intended by its designer to be used to produce small orders or unlimited sizes nor where frequent changes of rolls in a days work is required.

Where such conditions as noted above prevail the old type mill such as an ordinary bar or guide mill costing only a fraction of the amount a continuous or semi-continuous mill would cost and capable of turning out only a fraction of the output of these modern mills, would be the more profitable mill to install, because it would still have sufficient capacity to take care of the output required. The overhead charge, while costing more per ton of output capacity would still be much less than this same small tonnage would cost if made on the more costly modern equipment.

Furthermore, when the old type mill is down for any reason such as lack of orders or changing of rolls the overhead cost of such shutdown would be much less in comparison.

It would seem ridiculous to install a mill with an output of 250,000 pounds a turn on small sizes if the total of your orders or requirements is only 100,000 pounds per turn as the higher first cost and consequently higher fixed overhead would be prohibitive.

Costly Labor-Saving Machinery.

Another feature usually overlooked is that labor saving machinery is not always desirable or profitable from an investment point of view. If the first cost of the equipment necessary to be installed in order to cut down the number of employees required to do a certain amount of work plus the cost of upkeep, would increase your fixed overhead charge more per ton on your required production than the cost of hand labor per ton on this same production, then it is obvious that hand labor should be used.

The only excuse that could be offered for the installation of the costly labor saving appliances under such conditions would be inability to get sufficient hand labor to do the work. Yet many installations have been made under the guise of progress that have never returned in profits the amount of the interest on the investment much less the cost of the upkeep. This of course is generally due to the fact that the limited tonnage required never had justified the expenditure of the money necessary to cover the first cost of the installation.

Hand Labor.

The human machine, no matter how cold blooded this statement may sound, requires no upkeep so far as the employer is concerned. When men fail to be efficient they are replaced by younger, more efficient men, without extra cost to the manufacturer. There is no overhead to take care of except their daily wage. You are still getting all the output you require or can make use of and when the roll train is idle for a few days the daily wage ceases to be an overhead charge.

Therefore if the required output of any installation is so small that hand labor will easily produce it within the specified time, then it is ridiculous to install costly machinery with its rapid and expensive depreciation to do this work simply because it can be done quicker, when you have no way to utilize the time saved. You only need so much tonnage and therefore the time saved is wasted but your overhead charges such as interest on investment, and upkeep still go on.

Old Type Mill.

For instance a bar mill that would roll all the tonnage required in a given time when hand operated by means of the old-fashioned hooks instead of the expensive driven and tilting roller tables and served by the old hand charged heating furnace instead of the costly modern continuous furnace, will produce a limited tonnage at a much less cost per ton than this same small tonnage could be produced on the more modern equipment.

This is the reason why in times when keen competition exists due to scarcity of orders and lack of demand for any particular product, that many of the old so-called obsolete mills are able to make a little money for their owners when the bang up modern mill is eating its head off in idleness. It therefore behooves the purchaser to know the condition under which he must operate before he can select the type of mill that will best fill his requirements.

Manufacturing Steel and Iron Tubes

Youngstown Sheet and Tube Company's Method of Manufacturing Pipe Processes Used in Forming and Welding Steel Tubes—Process of Threading, Testing and Finishing.

By H. C. EBRIGHT.

PIPE in various forms and sizes being so important among the products of the Youngstown Sheet & Tube Co., and the processes used in its manufacture being so varied and complicated, three separate articles in this series will be devoted to this subject. The first will contain a brief description of the forming and welding of lap-weld and butt-weld tubes.

Tubes, or pipe, as they are commonly known in this country, were made as far back as 1790, when lead was used for this purpose. This material lacked strength and physical properties necessary for structural, conductive and mechanical purposes, however, and efforts were soon made to produce pipe from stronger materials, such as brass and iron. It will be seen that the entire history of iron and steel tubes does not date back much farther than 100 years. The earliest tubes were made for gun barrels by taking a strip of wrought iron and bending it so that the edges over-lapped, and then welding these edges by hammering with or without swages. It was not until the year 1815 that the first tubes were made for gas purposes, and these were no longer than six feet.

Looking back into the early history of the tube industry, we find that the most simple and obvious methods of manufacture were used. What we now call "lap-weld" tubes were made by taking a flat strip of steel of suitable thickness and width and bending this into a tube shape until its edges were either soldered or welded together. In 1812 the first patents were granted covering machinery and apparatus for carrying out this process.

Butt-weld tubes were first made by James Russell in 1824. He bent the iron skelp into cylindrical form until the edges butted together, and then welded these edges with a power hammer fitted with dies. The first attempt to carry out the modern process of making butt-weld pipe was made by Cornelius Whitehouse in 1825, when he used a chain bench placed in front of a furnace and arranged to pull the heated pipe through a die or bell by chain and tongs actuated by power. This, with modifications and improvements, is the same process used today.

Wrought iron made by the puddling process, was at one time the only available material for the manu-

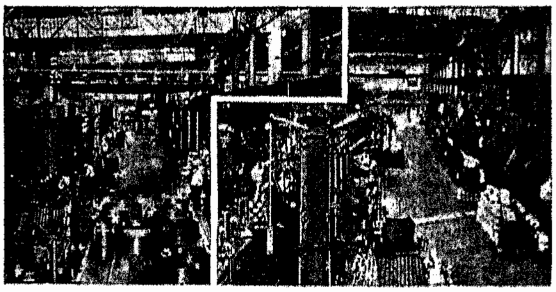

Fig. 1—Welding pipe by the lap weld process.

facture of pipe, but during the last thirty years this has been largely superseded by a purer grade of iron not only on the care used in its manufacture, but upon the quality of the steel.

All pipe made by this company is either lap-weld or butt-weld, and is manufactured by bending skelp and welding the edges together, either overlapping or edge to edge.

Our mills produce pipe in all standard sizes from one-eighth inch to twenty inches in diameter. By skelp is meant a flat sheet or plate used in making pipe by either of the above prosesses. Still another process for making tubes is by forming or drawing them from solid billets. The product is known as seamless tubing. The Youngstown Sheet & Tube Co. has six lap-weld furnaces, of which three can be heated either with coke or producer gas, while in the other three coke gas only is used. It has also five butt-weld furnaces in which either coke or producer gas can be used. These furnaces are all of the regenerative type.

The size of pipe is usually determined by its inside diameter up to and including the 12-inch size, and all larger is rated according to its outside diameter. Lap-weld pipe is made on our mills from two inches to 20 inches inclusive, from skelp 7¾ inches to 64½ inches in width.

One of the most important features in the manufacture of pipe is the use of skelp uniform in width and gauge, together with steel of proper analysis. On account of the larger production of our furnaces and the many different products made in our works, we have the opportunity to select the grade of steel essential for making the best quality of pipe, an advantage which is not enjoyed by all manufacturers of tubes in this country.

The Lap-Weld Process.

In making lap weld pipe the skelp is first rolled to the necessary length, width and gauge for the sizes to be made, and the subsequent process consists of two operations, bending or drawing, and welding. The skelp is first heated to a cherry red in the bending furnace and then put through a pair of scarfing rolls which bevel the edges so that when overlapped and welded the seam will be neat and smooth, with practically the same thickness as the remainder of the pipe wall. After this is done the skelp is drawn through a bending die where it is given roughly the cylindrical shape of a pipe with the edges overlapping, but not welded. This formed skelp is then rolled into a motor-driven buggy and hauled to another furnace, where it is recharged and heated evenly to a welding temperature of about 2,600 degrees F. Next it is pushed into rolls located at an opening in front of the furnace which draw it through and completes the welding operation. These rolls are two in number, and have semi-circular surfaces which together form a complete circle. Between these rolls a cast ball or mandrill of approximately the same diameter as the internal diameter of the pipe to be made and shaped somewhat like a projectile, is held by a strong bar while the pipe passes over it and between the rolls. This subjects the lapped edges to a pressure between the rolls and the mandrill and welds them firmly together, at the same time reducing the thickness of the lap to that of the remaining wall of the pipe. The welded tube is then carefully inspected for any flaw that may have occurred in the process.

If it passes inspection, the tube while still hot is then put through a similar set of rolls called "chilled rolls," and a mandrill held in the same position as in the welding rolls. This removes any inside irregularities and secures accuracy in the internal diameter. It is next put through another set of similar rolls called "size rolls" without the mandrill, and these give an equal pressure on the whole circumference, thereby securing accuracy in the outside diameter.

The pipe next enters a set of rolls called "cross rolls" which consists of two rolls set with their axes

Fig. 2—Skelp passing through die in process of forming and welding butt-welded pipe.

askew. The surface of these rolls is so curved that the pipe is in contact with each roll practically its full length, and this gives a clean surface and makes the pipe straight. The length of these cross rolls varies from four to sixteen feet, and after passing through them the pipe is approximately straight and uniform at all points.

After this process the lengths of pipe are then slowly rolled up an inclined cooling arch and allowed to cool off slowly and uniformly, the constant turning keeping it straight during this process. At the end of this rack the pipe is put through a cold straightening press, after which it is again inspected and then passed to the threading department.

The Butt-Weld Process.

Butt-weld pipe is made in sizes of one-eighth inch to three inches inclusive, the skelp ranging in width from 1-2/10 inches to 11¾ inches. It is essential that skelp for butt-weld pipe be rolled true to length, width and gauge for the size of pipe to be made. The edges are square, or, in some cases, slightly beveled so that the side of the skelp to form the interior wall of the pipe is not quite as wide as the side which is to form the exterior. The butt-end process is somewhat simpler than the lap-weld, since the latter has two operations, while the former has only one, both forming and welding of the skelp being done at the same time. Skelp for butt-weld pipe is not square at the end, but has the corners clipped off so that when it starts through the bell it will curve in the form of a cylinder. The skelp is charged into the furnaces by magnetic rolls, and after it is heated to a welding temperature the ends are seized by tongs in the hands of the welder, who then drops over the handles of these tongs a bell-shaped die. He then drops over the handles of the tongs on an endless chain which grasps them and pull tongs, skelp and bell out of the furnace together. The bell is caught and held just outside of the furnace and the skelp forced through, forming it into a pipe, and welding the edges firmly together.

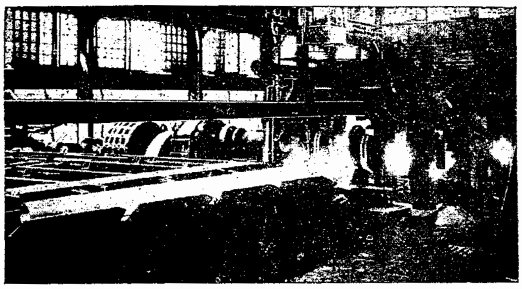

Fig. 3—Where couplings are made for "Youngstown" pipe.

The pipe is carried along the endless chain to a pair of rolls called "size rolls," the tongs being automatically released in the meantime. These size rolls give the pipe the external size desired. From these rolls the pipe passes to a cooling bed on which the pieces, about 20 feet in length, are slowly rolled until cool. After inspection the pipe is sent to the galvanizing or threading department for further finishing.

In making extra heavy butt-weld pipe, on account of the thickness of the skelp it is necessary to draw the pipe through several dies, each of which is silghtly smaller than the last, and this pipe must be reheated between each draw until the same is thoroughly welded.

The next process is inspection, and in this the pipe is inspected for any defects which may have occurred in the welding process. If any such defects are found it is rejected. Pipe that has passed inspection is then sent to the threading machines to be either cut with plain ends or fitted with "V" threads.

The term "plain end" may describe either pipe with ends cut square, which is used for patented sleeve joints, such as the "Dayton" or "Dresser" couplings, or pipe in which the end of the walls is beveled to various degrees for welding by the oxygen-acteylene or electric welding process for forming the joints. A more general definition would be pipe which has been finished but not threaded.

Threaded pipe is furnished with various threads distinguished from one another by the number of "V" threads per inch, the taper per inch and other differences, depending on the class of material and the purposes for which it is to be used.

For gas, steam and water pipe the standard for screw threads is the "Briggs" standard, adopted as the United States standard October 27, 1886. All such pipe has taper threads. The inclination of these, established by the Briggs standard, is 1 in 32 to the axis, or, as it is commonly stated, ¾ of an inch taper per foot on the diameter.

The total length of thread is made up of three parts. The first part consists of "perfect" threads, the second of "partially perfect" threads and the third of "imperfect" threads. The perfect threads are those that have perfect tops and bottoms and are tapered the entire length, in other words, threads of full size and shape. The partially perfect threads have perfect bottoms but are not perfect on their tops. The imperfect threads are not perfect either at top or bottom. The variation of these threads is, of course, due to the taper, those at the end of the pipe being of full depth and "perfect," while those farthest from the end are of partial depth, and, therefore, not complete at either top or bottom. The imperfect threads are not essential to the forming of a good joint, and are only incidental to the present method of cutting threads by means of a die. Ordinarily, there are three imperfect threads; in some cases four occur. The number of imperfect threads depends on the angle at which the "lead" of the die has been ground.

In addition to those above described, various other threads and tapers are employed in the manufacture of pipe, for which standards have not yet been adopted in the United States. All manufacturers, however, use the standards above described, so far as these types of threads and taper are concerned. The exterior surfaces of the threads have an angle of 60 degrees, but the threads are slightly rounded at both top and bottom, and it follows that the height or depth of the thread is not exactly equal to the pitch, but only four-fifths thereof.

Threading is one of the most important features in the manufacture of pipe, since upon it depends not only the strength and tightness of the joints, but also the ease and rapidity with which the pipe may be installed. To secure such a joint it is very essential that the pipe be made to the proper size and that the threads be clean and smoothly cut. For this work the selection of dies and their proper care is very important. Good threads can only be produced with good dies. The die consists of a frame or holder and a set of "chasers" that have the proper "lip," "chip space," "clearance" and "lead." The chasers are the cutting tools which actually form the thread.

"Lip" is the inclination of the cutting edge of the chaser to the surface of the pipe. The proper lip causes the chips to curl off clean and leave a smooth thread.

"Chip space" is the space required in the holder in front of the chaser to provide room for the accumulation of chips during the cutting of the thread.

"Clearance" is the room between the threads of the chasers and the threads of the pipe.

"Lead" is the angle which is machined or ground on the front of each chaser to enable the die to start on the pipe.

To produce the best results the die must have a suitable number of chasers. This number depends upon its size.

The dies are, of course, mounted in properly arranged machines driven by power.

In addition to the equipment described above it is necessary to use a good lubricating oil during the threading operation. This oil is kept flowing over the die and pipe. Without proper oil a good die will not cut a good thread.

After the pipe has been threaded it is again carefully inspected for the purpose of detecting any bad threads. If none of these are found, the couplings are next put on by hand, being turned on the proper distance in this way, and then screwed up to the allowance by machines called "socket screwing machines." Both pipe and couplings are then again inspected for any defects possibly overlooked in the previous inspections, and if they pass this final examination they are sent to the testing department. Here both are given the final test by being subjected for a short interval to an internal hydrostatic pressure. This pressure is secured by placing the pipe between two water tight heads, one of which is adjustable to suit the various lengths, and is connected with a hydraulic pipe line. The test pressures applied to each length vary from 400 to 2,500 pounds, according to the size and kind of pipe. Any bad welds or holes in the pipe will show up immediately under the pressure used.

If the pipe stands this hydrostatic test, it is next bundled and tagged, or, in the case of 2-inch and larger, is stenciled with marks showing the kind, length and weight. It is now ready for shipment as black pipe.

General Notes on Finished Pipe.

All weights are figured on the basis of each cubic inch of steel weighing .2833 pounds, and iron weighing 2 per cent less. All pipe, except that heavier than standard weight, is generally classified in regard to size by its normal inside diameter in all sizes from ⅛-inch to 12-inch inclusive. Sizes larger than these are generally classified by the outside diameter. From this fact come the symbols O.D. and I.D., meaning outside diameter, and inside diameter. In pipe, casing, tubing, etc., heavier than standard weight, the extra thickness of the walls reduces the inside diameter, which is relatively somewhat smaller in standard sizes of this pipe than it is in the same sizes of standard weight pipe.

All pipe is cut to random length except on special orders. On such orders the variations in length must not exceed one-eighth of an inch over or under, unless otherwise arranged. The permissible allowance in weight is 5 per cent above and 5 per cent below for standard weight pipe. For extra strong, or extra heavy pipe the allowance is greater.

The kinds and sizes of pipe at present regularly manufactured at Youngstown Sheet and Tube, are as follows:

Steam pipe ⅛" to 16" (O.D.)
Line pipe ½" to 20" (O.D.)
Drive pipe 2" to 20" (O.D.)
Tube 2" to 4".
Casing 2¾" to 15½".
California casing 4¾" to 15½".
Youngstown casing 2¾" to 15½"
Drill pipe 2½" to 6".
California tubing 2" to 3".
Extra strong pipe ⅛" to 15".
Double extra strong pipe ½" to 8".

In addition to these, however, they make a great many kinds of special pipe, such as signal pipe, dry kiln pipe, plugged and reamed pipe, and others. They also manufacture English tubes for steam, gas and water lines. The English tube is slightly different in the thickness of its walls, and therefore there is inside diameters of this pipe and those of the same sizes in American pipe.

There is also a difference in the shape of the "V" threads, and a different number of threads per inch are cut on the respective sizes. The English type of thread is known as the "Whitworth." The angle of this thread is 55 degrees and its depth is 64/100 of the pitch. Up to the present they have manufactured English steam, gas and water tubes in standard sizes from ⅛ inch to 6 inch inclusive. Tubes for Argentina and South America are furnished with English threads, but are somewhat lighter in weight than the standard English tubes.

Design of Ports for Open Hearth Furnaces

Two Types of Circular Water Cooled Ports of Simple Construction Having Many Advantages Over Old Designs Now Successfully Used by Lackawanna Steel Company for Over Two Years.

By HERBERT F. MILLER, JR.
Lackawanna Steel Company.

OPEN hearth furnace men have looked for the development of a port for open hearth furnaces that use producer gas for fuel which would surpass the older types of dry and water ports in ease of upkeep and in speed of production. They have wished for a port that would throw the flame so as to make it easy on the brickwork and at the same time would act constantly toward keeping a low bottom in the hearth. They wished for a furnace that would have a flame which worked on the charge from the time it entered the hearth until it went out as a waste gas, and to have a flame that would come into the hearth pot and go out relatively cool so that it is easy on the brickwork of the end-walls also.