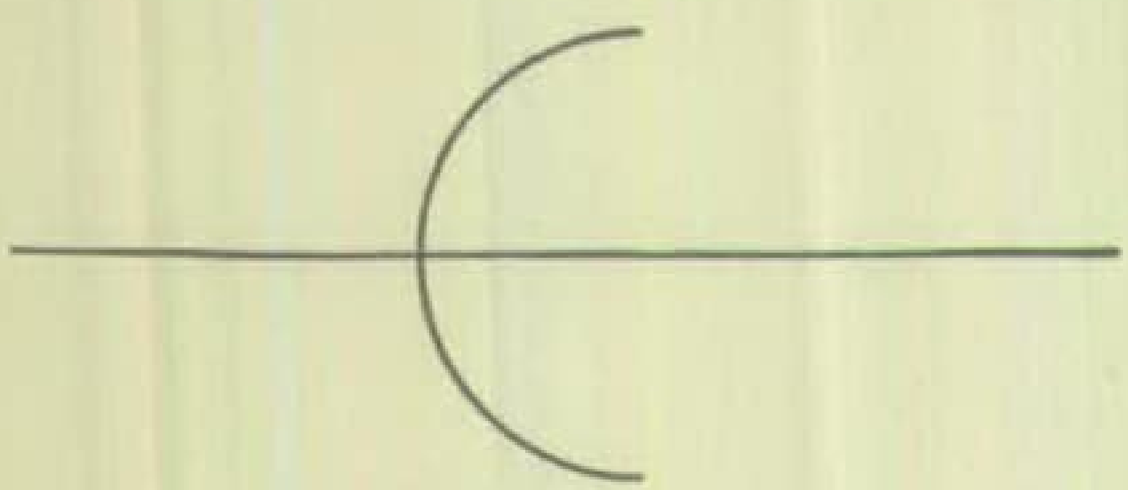
## Drawing Symbols



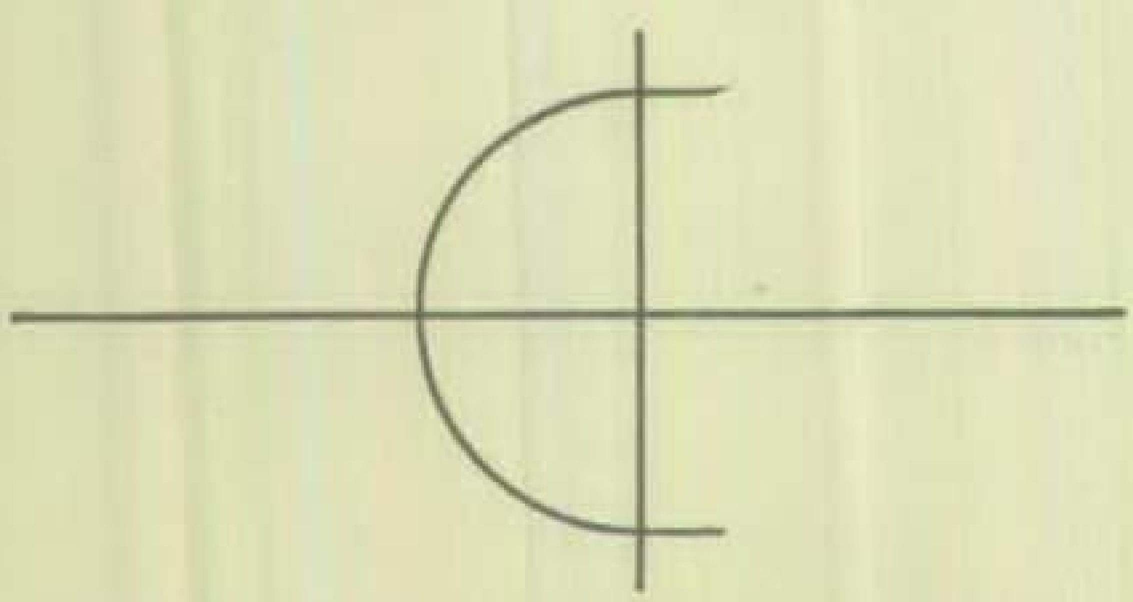
**Flanged Joint**



**Screwed Joint**



**Bell and Spigot Joint**



**Suggested Symbol for Mechanical Joint**

The symbols shown for bell and spigot, flanged, and screwed joints, are approved by American Standards Association and are reproduced from a publication issued by *The American Society of Mechanical Engineers* entitled "American Standard Graphical Symbols." The symbol for the mechanical joint is suggested by the Cast Iron Pipe Research Association as an addition to those now in use on drawings.

# Millimeters and Equivalent Decimals and Nearest Fractions of Inches

One Millimeter = 0.03937″ — One Inch = 25.40 Mill.

| Millimeter | Inches | | Millimeter | Inches | |
|---|---|---|---|---|---|
| | Decimal | Nearest Fraction | | Decimal | Nearest Fraction |
| 1 | 0.03937 | 3/64 | 51 | 2.00787 | 2 1/64 |
| 2 | 0.07874 | 5/64 | 52 | 2.04724 | 2 3/64 |
| 3 | 0.11811 | 1/8 | 53 | 2.08661 | 2 5/64 |
| 4 | 0.15748 | 5/32 | 54 | 2.12598 | 2 1/8 |
| 5 | 0.19685 | 13/64 | 55 | 2.16535 | 2 5/32 |
| 6 | 0.23622 | 15/64 | 56 | 2.20472 | 2 13/64 |
| 7 | 0.27559 | 9/32 | 57 | 2.24409 | 2 1/4 |
| 8 | 0.31496 | 5/16 | 58 | 2.28346 | 2 9/32 |
| 9 | 0.35433 | 23/64 | 59 | 2.32283 | 2 21/64 |
| 10 | 0.39370 | 25/64 | 60 | 2.36220 | 2 23/64 |
| 11 | 0.43307 | 7/16 | 61 | 2.40157 | 2 13/32 |
| 12 | 0.47244 | 15/32 | 62 | 2.44094 | 2 7/16 |
| 13 | 0.51181 | 1/2 | 63 | 2.48031 | 2 31/64 |
| 14 | 0.55118 | 35/64 | 64 | 2.51968 | 2 33/64 |
| 15 | 0.59055 | 19/32 | 65 | 2.55905 | 2 9/16 |
| 16 | 0.62992 | 5/8 | 66 | 2.59842 | 2 19/32 |
| 17 | 0.66929 | 43/64 | 67 | 2.63779 | 2 41/64 |
| 18 | 0.70886 | 45/64 | 68 | 2.67716 | 2 43/64 |
| 19 | 0.74803 | 3/4 | 69 | 2.71653 | 2 23/32 |
| 20 | 0.78740 | 25/32 | 70 | 2.75590 | 2 3/4 |
| 21 | 0.82677 | 53/64 | 71 | 2.79527 | 2 51/64 |
| 22 | 0.86614 | 55/64 | 72 | 2.83464 | 2 53/64 |
| 23 | 0.90051 | 29/32 | 73 | 2.87401 | 2 7/8 |
| 24 | 0.94488 | 15/16 | 74 | 2.91338 | 2 29/32 |
| 25 | 0.98425 | 63/64 | 75 | 2.95275 | 2 61/64 |
| 26 | 1.02362 | 1 1/64 | 76 | 2.99212 | 2 63/64 |
| 27 | 1.06299 | 1 1/16 | 77 | 3.03149 | 3 1/32 |
| 28 | 1.10236 | 1 7/64 | 78 | 3.07086 | 3 5/64 |
| 29 | 1.14173 | 1 9/64 | 79 | 3.11023 | 3 7/64 |
| 30 | 1.18110 | 1 3/16 | 80 | 3.14960 | 3 5/32 |
| 31 | 1.22047 | 1 7/32 | 81 | 3.18897 | 3 3/16 |
| 32 | 1.25984 | 1 1/4 | 82 | 3.22834 | 3 15/64 |
| 33 | 1.29921 | 1 19/64 | 83 | 3.26771 | 3 17/64 |
| 34 | 1.33858 | 1 11/32 | 84 | 3.30708 | 3 5/16 |
| 35 | 1.37795 | 1 3/8 | 85 | 3.34645 | 3 11/32 |
| 36 | 1.41732 | 1 27/64 | 86 | 3.38582 | 3 25/64 |
| 37 | 1.45669 | 1 29/64 | 87 | 3.42519 | 3 27/64 |
| 38 | 1.49606 | 1 1/2 | 88 | 3.46456 | 3 15/32 |
| 39 | 1.53543 | 1 17/32 | 89 | 3.50393 | 3 1/2 |
| 40 | 1.57480 | 1 37/64 | 90 | 3.54330 | 3 35/64 |
| 41 | 1.61417 | 1 39/64 | 91 | 3.58267 | 3 37/64 |
| 42 | 1.65354 | 1 21/32 | 92 | 3.62204 | 3 5/8 |
| 43 | 1.69291 | 1 11/16 | 93 | 3.66141 | 3 21/32 |
| 44 | 1.73228 | 1 47/64 | 94 | 3.70078 | 3 45/64 |
| 45 | 1.77165 | 1 49/64 | 95 | 3.74015 | 3 47/64 |
| 46 | 1.81102 | 1 13/16 | 96 | 3.77952 | 2 25/32 |
| 47 | 1.85039 | 1 27/32 | 97 | 3.81889 | 3 13/16 |
| 48 | 1.88976 | 1 57/64 | 98 | 3.85826 | 3 55/64 |
| 49 | 1.92913 | 1 59/64 | 99 | 3.89763 | 3 57/64 |
| 50 | 1.96850 | 1 31/32 | 100 | 3.93700 | 3 15/16 |

# Equivalents of Measure

## LENGTHS

1 meter, m = 10 decimeters, dm = 100 centimeters, cm = 1000 millimeters, mm.
1 meter, m = 0.1 decameter, dkm = 0.01 hectometer, hm = 0.001 kilometer, km.
1 meter, m = 39.37 inches, U. S. Standard = 39.370113 inches, British Standard.
1 millimeter, mm = 1000 microns, $\mu$ = 0.03937 inch = 39.37 mils.

| Meters m | Inches In. | Feet Ft. | Yard Yd. | Rods r. | Chains Ch. | Miles, U. S. | | Kilometers Km. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Statute | Nautical | |
| 1 | 39.37 | 3.28083 | 1.09361 | 0.19884 | 0.04971 | 0.0006214 | 0.0005396 | 0.001 |
| 0.02540 | 1 | 0.08333 | 0.02778 | 0.005051 | 0.001263 | 0.00001578 | 0.00001371 | 0.00002540 |
| 0.30480 | 12 | 1 | 0.33333 | 0.06061 | 0.01515 | 0.0001894 | 0.0001645 | 0.0003048 |
| 0.91440 | 36 | 3 | 1 | 0.18182 | 0.04545 | 0.0005682 | 0.0004934 | 0.0009144 |
| 5.02921 | 198 | 16.5 | 5.5 | 1 | 0.25 | 0.003125 | 0.002714 | 0.005029 |
| 20.1168 | 792 | 66 | 22 | 4 | 1 | 0.01250 | 0.01085 | 0.02012 |
| 1609.35 | 63360 | 5280 | 1760 | 320 | 80 | 1 | 0.86839 | 1.60935 |
| 1853.25 | 72962.5 | 6080.20 | 2026.73 | 368.497 | 92.1243 | 1.15155 | 1 | 1.85325 |
| 1000 | 39370 | 3280.83 | 1093.61 | 198.838 | 49.7096 | 0.62137 | 0.53959 | 1 |

1 yard, U. S. = 1.0000029 yards British. 1 yard British = 0.9999971 yard U. S.
1 chain, Gunter's = 100 links. 1 link = 7.92 inches.
1 cable length, U. S. = 120 fathoms = 960 spans = 720 feet = 219.457 meters.
1 league, U. S. = 3 statute miles = 24 furlongs.
1 international geographical mile = $^1/_{15}$° at equator = 7422 m = 4.611808 U. S. statute miles.
1 international nautical mile = $^1/_{60}$° at meridian = 1852 m = 0.999326 U. S. nautical miles.
1 U. S. nautical mile = $^1/_{60}$° of circumference of sphere whose surface equals that of the earth = 6080.27 feet = 1.15155 statute miles = 1853.27 meters.
1 British nautical mile = 6080.00 feet = 1.15152 statute miles = 1853.19 meters.

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# Equivalents of Measure

## SURFACES AND AREAS

**1 sq. meter, $m^2$ = 100 sq. decimeters, $dm^2$ = 10000 sq. centimeters, $cm^2$.**
**1 sq. meter, $m^2$ = 0.01 are, a = 0.0001 hectare, ha.**
**1 sq. millimeter, $mm^2$ = 0.01 $cm^2$ = 0.00155 sq. inch = 1973.5 circular mils.**
**1 are, a = 1 sq. decameter, dkm = 0.0247104 acre.**

| Sq. Meters $m^2$ | Sq. Inches Sq. In. | Sq. Feet Sq. Ft. | Sq. Yards Sq. Yd. | Sq. Rods Sq. r. | Acres A | Hectares Ha. | Sq. Miles Statute | Sq. Kilometers $Km^2$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 1550.00 | 10.7639 | 1.19599 | 0.03954 | 0.0002471 | 0.0001 | 0.0000003861 | 0.000001 |
| 0.0006452 | 1 | 0.006944 | 0.0007716 | 0.00002551 | 0.0000001594 | 0.00000006452 | 0.0000000002491 | 0.0000000006452 |
| 0.09290 | 144 | 1 | 0.11111 | 0.003673 | 0.00002296 | 0.000009290 | 0.00000003587 | 0.00000009290 |
| 0.83613 | 1296 | 9 | 1 | 0.03306 | 0.0002066 | 0.00008361 | 0.0000003228 | 0.0000008361 |
| 25.2930 | 39204 | 272.25 | 30.25 | 1 | 0.00625 | 0.002529 | 0.000009766 | 0.00002529 |
| 4046.87 | 6272640 | 43560 | 4840 | 160 | 1 | 0.40469 | 0.001563 | 0.004047 |
| 10000 | 15499969 | 107639 | 11959.9 | 395.366 | 2.47104 | 1 | 0.003861 | 0.01 |
| 2589999 | ........... | 27878400 | 3097600 | 102400 | 640 | 259.000 | 1 | 2.59000 |
| 1000000 | ........... | 10763867 | 1195985 | 39536.6 | 247.104 | 100 | 0.38610 | 1 |

**1 sq. rod, sq. pole, or sq. perch = 625 sq. links = 1/160 acre.**
**1 sq. chain, Gunter's = 16 sq. rods = 1/10 acre.**
**1 acre = 4 sq. roods = 160 sq. rods. Square of 1 acre = 208.7103 feet square.**

**Printed through the courtesy of the Carnegie Steel Company.**

# Equivalents of Measure

## MASSES AND WEIGHTS

1 gram, g = 10 decigrams, dg = 100 centigrams, cg = 1000 milligrams, mg.
1 gram, g = 0.1 decagram, dkg = 0.01 hectogram, hg = 0.001 kilogram, kg.
1 kilogram, kg = 1 cu. decimeter of water or liter, 4°C, 45° Lat. and sea level = 15432.35639 grains, U. S. and British Standard.

| Kilograms Kg. | Grains Gr. | Ounces | | Pounds | | Tons | | |
|---|---|---|---|---|---|---|---|---|
| | | Troy Oz. T. | Avoirdupois Oz. Av. | Troy Lb. T. | Avoirdupois Lb. Av. | Net, Short 2000 Lbs. | Gross, Long 2240 Lbs. | Metric 1000 Kg. |
| 1 | 15432.4 | 32.1507 | 35.2740 | 2.67923 | 2.20462 | 0.001102 | 0.0009842 | 0.001 |
| 0.00006480 | 1 | 0.002083 | 0.002286 | 0.0001736 | 0.0001429 | 0.00000007143 | 0.00000006378 | 0.00000006480 |
| 0.03110 | 480 | 1 | 1.09714 | 0.08333 | 0.06857 | 0.00003429 | 0.00003061 | 0.00003110 |
| 0.02835 | 437.5 | 0.91146 | 1 | 0.07595 | 0.06250 | 0.00003125 | 0.00002790 | 0.00002835 |
| 0.37324 | 5760 | 12 | 13.1657 | 1 | 0.82286 | 0.0004114 | 0.0003674 | 0.0003732 |
| 0.45359 | 7000 | 14.5833 | 16 | 1.21528 | 1 | 0.00050 | 0.0004464 | 0.0004536 |
| 907.185 | 14000000 | 29166.7 | 32000 | 2430.56 | 2000 | 1 | 0.89286 | 0.90719 |
| 1016.05 | 15680000 | 3266.7 | 35840 | 2722.22 | 2240 | 1.12 | 1 | 1.01605 |
| 1000 | 15432356 | 32150.7 | 35274.0 | 2679.23 | 2204.62 | 1.10231 | 0.98421 | 1 |

1 ounce avoir. = 16 drams, avoir. 1 ounce troy = 20 pennyweight, dwt.
1 ounce apoth., ℥ = 8 drams, ʒ = 24 scruples, ℈ = 480 grains, gr = 31.1035 gr.
1 hundredweight = 1/20 long ton = 4 quarters = 8 stone = 112 lbs. = 50.8024 kg.

Printed through the courtesy of the Carnegie Steel Company.

# Annuity Table
## Giving Yearly Payments Required to Redeem $100 at End of Any Year, From 1 to 100

| Years | 2½% | 3% | 3½% | 4% | 4½% | 5% | 6% |
|---|---|---|---|---|---|---|---|
| 1 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2 | 49.38 | 49.26 | 49.14 | 49.02 | 48.90 | 48.78 | 48.54 |
| 3 | 32.51 | 32.36 | 32.19 | 32.03 | 31.88 | 31.72 | 31.41 |
| 4 | 24.08 | 23.90 | 23.73 | 23.55 | 23.37 | 23.20 | 22.86 |
| 5 | 19.02 | 18.84 | 18.65 | 18.46 | 18.28 | 18.10 | 17.74 |
| 6 | 15.65 | 15.46 | 15.27 | 15.08 | 14.89 | 14.70 | 14.34 |
| 7 | 13.25 | 13.05 | 12.85 | 12.66 | 12.47 | 12.28 | 11.91 |
| 8 | 11.45 | 11.25 | 11.05 | 10.85 | 10.66 | 10.47 | 10.10 |
| 9 | 10.05 | 9.84 | 9.64 | 9.45 | 9.26 | 9.07 | 8.70 |
| 10 | 8.93 | 8.72 | 8.52 | 8.33 | 8.14 | 7.95 | 7.59 |
| 11 | 8.01 | 7.81 | 7.61 | 7.42 | 7.23 | 7.04 | 6.68 |
| 12 | 7.25 | 7.05 | 6.85 | 6.66 | 6.47 | 6.28 | 5.93 |
| 13 | 6.60 | 6.40 | 6.21 | 6.01 | 5.83 | 5.65 | 5.30 |
| 14 | 6.05 | 5.85 | 5.66 | 5.47 | 5.28 | 5.10 | 4.76 |
| 15 | 5.58 | 5.38 | 5.18 | 4.99 | 4.81 | 4.63 | 4.30 |
| 16 | 5.16 | 4.96 | 4.77 | 4.58 | 4.40 | 4.23 | 3.90 |
| 17 | 4.79 | 4.60 | 4.40 | 4.22 | 4.04 | 3.87 | 3.54 |
| 18 | 4.47 | 4.27 | 4.08 | 3.90 | 3.72 | 3.55 | 3.24 |
| 19 | 4.18 | 3.98 | 3.79 | 3.61 | 3.44 | 3.27 | 2.96 |
| 20 | 3.91 | 3.72 | 3.54 | 3.36 | 3.19 | 3.02 | 2.72 |
| 21 | 3.68 | 3.49 | 3.30 | 3.13 | 2.96 | 2.80 | 2.50 |
| 22 | 3.46 | 3.27 | 3.09 | 2.92 | 2.75 | 2.60 | 2.30 |
| 23 | 3.27 | 3.08 | 2.90 | 2.73 | 2.57 | 2.41 | 2.13 |
| 24 | 3.09 | 2.90 | 2.73 | 2.56 | 2.40 | 2.25 | 1.97 |
| 25 | 2.93 | 2.74 | 2.57 | 2.40 | 2.24 | 2.10 | 1.82 |
| 26 | 2.78 | 2.59 | 2.42 | 2.26 | 2.10 | 1.96 | 1.69 |
| 27 | 2.64 | 2.46 | 2.29 | 2.12 | 1.97 | 1.83 | 1.57 |
| 28 | 2.51 | 2.33 | 2.16 | 2.00 | 1.85 | 1.71 | 1.46 |
| 29 | 2.39 | 2.21 | 2.04 | 1.89 | 1.74 | 1.60 | 1.36 |
| 30 | 2.28 | 2.10 | 1.94 | 1.78 | 1.64 | 1.51 | 1.26 |
| 31 | 2.17 | 2.00 | 1.84 | 1.69 | 1.54 | 1.41 | 1.18 |
| 32 | 2.08 | 1.90 | 1.74 | 1.60 | 1.46 | 1.33 | 1.10 |
| 33 | 1.99 | 1.82 | 1.66 | 1.51 | 1.37 | 1.25 | 1.03 |
| 34 | 1.90 | 1.73 | 1.58 | 1.43 | 1.30 | 1.18 | .96 |
| 35 | 1.82 | 1.65 | 1.50 | 1.36 | 1.23 | 1.11 | .90 |
| 36 | 1.75 | 1.58 | 1.43 | 1.29 | 1.16 | 1.04 | .84 |
| 37 | 1.67 | 1.51 | 1.36 | 1.22 | 1.10 | .98 | .79 |
| 38 | 1.61 | 1.45 | 1.30 | 1.16 | 1.04 | .93 | .74 |
| 39 | 1.54 | 1.38 | 1.24 | 1.11 | .99 | .88 | .69 |
| 40 | 1.48 | 1.33 | 1.18 | 1.05 | .93 | .83 | .65 |
| 41 | 1.43 | 1.27 | 1.13 | 1.00 | .89 | .78 | .61 |
| 42 | 1.37 | 1.22 | 1.08 | .95 | .84 | .74 | .57 |
| 43 | 1.32 | 1.17 | 1.03 | .91 | .80 | .70 | .53 |
| 44 | 1.27 | 1.12 | .99 | .87 | .76 | .66 | .50 |
| 45 | 1.23 | 1.08 | .95 | .83 | .72 | .63 | .47 |
| 46 | 1.18 | 1.04 | .91 | .79 | .68 | .59 | .44 |
| 47 | 1.14 | 1.00 | .87 | .75 | .65 | .56 | .41 |
| 48 | 1.10 | .96 | .83 | .72 | .62 | .53 | .39 |
| 49 | 1.06 | .92 | .80 | .69 | .59 | .50 | .37 |
| 50 | 1.03 | .89 | .76 | .66 | .56 | .48 | .34 |

## Annuity Table
## Giving Yearly Payments Required to Redeem $100 at End of Any Year, From 1 to 100 (continued)

| Years | 2½% | 3% | 3½% | 4% | 4½% | 5% | 6% |
|---|---|---|---|---|---|---|---|
| 51 | .99 | .85 | .73 | .63 | .53 | .45 | .32 |
| 52 | .96 | .82 | .70 | .60 | .51 | .43 | .30 |
| 53 | .93 | .79 | .67 | .57 | .48 | .41 | .29 |
| 54 | .89 | .76 | .65 | .55 | .46 | .39 | .27 |
| 55 | .87 | .73 | .62 | .52 | .44 | .37 | .25 |
| 56 | .84 | .71 | .60 | .50 | .42 | .35 | .24 |
| 57 | .81 | .68 | .57 | .48 | .40 | .33 | .22 |
| 58 | .78 | .66 | .55 | .46 | .38 | .31 | .21 |
| 59 | .76 | .64 | .53 | .44 | .36 | .30 | .20 |
| 60 | .74 | .61 | .51 | .42 | .35 | .28 | .19 |
| 61 | .71 | .59 | .49 | .40 | .33 | .27 | .18 |
| 62 | .69 | .57 | .47 | .39 | .31 | .26 | .17 |
| 63 | .67 | .55 | .45 | .37 | .30 | .24 | .16 |
| 64 | .65 | .53 | .44 | .35 | .29 | .23 | .15 |
| 65 | .63 | .51 | .42 | .34 | .27 | .22 | .14 |
| 66 | .61 | .50 | .40 | .32 | .26 | .21 | .13 |
| 67 | .59 | .48 | .39 | .31 | .25 | .20 | .12 |
| 68 | .57 | .46 | .37 | .30 | .24 | .19 | .12 |
| 69 | .56 | .45 | .36 | .29 | .23 | .18 | .11 |
| 70 | .54 | .43 | .35 | .27 | .22 | .17 | .10 |
| 71 | .52 | .42 | .33 | .26 | .21 | .16 | .10 |
| 72 | .51 | .41 | .32 | .25 | .20 | .15 | .09 |
| 73 | .49 | .39 | .31 | .24 | .19 | .15 | .09 |
| 74 | .48 | .38 | .30 | .23 | .18 | .14 | .08 |
| 75 | .47 | .37 | .29 | .22 | .17 | .13 | .08 |
| 76 | .45 | .35 | .28 | .21 | .16 | .13 | .07 |
| 77 | .44 | .34 | .27 | .21 | .16 | .12 | .07 |
| 78 | .43 | .33 | .26 | .20 | .15 | .11 | .06 |
| 79 | .41 | .32 | .25 | .19 | .14 | .11 | .06 |
| 80 | .40 | .31 | .24 | .18 | .14 | .10 | .06 |
| 81 | .39 | .30 | .23 | .17 | .13 | .10 | .05 |
| 82 | .38 | .29 | .22 | .17 | .13 | .09 | .05 |
| 83 | .37 | .28 | .21 | .16 | .12 | .09 | .05 |
| 84 | .36 | .27 | .21 | .15 | .11 | .08 | .05 |
| 85 | .35 | .26 | .20 | .15 | .11 | .08 | .04 |
| 86 | .34 | .26 | .19 | .14 | .10 | .08 | .04 |
| 87 | .33 | .25 | .18 | .14 | .10 | .07 | .04 |
| 88 | .32 | .24 | .18 | .13 | .10 | .07 | .04 |
| 89 | .31 | .23 | .17 | .13 | .09 | .07 | .03 |
| 90 | .30 | .23 | .17 | .12 | .09 | .06 | .03 |
| 91 | .30 | .22 | .16 | .12 | .08 | .06 | .03 |
| 92 | .29 | .21 | .15 | .11 | .08 | .06 | .03 |
| 93 | .28 | .21 | .15 | .11 | .08 | .05 | .03 |
| 94 | .27 | .20 | .14 | .10 | .07 | .05 | .03 |
| 95 | .26 | .19 | .14 | .10 | .07 | .05 | .02 |
| 96 | .26 | .19 | .13 | .09 | .07 | .05 | .02 |
| 97 | .25 | .18 | .13 | .09 | .06 | .04 | .02 |
| 98 | .24 | .18 | .12 | .09 | .06 | .04 | .02 |
| 99 | .24 | .17 | .12 | .08 | .06 | .04 | .02 |
| 100 | .23 | .16 | .12 | .08 | .06 | .04 | .02 |

## Annuity Table

### Capitalization of Annuity of $1,000 for From 5 to 100 years

| Years | 2½% | 3% | 3½% | 4% | 4½% | 5% | 5½% | 6% |
|---|---|---|---|---|---|---|---|---|
| 5 | 4,645.88 | 4,579.60 | 4,514.92 | 4,451.68 | 4,389.91 | 4,329.45 | 4,268.09 | 4,212.40 |
| 10 | 8,752.17 | 8,530.13 | 8,316.45 | 8,110.74 | 7,912.67 | 7,721.73 | 7,537.54 | 7,360.19 |
| 15 | 12,381.41 | 11,937.80 | 11,517.23 | 11,118.06 | 10,739.42 | 10,379.53 | 10,037.48 | 9,712.30 |
| 20 | 15,589.215 | 14,877.27 | 14,212.12 | 13,590.21 | 13,007.88 | 12,462.13 | 11,950.26 | 11,469.96 |
| 25 | 18,424.67 | 17,413.01 | 16,481.28 | 15,621.93 | 14,828.12 | 14,093.86 | 13,413.82 | 12,783.38 |
| 30 | 20,930.59 | 19,600.21 | 18,391.85 | 17,291.86 | 16,288.77 | 15,372.36 | 14,533.63 | 13,764.85 |
| 35 | 23,145.31 | 21,487.04 | 20,000.43 | 18,664.37 | 17,460.89 | 16,374.36 | 15,390.48 | 14,488.65 |
| 40 | 25,103.53 | 23,114.36 | 21,354.83 | 19,792.65 | 18,401.49 | 17,159.01 | 16,044.92 | 15,046.31 |
| 45 | 26,833.15 | 24,518.49 | 22,495.23 | 20,719.89 | 19,156.24 | 17,773.99 | 16,547.65 | 15,455.85 |
| 50 | 28,362.48 | 25,729.58 | 23,455.21 | 21,482.08 | 19,761.93 | 18,255.86 | 16,931.97 | 15,761.87 |
| 70 | 32,897.85 | 29,123.36 | 26,000.65 | 23,394.57 | 21,202.16 | 19,342.74 | 17,752.90 | 16,384.51 |
| 100 | 36,614.21 | 31,598.81 | 27,655.36 | 24,504.96 | 21,949.21 | 19,847.90 | 18,095.83 | 16,612.64 |

# INDEX

*Abbreviations*
- **AGA . . . . American Gas Association**
- **ASA . . . . . American Standards Association**
- **AWWA . . . American Water Works Association**