July 6, 1965 L. KEHNE ETAL 3,192,754

APPARATUS FOR SPIRAL PIPE MANUFACTURING

Filed July 10, 1961 2 Sheets-Sheet 1

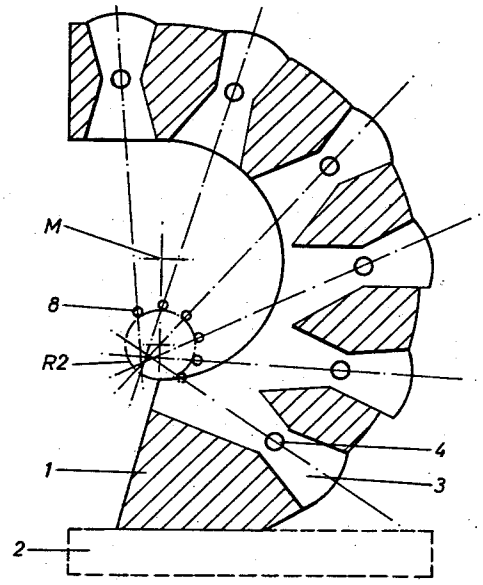


Fig.2

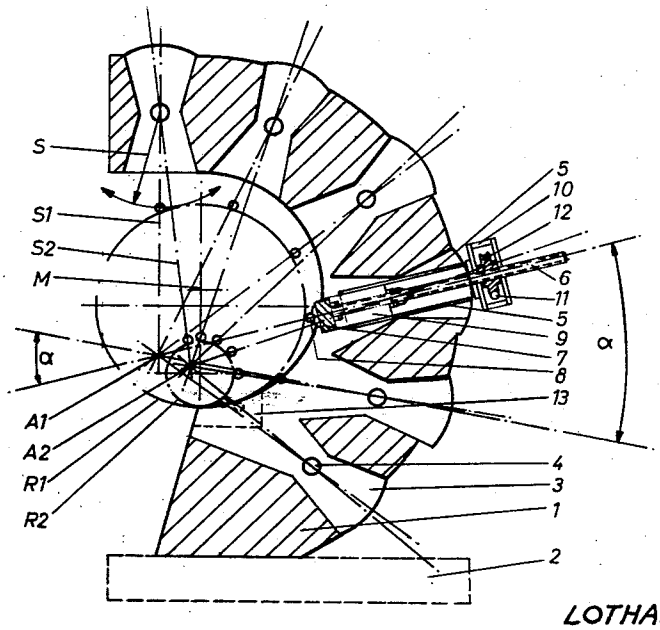


Fig.1

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Fig.3

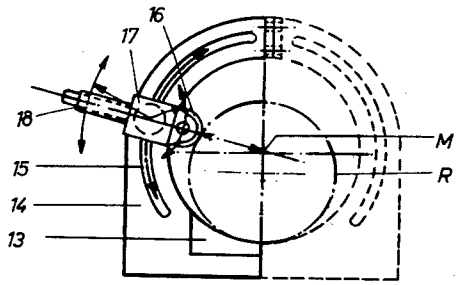



Fig.4

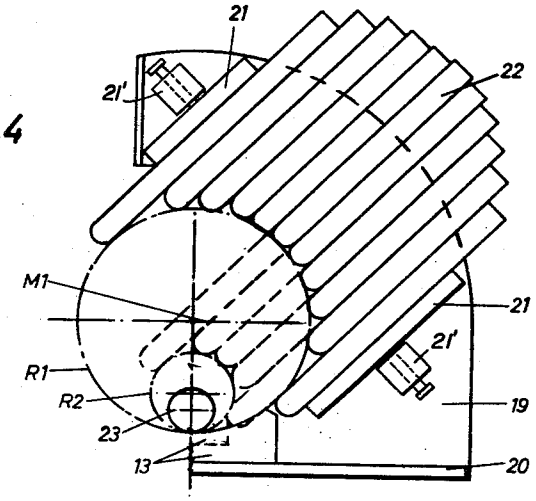
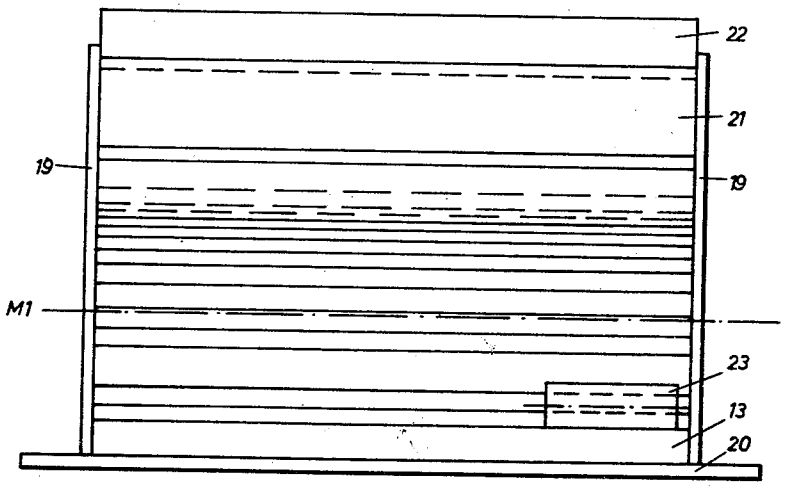



Fig.5

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# APPARATUS FOR SPIRAL PIPE MANUFACTURING

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The present invention relates to an apparatus for manufacturing spiral pipe or tubing, more particularly, to such an apparatus having a strip feeding device and a stand which are angularly adjustable with respect to each other with said stand having a plurality of pipe forming tools mounted thereon so that said tools can be asymmetrically adjusted with respect to the central axis of the pipe being formed.

Spiral pipe or tubing may be formed from hot or cold rolled steel strips so as to have a single continuous closed helical seam from end to end. This seam is usually closed by welding. These pipes are of relatively low weight but have large internal diameters ranging up to 42 inches or more and having lengths up to about 40 feet. Such spiral pipes are used in high and low pressure water lines, vacuum lines, exhaust steam lines, low pressure air lines, sand and gravel conveying and similar services. These pipes are also extensively used by the petroleum industry for conveying natural gas and crude oil.

Several forms of machines have been devised by which spiral pipes or tubes of various diameters can be manufactured. In general, the helical pitch and the thickness of the strips to be worked varies according to the diameter of the pipe. These machines generally comprise some form of a strip feeding device together with a stand upon which the various pipe forming tools are mounted. These pipe forming tools are radially adjustable with respect to the central axis of the pipe being formed. In order to adapt the machine to various conditions the strip feeding device and the table are mounted so as to be angularly adjustable with respect to each other.

Such machines form the strip into pipe in several different ways. In one form the strip is not only bent by pipe forming tools acting at the outside of the pipe but the strip is simultaneously wound onto a stationary or rotating mandrel. In some machines, the strip is worked by pipe forming tools which operate on the outside of the strip without using an interior mandrel.

In order to vary the diameter of the pipe which is to be formed not only must the pipe forming tools be radially adjustable but also either the strip feeding device or the table must also be adjusted.

In most of these machines the pipe forming tools are symmetrically adjusted with respect to the central axis of the pipe being formed. However, one form of machine has been constructed wherein the pipe forming tools are asymmetrically adjusted and the entrance for the strip into the pipe forming apparatus is not adjustable. This machine proceeds to bend the pipe according to the principle of the three roller plate bending machines but acts on less than 120 degrees of the circumference of the pipe. This type of machine comprises 2 interior and 2 exterior bending tools.

In order to adapt the pipe forming machine to various conditions the following components are constructed so as to be adjustable; the strip feeding device, the strip forming device, the series connected welding apparatus for the seams, and the pipe removal mechanism which removes the completed pipe from the machinery. The construction of the various components so as to be adjustable considerably increases the complexity of the construction and operation of the machines.



It is therefore the principal object of this invention to provide a novel and approved apparatus for manufacturing spirial pipe.

It is another object of this invention to provide a simplified apparatus for manufacturing spiral pipe and having a stand and a strip feeding device which are angularly adjustable with respect to each other and having a minimum number of elements for forming spiral pipes of various diameters.

The objects of the present invention are achieved and the disadvantages of known machines are eliminated by the apparatus disclosed herein which is of a pipe forming machine wherein the strip feeding and pipe forming devices are angularly adjustable with respect to each other.

The pipe forming tools are mounted so as to work on the exterior surface of the pipe over an angle of at least 120 degrees. No interior mandrel or internal forming tools are employed. The pipe forming tools in the present invention are so mounted that they are asymmetrically adjustable with respect to the central axis of the pipe being formed. This adjustment is made as a function of the diameter of the pipe.

The stand of the pipe forming device comprises a table upon which a jaw is mounted having width which is approximately equal to the maximum helical pitch of a pipe that can be formed by the present machine. The jaw is semi-circular in shape and has an opening so as to accommodate the largest diameter pipe. The strip to be formed is fed into the jaw upon a feeding means which can be fixed. It is also possible to feed the strip into the upper part of the jaw and to bend it into a reverse order of the described arrangement.

The smaller the diameter of a pipe which is to be formed, the greater the asymmetrical arrangement of the pipe formig tools. This asymmetry increases with the distance of the tools from the point in the jaw through which the strip enters. As result the greatest asymmetrical arrangement of the tools and accordingly, the smallest possible diameter of the pipe to be formed is determined only by the distance by which the last forming tool can be moved in the jaw towards the center thereof.

The pipe forming tools can be mounted on guide members which are sufficiently long and strong so that the pressure heads of the tools can be adjusted to reach the central axis of the jaw or to extend even further into the interior of the jaw. As a result, with this machine one can vary the diameter of the pipes which can be formed solely by changing the asymmetrical arrangement of the pipe forming tools.

In one modification of this invention the pipe forming tool comprises a plurality of pairs of guide rods which are mounted in radially extending passages in a jaw forming the stand for shaping the pipe. A pressure tool is mounted on each pair of guide rods. The guide rods may also be mounted so as to be pivoted through a determined angle.

In another modification the pipe forming tools are in the form of a plurality of stacked plates which are piled upon each other. These plates are positioned at an angle with respect to the table. Suitable clamping means are provided for wedging the stacked pipe forming tools in position once the tools have been radially adjusted. This angle may range from 0 to 90 degrees but is preferably about 45 degrees.

In a further modification pipe forming tools are used wherein the pressure head is narrow and has a length less than the width of the jaw of the stand. A plurality of these pipe forming tools are arranged in a stand so as to be staggered in the direction of rotation of the strip and are in side-by-side relationship over the width of the stand of the jaw.

The pressure heads of the pipe forming tools may com-

prise either fixed or rotatable wear resistant bodies such as balls or cylinders. The pressure heads may be so mounted that they may be readily interchanged depending on the diameter of the pipe to be formed.

Other objects and advantages of this invention will be apparent upon reference to the accompanying specification when taken in conjunction with the following drawings wherein:

FIGURE 1 shows a vertical sectional view of a stand of the machine embodying this invention wherein the pipe forming members are mounted in guides pivotally mounted on the jaw;

FIGURE 2 is a view similar to that of FIGURE 1 but discloses a somewhat different arrangement of the pipe forming tools;

FIGURE 3 is an end elevational view of a modification of a stand of this invention wherein the pipe forming tool is adjustable along a groove which is concentric to the center of the jaw;

FIGURE 4 is a front elevational view of a further embodiment of this invention wherein the pipe forming tools are in the shape of plates which are stacked upon each other; and

FIGURE 5 is a side elevational view of the modification illustrated in FIGURE 4.

Returning now to the drawings wherein like reference symbols indicate the same parts throughout the various views, there is illustrated in FIGURE 1 a pipe forming stand comprising a jaw 1 mounted upon a substantially horizontal table 2. While not shown in FIGURE 1 there is a second similar jaw positioned behind the illustrated jaw 1. This similar jaw is spaced from the jaw 1 a distance corresponding to the width of the jaw of the entire stand.

The jaw comprises two halves, each half jaw having complementary radially extending grooves therein. The walls of said grooves flare outwardly in opposite directions from a constricted mid-portion and cooperate with the walls of the adjacent groove to form radially extending passages 3. Said passages flare outwardly in opposite directions from said constricted mid-portion. Each of said passages is square in transverse cross-section. Bores 4 are positioned in each of the passages at said constricted mid-portion. Exterior guide members 5 are pivotally mounted in the passages 3 by means of pins extending through the bores 4.

A shaft 6 is positioned in each of the guide members 5 and is provided with an external thread which may be either a helical thread or a rack gear.

A similar construction as described above is also found in the second half of the jaws 1 which is not illustrated in the drawings. A bridge member 7 which is shown in section, FIGURE 1, interconnects the two shanks 6. A plurality of spiral pipe forming pressure members 8 are rotatably mounted in bearings positioned on the bridge 7. The length of the bridge 7 is approximately equal to the width of the jaw of stand.

The bridge 7 is mounted on a sleeve-shaped sliding member 9 which is positioned in each of the exterior guide members 5 and is also fixed to the inner end of the shaft 6.

A structure 10 is mounted on the end of each of the shanks 6 for radially adjusting the pipe forming tool. This adjustment structure may comprise a worm 11 which engages a worm gear 12 mounted on the shank 6. A crank handle may be mounted on the worm 11 so as to simultaneously adjust a pair of shanks.

With this adjustment means, the pipe forming members 7 can be radially moved within the stand. In addition, these pipe forming members 7 can be pivoted within an angle as defined by the double cone-shaped passages 3. After the outer guide members 5 have been pivoted into the desired position wedge clamps may be used to secure the positions of the members. Other suitable clamping structure may also be used.

The pivoting range of the pipe forming tools is illustrated in FIGURE 1 by line S which extends from the pivot point of the pipe forming tool. When forming two different sizes of pipes as indicated by the circles R1 and R2 the axes of the guide forming members would be in corresponding positions S1 and S2. The axes of the shanks 6 would intersect at the points A1 and A2 respectively. The angles between the pipe forming tools is about 25°. It is noted that the intersections of the axes of the pipe forming tools as indicated as A1 and A2 do not necessarily coincide with the centers of the pipe circles R1 and R2. In addition, because of the asymmetrical arrangement of the pipe forming tools these tools do not coincide with the central axis M of the jaw.

FIGURE 2 is similar to FIGURE 1 except that the angles between the axes of the tool forming members are unequal and vary from about 22 to 30 degrees. Accordingly, the axes of the tool forming members do not intersect at a single point. With this arrangement it is possible to have the pipe forming tools engage the outer surface of the pipe at approximately equal arcuate distances when forming a pipe having a diameter indicated as R2.

The asymmetrical arrangement of the passages 3 in the stands illustrated both in FIGURES 1 and 2 can be determined both empirically and mathematically for the desired range of diameters of the pipes which are to be manufactured.

In FIGURE 1 it can be seen that the angular positions of the lowest two tool forming members are substantially the same in spite of the considerable differences in the diameters of the pipes R1 and R2. Accordingly, it would be possible to modify this construction by providing that the two lowest radial passages 3 be cylindrical and that the two forming members mounted therein be only radially adjustable. The remaining tool forming members which are in greater distance from the strip entrance would be pivotally mounted.

The construction of the adjustably mounted strip feeding mechansim is not illustrated since it is conventional. Further, the strip which is to be formed into the pipe is not shown in the drawings because in all of the disclosed modifications the strip is fed into the lower end of the jaw without any modification in the height of the strip entering point.

As an alternative, the lower most radial passage 3 may be replaced by a wear-resistant strip entrance member 13. This member would be readily removable so as to be easily replaced when excessively worn.

With this invention, the pipe forming tools may be so positioned that the outer surface of the pipe may be contacted in the most effective manner. The portion of the periphery of the pipe which is contacted is greater than 120 degrees and in some cases even greater than 180 degrees. In order to determine the proper adjustment of the tool forming member it is preferable to insert a model of the pipe which is to be formed in the jaw of the stand of the machine.

Proceeding next to FIGURE 3 there is illustrated a modification of this invention wherein the tool forming member is mounted on a frame which is positioned in a groove concentric to the central axis of the jaw. The stand comprises a semi-circular jaw 14 which has a substantially sem-circular groove 15 therein. The groove 15 is concentric to the center of the jaw 14. For purposes of simplification, FIGURE 3 shows only one of the plurality of pipe forming tools which would be mounted on the jaw 14.

The pipe forming tool in FIGURE 3 comprises a pressure roller 16 which is rotatably mounted in bearings by means of pinions. These bearings can be moved radially with respect to the central axis M of the jaw in a frame 17. The bearings are mounted on the end of a spindle 18 which is supported in the frame 17. The frame 17 is mounted in the groove 15 by means of a bolt which extends the length of the stand.

In addition, the bearing plates can be pivotally mounted by said supporting bolt. The arrows in FIGURE 3 indicate the various adjustments which are possible with the pipe forming tool of this modification.

In FIGURE 3 the pipe forming tool is shown in a position wherein the central axis of a spindle **18** intersects the longitudinal central axis M of the jaw. By manipulating the pipe forming member as described previously, the axis of the spindle **18** can be pivoted downwardly so as to be directed to the axis of the pipe which is to be manufactured. This pipe is indicated by dashed circle R. The circumference of the pipe R as compared with the opening of the jaw also demonstrates that the pipe forming tools can be asymmetrically adjusted in a manner similar to that described in the modification of FIGURES 1 and 2.

The strip again enters the jaw at the lower portion thereof on a wear-resistant exchangeable feeding member **13** which is mounted on the lower portion of the jaw **14**.

The groove **15** can be replaced by a groove having a cruciform cross-section. Accordingly, a cross head can be used which is mounted within the groove instead of the exterior frame **17**. In this modification the spindle is moved in the cross head until it contacts a yoke-shaped supporting member in which the pressure roller **16** is mounted.

As illustrated in the dashed lines, a plurality of counter jaws can also be employed. These counter jaws can be so constructed that the strip which is to enter the jaw passes through a slot arranged in the stand at the feeding height. As an alternative, one of the counter jaws may be omitted and the strip can enter the jaws through this space. This arrangement can also be used for adjusting the distances of the edges of the strip which is to be formed into the pipe.

This arrangement considerably facilitates the welding of the seam of the finished pipe since rollers positioned in the counter jaws can act upon the strip in such a manner so as to regulate the space between the edges of the strip when a strip has been shaped by the pipe forming tools. In addition, the pipe forming tools can be automatically adjusted to said desired position. For this purpose hydraulic mechanism can be employed and, accordingly, a pipe manufacturing machine can be provided which acts automatically.

Proceeding next to FIGURES 4 and 5 there is illustrated a still further modification of this invention which comprises a pair of spaced similar semi-circular shaped jaws **19** which are mounted upon a substantially horizontal base plate **20**. A pair of clamp plates **21** are welded in the internal walls of the plates. These plates are fixed at an angle of about 45° such as illustrated in FIGURE 4. The clamp plate **21** can also be adjustably mounted on the jaws **19** such as by the mounting of a crosshead in the slot **15** of FIGURE 3 or the frame **17** in the same slot **15**.

A pile of eleven plate-shaped forming tools **22** are positioned between the clamp plates **21** which are at an angle between 0 and 90 degrees.

The interior ends of the pipe forming members which extend into the central portion of the jaw may either have fixed pressure heads such as illustrated, rotatably mounted rollers or spherical pressure members.

When adjusting the plates **22**, a model of the pipe to be formed is inserted into the jaw. The plates **22** are then pushed into the jaw until they engage the outer surface of the pipe indicated at **R1**. The pipe **R1** has its longitudinal central axis indicated as **M1**.

In the event a smaller pipe is to be formed having a diameter, for example, as shown as **R2** then it is only necessary to utilize five of the plate-shaped pipe forming members.

The plates **22** are retained in their adjusting position by pressure means **21** which clamp them against the plates **21**.



Instead of the strip feeding device an interchangeable entrance member **13** can be positioned in the lower portion of the jaw as illustrated in FIGURE 3.

A rotary roller **23** is positioned above the strip feeding device and is supported upon a shaft (not shown) fixed to the right hand half of the stand **19** as shown in FIGURE 4.

The roller **23** may have the same width as the strip. With this roller the strip can be pre-bent before entering the jaw to be worked upon by the pipe forming members.

The machine of this invention can not only be used for working hot and cool-rolled steel strips but also for bending strips of other materials such as non-ferrous metals or plastics, such as polyamides, polyvinylchlorides, polystyrenes, polyethylenes, etc.

Instead of forming the seams of the completed pipe by welding, the edges of the formed strips may be attached by the use of suitable adhesives. This is preferably accomplished when the edges of the strips are overlapped.

It is also possible that the asymmetrical adjustment of the pipe forming tools as disclosed in this invention can be used to manufacture conical pipes. For this purpose the special arrangements mentioned with respect to the modification of FIGURE 1, wherein the bridges of the pipe forming tools are attached to their guide shafts, can be employed and other smaller constructions of the pipe forming tools.

Thus can be seen that the present invention provides a simplified arrangement for forming spiral pipes by helically bending a strip into position. Further, the asymmetric adjustments possible with the pipe forming tools enables a wide range of diameters of pipe to be readily formed.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

What is claimed as this invention is:

**1.** In an apparatus for manufacturing spiral pipe of varying diameters from a spirally wound strip without the use of a mandrel, a pipe shaping arrangement comprising two semi-circular jaws, each having a plurality of radially extending flaring passages therethrough, a plurality of pipe forming tools arranged over an arc of about 120° and pivotally and adjustably mounted in said flaring passages of said jaws with each tool being individually pivotable about a transverse axis thereof, said pipe forming tools having pressure heads on the inner ends thereof to engage the outer surface of a pipe being formed and being also slidable substantially radially with respect to the central longitudinal axis of the pipe being formed, the central longitudinal axis of the pipe being formed being asymmetrically positioned with respect to the central longitudinal axis of said semi-circular jaws.

**2.** In an apparatus for manufacturing spiral pipe of varying diameters from a spirally wound strip without the use of a mandrel, a pipe shaping arrangement comprising two semi-circular jaws each having a plurality of double flared radially extending passages therein, a plurality of pipe forming tools arranged over an arc of about 120° and each mounted for individual pivotable movement about a transverse axis in said radially extended passages, said pipe forming tools comprising tubular members having guide rods slidably mounted therein and means for adjusting said guide rods in said tubular members, there being pipe forming tools on the inner ends of said guide rods to engage the outer surface of a pipe being formed with said guide rods being slidably mounted within said tubular members, the slidable movement of said guide rods being substantially radially with respect to the central longitudinal axis of a pipe being formed, the central longitudinal axis of the pipe being formed being asymmetrically positioned with respect to the central longitudinal axis of said semi-circular jaw.

3. In an apparatus for manufacturing spiral pipe of varying diameters from a spirally wound strip without the use of a mandrel, a pipe shaping arrangement comprising a plurality of semi-circular jaws, there being a plurality of double flared radially extending passages in said jaws concentric with respect to the center of said jaws, said passages flaring outwardly in opposite directions from the central mid-portion, a plurality of frames movably and pivotally mounted in said passages at said central mid-portion, a spindle adjustably mounted in each of said frames for radial movement thereon, and a pressure roller mounted on the inner end of each of said spindles to define a pipe forming tool.

4. In an apparatus for manufacturing spiral pipe of varying diameters from a spirally wound strip, a pipe shaping arrangement comprising a pair of spaced similarly shaped semi-circular jaws, a plurality of parallel plate-like pipe forming tools stacked upon each other and mounted on said jaws so that individual pipe forming tools are slidable with respect to each other and are thus movable radially with respect to the longitudinal central axis of the pipe being formed, the inner ends of said plate-like pipe forming tools engaging the outer surface of a pipe being formed and being positioned over an angle of about 120°, and clamping plates positioned on both ends of the stack of plate-like pipe forming tools



for securely clamping said pipe forming tools into selected positions at a predetermined angle of incidence with respect to the central longitudinal axis of the pipe being formed.

5. In an apparatus as claimed in claim 4, and further comprising spacing means between said semi-circular jaws, said plate-like pipe forming tools having widths substantially equal to the distance between said jaws.

6. In an apparatus as claimed in claim 5, and further comprising counter jaws similarly shaped to said jaws and being positioned with the open portions of the jaws and counter jaws cooperating so as to form a closed structure, and means on said counter jaws for adjusting the distances between the edges of the strip to be formed into a pipe.


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