June 17, 1941. W. E. ZOELLER 2,246,029

APPARATUS FOR MAKING PIPE BENDS AND THE LIKE

Filed July 13, 1937

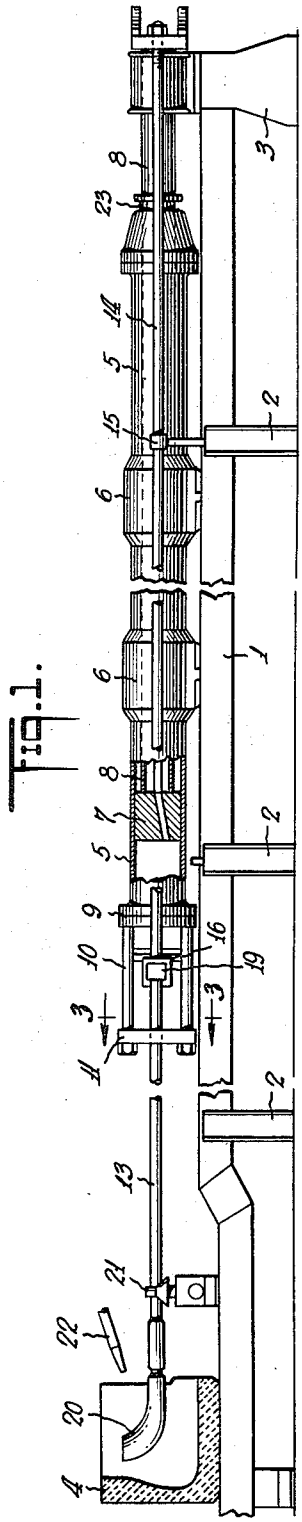


Fig. 1.

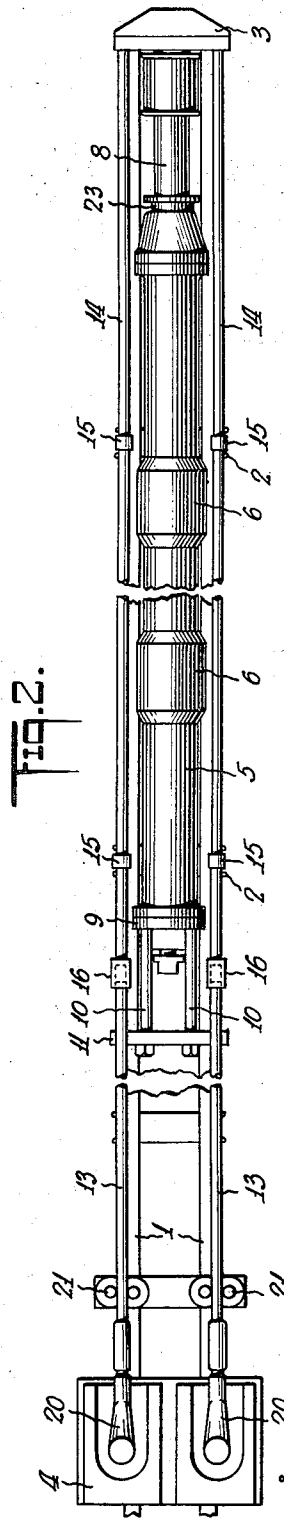


Fig. 2.

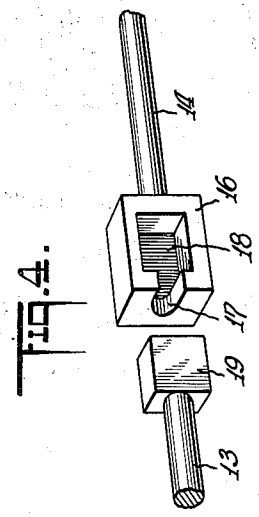


Fig. 4.

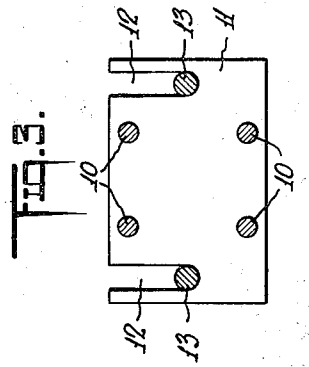


Fig. 3.

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APPARATUS FOR MAKING PIPE BENDS AND THE LIKE

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8 Claims. (Cl. 153—48)

This invention relates to improvements in apparatus for manufacturing curved tubes from straight tube stock by the use of an internal mandrel. Apparatus of this general type is shown in the United States patent to Bohling 1,648,161. In the use of such apparatus the upsetting and expanding action of the metal taking place in the production of tubular bends, coils, helices, serpentines and the like from tubular pipe stock requires high pressures for forcing the stock over a stationary mandrel or for drawing a movable mandrel through a stationary piece of stock. Although this operation customarily takes place with both the stock and the mandrel highly heated, nevertheless pressures in the order of 3000 pounds per square inch are required at times for the satisfactory operation of the machine used for forming the final product.

Due to the use of this high pressure certain operating problems arise in the commercial usage of such apparatus. One such problem arises because of the packing required for the pressure head of a machine of the nature disclosed by the said Bohling patent. When an external rod or other member extends from a pressure chamber relatively movable with respect to such member, and filled with an operating medium at high pressure, the resulting joint necessitates the use of special packing means and requires constant supervision to prevent gradual leaking of the medium under pressure or the actual forcing out of such packing under the high pressure.

Furthermore when reloading the external rod with tubular stock, it has been necessary to disconnect the mandrel and to support the rod by means of a crane or the like, thus causing a bending movement of the rod about the head of the cylinder through which it extends. This bending action even when only of a minor degree tends to loosen the high pressure packing in the cylinder head and adds to the disadvantage above noted.

It has also been necessary to load the tubular stock upon the mandrel rod from the mandrel end. This inherent limitation requires removal of the hot mandrel, a relatively slow loading of tube stock while awaiting the withdrawal of the machine cylinder, and then a replacing and reheating of the mandrel prior to renewing the tube bending operation. It has been estimated that this procedure takes up from 10 to 15% of the total time of a cycle of machine operation, and thus far has been considered an unavoidable loss. Furthermore, the repeated cooling and reheating of the mandrel element has reduced the useful life of the same as more specifically described hereinafter, and has increased the cost of manufacturing the product.

It will be noted that the presence of a mandrel rod within the movable cylinder diminishes the effective working area contacted by the pressure fluid. Thus prior machines have required either a larger cylinder or a higher working pressure in order to accomplish the same amount of work as could be secured were the mandrel rod located externally of the cylinder.

By means of the present invention each of the above disadvantages have been overcome.

One object of my invention is to permit the tube stock to be loaded upon the mandrel rod from the rear end, thus permitting the operator to work efficiently in a zone much cooler than that in which he is compelled to work with the type of machine heretofore used where the loading has been at the hot region adjacent the mandrel and the heating nozzle area.

Another object of the invention is to permit the mandrel element to remain fastened to the mandrel rod at all times and be retained in a hot environment during the entire cycle of operation in order to eliminate weaknesses resulting from repeated temperature changes in the region of the critical temperature of the mandrel metal.

A further object is to provide a machine of the type referred to in which the entire exposed interior area of the cylinder is acted upon by the pressure medium.

Another important object of the invention is to provide a method of shaping tubes over a mandrel by combined pressure and heat wherein the mandrel is maintained in a heated condition at all times.

Another object is to permit and facilitate a more rapid loading operation.

A further object is to provide means whereby a plurality of manufacturing operations may be conducted simultaneously from a single source of power.

Another object is to eliminate the trouble heretofore encountered in the packing means.

Other advantages and objects, such as the increased efficiency of operation by savings in time of operation and amount of labor, the increased capacity of the apparatus and the improved working conditions for the operator, will become more apparent when considered in conjunction with the accompanying drawing in which:

Fig. 1 is a side elevation showing the general

assembly of one apparatus which may be used in carrying out this invention,

Fig. 2 is a plan view of the structure shown in Fig. 1,

Fig. 3 is a section on the line 3—3 of Fig. 1, and

Fig. 4 is a perspective view of one form of connecting means for the stationary rods.

In the form illustrated, an elongated press bed 1 is supported by a plurality of standards 2 intermediate its ends and provides a supporting track upon which the power mechanism for moving the tube sections over the shaping mandrel may be mounted. At one end the press bed may be mounted upon a support 3 serving as an anchoring means for the mandrel rods and plunger rod later to be described. If desired, the opposite end of such press bed may be so arranged as to provide a guide means for the movable hood or oven structures shown generally at 4.

A power mechanism of the general type shown in the Bohling Patent 1,648,161, may be mounted upon the press bed 1 for the purpose of moving the tube stock over the mandrels and thus forming bent tubes according to the process disclosed in Bohling Patent 1,353,714. Such a machine may comprise a movable cylinder 5 having supports 6 slidable along the press bed 1. Within the cylinder is a stationary piston 7 from which extends a stationary hollow plunger rod 8 rigidly fastened at one end to the support 3. Any suitable arrangement of conduits or passages may be placed or formed within such piston, plunger rod and support for delivering a pressure fluid into and from the spaces within the movable cylinder 5 upon either side of the stationary piston so as to force the cylinder endwise in either direction.

The working end of said cylinder is completely closed in accordance with this invention by a pressure tight head 9 which has a bracket carrying rods 10 secured to a pusher plate 11.

One form of such pusher plate is shown in Fig. 3 wherein a pair of open slots 12 is provided for the reception of mandrel rods 13 later to be described. As the purpose of the plate is primarily to force tubular stock along the mandrel rods and over the mandrels, it is obvious that numerous variations in size and shape of the plate as well as the location and number of the mandrel rod slots therein may be employed without departing from the teaching of the invention. The slots 12 may extend horizontally in from opposite edges if the mandrel rods are to be disengaged laterally, or may extend at an inclined angle if the rods are to be lifted as well as moved transversely, or may extend down from the top edge if the mandrel rods are to be lifted.

Securely fastened to the support 3 in any suitable manner is a plurality of stress rods 14 extending forwardly, parallel to the path of movement of cylinder 5. While two such rods are shown herewith it is obvious that a single rod or any number of rods may be so employed. These stress rods are preferably constructed of high tensile strength material, and since they are normally of appreciable length will ordinarily be flexible to a limited degree. Suitable bracket 15 may be provided for holding the rods generally in position during the period in which no stress is applied thereto. At their forward ends the stress rods 14 are provided with any suitable means whereby they may be readily attached to or detached from the mandrel rods 13, and for holding the stress and mandrel rods positively in engagement during the working stroke of the mechanism.

One simple form of such means, shown in Fig. 4, includes a block 16 having a slot 17 for reception of the mandrel rod 13 and a recess 18 for reception of a head 19 on the mandrel rod. The head and block may be integrally and permanently fastened to the ends of their respective rods 13 and 14. Various other fastening arrangements may be employed, for instance, a screw coupling or a turn buckle with its ends threaded on the mandrel and stress rods.

The location of the connecting means employed will normally be shortly beyond the piston and a short distance to the rear of pusher plate 11 when the cylinder is in fully retracted position.

The mandrel rods 13, over which the tubular stock is to be moved for the purpose of forming the bent tubes, extend forwardly from the connecting means. Such mandrel rods are customarily of somewhat greater length than the displacement stroke of cylinder 5 and carry at their forward ends the mandrels 20 securely affixed thereto. Intermediate of their ends, rods 13 are supported within slots 12 in the pusher plate 11, and upon a supporting structure 21 including rollers adapted to embrace, guide and support the pipe stock which is slid along the mandrel rod by the pusher plate.

When it is desired to load a mandrel rod from the rear end, the said rear end is disengaged from the stress rod and swung at a slight angle. Such support 21 then functions as a fulcrum about which the elongated mandrel rod and its attached mandrel element may be pivoted. If the swinging movement of the mandrel rod be in a vertical plane and the rear end of the rod be lifted through any considerable angle, the mandrel or the tube thereon may engage the bottom of the oven 4 so that said bottom acts as the fulcrum support.

It is contemplated that the mandrel rods may swing about these support rolls and out of the slots 12 in the pusher plate 10 to bring the free end to any convenient loading position. The direction of swing will depend upon the location and direction of the slots. If they swing vertically the rear ends of the mandrel rods may be raised into a convenient loading position, as for example adjacent to an elevated platform or a second floor. In such a case the pipe stock could be slid thereon by gravity, thus providing a simple and rapid loading operation. When it is desired to reload, the motive fluid flow is reversed to move the cylinder 5 and pusher plate 11 rearwardly, and by the time the disengagement of stress and mandrel rods takes place and the mandrel rods have been swung to loading position, the rearwardly moving plate 10 has reached such a point as will allow the new load of tubes to slide along the mandrel rod and against the tube which is still held between the rolls of support 21. Moreover the swinging of the mandrel rods moves them out of slots 12 of the plate so that the rods are unobstructed by such plate.

If the rods be swung horizontally and horizontal slots 12 are used in pusher plate 11, the loading could be conducted from a convenient location of stock upon the same floor as the machine location. By using any proper design and location of support 21, the mandrel rod and attached mandrel can be held in proper displaced position relative to normal working position whereupon no adjustment of the mandrel rod

either longitudinally or radially is necessary upon starting the subsequent working cycle. However, should the mandrel rod, the attached mandrel and the tube stock carried thereby deviate from this exact position, it is a simple matter to realign the same after the stress and mandrel rods are again connected.

Heretofore alternate heating of the mandrel to a high temperature and a cooling thereof to a relatively low temperature have occurred in each cycle of operation. These mandrels are customarily constructed of alloy metals having a critical temperature range through the limits of which the temperatures employed in the normal usage of the process frequently vary. This variation of temperatures of the mandrel metal through the critical range causes a relatively rapid degradation of the metal and results in the formation of small cracks, loss of proper shape and a general weakening of the metal. In addition the mandrel is being subjected to high working stresses as the tube stock is forcibly pushed thereover, and due to these factors the useful life of these expensive mandrels has been relatively short.

By means of this invention the ovens **4** may be designed with sufficient depth and/or width so as to contain the mandrel and the partially formed bend thereon during the loading operation. The burner **22** may continue to supply heat at an appropriate rate to keep the mandrel within suitable temperature limits during this period, and in so doing thus diminish the degradation of the metal and thus prolong the mandrel life.

By employing an external pushing connection between cylinder and exteral mandrel rods, the mandrel rod formerly connected to the stationary piston within the movable cylinder is completely eliminated with the result that a troublesome packing joint is now unnecessary. Since the working end of cylinder **5** may employ pressures in the order of 3000 pounds per square inch a material saving in cost and maintenance is thus effected. Furthermore, the omission of the mandrel rod from the working space increases the capacity of the machine by the amount equal to the product of the pressure employed times the area formerly occupied by the cross-section of such rod.

At the end removed from the working section of the cylinder **5** a conventional packing gland assembly **23** serves to pack the plunger rod **7** and to prevent leakage from cylinder **5** during rearward movement thereof. Since the rearward movement of such cylinder is made without appreciable load, the pressures applied thereto are substantially less than those used on the working stroke and little difficulty with the packing gland **23** is had. The plunger **7** serves to hold the internal piston in place within cylinder **5**, and due to engagement with the rear of cylinder **5** also serves to guide and stablize the movement of the cylinder along the press bed **1** and over the interiorly disposed piston. Consequently, the reactions of the forces exerted upon the movable cylinder during the loaded forward stroke and the unloaded rearward stroke are transmitted directly through plunger **5** to support **3**.

Due to these several advantages resulting from the invention it is obviously preferably to load the mandrel rods from the rear. However, in this connection it is to be expressly understood that if desired the mandrel rods may be loaded from the front end without departing from the invention should such an operation be desired.

In such a case it is contemplated that the heating medium from burner **22** may be cut off, the oven **4** may be rolled backward, the mandrel **32** may be disconnected and removed, and the pipe stock may be loaded directly upon the open ends of mandrel rods **13** during the retraction of the cylinder **5**, after which the entire sequence of these operations may be repeated in reverse and the new cycle of operation started.

It is thought that the sequence of operations will be apparent, but may be briefly summarized as follows:

When the mandrel rod is nearly empty the operator directs the pressure fluid into cylinder **5** on the right of the stationary internal piston and permits escape of the pressure fluid entrapped on the left of said piston. Cylinder **5** and pusher plate **10** then begin their rearward movement which may be accelerated if desired by any suitable arrangement. At this same time the operator may cut down the heat supply through burner **22** as desired, or may allow this heat supply to remain unchanged.

When the rod connecting means shown in Fig. 4 is employed the operator then moves the rear ends of the mandrel rods **13** to disengage them from the stress rods. This disengaging operation may be expeditiously effected in a matter of seconds. It will be noted that all tensile stresses on these rods are relieved at this time since cylinder **5** is moving backward without load. Upon being disengaged the rear end of the mandrel rods may be tilted in accordance with the angle of slots **12** in plate **11** and thus be disengaged therefrom and brought to loading position, the stress rods meanwhile lying loosely in brackets **15**. While this operation is taking place cylinder **5** and plate **11** have moved rearwardly sufficiently far to enable the pipe stock to be slid along the mandrel rods by gravity or by pushing motion. By the time the mandrel rods are reloaded completely the plate **11** has been retracted to the position shown in Fig. 1. The loaded rods are dropped into position in slots **31** of the plate **10** with the rear of the final pipe stock terminating a short distance ahead of the plate **11**.

When the loaded mandrel rods are dropped into place in slots **12** the mandrels **20** are again raised by this leverage to their former positions. Stress rods **14** are then sprung outwardly slightly to engage recesses **18** of connectors **16** with the head **19** of mandrel rods **13**. The resiliency of stress rods **14**, the working clearance in connectors **16** and the ability of the mandrel rods **13** to move longitudinally through support **21** will enable the operator to accomplish this reconnection in a short period of time. The controls for the pressure fluid are again reversed and cylinder **5** starts to move upon its working stroke. Preferably this initial movement is throttled somewhat so that the pusher plate **11** will engage the pipe sections without shock and enable the operator to align any of the separate pipe sections which may be slightly out of alignment on mandrel rods **13**.

After aligning all pipe sections the operator admits the pressure fluid at full operating pressure to cylinder **5** and the manufacturing operation disclosed in said Bohling patents then takes place. It will be noted that at this time the reaction forces of the pressure fluid acts upon the stationary internal piston and through stationary plunger rod **8** back upon support **3** in one di-

rection, while at the same time the pusher plate 11 acts against the pipe stock and against mandrels 20 in the opposite direction. The force on mandrels 20 exerts an equivalent action upon the mandrel rods 13 and the rigidly connected stress rods 14 upon support 3 in a direction opposite to the reactive force of plunger rod 8 and thus maintains the stresses of the entire structure internal within itself. In so doing, all advantages of the Bohling inventions are retained while at the same time the enumerated advantages of the present invention are added thereto.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A machine for shaping tube sections, including a mandrel rod having a die mandrel at one end thereof, a supporting structure, means detachably securing the other end of said rod to said structure, a fulcrum support for said rod interposed intermediate the mandrel and the securing means whereby the detached mandrel rod may be pivotally moved on the fulcrum support to a raised and accessible loading position while tube stock is loaded thereon from said other end, said mandrel support acting to support the mandrel at a point spaced from said securing means when the machine is in operation, a movable power element mounted upon said supporting structure, and means connected to said power element for forcing tubular stock along said rod and over said mandrel when said mandrel rod is in loaded position.

2. An apparatus for shaping tube sections, including an endwise movable cylinder, an anchorage at one end, a piston in said cylinder and secured to said anchorage, a plurality of stress rods parallel to and outside of said cylinder and secured to said anchorage, a plurality of mandrels each having a tube stock carrying rod in alignment with and detachably secured to a corresponding stress rod whereby said mandrel rods when detached may be loaded with tube stock from the rear end, means for heating said mandrels, and a pusher plate secured to said cylinder and slidable along all of said mandrel rods for forcing the stock over the mandrels.

3. In an apparatus for shaping tube sections, a reciprocable actuating means, a stationary stress rod extending parallel with and externally of the actuating means, a mandrel rod adapted to carry tube sections, an enlarged mandrel at one end of said mandrel rod and over which the tube sections are forced by the actuating means, heating means for said mandrel, connecting means joining the other end of the loaded mandrel rod to the stress rod and means on said actuating means cooperating with the loaded mandrel rod and serving to push the tube sections over the heated mandrel when the actuating means is moved in one direction.

4. In an apparatus for shaping a plurality of tube sections simultaneously, a reciprocable actuating means, a plurality of stationary stress rods extending parallel with and externally of the actuating means, a plurality of mandrel rods adapted to carry tube sections, an enlarged mandrel at one end of each of said mandrel rods and over which the tube sections are forced by the actuating means, heating means for said mandrels, connecting means joining the other end of the loaded mandrel rods to the stress rods and pushing means on said actuating means cooperating with the loaded mandrel rods and serving to push the tube sections over the heated mandrels when the actuating means is moved in one direction.

5. A machine for shaping tube sections, including tiltable mandrel rod having a die mandrel at one end thereof, a supporting structure, means detachably securing the other end of said rod to said structure and comprising the sole means for securing said rod to said structure and holding it against endwise movement, a fulcrum support for said rod whereby the detached rod adjacent to said mandrel may be pivotally swung to loading position when the securing means is detached, and will be supported in loaded position when said rod is attached by said securing means, a movable power element mounted upon said supporting structure, and means connected to said power element for forcing tube stock along said rod and over said mandrel when said mandrel rod is in loaded position and said securing means is functioning.

6. A machine for shaping tube sections, including a tiltable mandrel may be pivotally swung drel at one end thereof, a supporting structure, a movable power element mounted upon said supporting structure, means connected to said power element for forcing tubular stock along said rod and over said mandrel, means detachably securing the end of said rod to said supporting structure at a point closely adjacent to the rearmost position of said forcing means whereby said rod may be detached from the supporting structure at said point and tilted into stock receiving position, or may be held rigidly in a position parallel with the line of movement of said first mentioned means, and comprising the sole means for securing said rod to said structure, and a fulcrum support for said rod whereby the detached mandrel rod may be pivotally held on the fulcrum support with its detached end in a raised and accessible loading position while tube stock is loaded thereon.

7. A machine for shaping tube sections, including a tiltable mandrel rod having a die mandrel at one end thereof, means for heating said mandrel, a supporting structure, a movable power element mounted upon said supporting structure, means connected to said power element for forcing tubular stock along said rod and over said mandrel, means detachably securing the other end of said rod to said supporting structure whereby said rod may be detached from the supporting structure at said point and tilted into stock receiving position, or may be held rigidly against endwise movement and in a position parallel with the line of movement of said means connected to the power element, said securing means comprising the sole means for securing said rod to said structure, and a fulcrum support for said tiltable rod and independent of said power element, whereby the detached mandrel rod may be pivotally held by the fulcrum support with its detached end in a raised and accessible loading position while tube stock is being loaded thereon and the power element is being moved away from the heating means, and without removing the mandrel from the heating means.

8. A machine for shaping tube sections, including a tiltable mandrel rod having a die mandrel at one end thereof, means for heating said mandrel, a supporting structure, a movable power element mounted upon said supporting structure, means connected to said power ele-

ment for forcing tubular stock along said rod and over said mandrel, means detachably securing the other end of said rod to said supporting structure whereby said rod may be detached from the supporting structure at said point and tilted into stock receiving position, or may be held rigidly against endwise movement and in a position parallel with the line of movement of said means connected to the power element, said securing means comprising the sole means for securing said rod to said structure, and a fulcrum located between said power element and said heating means and arranged so that the detachable mandrel rod may be pivotally held by the fulcrum support with its detached end in a raised and accessible loading position while tube stock is being loaded thereon and the power element is being moved away from the heating means, and without removing the mandrel from the heating means.

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