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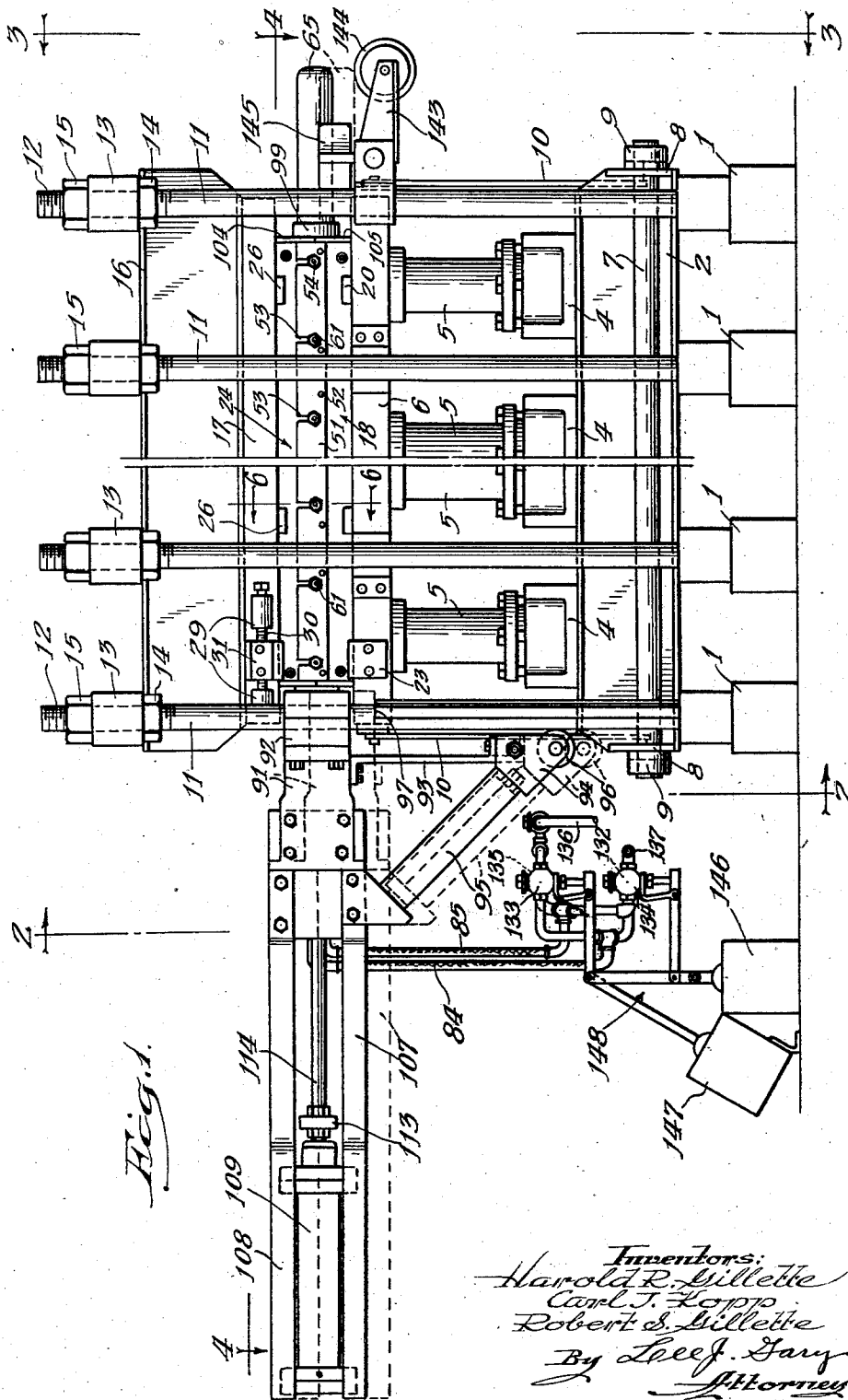
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2,401,728

TUBE FORMING MACHINE

Filed July 2, 1942

7 Sheets-Sheet 1



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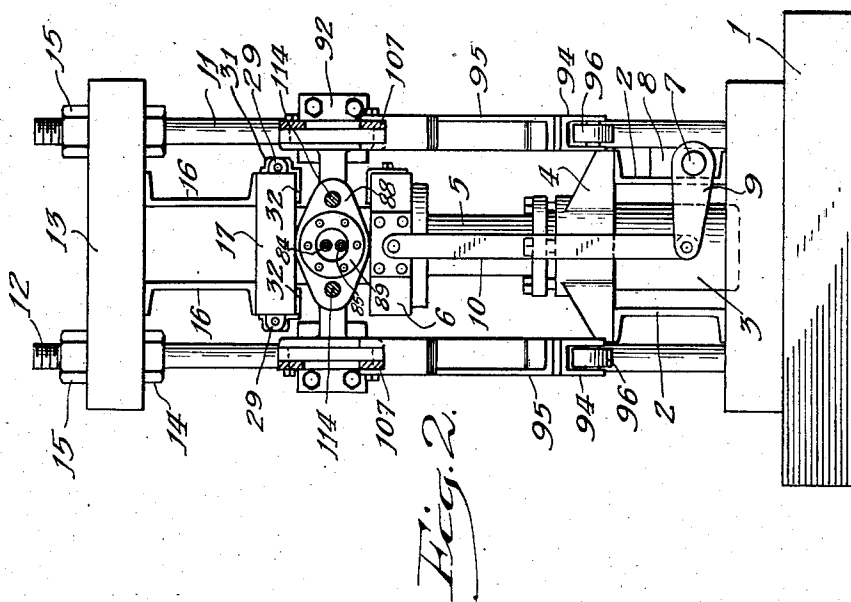
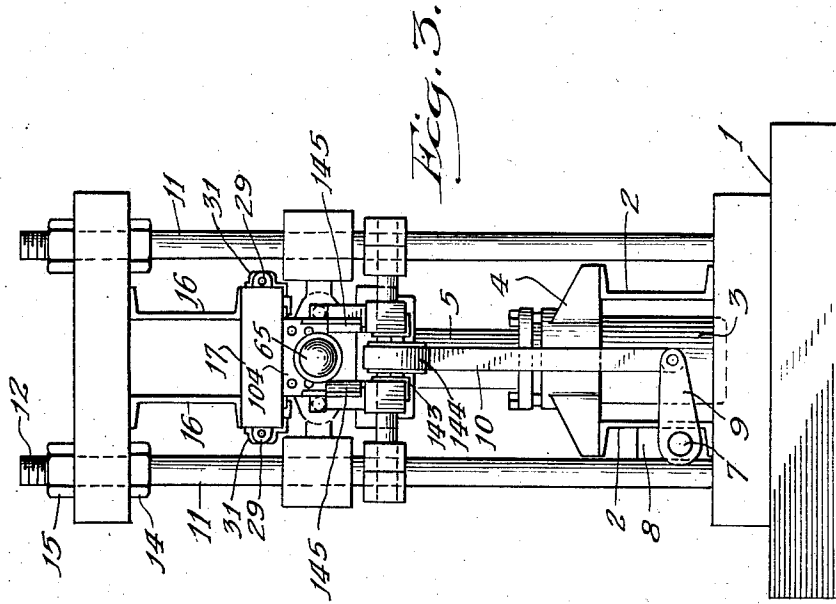
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7 Sheets-Sheet 3

Fig. 4.

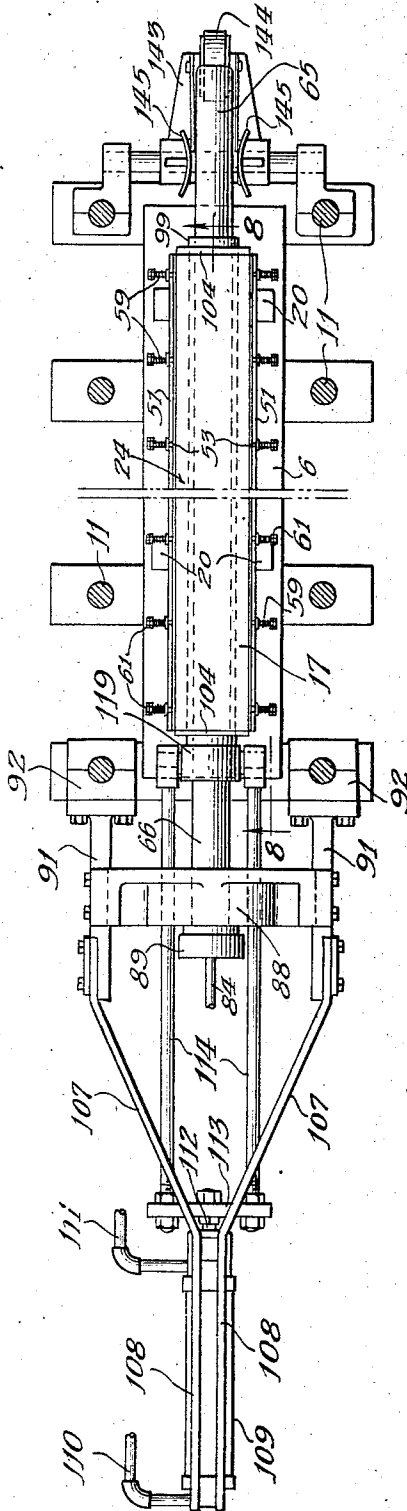
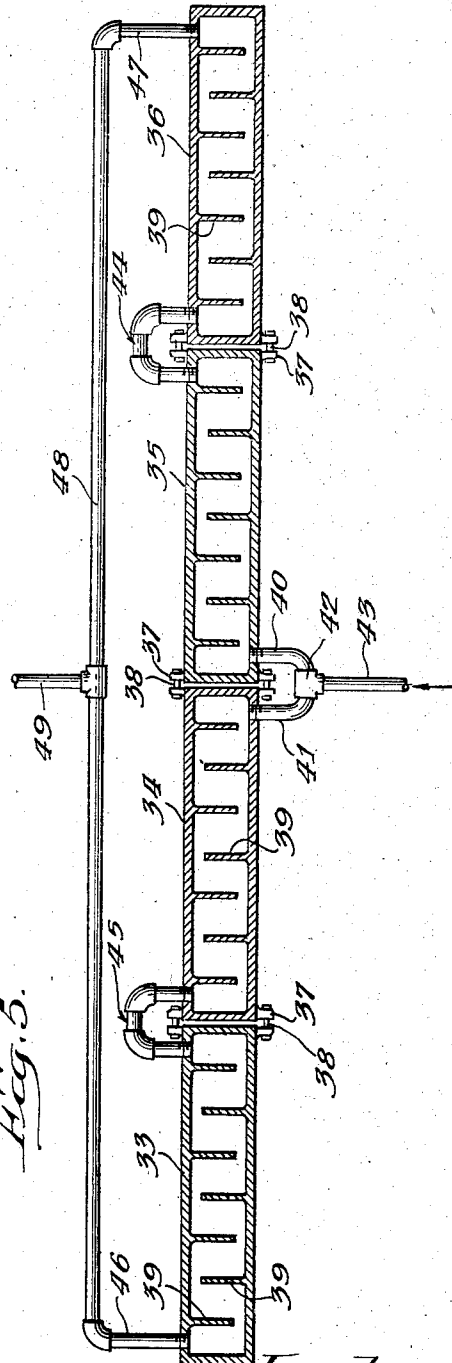


Fig. 5.



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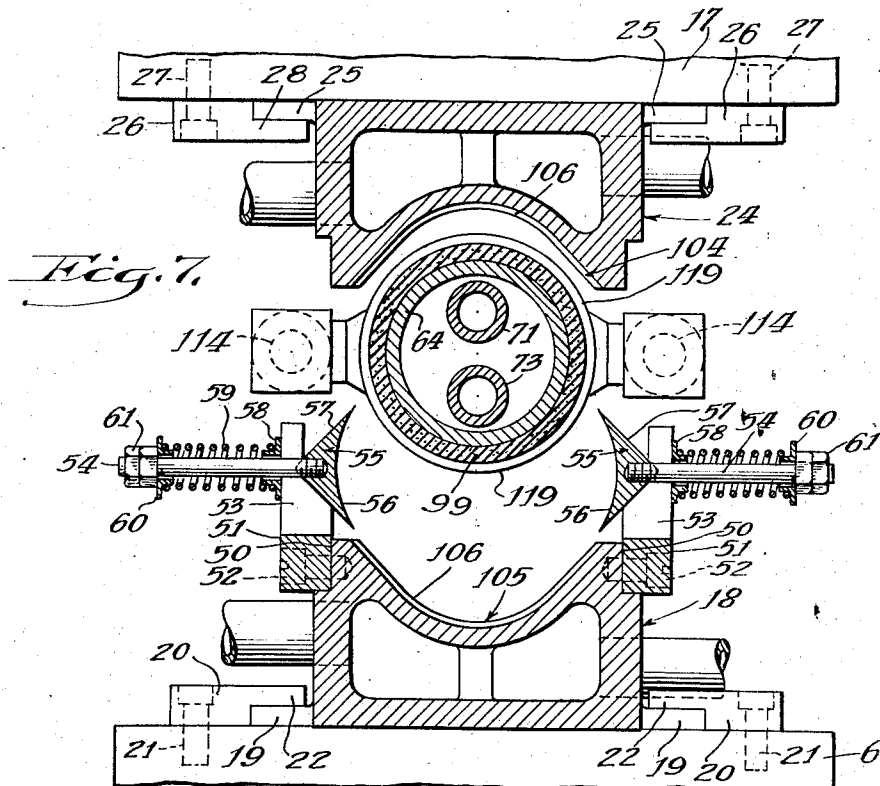
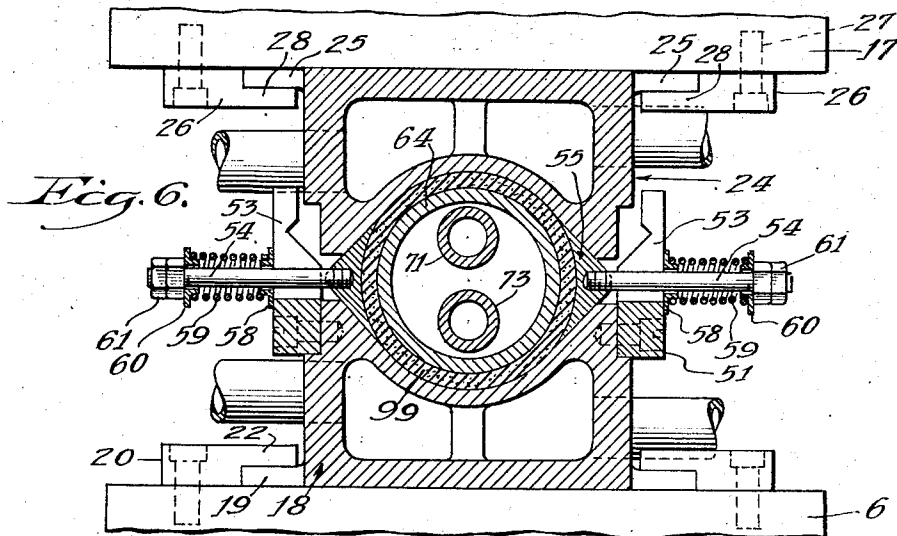
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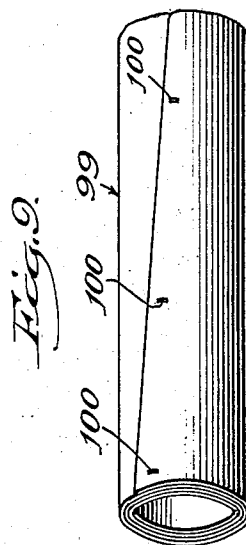
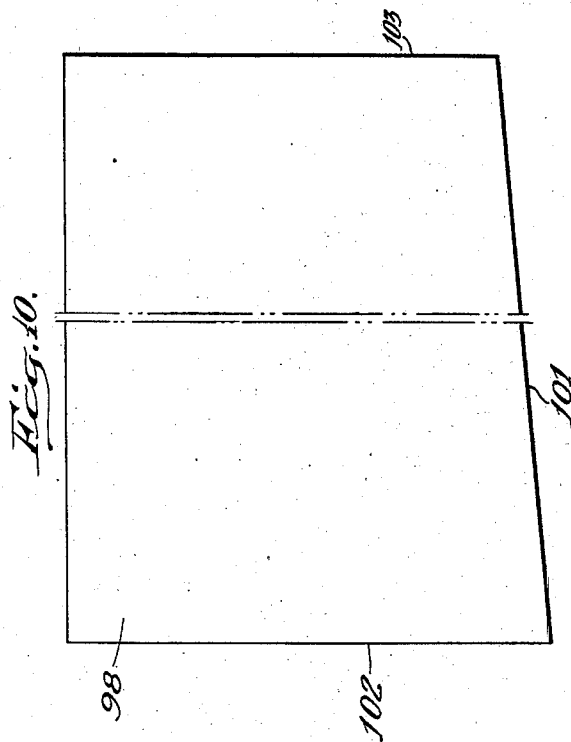
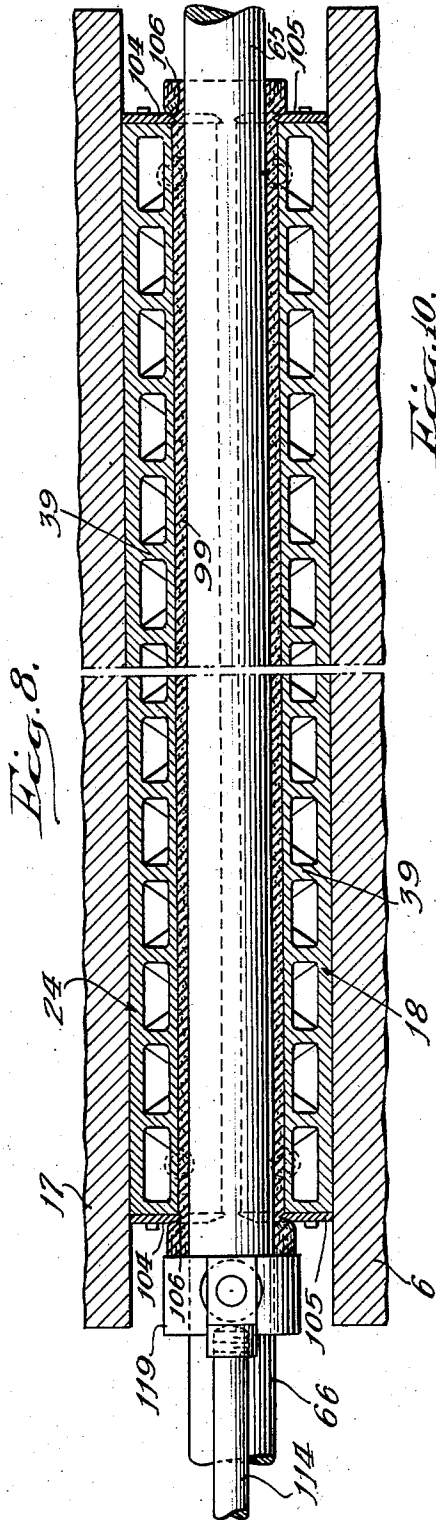
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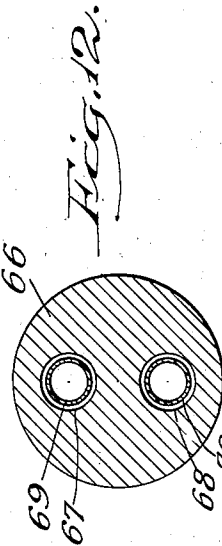
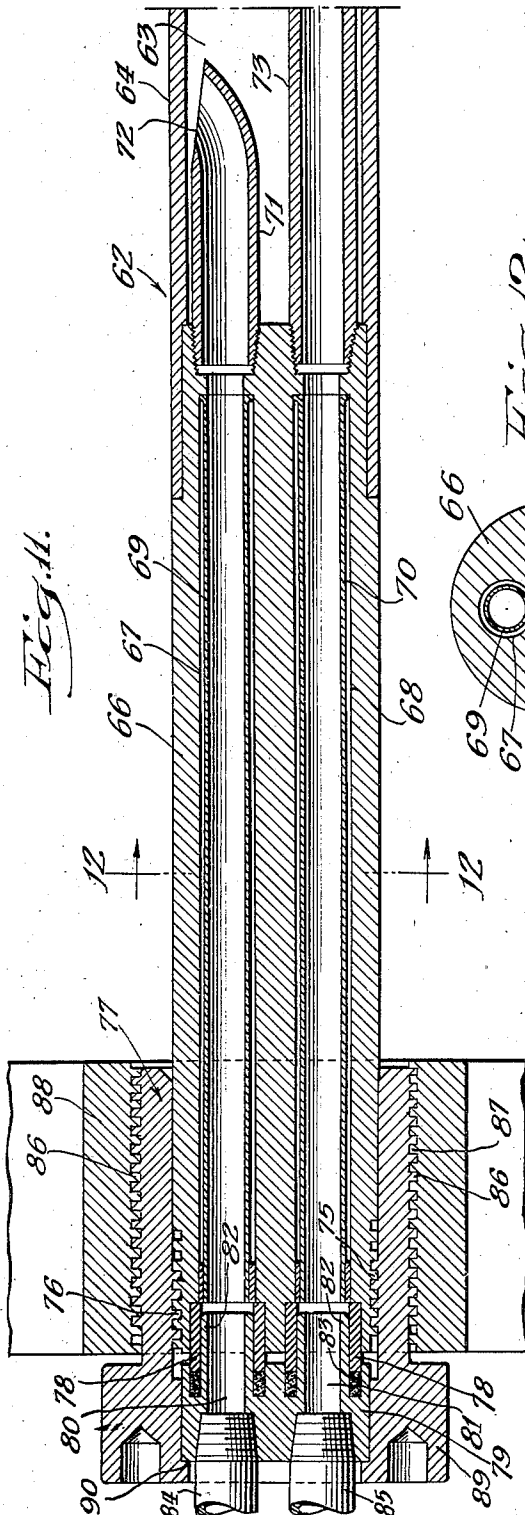
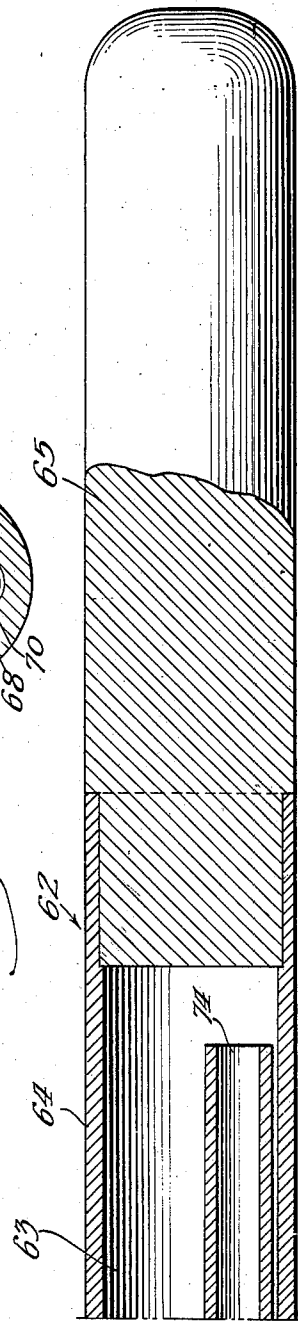


Fig. 11A.



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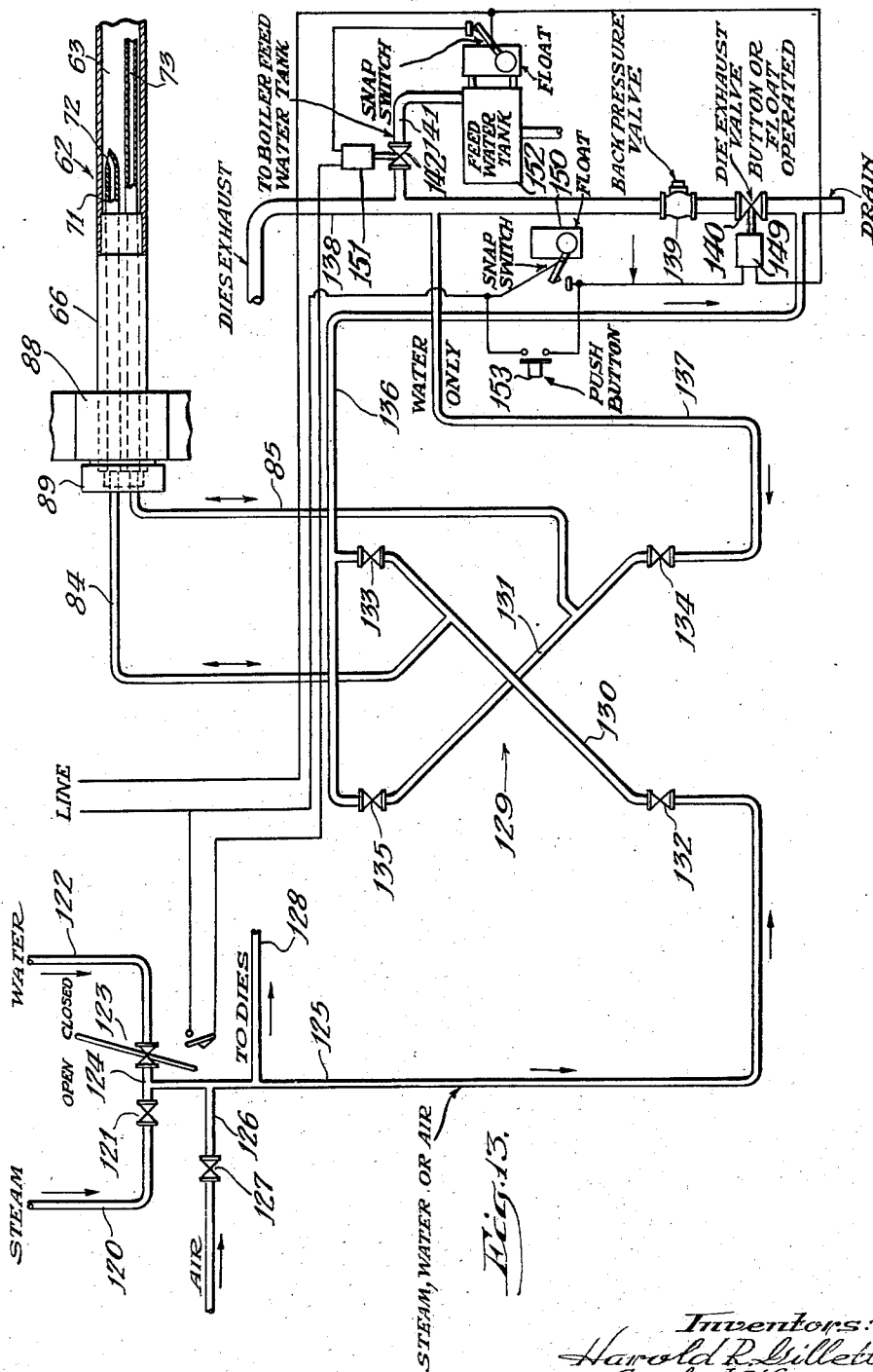


Fig. 13.

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UNITED STATES PATENT OFFICE

2,401,728

TUBE FORMING MACHINE

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Application July 2, 1942, Serial No. 449,466

9 Claims. (Cl. 18—19)

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This invention relates to improvements in a machine for pressing plastic articles, and relates specifically to a means for pressing and forming fibrous tubes or pipes the walls of which carry a plastic binder which is caused to flow and set during the pressing operation.

An important feature of the invention resides in an apparatus which is of comparatively simple construction and can be quickly and conveniently operated to press and compact the walls of fibrous tubes.

A further important feature of the invention resides in the unique four-piece outer dies embodied in the apparatus, so arranged and constructed as to function simultaneously and impart a uniform pressure to the outer cylindrical walls of the tube being pressed and compacted.

Another important feature of the invention resides in the construction of the mandrel upon which the tube or pipe is formed, and specifically the means for uniformly heating and chilling the mandrel throughout its entire length.

Other objects, advantages and important aspects of the invention will be apparent from the accompanying drawings and following detailed description.

In the drawings,

Fig. 1 is a side elevational view of the pressing machine comprising the present invention.

Fig. 2 is a transverse sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is an end elevational view looking in the direction of the arrows 3—3 of Fig. 1.

Fig. 4 is a plan sectional view of the machine taken on the line 4—4 of Fig. 1.

Fig. 5 is a plan sectional view taken through one of the dies.

Fig. 6 is a detailed transverse sectional view taken on line 6—6 of Fig. 1, showing the dies in closed or pressing position.

Fig. 7 is a similar view showing the dies in open position and further illustrating the stripping mechanism in operative position.

Fig. 8 is a detailed longitudinal sectional view taken through both the upper and lower dies, showing a pipe being pressed.

Fig. 9 is a fragmentary perspective view of a rolled fibrous pipe preliminary to pressing.

Fig. 10 is a development view of a fibrous sheet from which the pipe shown in Fig. 9 is formed.

Fig. 11 is a fragmentary sectional view taken through a portion of the mandrel.

Fig. 11a is a continuation of the view shown in Fig. 11.

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Fig. 12 is a transverse sectional view taken on line 12—12 of Fig. 11.

Fig. 13 is a diagrammatic view of a portion of the piping system for the machine.

Referring in detail to the drawings, and particularly Figs. 1, 2 and 3 thereof, 1 indicates a transverse supporting member, a plurality of which are employed constituting the foundation of the press. Two channel irons 2, each mounted on edge, are positioned in spaced parallel relationship upon the supporting members 1, the channel irons traversing substantially the length of the press.

A plurality of hydraulic cylinders 3 are mounted upon the channels 2, one cylinder being positioned between each two adjacent supporting members 1. The cylinders 3 carry transverse extensions 4 which rest upon the channels and may be secured to said channels by welding or other suitable means of attachment. A piston rod or ram 5 is slidably positioned in each cylinder, being carried by a piston (not shown) in each cylinder, whereby said rams may be raised or lowered hydraulically, as desired. The hydraulic connections to the cylinders 3 are not shown, but are of conventional construction and, in themselves, constitute no part of the present invention.

A platen 6 is carried upon the feet of the rams 5 and extends longitudinally of the machine whereby simultaneous movement of the rams functions to uniformly raise or lower the platen. A rotatable shaft 7 journaled in bearing blocks 8 extends throughout the length of the machine and at each end carries an arm 9. Each arm 9 is pivotally connected to a connecting rod 10 and each of the latter is, in turn, pivotally connected to an end of the platen 6. By the provision of shaft 7, arms 9 and connecting rods 10 uniform vertical movement of the platen is assured.

A pair of spaced tie rods 11 extend upwardly from each supporting member 1, said rods carrying threads 12 adjacent their upper ends. A cross support 13 is carried by each pair of tie rods, each of said supports being confined between nuts 14 and 15 threaded upon the rods 11, the arrangement being such as to permit a limited vertical adjustment of the cross-supports upon the tie rods. A pair of channel irons 16 depend from the cross-supports, said channels being spaced from each other and disposed longitudinally of the machine, the flanges of the channels being welded or otherwise suitably secured to the cross-supports. The opposite flanges of the channels 16 are suitably secured

to an upper platen 17 which extends longitudinally of the machine immediately above the lower platen 6.

The lower platen 6 carries a lower die 18 which has projecting from the lateral sides thereof lugs 19 which are spaced from each other along the length of the die. A plurality of clamps 20 are secured to the platen 6 by means of screws 21, said clamps having overhanging portions 22 which embrace the spaced lugs 19, the arrangement being such that longitudinal movement of the die 18 with respect to the platen 6 is permitted whereas lateral and vertical relative movement is prevented. At one end of the die 6 a pair of anchor plates 23, one on each side of the die, rigidly anchors the die to the platen. Throughout the length of the die, however, and at the opposite end of the die relative longitudinal movement of the die and platen is permitted, due, as will be hereinafter more fully described, to heating and cooling of the die.

An upper die 24 is carried upon the lower surface of the upper platen 17, said die being provided with a plurality of laterally projecting lugs 25 which are spaced from each other along each side of the length of the die. Clamps 26, secured to the platen 17 by means of screws 27, function to confine the lugs 25, said clamps being provided with overhanging portions 28, the arrangement being such that the die 24 is held immovable laterally and vertically with respect to the platen 17, but is permitted to move longitudinally. A pair of spaced sleeves 29 are secured to a lateral wall of the platen 17 adjacent one end thereof, said sleeves being internally threaded to receive adjusting screw 30. A sleeve 31 is adapted to threadedly engage an intermediate portion of screw 30, said sleeve having an inwardly projecting lug portion 32 which is secured to the opposite lateral walls of the die 24. The arrangement is such that by manipulation of the screws 30 on each side of the platen, the die 24 may be adjusted longitudinally with respect to the platen and also with respect to the lower die 18.

It can readily be seen that the upper die 24 is anchored at one end only and the intermediate portion of said die and the opposite end thereof is free to move longitudinally when subjected to variations in temperature.

The dies 18 and 24 are of hollow construction as shown best in Figs. 5, 6, 7 and 8 whereby a heating or cooling fluid may be introduced into the interior of said dies. Each of the dies is preferably constructed in a plurality of sections as indicated at 33, 34, 35 and 36 in Fig. 5. It is to be understood, of course, that the upper and lower dies 18 and 24, if desired, may be constructed as one section each or each of said dies may comprise any desired number of sections.

It has been found, however, that in the pressing of a pipe of a length of about 10 feet, upper and lower dies having four sections constitute an economical and efficient arrangement. If each of the upper and lower dies is to be constructed of a plurality of sections, the sections are preferably joined in abutting relationship as illustrated in Fig. 5, each of the sections being provided with projecting lugs 37 which may be secured together by suitable fastening means 38. Preferably an anchoring device, not shown, is interpositioned between the ends of the abutting sections whereby said sections may be conveniently aligned.

The hollow interior of the dies 18 and 24 is provided with a plurality of baffles 39 which cause

fluid introduced into the interior of the dies to circulate uniformly throughout the entire interior of the dies. As illustrated in Fig. 5 a pipe 40 connects into die 35 adjacent one end thereof and another pipe 41 connects into the section 34 adjacent its end which abuts the section 35. Fittings 42 connect both pipes 40 and 41 to a common inlet pipe 43 whereby fluid may be introduced into the sections 34 and 35. Fittings 44 and 45 connect the opposite ends of the sections 35 and 34 to the ends of sections 36 and 33 respectively whereby fluid introduced into the sections 34 and 35 is passed into the sections 33 and 36 respectively. A pipe 46 connects into the opposite end of the section 33 and a pipe 47 connects into the opposite end of the section 36, both of said pipes connecting into a header 48 which in turn connects with a drain 49 whereby the liquid introduced through the inlet pipe 43 passes through the various sections of the die and is discharged through the drain 49.

It is to be understood, of course, that the fluid connections to each of the dies 18 and 24 are the same. Of course, if the dies are made in a greater or lesser number of sections, a greater or lesser number of fittings similar to fittings 44 and 45 will be employed. If the total die length is comparatively short, the fluid may be introduced at one end of the die and discharged at the opposite end thereof without materially causing a wide degree of temperature differential between the opposite ends of the die. As will be hereinafter more fully appreciated, it is desirable that the dies be maintained uniform in temperature throughout their entire length and throughout their entire pressing surface.

The juxtaposed faces of the dies 18 and 24 are concave, as shown best in Figs. 6 and 7. The longitudinal central portion of each of the concave surfaces of the dies is constructed along the arc of a circle, the transverse section of said dies being substantially circular throughout an arc of about 45° on each side of the longitudinal center line of the dies. The cylindrical arced surface of the dies is then carried along a substantially tangential line at an angle of about 45°.

Thus, it can be seen that the pressing surfaces of the upper and lower dies constitute a cylindrical arced surface of a total of about 180°. In view of the fact that the press is adapted to operate upon a substantially cylindrical pipe, means, to be hereinafter more fully described, is so arranged and constructed as to press the remaining half surface of the pipe. The lower die 18 is notched or rabbetted as indicated at 50 in Figs. 6 and 7, plates 51 being adapted to rest in said notches and being secured by means of screws 52 rigidly to the die 18. The plates 51 are co-extensive with the length of the die 18 and project upwardly therefrom. Each of the plates 51 is provided with a plurality of spaced transverse slots 53 which open to the upper surfaces of the plates. A bolt 54 is positioned in each of the slots 53 and carries at one end an auxiliary die section 55. The die section 55 is provided with a concave outer surface 56 which substantially spans an arc of 90°. The opposite surfaces of the auxiliary die sections 55 are formed at an angle, of approximately 45° as indicated at 57 in Figs. 6 and 7.

A washer 58 embraces each of the bolts 54, said washer being normally urged into contact with the outer surface of the plate 51 by means of coil spring 59, the opposite end of which abuts against washer 60 which is maintained at a predetermined

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position upon bolt 54 by means of nuts 61. The arrangement is such that the bolts 54 and hence the auxiliary die sections 55 are resiliently movable inwardly and outwardly with respect to the plates 51.

In operation, when the lower platen 6 is moved upwardly by the action of the rams 5, the tangential surface portions of the upper die contact the outer angular faces 57 of the upper portions of the auxiliary die sections 55. In so contacting the faces 57 of the auxiliary die sections 55, the bolts 54 are moved inwardly and downwardly in slots 53. When the bolts have moved a predetermined distance downwardly, the lower angular faces 57 of the auxiliary die sections 55 are brought into contact with the tangential surface portions of the lower die 18 which assist in moving the auxiliary die sections inwardly. The arrangement is such that as the upward motion of the die 18 continues, the downward and inward motion of the bolts 54 eventually ceases, at which time the arcs 56 of the auxiliary die sections merge with the cylindrical portions of the arcs of the dies 18 and 24 and describe a complete circular cylindrical pressing surface.

The dies 18 and 24, during operation, function in conjunction with a mandrel 62 which is positioned between said dies and extends outwardly at each end from the die cavity. That portion of the mandrel which is confined within the die cavity is of hollow construction, being provided with a zone 63 in which hot or cold liquid may be circulated to heat or chill the surface of the mandrel within the die cavity. The tubular wall 64 which defines the zone 63 carries at one end a plug 65 which functions as an end closure for the zone 63. An extension 66 is joined to the opposite end of the tube 64, said extension being provided with two parallel bores 67 and 68 which connect into the end of the zone 63. Pipes 69 and 70 are respectively positioned in the bores 67 and 68, the walls of the pipes being spaced from the walls of the bores whereby hot liquid passing through said pipes to and from the zone 63 will not transfer an excessive amount of heat to the walls of the extension.

A pipe 71 is threadedly carried at the end of the extension 66 and projects a relatively short distance into the zone 63. Pipe 71 connects with pipe 69 and the mouth 72 thereof faces the wall of tube 64. A second pipe 73 is also threadedly carried at the end of extension 66 and projects into zone 63, the mouth 74 of said pipe being positioned at the opposite end of the zone adjacent plug 65. Pipe 73 connects with pipe 70 in bore 68.

The arrangement is such that liquid or steam may be introduced and circulated through zone 63 to cool or heat the wall 64 which faces the dies 18 and 24 and auxiliary dies 55. The fluid may be introduced through pipe 70 and pipe 73 and discharged adjacent the far end of the zone 63, the fluid being withdrawn through pipes 71 and 69, or the fluid may be introduced through pipes 69 and 71 and withdrawn through pipes 73 and 70. In this manner, during a phase of heating or chilling the tube 64, the tube may be raised or lowered in temperature, as the case may be, in a uniform manner throughout its length.

The extension 66, adjacent one end, is provided with threads 75 which are engageable with threads 76 provided on the inner surface of bushing 77. The bores 67 and 68 adjacent the threaded end of the extension 66 are enlarged to receive packing glands 78. A plug 79 is provided with two apertures or bores 80 and 81 which extend

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through tubular projections 82. An annular groove is provided in the face of plug 79 circumscribing each projecting tube 82, said grooves being adapted to contain a suitable packing material 83. Packing glands 78 are receivable in the annular grooves and bear against the packing material 83 to form fluid-tight joints. The opposite ends of bores 80 and 81 are threaded to receive pipes 84 and 85, respectively.

The outer portion of the bushing 77 is provided with threads 86 which engage with threads 87 provided upon the interior wall of yoke 88. The bushing 77 is flanged adjacent one end, as shown best at 89 in Fig. 11, said flange being provided with an offset shoulder 90 which is adapted for engagement with the plug 79.

As has been hereinbefore described, the mandrel 62 is adapted to be positioned in the die cavity. However, said mandrel is supported only adjacent one end, to-wit, upon the yoke, the mandrel extending cantilever-fashion therefrom. To secure the mandrel in the yoke, the bushing 77 is first loosely threaded into the yoke; the plug 79 is then inserted in the bushing and subsequently the extension 66 is threaded in the bushing with the projecting tubes 82 of the plug engaging in the glands 78. With the bore 67 vertically above the bore 68, the bushing 77 and extension 66 are drawn together securely.

The yoke 88 is supported by bars 91 which are, in turn, secured at their ends to blocks 92 which slidably embrace opposite tie-rods 11. Struts 93 extend downwardly from bars 91 and are anchored upon blocks 94 on each side of the machine. Angular braces 95 extend from blocks 94 to points adjacent the ends of bars 91. Blocks 94 carry wheels 96 which bear against the tie-rods 11 which are embraced by the slidable blocks 92. A vertically movable supporting assembly is thus provided for the mandrel 62 whereby the mandrel may be raised or lowered a limited distance as die 18 is raised or lowered. Stops 97 are mounted upon the tie rods 11 to prevent excessive downward movement of the mandrel, to afford clearance between the mandrel and die 18 and auxiliary dies 56 when the dies are open.

In employing the present invention, a pipe or tube is adapted to be pressed between dies 18 and 24, auxiliary dies 56 and mandrel 62. Preferably the tube or pipe is constructed of paper or other fibrous material which carries a uniformly dispersed thermoplastic binder of the plastic or cold setting type. The binder may be dispersed throughout the thickness of the paper or fibrous material by saturation or impregnation, or the binder in discrete particle form may be added to the paper or fibrous stock in the beater of the usual paper machine.

As a specific example, which however is not to be construed as a limitation, a web may be formed upon the usual paper machine, the stock from which the web is made comprising fibrous material, and extracted pine wood pitch treated with a basic substance comprising certain metal oxides or hydroxides, in accordance with the invention set forth in the copending application of Phillip Goldstein and Harold R. Gillette, Serial No. 258,577, filed February 25, 1939, or the web may be made in accordance with the teaching of the patent to Richter and Gillette, Patent No. 2,264,189, issued November 25, 1941.

For purposes of the present invention, the web may be cut into suitable sheets, such as indicated at 98 in Fig. 10, and each sheet may be rolled upon itself to form a tube 99, the free

edge thereof being stapled, as shown at 100 (Fig. 9) to form a pipe or tube with a rolled wall. It will be noted that in cutting the web, one edge 101 of the area 98 is cut along an oblique angle to the adjacent edges 102, 103 of the area and that the edges 102 and 103 constitute the ends of the tube 99. Therefore, the thickness of the wall of the tube 99 adjacent one end is greater than the thickness of the tube wall adjacent the opposite end. This difference in tube wall thickness is made for purposes which will more clearly be brought out hereinafter. In addition, the tube when being rolled may be rolled upon a tapered mandrel whereby the inner diameter of the tube varies progressively throughout its length. Of course, it is to be understood that the wall thickness gradient throughout the length of the tube may be secured by expedients other than that hereinbefore described and, hence, the present invention is not to be limited to this detail.

The tube or pipe 99 is charged to the pressing machine by threading the same over mandrel 62. Of course, the dies are in open position during the threading operation. The mandrel is slightly larger in diameter adjacent the extension 66 than it is adjacent the plug 65 and tapers from one end to the other. By this provision the removal of the pipe, after pressing, is facilitated. The tube 99 is threaded onto mandrel 62 with the thinner-walled end adjacent the extension 66, or adjacent the portion of the mandrel of larger diameter. Hence, inasmuch as the surfaces of the dies are parallel, the thickness of the pipe compensates for the taper of the mandrel and when the pressing takes place the wall of the pipe will be subject to the same degree of pressure throughout its entire length. Hence, the pipe wall will be pressed to a substantially uniform density throughout. In addition, the tapered inner diameter of the preliminarily rolled tube conforms with the taper of the mandrel and assures a snug fit of the tube upon the mandrel.

After the pipe 99 has been mounted upon the mandrel 62, fluid under pressure may be introduced into the lower portions of cylinders 3 and rams 5 will move the lower die 18 upwardly. As has been hereinbefore described, this movement causes the auxiliary dies 55 to move laterally inwardly. Eventually the press closes to the position shown in Fig. 6 at which time the entire wall of the pipe is pressed between the outer dies and the mandrel. As will be hereinafter more fully described, steam is introduced into the dies 18 and 24 through the respective pipes 43 connecting into each die. Simultaneously steam may be introduced into the mandrel through, for instance, pipe 71.

The pressing period with the simultaneous application of heat is carried out for a sufficient length of time to cause the plastic binder carried by the fibrous material constituting the pipe walls to soften and flow. The pressure exerted upon the walls of the pipe 99 is sufficient to densify the wall structure and cause a flow of the binder across the planes of contact of adjacent convolutions of the sheet material constituting the pipe 99. In this manner a pipe or tube is formed having a relatively dense wall structure in which the binder is uniformly distributed. The flow of the binder between adjacent convolutions of the sheet constituting the pipe renders the wall structure substantially homogeneous. The time necessary to cause the desired flow and densification properties has been found to be sufficient to raise the temperature of the auxiliary dies 55

to substantially the same temperature as the pressing surfaces of dies 18 and 24, the auxiliary dies being heated by their contact with the tangential surfaces of the dies 18 and 24 as can be readily seen from Fig. 6. In this manner the circumscribing dies transfer a substantially uniform amount of heat over the entire outer area of the pipe.

After a predetermined period of pressing with heat, the introduction of steam to the dies and mandrel is discontinued and cold water is introduced into the dies 18 and 24 through their respective inlet pipes 43, the water being discharged through the respective drain pipes 49 so as to cause a circulation of water in the interior of the dies. Of course, by the provision of the baffles 39, the heat transfer of the steam or cold water passing through the dies is maintained at an efficient temperature differential between the fluid introduced and the fluid discharged from the dies. For efficient operation the cooling water introduced into the die interiors may be employed as pre-heated feed-water for the steam boiler employed in conjunction with the machine.

Of course, the introduction of the cooling medium to the dies 18 and 24 reduces the temperature of the outer portion of the tube or pipe being pressed. Hence, the binder is caused to set within the tube wall, the setting having its inception in the outer surface of the pipe and progressing inwardly. As a feature of the present invention the average temperature of the pipe is reduced an appreciable degree from its maximum temperature by the chilling of the outer dies prior to the introduction of cooling water to the interior of the mandrel 62. It has been found that if the mandrel and outer dies are chilled at a substantially uniform rate, the pipe shrinks upon the mandrel and can only be removed therefrom with difficulty. However, by commencing the cooling or setting of the resin adjacent the outer surface of the pipe, the shrinkage of the pipe wall tends merely to increase the densifying pressure. Before cooling water is introduced into the mandrel, it is believed that a considerable portion of the binder in the pipe has set. Consequently, the delayed chilling of the mandrel eliminates the possibility of excessive shrinkage of the pipe upon the mandrel.

Referring particularly to Fig. 8, 104 and 105 indicate plates which are secured to the opposite ends of the dies 24 and 18 respectively. The inner edges of said plates traverse the pressing surface of the dies. Said inner edges are chamfered as indicated at 106 (Fig. 8) and the edges of said plates extend beyond the pressing surfaces of the dies. During the pressing operation the chamfered edges of the plates 104 and 105 "pinch" the pipe 99 being pressed adjacent both ends thereof.

It has been found, when employing certain types of binders, for instance, the pine wood pitch-zinc oxide binder hereinbefore described, that a predetermined minimum moisture content must exist in the fibrous stock during the pressing operation. Otherwise there is a tendency for the finished pipe to delaminate along the convolutions of the sheet comprising the pipe wall. By the provision of the plates 104 and 105, the escape of the moisture during the heating and pressing operation is substantially prevented and the resulting pipe wall structure shows no tendency to delaminate.

Of course it is to be understood that with other types of binders this precaution may not be nec-

essary and, consequently, the plates 104 and 105 may or may not be used as desired.

A pair of supporting bars 107 may be mounted at one end upon the bars 91, which project from the slidable blocks 92. The bars 107 converge toward each other away from the machine proper and terminate in two pair of parallel supports as shown at 108 in Fig. 4. A cylinder 109 is carried between the bars 107, said cylinder having pipe connections 110 and 111 at opposite ends thereof. The cylinder 109 is adapted to function as a hydraulic motor having a piston reciprocally positioned therein. A piston rod 112 is connected to the piston and carries, externally of the cylinder, a cross head 113. A pair of connecting rods 114 are secured adjacent opposite ends of the cross head 113 and carry at their opposite ends a stripping ring 119. The ring 119 has an internal diameter substantially equal to the external diameter of the extension 66, and said ring is adapted to be reciprocally movable along the axis of the mandrel 62.

After the pipe 99 has been suitably pressed and the binder has been set, the rams 5 are lowered thus lowering the die 18. During the pressing period the mandrel is essentially supported by the lower die 18, said mandrel being raised from the position shown in Fig. 7 to the position shown in Fig. 6. This upward movement of the mandrel is accommodated by the movable supporting structure comprising the blocks 92, blocks 94 and associate structure. Accordingly when the die 18 moves downwardly, the mandrel 62 follows the lower die for a predetermined distance until the slidable blocks 92 contact the stops 97, at which time further downward movement of the mandrel is prevented while the die 18 moves to the position shown in Fig. 7.

In view of the fact that the cylinder 109 is carried by the same carriage which supports the mandrel, the cylinder moves downwardly with the mandrel until the downward motion is prevented by the blocks 97. At this period fluid under pressure may be introduced into the cylinder 109 through the pipe 110 thereby projecting the stripping ring 119 forwardly. The ring 119 abuts the end of the pipe and drives said pipe toward the free end of the mandrel, that is, the end which carries the plug 65. It has been found that the stroke of the ring 119 need only be sufficiently long to move the pipe a relatively short distance along the length of the mandrel. Thereafter, the pipe can easily be removed by hand.

Referring particularly to Fig. 7, it will be noted that the downward movement of the die 18 is sufficient, correlated with the position of the stops 97, to permit the connecting rods 114 which carry the ring 119, to pass into the die cavity without obstruction. After the ring 119 has reached its outermost throw, fluid under pressure may be introduced into the cylinder 109 through the pipe 111 whereby the ring 119 may be retracted.

Referring particularly to Fig. 13, a diagrammatic showing of the piping system for the dies and mandrel is set forth. Pipe 120 is connected to a source of steam under pressure such as a boiler (not shown). Pipe 120 is controlled by valve 121. Pipe 122 is connected to a source of water under about 30 to 40 pounds per square inch pressure and is controlled by valve 123. Valves 121 and 123 are connected together by pipe 124 which, in turn, is connected to pipe 125. A pipe 126, controlled by valve 127 connects pipe 125 to a source of air under a pressure of about 70 pounds per square inch. Pipe 128 connects with

pipe 125 at one end, and at the other said pipe connects with the inlet pipes 43 to the dies 18 and 24.

Pipe 125 connects into a flow reversing system 129 which comprises pipes 130 and 131. Valves 132 and 133 are interposed in pipe 130, the other side of valve 132 being connected to pipe 125. Valves 134 and 135 are connected in pipe 131. Pipe 84, connected at one end to mandrel 62, is connected at its opposite end into pipe 131, and pipe 85 also connected at one end to mandrel 62, is connected into pipe 130.

Valves 133 and 135 are connected with pipe 136 and valve 134 is connected with pipe 137. The drain pipes 49 of dies 18 and 24 connect with pipe 138 which is controlled by a back pressure relief valve 139 which operates at about ten pounds per square inch pressure, and also by the die exhaust valve 140. Pipe 136 connects into pipe 138 on the atmospheric side of valve 139 and pipe 137 connects into pipe 138 on the pressure side of valve 139. A pipe 141, controlled by valve 142, connects at one end to pipe 138 on the high pressure side of valve 139 and at the other end to the aforesaid steam boiler feed water tank (not shown).

Valves 142 and 140 are preferably solenoidally operated. Valve 140 which is normally closed may be opened by push button control 153 of the solenoid 149 or said solenoid may be controlled to open said valve by a float 150 which is responsive to the level of condensate from the dies which may accumulate in pipe 138. Valve 142 is also normally closed and the solenoid 151 thereof may be energized to open the same when valve 123 is opened provided, however, the liquid in the feed water tank 152 is below a predetermined level. If the liquid level in the feed water tank 152 is above said predetermined level, valve 142 will not open.

In carrying out the present process, a tube 99 constructed from a web made in accordance with the Goldstein and Gillette patent application, Serial No. 258,577 hereinbefore referred to, having a binder content of about 40%, an average wall thickness before pressing of about $\frac{3}{8}$ inch, a length of about 10 feet and an average internal diameter of about $2\frac{3}{4}$ inches, is threaded upon mandrel 62. With the assumption that a pressing cycle has just been completed, the dies will be at a temperature of about 100° F., when valve 121 is initially opened. Valves 121, 123 and 127 may comprise a 3-way valve wherein the opening of one valve closed the other two.

Steam at about 100 pounds per square inch pressure is passed through pipe 128 to the dies 18 and 24 through the respective inlet pipes 43 and is discharged from said dies through the respective outlet pipes 49. The dies will then increase in temperature.

Simultaneously with the introduction of steam into the dies 18 and 24, steam is also introduced into the mandrel 62. At this phase of the operation valves 132 and 135 are open and valves 133 and 134 are closed. Consequently steam passes through pipes 125, 130 and 84, and is introduced into the interior of the mandrel via pipe 71, the steam discharging from the mandrel through pipe 73, pipe 85, pipe 131 and through the opened valve 135 to pipe 136 and thence to the drain pipe 138 on the atmospheric side of the back pressure valve 139. Shortly thereafter when the condensate has been blown from the mandrel, valve 135 is closed cutting off communication with the drain pipe 138.

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At the commencement of the pressing operation the pipe 99 is subjected to a pressure of between about 50 to 200 pounds per square inch. This pressure is maintained upon the pipe until the dies reach a temperature of approximately 260° F. At this phase of the operation the binder in the pipe will have been softened to the extent where it is ready to flow. The pressure upon the pipe is then increased to between about 900 to 1,000 pounds per square inch and said pressure is maintained to the end of the pressing cycle.

When the dies have reached a temperature of about 275° F., the valve 132 is closed and valve 121 is closed and the valve 127 is opened to admit air to the system at about 70 pounds per square inch pressure which exhausts the steam from the dies and blows out the condensate through valve 140. Valves 132 and 135 being closed, the valve 123 is opened to admit water to the system at about 30 to 40 pounds per square inch pressure. In view of the fact, however, that valve 132 is closed the water passes only through the dies and consequently the dies cool at a relatively rapid rate cooling the exterior surface of the pipe 99. The mandrel, not being connected to the water supply at this phase of the operation cools at a relatively lower rate and consequently the interior surface of the pipe 99 is at a considerably higher temperature than the external surface thereof.

When the dies have reached a temperature of about 140° on the cooling phase of the cycle, valves 133 and 134 are opened. The water passing through the dies and discharging into pipe 138 then passes through pipe 137 at about 10 pounds pressure, the pressure at which the back pressure valve 139 is set. The water thus passes through valve 134 to pipe 131 and thence into pipe 85 and into the interior of the mandrel 62 via pipe 73. By introducing the water into the mandrel via pipe 73, which is located at the lower portion of the zone 63 no steam or air pockets are permitted to form in the zone 63 since the mouth of the pipe 71 is positioned adjacent the upper wall of the mandrel and at the opposite end of the mandrel from which the water is introduced. The water from the mandrel is discharged through pipe 84 and into pipe 130, thence through valve 133 to pipe 136 and thence to pipe 138 on the atmospheric side of valve 139.

When the temperature of the dies reaches about 115° F., valves 133 and 134 are closed and the valves 132 and 135 are opened. In this manner the flow of water through the mandrel is reversed, the water being introduced through the pipe 71 and being discharged through the pipe 73. Shortly thereafter, that is, when the temperature of the dies reaches about 100° F., the press is opened and the pipe may be removed therefrom in the manner hereinbefore described. The pressing cycle can then be repeated, it being the practice to immediately open valve 121 when the previously pressed pipe has been removed so that the dies and mandrel will have their temperature increasing when the next pipe is threaded upon the mandrel.

To support the free end of the mandrel while the pipe 99 is being threaded upon or removed from the mandrel a pair of brackets 143 are mounted upon the endmost tie rods 11, said brackets carrying a roller 144 upon which the plug-portion 65 of the mandrel rests. To facilitate threading of the pipe upon the mandrel lateral guides 145, mounted upon the brackets 143

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are positioned adjacent each side of the mandrel, the ends of said guides being flared outwardly.

Valves 132, 133, 134 and 135 may be automatically operated by means of solenoids 146 and 147 connected by a linkage system 148 to the various valves. In view of the fact, however, that these valves may be operated in any desired manner the use of the solenoids and connecting linkage is not intended as a limitation of the present invention and per se does not constitute a part of the present invention. In view of the fact that the mandrel is movable vertically, the pipes 84 and 85 are preferably of flexible construction.

It will be apparent that the machine comprising the present invention is particularly adaptable for making tubes, conduits or pipes from fibrous materials, preferably in laminated sheet or strip form, which carry or have been impregnated with a plastic binder. The machine is particularly suitable for operating upon fibrous materials having cold setting binders, although the same may be advantageously employed with thermo-setting or heat curable binders carried by the fibrous stock.

Although the preliminarily formed pipe or tube is herein described as being made up of a fibrous sheet convolutely wound, the preliminary tube may be wound of spirally wrapped strips or may comprise a relatively thick fibrous board wound as a single layer and joined along a longitudinal seam.

The process herein described is particularly suitable in pressing fibrous pipes, tubes or conduits which are made up in multiple wall thicknesses, although the process also contemplates pressing a single-layered wall tube since the problem of joining the edges of single layered tube to form a longitudinal seam is somewhat similar to the problem of causing ply convolutions to adhere to each other.

The pipe, tube or conduit which results from the practice of the present invention has a continuous, substantially homogeneous wall structure of substantially uniform strength and elasticity, which is substantially impervious to moisture, light in weight and resistant to corrosive influence.

It is to be understood, of course, that the pipe press herein described may be so constructed as to simultaneously press a plurality of pipes merely by duplicating the dies and mandrel and having all subjected to the pressure of one set of hydraulic rams. In addition, if desired the machine may be so disposed as to have the rams acting laterally instead of vertically.

We claim as our invention:

1. A machine for pressing pipe or conduit constructed of fibrous material carrying a plastic binder which comprises in combination, a frame, a plurality of dies carried by said frame, a mandrel positioned between said dies and adapted to carry a binder-carrying fibrous pipe or conduit in enveloping relation thereon, means for moving said dies relatively to each other to press and compact the walls of the pipe or conduit upon the mandrel, means for heating said dies and mandrel to fuse the binder carried by said pipe or conduit whereby the pressure upon the walls thereof causes the binder to flow, means for chilling said dies and mandrel, and means for moving said pipe or conduit longitudinally along said mandrel when the pressure upon the pipe or conduit has been relieved.

2. A machine for pressing pipe or conduit con-

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structed of fibrous material carrying a plastic binder which comprises in combination, a frame, a plurality of dies carried by said frame, the surfaces of said dies being substantially parallel to each other, a tapered mandrel positioned between said dies and adapted to carry a binder-carrying fibrous pipe or conduit in enveloping relation thereto, means for moving said dies relatively to each other to press and compact the walls of the pipe or conduit upon the mandrel, means for heating said dies and mandrel to fuse the binder carried by said pipe or conduit whereby the pressure upon the walls thereof causes the binder to flow, means for chilling said dies and mandrel, and hydraulic means for moving said pipe or conduit longitudinally along said mandrel when the pressure upon the pipe or conduit is relieved.

3. A machine for pressing pipe or conduit constructed of fibrous material carrying a plastic binder which comprises in combination, a frame, a stationary upper die carried by said frame, a lower die carried by said frame, means for moving said lower die vertically relatively to said upper die, a supporting carriage mounted for vertical movement upon one end of said frame, a mandrel supported in cantilever fashion at one end upon said carriage and positioned between said upper and lower dies, said mandrel being adapted to carry a binder-carrying fibrous pipe or conduit in enveloping relation thereon, means for moving said lower die upwardly to carry said mandrel and pipe or conduit into pressure contact with said upper die, means for heating said mandrel and dies to soften the binder carried by the pipe or conduit whereby the pressure upon the walls thereof causes the binder to flow, and means for chilling said dies and mandrel.

4. A machine for pressing pipe or conduit constructed of fibrous material carrying a plastic binder which comprises in combination, a frame, a stationary upper die carried by said frame, a lower die carried by said frame, means for moving said lower die vertically relatively to said upper die, a supporting carriage mounted for vertical movement upon one end of said frame, a mandrel supported in cantilever fashion at one end upon said carriage and positioned between said upper and lower dies, said mandrel being adapted to carry a binder-carrying fibrous pipe or conduit in enveloping relation thereon, means for moving said lower die upwardly to carry said mandrel and pipe or conduit into pressure contact with said upper die, means for heating said mandrel and dies to soften the binder carried by the pipe or conduit whereby the pressure upon the walls thereof causes the binder to flow, means for chilling said dies and mandrel, and means for moving said pipe or conduit longitudinally on said mandrel when the lower die has moved downwardly.

5. A machine for pressing pipe or conduit constructed of fibrous material carrying a plastic binder which comprises in combination, a frame, a stationary upper die carried by said frame, a lower die carried by said frame, means for moving said lower die vertically relatively to said upper die, a supporting carriage mounted for vertical movement upon one end of said frame, a mandrel supported in cantilever fashion at one end upon said carriage and positioned between said upper and lower dies, said mandrel being adapted to carry a binder-carrying fibrous pipe or conduit in enveloping relation thereon, means for moving said lower die upwardly to carry said mandrel and pipe or conduit into pressure contact with

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said upper die, means for heating said mandrel and dies to soften the binder carried by the pipe or conduit whereby the pressure upon the walls thereof causes the binder to flow, means for chilling said dies and mandrel, and means for moving said pipe or conduit longitudinally on said mandrel when the lower die has moved downwardly, said means comprising a stripping ring circumscribing said mandrel, and pressure means mounted on said carriage for moving said ring into abutting relationship with an end of said pipe or conduit.

6. In combination with a machine for pressing the walls of cylindrical pipe or conduit comprising a frame, a stationary die carried by said frame a portion of the surface of which conforms with a portion of the cylindrical surface of the pipe or conduit, a diametrically disposed similar die movable diametrically with respect to said stationary die, a pair of diametrically opposite side dies having similar pressing surfaces carried by said second mentioned die, said side dies being movable diametrically with respect to each other and being movable parallel to the path of movement of said second mentioned die and relative thereto, said side dies being moved by contact with the first two mentioned dies when said second mentioned die moves into pressing relationship whereby all of said dies simultaneously exert a pressing force upon the exterior of the tube or conduit.

7. In combination with a machine for pressing the walls of cylindrical pipe or conduit comprising a frame, a stationary die carried by said frame a portion of the surface of which conforms with a portion of the cylindrical surface of the pipe or conduit, a diametrically disposed similar die movable diametrically with respect to said stationary die, a pair of diametrically opposite side dies having similar pressing surfaces carried by said second mentioned die, said side dies having cam surfaces at their rear for contacting said first two mentioned dies when the second mentioned die moves into pressing relationship with the stationary die, said side dies being movable diametrically inwardly toward each other when their cam surfaces contact said two first mentioned dies whereby all of said dies simultaneously exert a pressing force upon the exterior of the tube or conduit.

8. In combination with a machine for pressing the walls of cylindrical pipe or conduit comprising a frame, a pair of relatively movable primary dies supported in said frame, a second intermediately positioned pair of dies movable in the same relative direction as the primary dies and in a direction transverse thereto upon being embraced thereby, each of said dies having similar arcuate pressing surfaces and being constructed and arranged to present a substantially continuous surface to the outside of the pipe or conduit from the beginning to the end of the pressing cycle, coacting cam surfaces formed on each of said dies for moving said intermediately positioned dies, the cam surfaces of one pair of said dies being tangential to and forming continuations of said pressing surfaces, and a mandrel positioned between said dies to receive the pipe or conduit to be formed.

9. In combination with a machine for pressing the walls of cylindrical pipe or conduit comprising a frame, a pair of relatively movable primary dies supported in said frame, a second intermediately positioned pair of dies movable in the same relative direction as the primary dies and in a direction transverse thereto upon being em-

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braced thereby, each of said dies having similar arcuate pressing surfaces and being constructed and arranged to present a substantially continuous surface to the outside of the pipe or conduit from the beginning to the end of the pressing cycle, coacting cam surfaces formed on each of said dies for moving said intermediately positioned dies, the cam surfaces of said primary dies being tangential to and forming continuations of

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said pressing surfaces, means for moving said intermediately positioned dies out of pressing engagement with said pipe or conduit responsive to opening movement of said primary dies, and a mandrel positioned between said dies to receive the pipe or conduit to be formed.

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