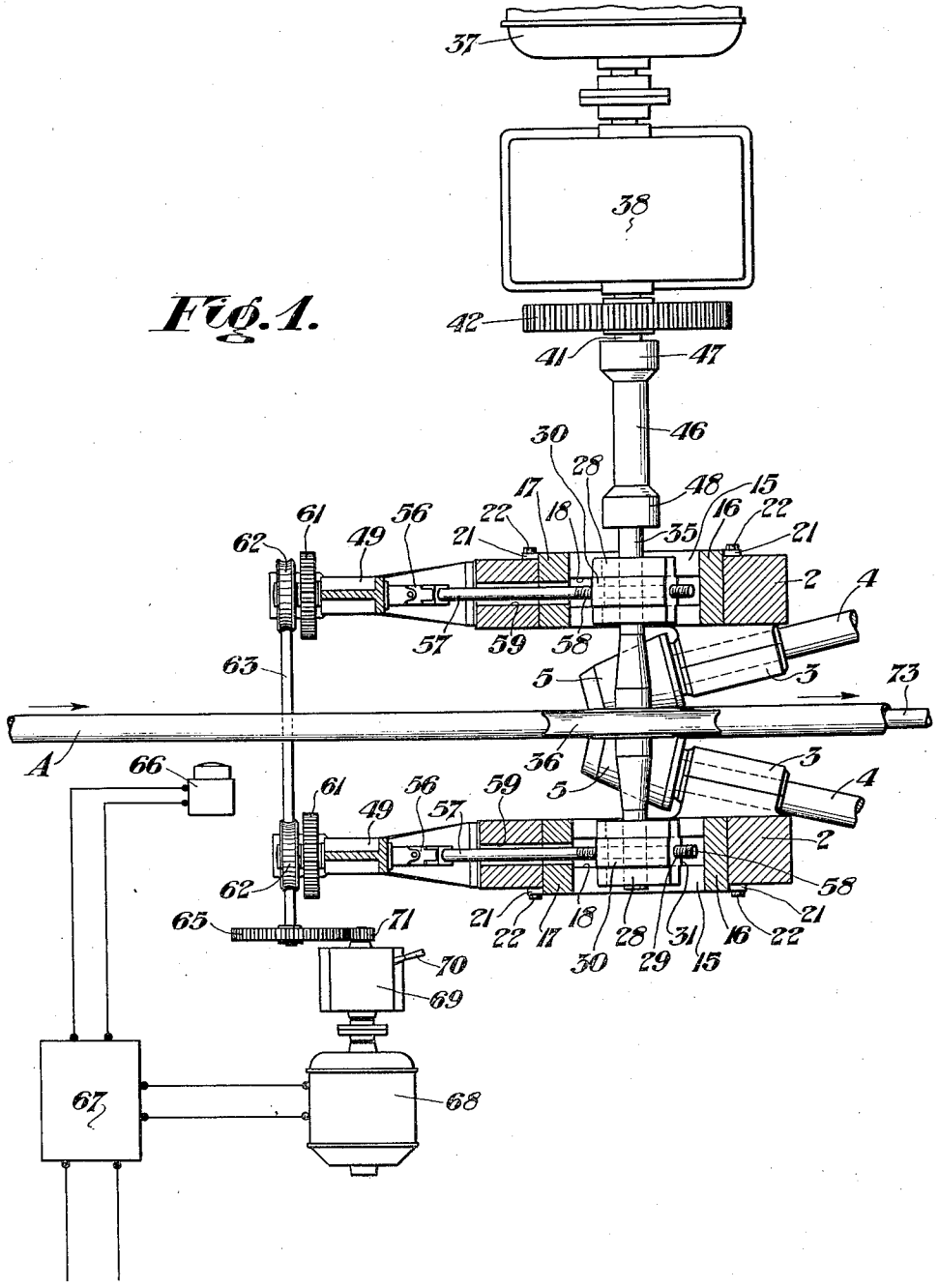
May 12, 1936. R. U. GEIB, JR 2,040,477

APPARATUS FOR PROCESSING TUBULAR METAL WORKPIECES

Filed Oct. 9, 1933 3 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

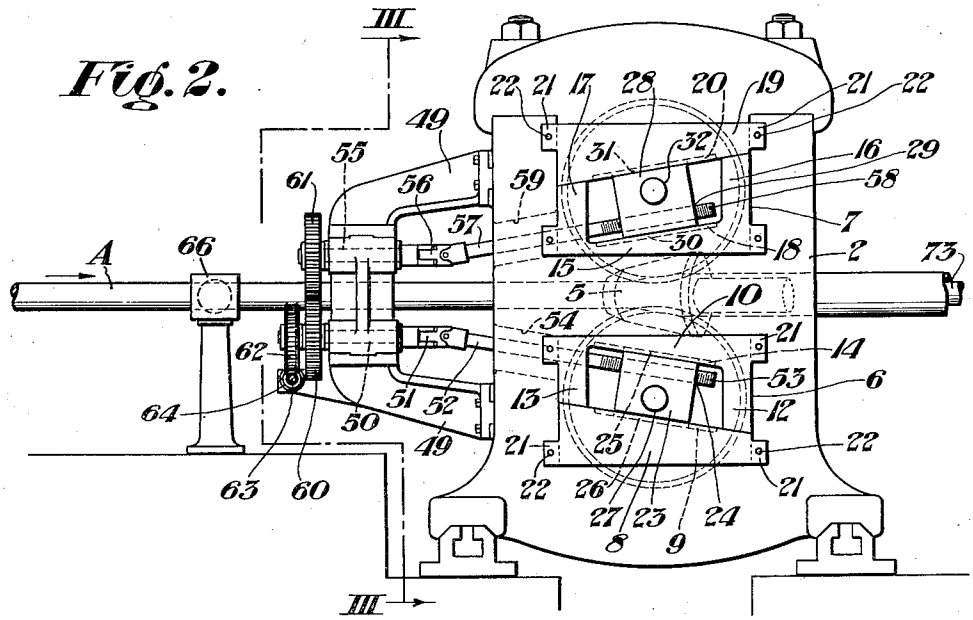
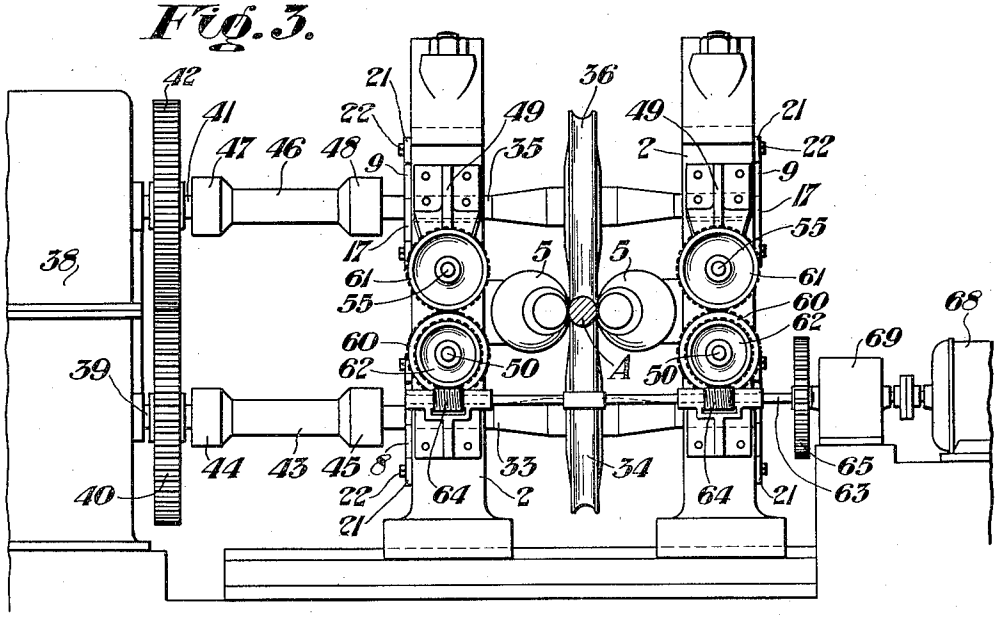


Fig. 3.



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Fig. 4.

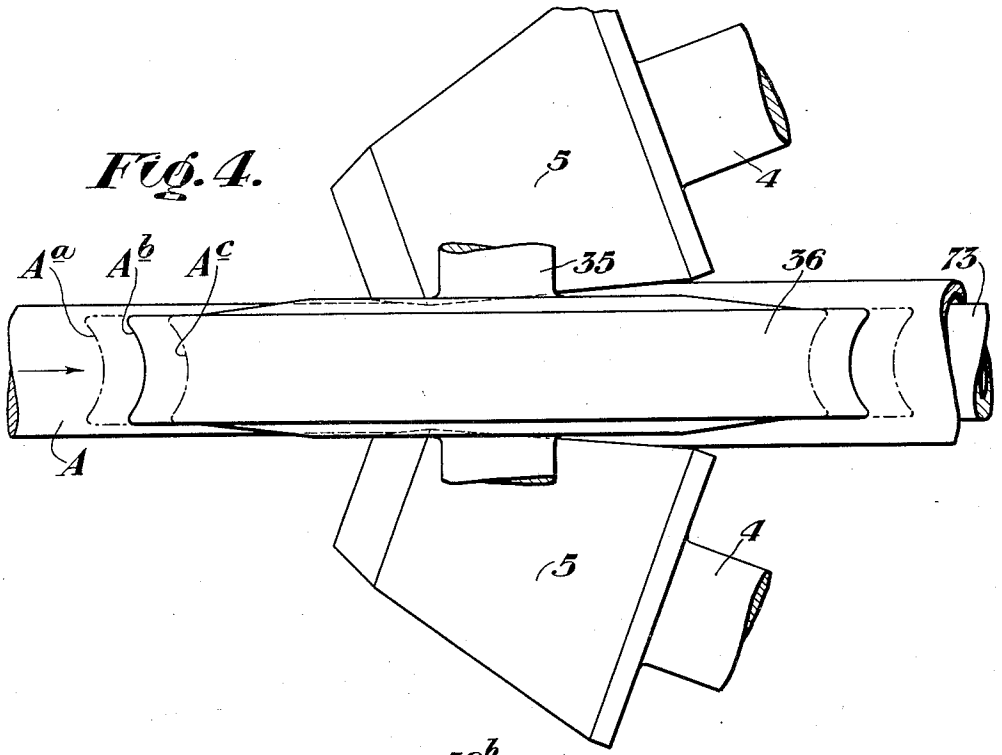
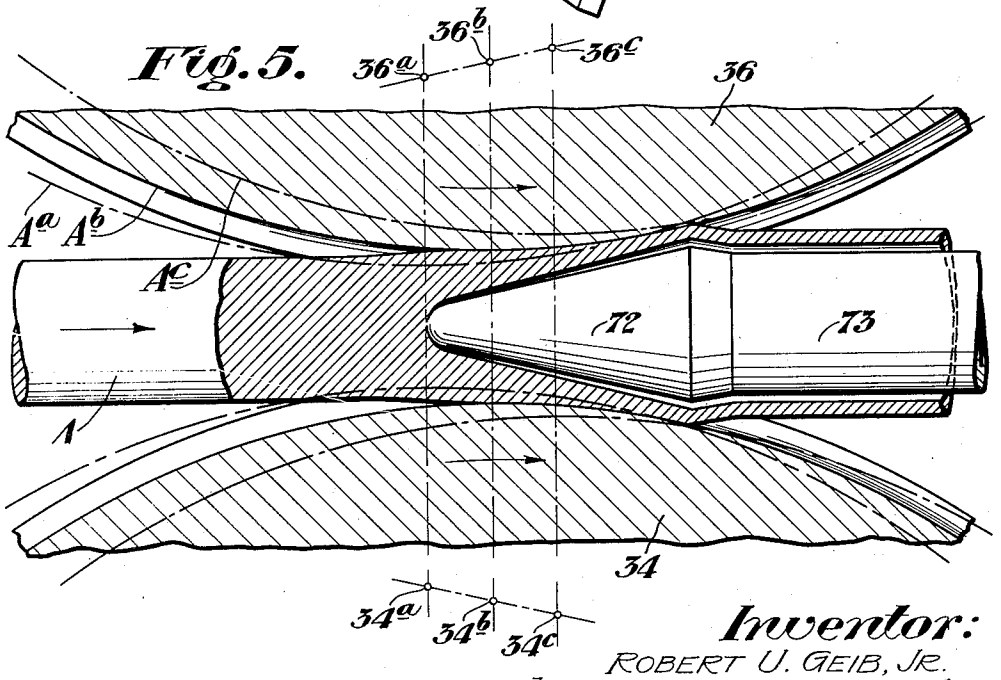


Fig. 5.



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UNITED STATES PATENT OFFICE

2,040,477

APPARATUS FOR PROCESSING TUBULAR METAL WORKPIECES

Robert U. Geib, Jr., Edgewood, Pa.

Application October 9, 1933, Serial No. 692,878

9 Claims. (Cl. 80—13)

This invention relates to an apparatus for processing tubular metal work-pieces in the manufacture of seamless pipes and tubes from solid rounds, or "billets", and to any and all of the various operations used therein.

In the manufacture of seamless pipes and tubes it has, in the past, been very difficult to obtain flawless products from the power-actuated metal-working rolls commonly used therein. Extreme care must be exercised in the processing of the metal of the billet, or work-piece, or numerous defects, or variances, will result.

A number of comparatively late developments tend to overcome a great many of the usual difficulties in obtaining flawless products, in addition to very substantially increasing delivery speeds. In accordance with these principles, the conventional stationary work-piece guides are superseded by power-actuated grooved rolls, rotating on axes substantially at right angles to the pass defined by the metal-working rolls of the mill, and each having a peripheral velocity in the direction of and greater than the longitudinal travel of the work-piece progressing therethrough.

The effect of these power-actuated guide rolls is to lower the usual resistance to rotation of the work-piece offered by the stationary guides, and to greatly assist the longitudinal travel thereof. That is to say they divert longitudinally the peripheral, or tangential, flow of the metal of the work-piece which is imposed by the metal-working rolls. In order to accomplish this result with any degree of satisfaction, the guide rolls should cause a tension, or at least materially reduce the compression of the metal in those portions of the pass wherein the greater part of the processing is done.

The conventional disposition of these guide rolls was with their closest contact surfaces at the "gorge", or most constricted portion of the pass, which permitted too much distortion, or "ovality", in the outlet end of the pass, with the result that the metal of the work-piece was diverted from a tangential into a longitudinal direction in an improper manner, or degree. Under these conditions, not only was it difficult to control the diameter of the work-piece, but numerous other variances were encountered, together with accompanying flaws in the product.

More recent developments have taught that guide rolls should be disposed with their closest contact surfaces at the outlet end of the pass; for the reason that the metal of the work-piece displaced by the metal-working rolls is free at this section to move in a longitudinal direction.

If the metal of the work-piece is unusually plastic it will, of course, offer very little resistance to displacement, and advantage could be taken of this fact by disposing the contact surfaces of the guide rolls even farther in the outlet end of the pass. However, this highly desirable condition of the metal is not constantly encountered in successive, or even single, work-pieces.

If the metal of the work-piece is not unusually plastic, due to insufficient heating or other causes, the guide roll contact surfaces should still be disposed in the outlet end of the pass, but at a point more adjacent the "gorge" of the metal-working rolls, in order to more effectively limit distortion which, in this condition, cannot be easily displaced from a point adjacent the extreme outlet end of the pass.

In order to cope with these varying conditions, it has been deemed necessary to dispose the closest contact surfaces of the guide rolls in a predetermined "mean" position in the outlet end of the pass.

In a co-pending application, entitled "Apparatus for processing tubular metal work-pieces", filed October 9, 1933, Serial No. 692,876, there is disclosed a means for compensating for the varying conditions referred to. The guide roll contact areas are moved longitudinally in the pass to positions in direct ratio, or proportion, to the degree of the plasticity of the metal of the work-piece, assuring the exactly proper displacement thereof under all conditions.

In accordance with the teaching of this co-pending application, the axes of rotation of the guide rolls are made to travel exactly parallel to the horizontal center-line of the pass. In piercing operations, wherein a conical plug is used, the guide rolls travel relative to the plug, and accordingly move closer to the surface of the latter as it approaches the outlet end of the pass. It is, of course, true that the closest contact surfaces of the guide rolls will be in the extreme outlet end of the pass, and consequently closer to the surface of the piercing plug only when the metal of the work-piece is unusually plastic and therefore easily displaced.

In practice, the guide roll contact surface will serve only to divert the tangential displacement of metal of the work-piece into a longitudinal direction, and not move too close to the nearest surface of the piercing plug. That is to say, the guide rolls are initially disposed with the distance between them greater than the distance

between the metal-working rolls, with the result that even as the guide roll contact surfaces move closer to the outlet end of the pass they will not be closer to the surface of the piercing plug than the corresponding surfaces of the metal-working rolls. This will permit a slight distortion, or "ovality," of the work-piece even to the end of the zone of contact of the guide rolls, it being understood, of course, that the metal-working rolls continue their contact until it is "rounded-up" immediately prior to its exit from the mill. In order to permit this necessary "ovality" at points adjacent the outlet end of the mill, it naturally follows that the distortion must be provided to a considerably greater extent at points adjacent the "gorge" of the pass, due to the taper of the piercing plug.

Some types of metal will permit of obtaining acceptable products even if it is given varying amounts of distortion while being processed in the mill, although it would be decidedly superior if this condition could be avoided. Other types of metal cannot even be processed to an acceptable product, due to the inability of the mill to control its movement in such manner as to avoid what, because of its characteristics, is excessive distortion.

It will thus be seen, by those skilled in the art, that ordinarily the distortion-limiting effect of the guide rolls should be constant, or substantially so, throughout the entire length of the pass. That is, the same degree of "ovality" should accrue adjacent the "gorge" of the pass as when the work-piece is about to encounter the final "rounding-up" effect of the metal-working rolls in the extreme outlet, end of the pass.

According to the present invention, means are provided for eliminating all of the difficulties referred to.

One object of the present invention is the provision of a novel apparatus for processing tubular work-pieces in such manner as to completely avoid the possibility of flaws, defects or variances in the processed work-piece.

A further object is the provision of a novel apparatus of the class described in which the metal of the work-piece is diverted from a tangential flow (imparted by helically acting metal-working rolls) into a longitudinal direction, the diversion being exerted to a degree determined by the placticity of the metal, together with compensating means for maintaining constant, or substantially so, the degree of "ovality," or distortion.

A still further object is to provide a novel means for automatically controlling the diversion in accordance with the varying temperature of single, or successive, work-pieces, separate means compensating for the various degrees of plasticity characteristic of different metals at the same temperature; together with means for maintaining constant the degree of distortion, or "ovality," of the work-piece throughout the entire pass.

The foregoing and further objects will be apparent after referring to the drawings, in which:

Figure 1 is a plan of the apparatus of the invention.

Figure 2 is a side elevation of a part thereof.

Figure 3 is an elevation taken from the inlet end of the apparatus.

Figure 4 is an enlarged plan graphically representing the function of the apparatus.

Figure 5 is a sectional elevation representing the function of the apparatus when used in piercing operations.

Referring more particularly to the drawings, the numeral 2 designates a housing for part of the apparatus of the invention. A pair of bearings 3 are mounted one on each side of the housing 2 for rotatably supporting a pair of suitably driven shafts 4, each of the latter having secured to its end a conventional metal working roll 5, such as is commonly used in the manufacture of seamless pipes and tubes.

The housing 2 is apertured on each of its sides in such manner as to provide rectangularly shaped frames below and above the metal-working rolls 5, as at 6 and 7, respectively. A wedge-shaped bearing block 8, having a grooved way 9, and a bearing block 10 having legs 12 and 13 which are adapted to contact with the former, when taken together, provide a unitary construction which snugly occupies each of the lower frames 6. The bearing blocks 10 are each provided with a way, as at 14.

A bearing block 15 is provided with legs 16 and 17, and a way 18, and adapted to cooperate with a wedge-shaped bearing block 19 in such manner as to fit snugly within each of the upper frames 7. The bearing blocks 19 are each provided with a way, as at 20.

All of the bearing blocks 8, 10, 15, and 19 are provided with ears 21 which enable them to be snugly held in their respective frames by means of capscrews 22.

A relatively square sliding block 23 is internally bored and screw-threaded, as at 24, and provided with upper and lower tongues 25 and 26 for cooperation with the ways in the several pairs of upper and lower bearing blocks 8 and 10, respectively.

Each of the sliding blocks 23 is provided with a bearing 27 which is at right angles to the screw-threaded bores 24.

A sliding block 28 is similarly bored and screw-threaded, as at 29, and provided with tongues 30 and 31 which are adapted to cooperate with the ways in the upper pairs of bearing blocks 15 and 19, respectively. Each of the sliding blocks 28 is provided with a bearing 32 which is at right angles to the screw-threaded bore 29.

The construction being the same on either side of the housing 2, as described, means are provided for rotatably supporting a shaft 33 in the bearings of the lower sliding blocks 23, and a shaft 35 in the journals 32 of the upper sliding blocks 28.

The shaft 33 carries a grooved guide roll 34 intermediate its ends, while the shaft 35 carries a guide roll 36 which is similarly disposed.

A motor 37 is mounted adjacent the housing 2 and provided with a transmission unit 38, having a lower driven shaft 39 on which there is mounted a gear 40. The transmission unit 38 is also provided with a shaft 41 carrying a gear 42 which is in constant mesh with the gear 40. The lower driven shaft 39 drives the lower guide roll shaft 33 through a shaft 43 and universal joints 44 and 45. The upper guide roll shaft 35 is driven from the shaft 41 by means of a connecting shaft 46 and universal joints 47 and 48.

The housing 2 has an extension 49 on either side of the "pass", which provides a bearing for one of the shafts 50. A shaft 52 is driven by each of the shafts 50 through a universal joint 51, and has a threaded end 53 which is adapted to cooperate with the threaded bore 24 in one of the sliding blocks 23. The shafts 52 extend through

enlarged apertures 54 in the housing 2, thus enabling the variations in their angular dispositions. A shaft 55 is similarly journaled in a bearing provided by each of the extensions 49 above the metal-working rolls 5. Each shaft 55 is provided with a universal joint 56 to which there is connected a shaft 57 having a threaded end 58. Each of the shafts 57 is extended through an enlarged aperture 59 in the housing 2 and adapted to have its threaded end 58 cooperate with the bore 29 in one of the sliding blocks 28.

A gear 60 is secured to each of the shafts 50. Each of the gears 60 is adapted to constantly mesh with a gear 61, one of which is secured to each of the shafts 55. Each of the shafts 50 carries a worm gear 62, which, when rotated, will cause synchronous rotation of the shafts 52 and 57 in such manner as to move the sliding blocks 23 and 28 toward and away from the metal-working rolls 5.

A shaft 63 is mounted transversely of the line of pass and carries a worm 64 for engagement with each of the worm gears 62. A gear 65 is mounted on the shaft 63 for enabling its rotation.

A heat-responsive circuit making-and-breaking device, such as a conventional photoelectric control unit, generally indicated in the drawings at 66, is "trained" on a work-piece A which is being processed at a point immediately before it is contacted by the metal-working rolls 5, and provides means for registering a relatively wide temperature range inherent in the work-piece at this point. The heat-responsive circuit making-and-breaking device 66 is operatively associated with a motor control box 67.

The motor control box 67 is provided with any of the well known commercial types of starting and stopping devices, limit relays and reversing media for automatically operating an adjacent motor 68 in accordance with the temperatures registered by the heat-responsive circuit making-and-breaking device 66.

A selective gear reduction transmission unit 69 having the usual manual selector 70, is connected to the motor 68 and has a driven gear 71 which is in constant mesh with the gear 65 on the worm shaft 63.

The function of the selective gear reduction transmission unit 69 is to further, and adjustably, modify the operation of the motor control box 67, in order to compensate for varying conditions existent at the mill.

Referring to Figure 5 of the drawings, a piercing plug 72, having a truly conical contour and a rounded point, is shown as mounted on a mandrel bar 73 and positioned with its point adjacent the most constricted portion of the pass, as defined by the "gorge" of the metal-working rolls 5.

In operation, the work-piece A, in the present instance a solid round, or "billet", which is to be pierced, is introduced between the metal-working rolls 5 wherein it is "necked down" in accordance with the usual practice, to obtain a tendency of the central fibers of the metal to open preparatory to its being forced over the point of the piercing plug 72.

This "necking down" operation directs the metal of the "billet" into vertical, or "ovality". From the "gorge" of the metal-working rolls 5, where the actual piercing operation is initiated, this tendency toward "ovality" is much greater as the "billet" being pierced progresses through the outlet of the mill, and should therefore be limited as much as possible in order to avoid defects in the processed work-piece.

As the function of the guide rolls 34 and 36 is to limit this injurious distortion and to divert the successive increments of the metal of the work-piece from circumferential into longitudinal movement, they should be located as near the outlet of the metal-working rolls 5 as possible, as it is more freely displaced from this point. Obviously, this condition is particularly true if the work-piece is very highly heated, and therefore unusually plastic. If, for any reason, the work-piece is not in this preferred condition, the guide rolls 34 and 36 should not be positioned so close to the outlet end of the pass, but should limit the distortion from a point closely adjacent the "gorge."

In order to automatically compensate for these varying conditions inherent in successive, or even single, work-pieces, the heat-responsive circuit making-and-breaking device 66 actuates the devices of the motor control unit 67 for automatically starting, stopping and reversing the operation of the motor 68, which will function through the selective gear reduction transmission unit 69 to properly position the axes of the guide rolls 34 and 36 longitudinally with respect to the metal-working rolls 5, and the piercing plug 72. The lever 70 is manually set to compensate this operation in accordance with varying conditions of plasticity characteristic of different metals at the same temperature.

If desired, the heat-responsive circuit making-and-breaking device 66 may be disconnected, and the motor control unit 67 actuated manually by an operator who is in a position to closely observe the condition of the work-piece.

Due to the fact that the angle of diversion afforded by the various removable bearing blocks 8, 10, 15 and 19 is substantially the same as the angle of expansion of the piercing plug 72, the guide rolls, while varying with respect to one another, will always be spaced approximately the same distance from the most adjacent surface of the piercing plug. In other words, the difference between the surface of the piercing plug and the effective contact area of the guide rolls 34 and 36 will be substantially constant, regardless of the longitudinal disposition of the axes of the guide rolls.

Referring to Figure 4 of the drawings, three positions of the guide roll 36 have been illustrated with respect to the work-piece, as at A^a, A^b and A^c.

In Figure 5, three longitudinal positions of the guide rolls 34 and 36 are disclosed relative to the piercing plug 72, which, of course, does not vary with respect to the positions of the metal-working rolls 5. From this it will be seen that as the guide rolls move toward the outlet end of the pass they also diverge from the center-line of the mill in a degree determined by the relative angles of the bearing blocks, which correspond with the taper of the conical piercing plug 72. The center-line of the guide roll 34, in three positions in the mill, is illustrated by the characters 34^a, 34^b and 34^c, while the corresponding position of the upper guide roll 36 is illustrated by the characters 36^a, 36^b and 36^c. The peripheries of the guide rolls with respect to the work-piece is represented in the three various positions by the characters A^a, A^b and A^c.

The sliding blocks 23 and 28 are fitted within

the bearing blocks 8, 10, 15 and 19 before the latter are placed in the apertures 6 and 7 in the housing 2. Modified replacement bearing blocks may be quickly substituted for the elements 8, 10, 15 and 19 if different metal-working rolls and piercing plug, or other mandrel, are used.

It is to be understood that my invention is not limited to the specific means for moving the sliding blocks 23 and 28 away from the mandrel, or piercing plug; that any satisfactory secondary modifier for the final effect of the motor 68 may be used instead of the selective gear reduction transmission unit 29; that any other satisfactory means may be used for controlling the operation of the motor 68 in lieu of the devices mentioned to be associated with the motor control unit 67; that any heat-responsive electric circuit making-and-breaking device may be used instead of the suggested photoelectric unit 66; that the invention is not limited to piercing operations but may be used with any type of metal-working rolls and mandrel; and that while I have shown and described one specific embodiment of the remainder of the invention, I do not wish to be limited exactly thereto, since various modifications may be made without departing from the scope thereof as defined in the following claims.

I claim:

1. Apparatus for processing tubular workpieces comprising, in combination, a pair of power-actuated metal-working rolls, a mandrel, means for diverting longitudinally the tangential flow of the metal accruing from the action of the metal-working rolls, means for automatically regulating the longitudinal disposition of said diverting means with respect to said metal-working rolls in accordance with the plasticity of the metal of the work-piece, means for maintaining substantially constant the pressure of said diverting means on said work-piece, and secondary means for modifying the effect of said regulating means.

2. Apparatus for processing tubular workpieces comprising, in combination, a pair of power-actuated metal-working rolls, a mandrel, at least one extraneous device for diverting longitudinally the tangential flow of the metal of the work-piece accruing from the action of the metal-working rolls, means for supporting said extraneous device and automatically moving its longitudinally with respect to the axis of the work-piece to a position determined by its temperature, said supporting and moving means providing for maintaining substantially constant the pressure of said extraneous device on said work-piece, and secondary regulating means for further modifying the longitudinal disposition of said extraneous device in accordance with the resistance to displacement of the metal of the work-piece.

3. In apparatus for processing tubular workpieces a housing, a pair of power-actuated metal-working rolls supported by said housing, a mandrel, removable guideways associated with said housing above and below said metal-working rolls, said guideways diverging in a vertical plane from said metal-working rolls at angles corresponding to the surface of said mandrel, a block in each of said guideways, extraneous devices supported by said blocks and acting to divert longitudinally the tangential flow of the metal of the work-piece accruing from the metal-working rolls, and means for moving said blocks in said guideways.

4. In an apparatus for processing tubular workpieces a housing, a pair of power-actuated metal-working rolls supported by said housing, a mandrel, removable guideways associated with said housing above and below said metal-working rolls, said guideways diverging in a vertical plane from said metal-working rolls at angles corresponding to the surface of said mandrel, a block in each of said guideways, extraneous devices supported by said blocks and acting to divert longitudinally the tangential flow of the metal of the work-piece accruing from the metal-working rolls, and means for moving said blocks in said guideways to positions determined by the temperature of the metal of the work-piece.

5. In apparatus for processing tubular workpieces, a housing, a pair of power-actuated metal-working rolls supported by said housing, a mandrel, removable guideways associated with said housing above and below said metal-working rolls, said guideways diverging in a vertical plane from said metal-working rolls at angles corresponding to the surface of said mandrel, a block in each of said guideways, extraneous devices supported by said blocks and acting to divert longitudinally the tangential flow of the metal of the work-piece accruing from the metal-working rolls, means for moving said blocks in said guideways to positions determined by the temperature of the metal of the work-piece, and secondary means for further modifying the positions of said blocks in accordance with the resistance to displacement of the metal of the work-piece.

6. In apparatus for processing tubular workpieces, a housing, a pair of power-actuated metal-working rolls supported by said housing, removable guideways disposed in apertures above and below the pass line of said metal-working rolls and on either side thereof, a block in each of said guideways, extraneous guiding and assisting devices for said work-piece supported by said blocks, and means for moving said blocks into positions determined by the plasticity of the metal of the work-piece, said removable guideways diverging from the horizontal center line of the mandrel at angles corresponding to its working surface.

7. In apparatus for processing tubular workpieces, a housing, a pair of power-actuated metal-working rolls supported by said housing, a mandrel, removable guideways disposed in apertures above and below the pass line of said metal-working rolls and on either side thereof, each of said guideways having a keyway, a block in each of said guideways, each of said blocks having a tongue adapted to seat in one of said keyways, extraneous guiding and assisting devices for said work-piece supported by said blocks, means for moving said blocks into positions determined by the plasticity of the metal of the work-piece, said removable guideways diverging from the horizontal center line of the mandrel at angles corresponding to the working surface of said mandrel, and means for maintaining a spaced relationship between the guideways in each aperture.

8. Apparatus for manufacturing pipes and tubes comprising a plurality of power-actuated metal-working rolls, said metal-working rolls being constructed and arranged to move the work-piece longitudinally and work the material of which it is composed, whereby portions of the work-piece are caused to bulge intermediate the metal-working rolls, at least one power-actuated guide roll disposed intermediate said metal-working rolls for limiting the bulging of the material of the work-piece and moving it longitudinally of its axis, in combination with means for

registering the temperature of the work-piece, and means operated by said temperature-registering means for moving said power-actuated guide roll axially with respect to the direction of longitudinal movement of the work-piece, said last named means being constructed and arranged to move said guide roll toward and away from the axis of said work-piece.

9. Apparatus for manufacturing pipes and tubes comprising a plurality of power-actuated metal-working rolls, said metal-working rolls being constructed and arranged to move the work-piece longitudinally and work the material of which it is composed, whereby portions of the work-piece are caused to bulge intermediate the metal-working rolls, at least one power-actuated guide roll disposed intermediate said metal-work-rolls for limiting the bulging of the material of the work-piece and moving it longitudinally of its axis, in combination with means for registering the temperature of the work-piece, means operated by said temperature-registering means for moving said power-actuated guide roll axially with respect to the direction of longitudinal movement of the work-piece, said last named means being constructed and arranged to move said guide roll toward and away from the axis of said work-piece, and separate means for modifying the operation of said last named means.

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