

CHAPTER II

THE MANUFACTURE OF CAST IRON SOIL PIPE AND FITTINGS

The chapter discusses the manufacture of cast iron soil pipe and fittings in the United States, the methods of production, and the new techniques and improvements in manufacturing that have been introduced. It contains information on the availability and the acceptance of cast iron soil pipe and fittings.

THE CAST IRON SOIL PIPE INDUSTRY

A list of the Cast Iron Soil Pipe Institute members who are manufacturers of cast iron soil pipe and/or fittings and their foundry locations and principal sales offices at time of publication follows:

Manufacturers of Cast Iron Soil Pipe and Fittings

AB & I
7825 San Leandro Street
Oakland, California 94621

Charlotte Pipe & Foundry Company
P.O. Box 35430
Charlotte, North Carolina 28235

Tyler Pipe Industries
National Headquarters
P.O. Box 2027
Tyler, Texas 75710
Sales Office and Manufacturing Plants
P.O. Box 2027, Tyler, Texas 75710
P.O. Box 35, Macungie, Pennsylvania 18062

PRODUCTION OF CAST IRON SOIL PIPE AND FITTINGS IN THE UNITED STATES

Shipments of cast iron soil pipe and fittings have followed the path of the Nation's economy, lower in recession years and higher in the more prosperous years. An all time high in tonnage shipments occurred in 1972 according to figures compiled by the U.S. Department of Commerce.

Of the total tonnage of cast iron soil pipe and fittings production, it is estimated that fittings constitute 22 to 25 percent. Pipe sizes are divided as follows: approximately 59 percent is 3 inch and 4 inch, 25 percent is 1½ inch and 2 inch and 16 percent is 5 inch and over.

Since 1972 the tonnage has dropped; however, tonnage of cast iron soil pipe and fittings produced does not indicate that the demand for soil pipe and fittings is declining. The demand for cast iron soil pipe and fittings is strong and will be for many years to come.

Tonnage of cast iron soil pipe changed drastically when centrifugal pipe casting machines made their appearance. These machines produced more uniform wall thicknesses which created a greater acceptance of service weight soil pipe. As a result, the demand for extra heavy pipe and fittings decreased year after year to a point where it is now less than 3% of the cast iron soil pipe produced.

The introduction of ¶ NO-HUB® soil pipe and fittings also reduced the total tonnage. The iron required to produce hubs was eliminated, but the compactness of the fittings also reduced the consumption of iron. The overall acceptance and demand for ¶ NO-HUB® in every state has had an effect on the tons produced each year.

Cast iron soil pipe fittings are castings of various shapes and sizes used in conjunction with cast iron soil pipe in the sanitary and storm drain, waste, and vent piping of buildings. These fittings include various designs and sizes consisting of bends, tees, wyes, traps, drains, and other common or special fittings, with or without side inlets. The large variety of cast iron soil pipe fittings required in the United States is attributable to the many types and sizes of buildings and to the variety of requirements of various city, state, and regional plumbing codes. There are many plumbing codes in the United States, and often special cast iron soil pipe fittings are specified by individual codes. As a result, foundries in the industry make a large variety of special fittings to meet the requirements of their customers.

DISTRIBUTION OF CAST IRON SOIL PIPE AND FITTINGS

Good distribution and large inventories provide ready availability of cast iron soil pipe and fittings. The foundries, working cooperatively with wholesalers and plumbing contractors, will fill an order, and deliver it directly to the job site so that it does not have to be unloaded and reloaded at a supply house. This is of particular assistance to plumbing contractors working on large buildings. Nearly all of the industry's production is delivered by truck throughout the continental United States. Deliveries may be made on 24 to 48 hour notice from inventories. Sales are made through plumbing wholesalers.

NUMBER OF OPERATING UNITS

Technological improvements in the manufacture of cast iron soil pipe and fittings have brought about a reduction in the number of operating plants, even though industry output has been increasing. In December of 1953 there were 56 plants reporting shipments to the U.S. Bureau of the Census. This number declined to 47 in 1956, to 38 in 1959, to 31 in 1967, and by 1980, according to the *Census*, there were 15 operating plants in the industry. Thus, although industry shipments increased by 53.9 percent between 1953 and 1972, the number of plants declined by 62.5 percent over the same period. It is important to note that despite the reduction in operating units, total capacity in the industry has remained fairly constant. EPA rules and OSHA Regulations created overwhelming costs that a great many small producers could not endure. Modern efficient mechanized manufacturing methods allowed current producers to increase overall production capacity.

THE MANUFACTURING OF CAST IRON SOIL PIPE AND FITTINGS

Type of Iron

Soil pipe and fittings are manufactured of cast iron. Cast iron is a generic term for a series of alloys primarily of iron, carbon and silicon. Cast iron also contains small amounts of other elements such as manganese, sulfur and phosphorous. The chemical composition of the iron is determined by regularly scheduled analysis of samples taken from test blocks or test specimens or directly from castings. The hardness of the iron is determined by its chemical composition and the rate that the casting is cooled.

The Modern Cast Iron Soil Pipe and Fittings Foundry

The design and layout of the modern cast iron soil pipe and fittings foundry is planned so that there can be a smooth and efficient flow of production from raw materials to finished products. Typically, the foundry consists of five major sections or departments which are: 1) the storage yard for raw materials; 2) the melting area; 3) the molding and casting area where the pipe and fittings are manufactured; 4) the cleaning department where the pipe and fittings are cleaned, coated and prepared for storage or shipment, and 5) the storage and shipping area for finished products.

Adjacent is an area for mold preparation, and a core room is provided to house coremaking machinery. The cleaning department contains abrasive shot blast machinery, and chipping and grinding equipment to remove sand, fins, gates, and risers from the pipe and fittings. Coating equipment is located in or adjacent to this section. The modern soil pipe foundry also includes a pattern shop and pattern storage room, a testing laboratory, a storage area for finished product inventories, and a packing and shipping section.

Melting Devices Used and Raw Materials

The cupola furnace is used as the principle method for obtaining the molten metal required for production. Electric melting equipment such as coreless induction furnaces, may also be used. Regardless of the type of melting equipment employed, the make up of the furnace charge determines the composition of the molten iron.

The basic raw materials used to produce cast iron soil pipe and fittings are scrap iron, steel scrap, alloys, coke and limestone. These materials are stockpiled in the raw materials storage yard. The ratio between scrap iron and steel scrap for a given charge can vary over a wide range depending upon the relative availability of these materials. Silicon and carbon may be added to the molten iron in pre-determined amounts to provide the proper final chemical composition.

An overhead bridge crane is used to handle these materials for charging into the melting furnace which is normally located in close proximity to the raw materials storage yard. (See Figure No. 1)



FIG. 1 — The Raw Materials Storage Yard of the Foundry

The Cupola Furnace for Melting Iron

Melting of the raw materials to produce molten iron is usually accomplished in the cupola. The cupola is a vertically erected cylindrical shell of steel that can be either refractory lined or water cooled (See Figure No. 2). Cupolas are classified by shell diameter that can range from 32" up to 150". A typical cupola consists of three main sections: the well, the melting zone and the upper stack. The refractory lined well section includes the bottom doors that are hinged to the shell, the sand bottom and the taphole. The bottom doors permit the removal of the sand bottom and the remaining material from the cupola after the last charge has been melted. The taphole is connected to a refractory lined slag separator that is attached to the outside of the shell. The melting zone features the tuyeres that introduces the combustion air into the cupola from the wind box which surrounds the shell. The upper stack extends from the melting zone toward the charging door and may be as tall as 36 ft. above tuyere level. The upper stack is connected to the air pollution control equipment with which modern cupolas are equipped in order to eliminate particulate matter discharge into the atmosphere.

The Start of the Operation of the Cupola

First, the bottom doors are closed and secured. A sand bottom, slanted toward the taphole, is then rammed in place. Directly on this sand bottom a coke bed is charged to the desired height above the tuyeres. Once the coke bed is thoroughly ignited and incandescent, alternate layers of ferrous scrap, coke and limestone are charged through the charge door into the cupola. Coke is used to provide the necessary source of heat for the melting process. Limestone is added to flux

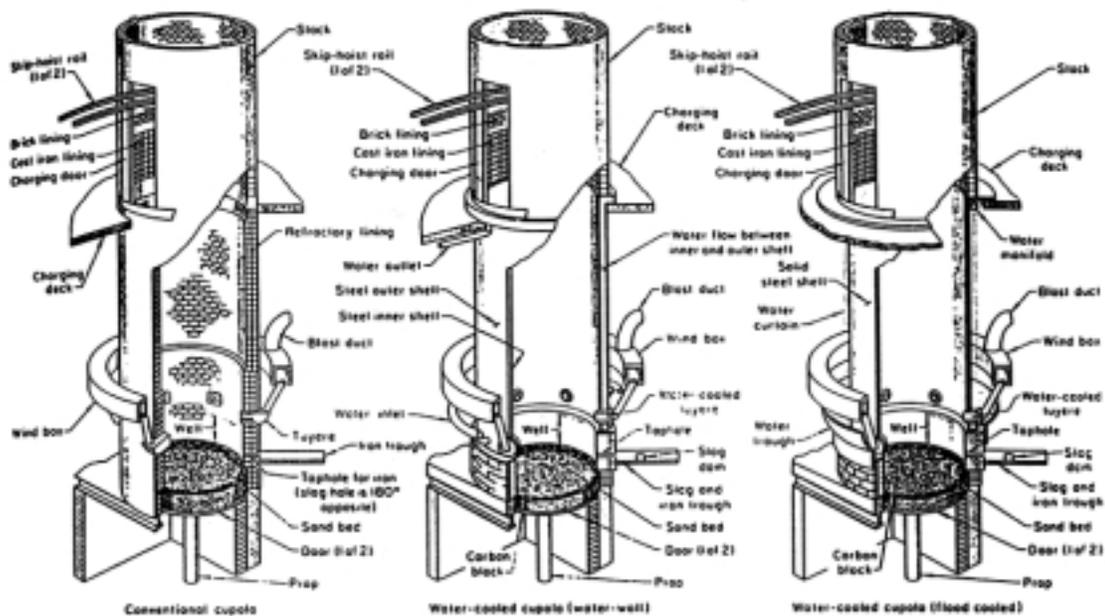


FIG. 2 — Sectional views of conventional and water-cooled cupolas. The conventional type shown is refractory lined. Water-cooled types incorporate either an enclosed jacket or an open cascade flow.

away coke ash and other impurities from the charge. A cupola charge usually consists of 8 to 10 parts of metal by weight to 1 part of coke. When the cupola is filled up to the charging door, combustion air is introduced through the tuyeres to start the melting process. The combustion or blast air may be preheated up to 1200°F to improve melting efficiencies.

As melting occurs, the charges start to descend and additional layers of scrap, coke and limestone are charged alternately into the cupola so that it remains filled up to the charge door. At the conclusion of the operation all the charge in the cupola is melted down. When the melt down is complete, the remaining molten metal and slag are drained. The bottom doors are opened and the sand bottom together with the material remaining in the cupola is dropped onto the ground.

The rate of melting in the cupola is governed by the diameter of the melting zone and by the amount of blast air blown through the tuyeres. Cupola melting capacities may range from 10 to 100 tons per hour. The molten iron temperature at the taphole is normally between 2700°F and 2900°F. The melting operation is usually continuous. The molten metal that is discharged through the taphole is either accumulated in a forehearth or holding furnace or taken directly to the pouring area in refractory lined ladles. When holding furnaces are utilized, they serve as a buffer or an accumulator between the melting and the casting operations, allowing molten iron temperatures to be controlled.

Rigid control is maintained during the melting and pouring processes to assure the proper composition of the molten iron necessary to cast quality soil pipe and fittings. During the operation frequent metallurgical tests are taken to insure the required chemical and physical properties of the pipe and fittings produced.



FIG. 3 — The Charging Door of the Cupola Furnace



FIG. 4 — Mixing Ladle Located in Front of a Cupola

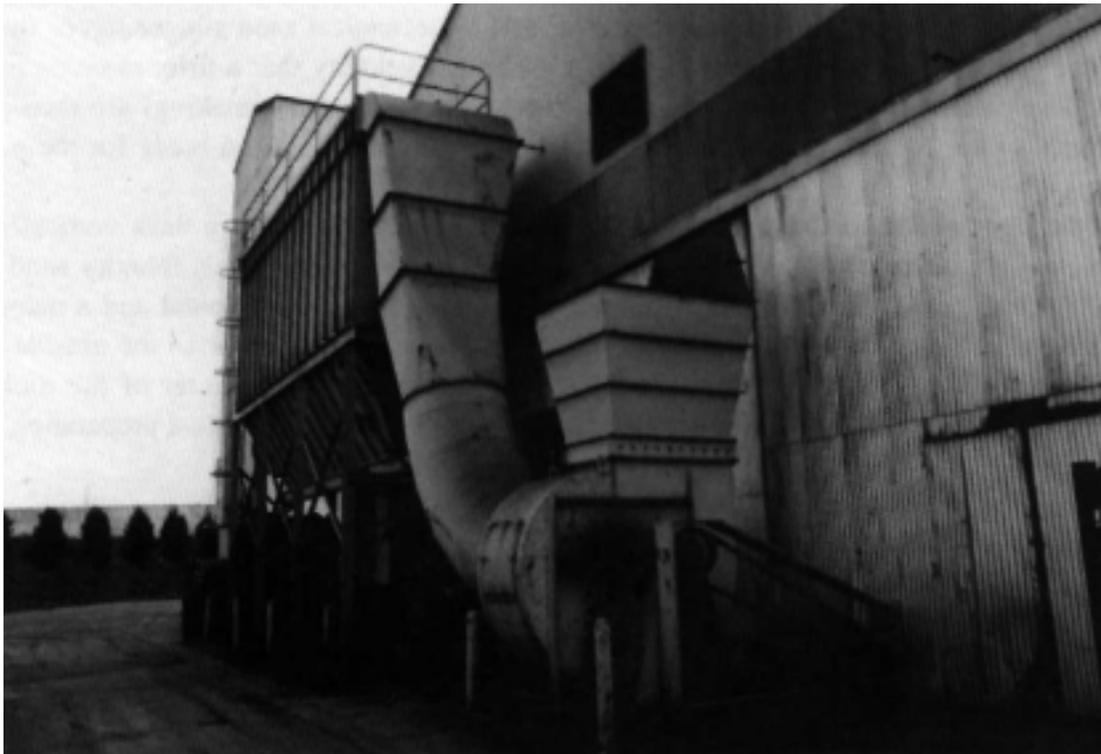


FIG. 5 — Exterior View of a Cupola with Air Pollution Control Equipment

CASTING OF SOIL PIPE AND FITTINGS

The casting of soil pipe and fittings in foundries throughout the United States is highly mechanized and incorporates the latest advances in foundry technology. The centrifugal casting process is used to produce pipe, while static casting is used to produce fittings. Centrifugal casting and modern static casting provides rigid production control and yields high quality pipe and fittings of uniform dimensions cast to exacting specifications.

Centrifugal Pipe Casting

Centrifugal casting in horizontal molds is used to make long, concentric, hollow castings of uniform wall thickness. In the centrifugal pipe casting process, a sand-lined or water-cooled metal mold is rotated on a horizontal axis during the interval of time that it receives a pre-measured quantity of molten iron. The centrifugal force created by this rotation causes the liquid iron to spread uniformly onto the mold's inner surface, thereby forming upon solidification a cylindrical pipe conforming to the inside dimensions of the mold. One type of centrifugal pipe casting machine is illustrated in Figure 6.

Sand-Lined Molds

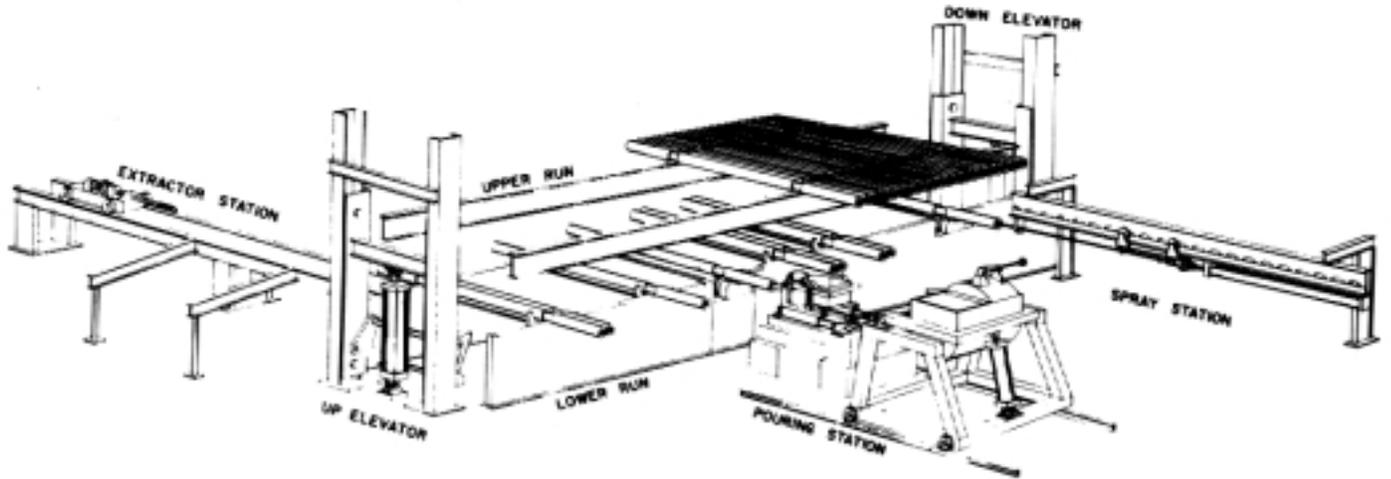
Sand-lined molds for a centrifugal pipe casting machine use foundry sand rammed into a cylindrical flask as it rotates in a horizontal position around a centered pipe pattern. One end of the flask is closed after the pattern has been inserted, and a mechanical sand slinger forces the sand through the opposite end and around the pattern with such velocity that a firm, rammed mold is obtained. The pattern is then withdrawn. Cores (see description of coremaking) are then placed into the ends of the flask to contain the liquid metal, and the mold is then ready for the pouring operation.

Another method of making sand-lined molds consists of positioning a flask vertically on a revolvable metal platen, which closes off its lower end. As the flask rotates, foundry sand drops into its open upper end. The flask, still spinning, then rotates to the horizontal and a mandrel is introduced and offset to form a cavity in the sand having the same contour as the outside of the pipe to be cast. Once this is accomplished, the mandrel shifts to the center of the mold and retracts. Next, cores are automatically set into the ends of the flask to complete preparation of the mold.

Metal Molds

Metal molds used in centrifugal pipe casting machines are spun on rollers and externally cooled by water. Prior to casting, the mold's inner surface may be coated with a thin refractory slurry as a deterrent to sticking.

FIG. 6—Illustration of a Centrifugal Pipe Casting Machine



Casting Process

Molten iron from the melting area is transferred to a pouring ladle which is adjacent to the casting machine. The iron is weighed, taking into account the length and diameter of the pipe to be cast and its desired wall thickness. When the pouring ladle is tilted, the stream of molten iron enters a trough which carries it into one end of the rotating pipe mold. Pouring continues until the supply of iron in the pouring ladle is exhausted. After the pipe is cast, it is allowed to solidify in the still rotating mold. Finally, the pipe is removed from the mold and is conveyed to the foundry's cleaning and finishing department.

STATIC CASTING OF FITTINGS

Cast iron soil pipe fittings can be produced by two different static casting processes. One process casts fittings in sand molds, while the other uses permanent metal molds. Both processes use precision metal patterns and are highly mechanized to permit the volume production of fittings to close tolerances.

Sand Casting

Static sand casting uses sand cores surrounded by green-sand molds into which molten iron is poured to form castings. The sand is termed "green" because of its moisture content rather than its color. Sand which does not contain moisture is appropriately termed "dry" sand. The sand-casting process involves patternmaking, molding, coremaking, pouring, and shaking out.

Patternmaking: A pattern is a form which conforms to the external shape of the fitting to be cast and around which molding material is packed to shape the casting cavity of the mold. It is made usually out of metal in a pattern shop by skilled craftsmen using precision machine tools and equipment. (See Figure 7.)

Molding: Fitting molds are prepared by machine molding, either in flasks or by means of flaskless compression techniques. In both cases, the material used for molding is an aggregation of grains of sand mixed with small quantities of clay and other additives. It retains its shape when formed around a pattern and, given its refractory quality, can remain in contact with molten iron without the likelihood of fusion to the casting.

In molding machines using flasks, both the pattern and the flask are separated in two halves to facilitate removal of the pattern during the molding operation. The upper part of the flask is called the "cope", and the lower part is called the "drag". The pattern is used to form a cavity in the molding sand which is rammed into both parts of the flask.

At the start of the molding operation, the lower half of the pattern is placed with the flat side down on the platen or table of a molding machine. The drag or lower half of the flask is then placed around it. The void between the pattern and the flask is filled with molding sand, which is rammed into a solid mass. When the flask and sand are lifted from the pattern, a molded cavity is obtained, corresponding to half of the outside surface of the fitting to be cast. The cope is formed

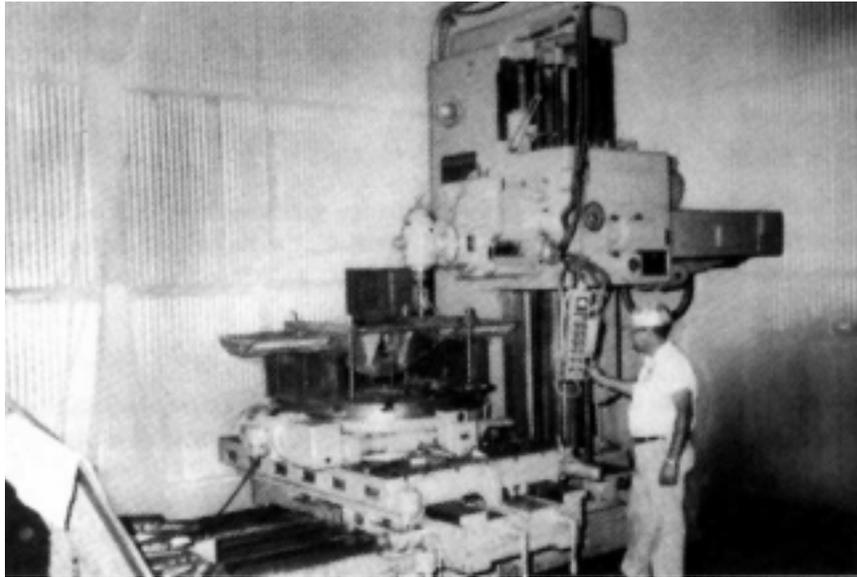


FIG. 7 — Operation of Precision Milling Machinery for Patternmaking

in the same manner; and when it is placed over the drag, the resultant cavity in the sand corresponds to the entire outside surface of the fitting. However, before pouring, a sand core must be inserted in the mold to keep the molten iron from completely filling the void. The core forms the fitting's inner surface. Extensions on the pattern are provided to form "core prints" or depressions in the molding sand that will support the core at both ends. This prevents the core from dropping to the bottom of the sand cavity or from floating upward when the molten iron is poured into the mold. Figure 8 shows fittings molds being made.

Some molding machines use mechanical jolting and/or squeezing to pack the sand about the pattern. The cope and the drag, both empty, are placed on alternate sides of a matchplate and surround the pattern, also mounted on the two sides. Molding sand is released from an overhead hopper into the drag, and the entire assembly is then jolted to distribute the sand evenly, after which the excess is scraped off. A bottom board is then placed on the drag, and the assembly is rotated 180 degrees to expose the cope. It is similarly filled with molding sand, and after this, a simultaneous squeezing of both the cope and the drag takes place. The cope is then lifted so that the operator can remove the pattern and insert a sand core.

The second method of fitting mold preparation for sand casting, using flaskless compression molding machines, has greatly increased the speed and efficiency of the molding operation. Although molding time varies depending upon the type and size of the fittings to be cast, it is not uncommon for flaskless molding to be several times faster than cope and drag flask molding.

In flaskless compression molding, two matched patterns, each conforming to half of the outside surface of the fitting to be cast, are used in a compression chamber to form flaskless sand molds. The patterns are mounted vertically inside the chamber, their flat sides fixed against two of the chamber's opposite ends, generally referred to as "pattern plates". Molding sand is fed into the chamber from an overhead bin and is squeezed between the patterns to form a mold with a pattern



FIG. 8 — Making a Fitting Mold

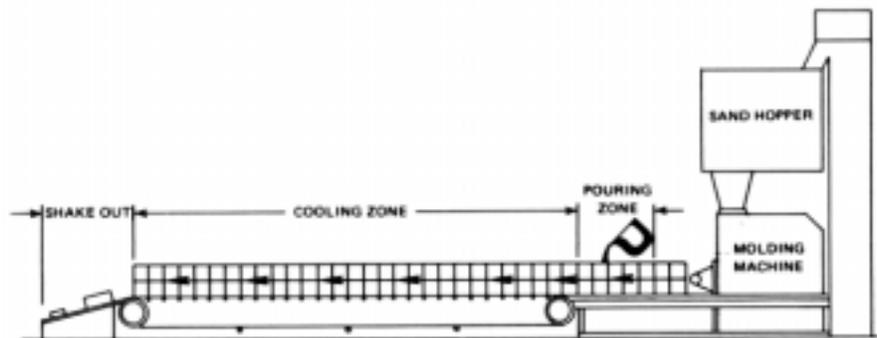


FIG. 9 — Illustration of Flaskless Fitting Molds

impression (one-half of a casting cavity) in each of its end surfaces. During the squeezing operation, one of the pattern plates, also known as the “squeeze plate”, moves inward to compress the molding sand. The other pattern plate remains stationary until the mold is formed and then releases, moving outward and upward, whereupon a core is automatically set in the exposed pattern impression. The squeeze plate then pushes the mold out of the compression chamber directly onto a “pouring rail” to close up with the previously prepared mold just ahead of it. In this manner, once a number of such close-up operations have occurred, a string of completed fitting molds ready for pouring is obtained, and it advances a short distance as each newly-prepared mold arrives on the pouring rail. A string of flaskless fitting molds is illustrated in Figure 9.

In recent years several highly automated casting machines have been installed to make soil pipe fittings. Most of these machines use sand molds, while some are designed to use permanent molds. Some are computer operated with process controllers.



FIG. 10 — Automatic Core Setter for Flaskless Molding Machine



FIG. 11 — Mechanical Core Production

Coremaking: Core production must actually precede mold preparation so that a sufficient number of cores are available for insertion into the molds.

Most cores made for soil pipe and fittings are shell cores. In this method, sand which has been coated with resin binders is blown into a pre-heated metal core box. The heat sets the resin and bonds the sand into a core that has the external contours of the inside of the core box and the internal shape of the fitting. Automatic shell core machines, such as those shown in Figure 11, are in use throughout the industry. An automatic core setter is shown in Figure 10.

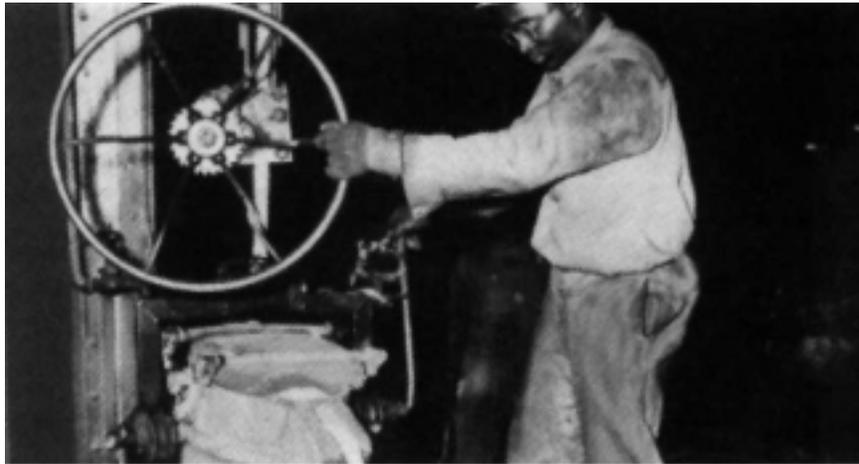


FIG. 12 — Pouring of Cast Iron Soil Pipe Fittings

Pouring: During the preparation of fitting molds, openings called pouring “sprues” are provided to permit molten iron to enter the mold cavity. Before pouring, molten iron is transported from the melting area in a ladle and then distributed to pouring ladles suspended from an overhead conveyor system. An operator pours the liquid iron into individual fitting molds. (See Figure 12.) (This may also be accomplished by an automated pouring device.)

Shaking Out: After pouring, the fittings are allowed to cool inside the mold until the iron solidifies. The hot castings are removed from the mold by dumping the mold onto a grating where the hot sand drops through and is collected for recycling. The castings are then allowed to cool further in the open air. At this stage, they are still covered with a small amount of sand which must be removed in the cleaning department (See Figures 17 & 20).

Permanent Mold Casting

The permanent mold process is an automated process that represents an advance in the production of cast iron soil pipe fittings. Permanent-mold casting produces fittings in reusable, two-piece, water or air-cooled metal molds. Casting occurs with the molds set in a stationary position on a rectangular indexing line, or on a rotating wheel-type machine. (See Figure 14.)

The latter arrangement employs multiple molds mounted in a circle, and as the machine rotates, production steps are performed, some automatically, at various stations.

At the start of the casting procedure, with the two-piece mold in an open position, a coating of soot from burning acetylene is applied to prevent the mold from chilling the molten iron and to prevent the casting from sticking to the mold. A core is then set, and the mold is closed. The mold is then ready for pouring. Molten iron, meanwhile, has been distributed from a large ladle traveling on an overhead monorail system to a smaller pouring ladle. The iron is poured into the fitting molds as shown in Figure 13. The cast fitting solidifies in the mold that is cooled by a controlled flow of water or by air passing over cooling fins built into the mold. When sufficiently solid, the fitting is released from the mold onto a conveyor for transporting to the cleaning department. The mold is then cleaned and made ready for recoating, and the entire production cycle starts once again. The result is a highly efficient casting operation.



FIG. 13 — Permanent-Mold Casting for Fittings Production



FIG. 14 — Rotating Wheel-Type Machine for Fittings Production

Cleaning and Finishing Operations

Cleaning: After the newly cast pipe and fittings have been removed from their molds and allowed to cool, they must be properly cleaned to remove molding sand, core sand, gates, fins, and risers. The cleaning operation may use any of several methods, including shot blast, tumbling machines, reamers, and grinding equipment. Fins are usually ground off with an abrasive wheel, while gates and risers are knocked off with chipping equipment and then ground smooth. Modern shot blast cleaning machine and grinding equipment are shown in Figures 15, 16, & 18.

Inspection & Testing: After the castings have been cleaned, they are inspected and tested for strict conformance to all standards and specifications. In the laboratory, test samples undergo more exacting physical testing and chemical analyses. (See Figures 21 through 25.)

Coating: After inspection and testing, pipe and fittings to be coated are dipped in a bath of coating material. Dipping is the most satisfactory method since it provides a finish which is smooth, glossy, hard but not brittle, and free of blisters and blemishes. The finished pipe and fittings are then moved into storage or prepared for shipment.



FIG. 15 — Modern Shot Blast Cleaning Machine



FIG. 16 — Grinding Equipment for Foundry Use



FIG. 17 — Castings Being Shaken Out of the Mold



FIG. 18 — Modern Grinding & Inspection Department

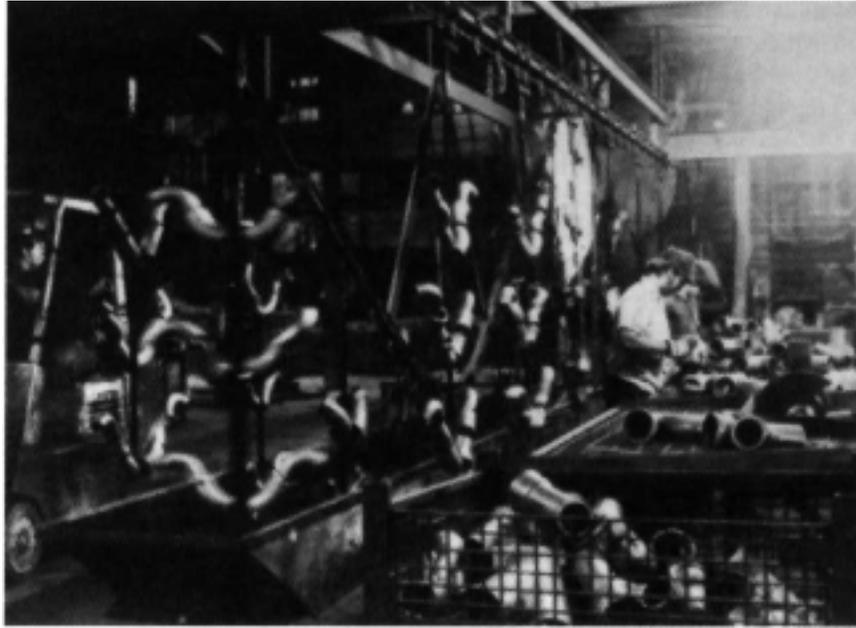


FIG. 19 — Inspection and Grinding of Fittings



FIG. 20 — Modern Shakeout



FIG. 21 — Atomic Absorption Spectrophotometer — Analysis of environmental samples, raw materials, control checks of optical emission and X-ray spectrometers.



FIG. 22 — Energy Dispersive X-Ray Spectrometer — Analysis of iron, slag and raw materials.



FIG. 23 — Image Analyzer — Defining the microstructure matrix of final product.



FIG. 24 —Optical Emission Spectrometer (OES) — Analysis of irons, production control samples and final product



FIG. 25 — Laboratory Testing of Cast Iron for Soil Pipe and Fittings



FIG. 26 — Shell Core Making Equipment

NEW TECHNOLOGY AND IMPROVEMENTS IN MANUFACTURING METHODS

The foregoing abbreviated description of the manufacturing process for cast iron soil pipe and fittings indicates that a number of technological improvements in mechanized production have taken place in recent years. These have increased operating efficiency and improved product quality. The following is a brief review of the principal new techniques and equipment.

The Melting Section

In the melting section, cupolas are equipped with automatic controls, which insure a uniform melting of the furnace charge. Shutdown for refractory repair and relining is less frequent because of improved refractories or the use of water-cooled shells. The water-cooled cupola can be operated continuously over extended periods and provides additional versatility in the selection and use of raw materials. Oxygen is now commonly available to enrich the cupola air blast in amounts of 1 to 4% of the air volume. Air for the cupola blast is also being preheated to temperatures up to 1200°F in externally fired hot blast systems or in recuperative heating units. The recuperative units utilize the carbon monoxide from the cupola effluent gases as a fuel or extract the sensible heat from the hot gases emitted from the cupola. Divided blast cupolas, where the air blast enters the cupola through two separate levels of tuyeres, are also being used. These new techniques provide increased melting efficiency as well as increases in iron temperature and melting rate.

The Casting Section

The principal technological advance in the industry has been centrifugal casting, which has long been used to manufacture cast iron pressure pipe. Once it was adapted to soil pipe production, the process was widely accepted and quickly made the hand cast method economically and technologically obsolete. The centrifugal method makes it possible to produce an equivalent tonnage in less time than formerly required, and consistently yields high quality pipe of uniform wall thickness.

A parallel advance in fitting production has been the introduction of automatic high production molding systems which have made dramatic increases in operating efficiency. At the same time, other aspects of fittings production have improved as well. Pattern shops, for example, use the most modern machine tools and the latest patternmaking materials to insure dimensional accuracy. Molding machines for cope and drag casting, as well as flaskless molding machines, have eliminated the time consuming drudgery of hand ramming, and contribute greatly to the speed and precision of fitting mold preparation. Finally, these developments have been complemented by the use of automatic core-blowing machines, which have kept core production in step with the simultaneous advances in molding and casting.

PATTERNS FOR CAST IRON SOIL PIPE AND FITTINGS

The manufacture of cast iron plumbing products has gone through several major changes beginning in the latter part of the 1940's. The demand for cast iron plumbing material increased greatly after World War II. Manufacturers began developing new and better methods which required patterns designed for higher and more economical production.

Automation always requires precise tooling. This led to a product that was uniform and had precise dimensions. This accuracy of patterns and equipment made possible the rubber compression gasket joint and the hubless coupling method of joining cast iron soil pipe and fittings.

The process of making cast iron fittings prior to 1945 was extremely slow, requiring a highly skilled foundry molder. The pattern was simply a casting split on its center. The core was made with green sand supported by a cast iron arbor. This process evolved into a matched pattern in a cradle called a follow board rollover.

About 1950, aluminum match plates using hinged aluminum core boxes and cast iron arbors became the latest production method. Then, in the middle fifties, large machine-made sand molds and machine-made green sand cores on arbors came into use. About 1960, the old green sand core made on an arbor gave way to shell cores made in a hot core box. These shell cores were used in both water-cooled cast iron permanent molds and in green sand molds. In 1970 fittings began to be produced with modern high speed molding machines which produce 100 to 150 molds per hour.

The cast iron soil pipe and fittings manufacturers are now using modern computer-controlled equipment, which can produce in excess of 350 molds per hour.

Materials Handling Equipment

The latest mechanical equipment is used to handle materials within the foundry and to transport them from one section to another. Cranes and conveyors are used in the storage yard to move pig iron, scrap metal, coke and limestone. The distribution ladle, filled with molten iron, is moved from the melting area to the casting floor on an overhead rail conveyor or by fork lift. Pouring ladles for pipe and fittings are also supported by overhead rail systems. Finished molds are placed mechanically on conveyors for delivery to pouring stations. An overhead conveyor belt transports recovered molding sand to the molding section for use, and another conveyor system carries pipe and fittings to the cleaning and inspection department. Materials handling equipment has mechanized coating operations, and fork lifts are used to stack and load packaged fittings and palletized pipe for shipment. Thus, mechanization has been introduced in all phases of the manufacturing process, from the receipt of raw materials to the shipment of finished products. Figure 27 depicts the use of materials handling equipment in foundry operations.



FIG. 27 — Materials Handling Equipment for Foundry Use

POLLUTION EQUIPMENT

The passing of the Clean Air and Clean Water Acts of the early 1970's introduced one of the most critical periods of the Cast Iron Soil Pipe Industry. Government regulations required that air pollution control equipment be installed on melting, sand handling, grinding and cleaning systems, and that water treatment systems be installed on all industrial waste water systems.

Very little information was available in the 1970's on Pollution Control. Many foundries closed their doors because they could not meet the minimum regulations due to either financial or technical problems.

The remaining foundries spent millions of dollars installing pollution control equipment and similar amounts annually to maintain the control equipment. More recent environmental regulations will necessitate the expenditure of additional millions of dollars for compliance.

Within the last decade, the soil pipe foundry has gone from a smokestack industry to a leader in clear air and water campaigns. Many of the soil pipe foundries are situated in highly populated areas without anyone being aware of their operations, due to efficient air pollution control.

Results of Technological Improvements

The results of the technological improvements in production can be summarized as follows:

- (1) Improved metal quality
- (2) Precision casting with controlled tolerances
- (3) Straighter pipe
- (4) Smoother walls
- (5) More uniform wall thickness
- (6) More uniform hubs and spigots
- (7) Standardized pipe and fitting dimensions providing complete product interchangeability
- (8) Assurance of long-lived, economical and trouble free service
- (9) Hubless couplings and compression gasketed joints
- (10) Lower installation cost