Jan. 8, 1963 A. MARTIN ET AL 3,071,992

PRODUCTION OF VARIATIONS IN THE PROFILES OF METAL TUBES

Filed Jan. 17, 1961 5 Sheets-Sheet 1

Fig. 1

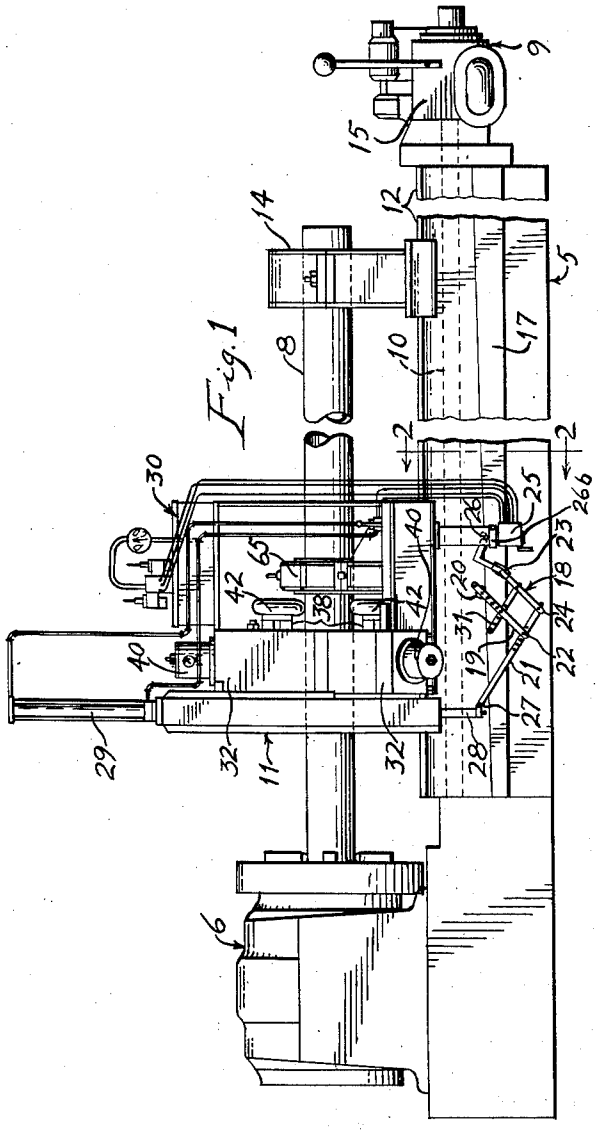

Fig. 2

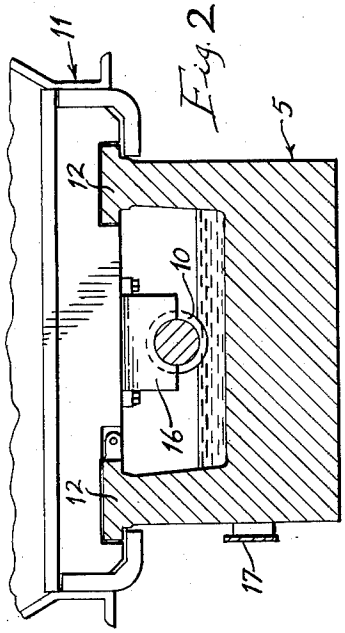

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Fig. 3

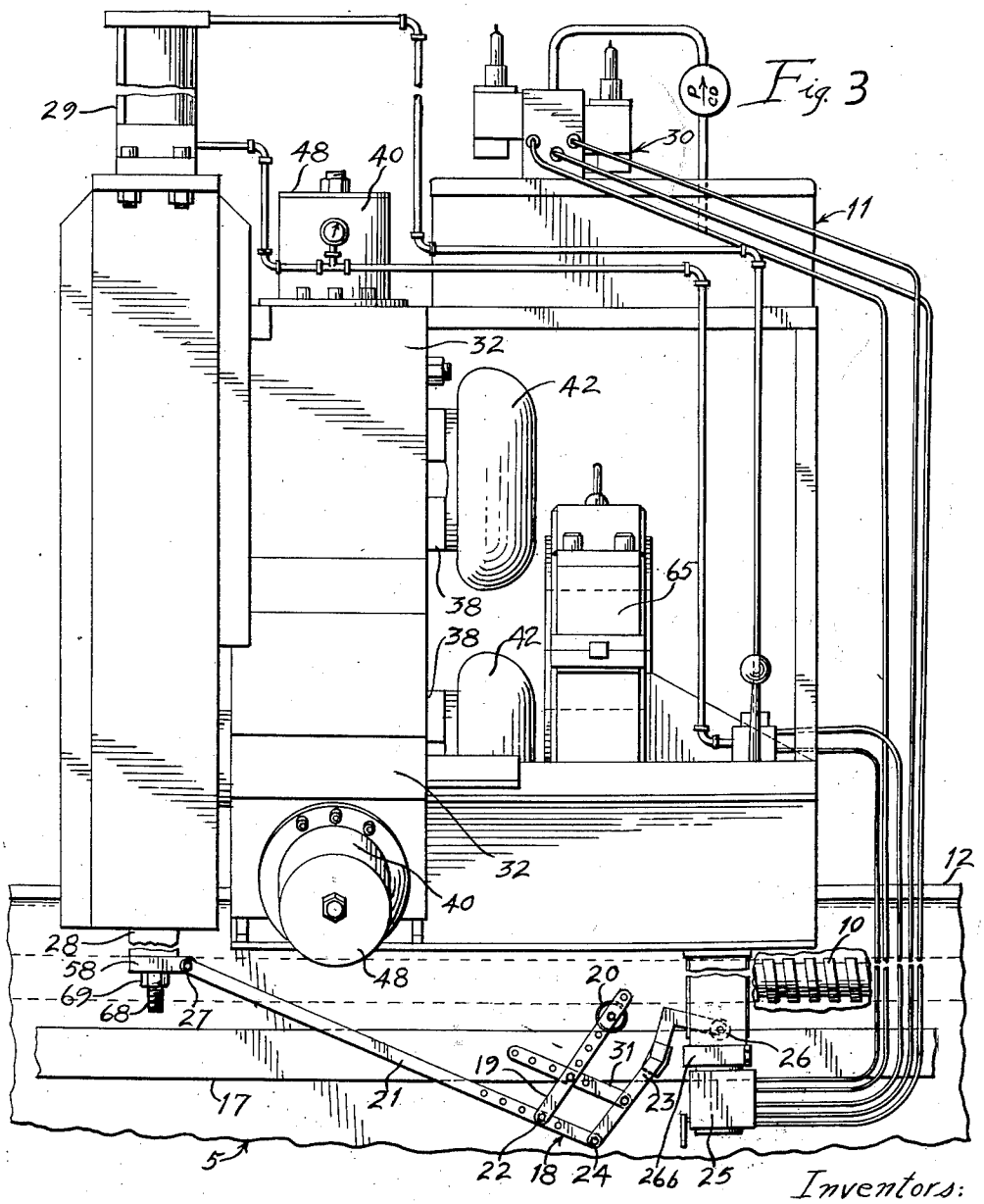

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Fig. 5

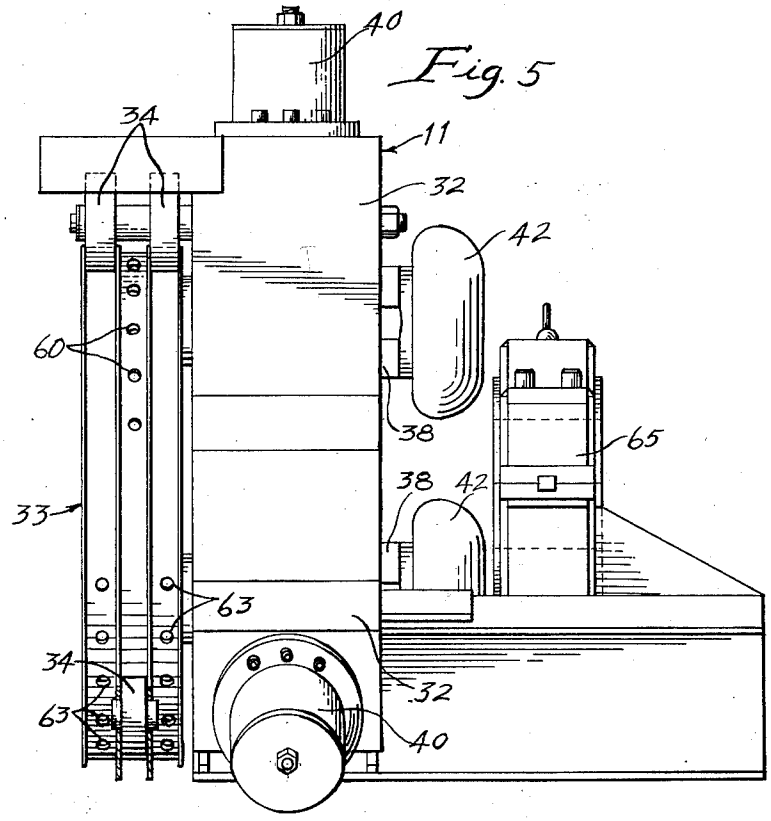

Fig. 4

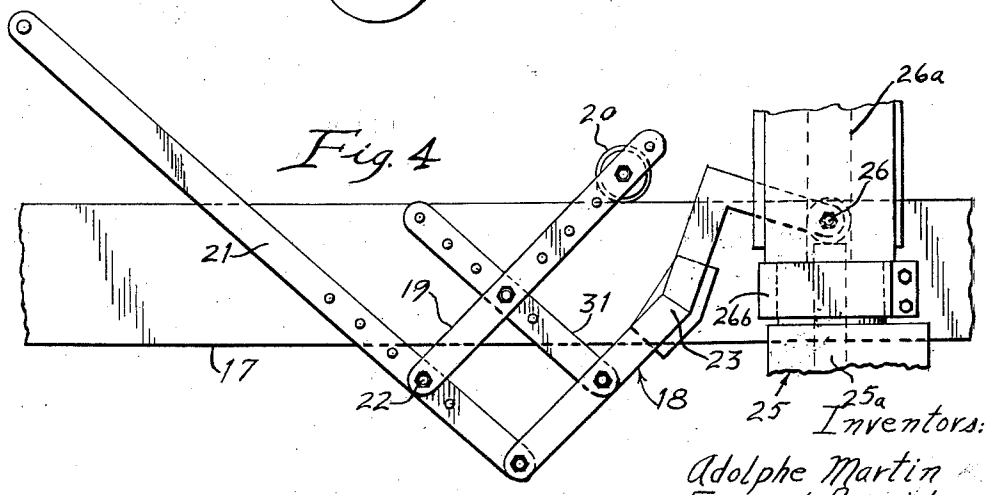

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Fig. 6

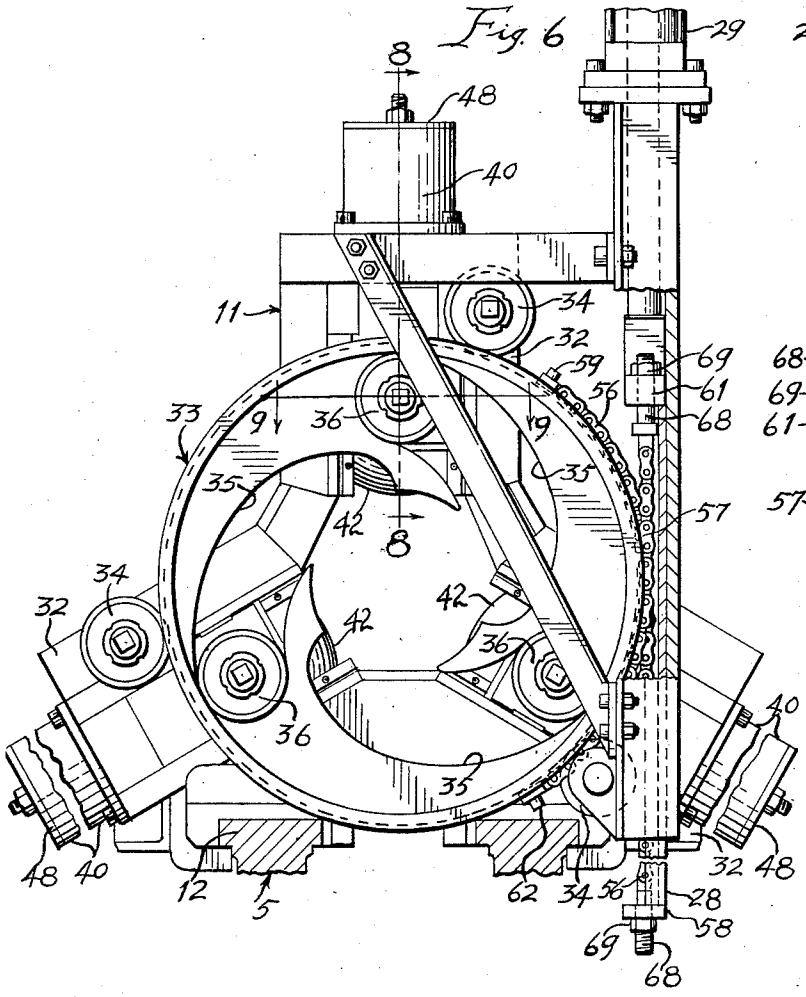

Fig. 7

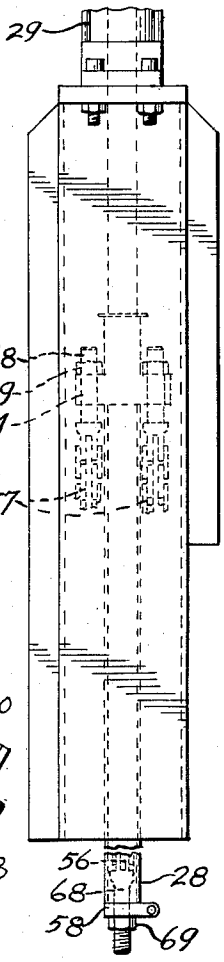

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Fig. 8

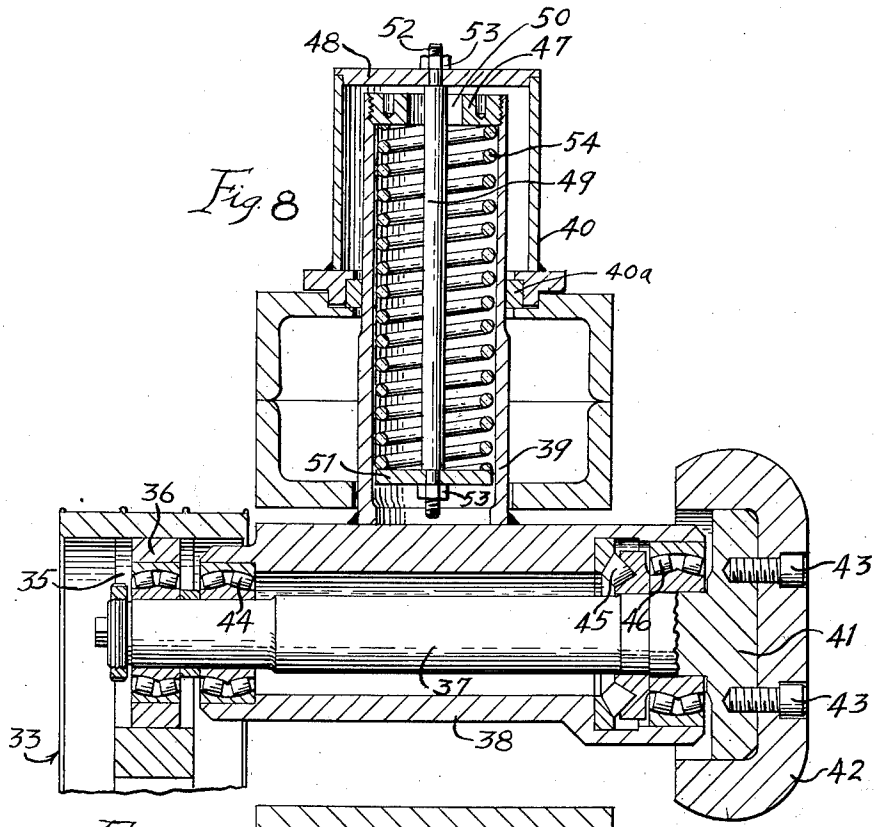
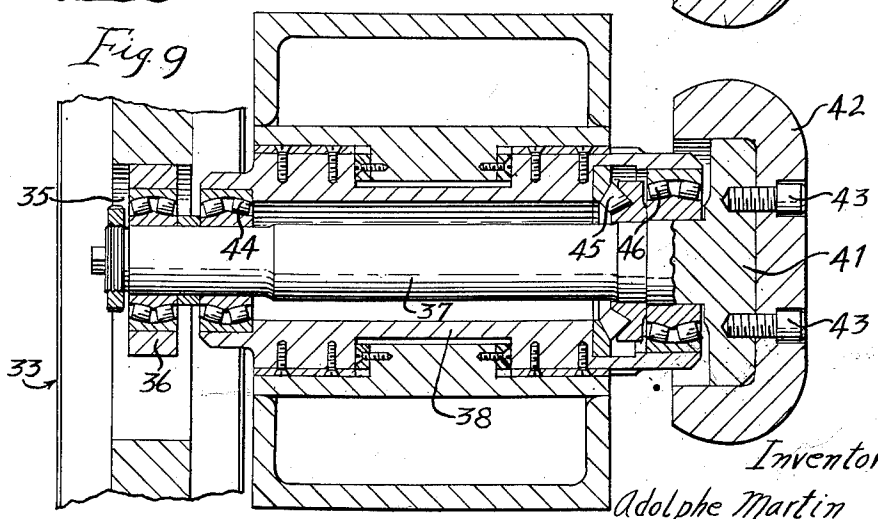


Fig. 9



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3,071,992

PRODUCTION OF VARIATIONS IN THE PROFILES OF METAL TUBES

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9 Claims. (Cl. 80—11)

This invention relates to the production in metal tubes of variations in the longitudinal profiles thereof.

A particular object of this invention is to provide an apparatus which is adapted to support a metal tube for rotation about its longitudinal axis and having a forming head mounted thereon for movement along the lengthwise direction of the tube, said forming head being provided with forming rolls spaced about the tube for movement along radial lines toward and away from the axis of the tube so that pressure from the forming rolls on the tube imparts to the tube variations in the longitudinal profile of said tube as the forming head is moved along said tube.

Another object of this invention is to provide an apparatus of the character described with a template the profile of which determines the longitudinal profile of the tube and a pantograph operably connected between said template profile and actuating means for controlling the radial movement of the forming rolls according to said template profile.

The above and other objects of this invention as well as the characteristic features thereof will be understood more readily from the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. 1 is an elevational view of a preferred embodiment of this invention.

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1.

FIG. 3 is an enlarged view in elevation of the forming head shown in FIG. 1.

FIG. 4 is a fragmentary view enlarged, of the pantograph shown in FIG. 1.

FIG. 5 is an elevational view of a portion of the forming head, certain of the component parts being removed for clarity.

FIG. 6 is an end view of one portion of the forming head.

FIG. 7 is a side view of the portion of the forming head shown in FIG. 6.

FIG. 8 is a sectional view taken through a forming roll along the line 8—8 of FIG. 6.

FIG. 9 is a sectional view taken through a forming roll along the line 9—9 of FIG. 6.

Referring more particularly to the drawings, 5 generally indicates a lathe bed having at one end a motor driven head stock 6 which rotates a metal tube 8, and at the other end a tail stock 9 which actuates a helical screw 10 for moving a forming head 11 forward and backward along the rails 12 of the lathe bed 5.

The metal tube 8 is secured at one end to the head stock 6 and is rotated thereby. The other end of the tube is held or supported by a steady rest 14 which is mounted on the rails 12 of the lathe bed 5 and permits rotation of the tube about the axis of the head stock 6. The steady rest 14 is slidable along the length of the lathe bed to any suitable position for engagement with the tube according to the length thereof. Any suitable clamping means, not shown, secures the steady rest 14 against further longitudinal movement after being suitably located along the lathe bed for engagement with the tube end.

The metal tube 8 extends through the central portion of the forming head 11. The forming head 11 is capable of movement axially of the metal tube 8 at any predetermined speed through the medium of helical screw 10 which is driven by a variable speed drive and motor 15 forming part of the tail stock 9. The screw 10 engages a half nut 16 carried by the under side of the forming head 11.

A template 17 of any desired profile is secured along one side of the lathe bed 5 in the longitudinal direction thereof. A pantograph 18 has one arm 19 provided near one end with a template follower 20 which rides along the profiled edge of the template 17. The other end of arm 19 is connected to a second arm 21 intermediate the length thereof as indicated at 22. One end of arm 21 is connected to one end of a third arm 23, as indicated at 24, which is fitted at its other end with a follower which rides into the valve follower guide 26*a* to actuate a spindle 25*a* of hydraulic valve 25, as indicated at 26. The second arm 21 has its other end connected, as indicated at 27, to the lower end of a piston rod extension 28 of a hydraulic cylinder 29 to provide feed back to the hydraulic valve mechanism 25. The valve mechanism 25 controls a hydraulic power system, generally indicated at 30, which actuates the hydraulic cylinder 29. The pantograph 18 is further provided with a link 31 connected between intermediate portions of the first arm 19 and the third arm 23. Spaced holes along arms 19, 21 and link 31 permit adjustment of the pantograph arms as well as adjustment of the template follower 20 so that by joining the arms in predetermined sets of holes, as well as locating the template follower according to a predetermined pattern, a plurality of different longitudinal profiles along the surface of the metal tube may be obtained with the use of a single template. Adjustments to the arms of the pantograph 18 allow to change the ratio of the template profile as compared to the tube profile given by the forming rolls 42.

A rotary cylindrical cam member, generally indicated at 33, is mounted between a series of rollers 34 which are mounted on spherical roller bearings and which are suitably spaced around the cam member 33 to engage the peripheral edge of the cam member. Rollers 34 are carried by frame members 32 of the forming head 11.

The cam member 33 has a web inside the periphery thereof provided with three identically contoured grooves 35 equally spaced about the axis of member 33. Rollers 36 ride in grooves 35. As shown in FIGS. 8 and 9, the rollers 36 are rotatable on spindles 37 which are mounted for rotation in spindle housings 38, which are secured to spring loaded cylindrical guides 39 integral to housings 38 and slidable at right angles to the axis of an associated spindle 37 on a bearing bushing 40*a* in a guide housing 40. The end of spindle 37 remote from roller 36 is provided with a head 41 to which a forming roll 42 is secured by bolts 43. Bearings 44, 45 and 46 permit rotation of the spindle 37 and forming roll 42 relative to the housing 38.

The cylindrical guide 39 has its inner end secured by welding or other suitable means to the spindle housing 38. The outer end of cylindrical guide 39 is closed by a plate member 47 which is screw-threaded into said cylindrical guide. Cylindrical guide housing 40 which surrounds cylindrical guide 39 is mounted on the forming head 11 and is provided with an end plate 48 through which a tie-rod 49 extends into the cylindrical guide and through a central opening 50 provided in the screw-threaded outer plate member 47. An inner plate 51 is mounted on the inner end of tie-rod 49. A reduced shank 52 on each end of the spindle is fitted through an opening in plates 48 and 51, and a nut 53 threaded on each

shank 52 so that the plates 48 and 51 bear against the shoulder provided at the juncture of the tie-rod 49 and the reduced shank portion thereof. A compression spring 54 is arranged about tie-rod 49 between plates 47 and 51. The axes of the tie-rod 49 and the cylindrical guide 39 extend radially with respect to the cam member 33 and cylindrical guides 39 are spaced at 120° about the cam member to enable the forming rolls 42 to engage the outer surface of tube 8 at 120° intervals.

The cylindrical guides 39 normally exert an outward tension on the spindle housings 38 by means of compression springs 54 to maintain positive contact between the rollers 36 and the working face of the corresponding grooves 35.

Movement of the cam member 33 is regulated by upper and lower chains 56 and 57 (see FIGS. 6 and 7). Chain 56 is secured at one end to the lower end of the hydraulic cylinder piston rod extension 28, as indicated at 58. Chain 56 extends upwardly to lay along the periphery of cam member 33 and is secured at the other end to the central peripheral surface of cam member 33 by bolts or any other suitable securing means 59, receivable in one of the spaced openings 60 (see FIG. 5) in the central peripheral surface of said cam member 33. The openings 60 permit initial rotary adjustment of the cam member 33 so as to locate the rollers 36 at predetermined positions along the grooves 35 according to any particular pattern of forming the tube 8.

Chain 57 is secured at one end to a bracket 61 arranged at the upper end of piston extension 28. As will be seen in FIGS. 6 and 7, chains 57 are connected to bracket 61 on either side of the piston extension 28 and depend downwardly therefrom to lay along either sides of the peripheral portion of cam member 33. The ends of chains 57 remote from the bracket 61 are secured to the peripheral surface of cam member 33 by bolts or any other suitable means 62, receivable in one of the spaced openings 63 in the peripheral surface of said cam member 33. The openings 63 permit adjustment of the cam member 33 relative to the rollers 36 in the same manner as that described with respect to chain 56.

In operation, a hollow metallic tube 8 is secured at one end to the rotary head stock 6. The tube 8 extends through a central opening provided in the forming head 11.

The other end of tube 8 is secured for free rotation in steady rest 14 which is slidable along the rails 12 of the lathe bed 5 to a position permitting engagement of the tube portion substantially adjacent its other end remote from the head stock 6 and the steady rest 14 is there secured by any suitable means (not shown) against further longitudinal movement along the rails 12. Additional steady rests not shown but similar to steady rest 14 may be mounted along the rails 12 at intermediate stations for support of the tube between the outer steady rest 14 and the forming head 11. An intermediate tube guide member 65 mounted on the forming head 11 ensures stabilization of the tube 8 along the axis of the rotary head stock 6 while permitting freedom of rotation of the tube. Tube guide member 65 is free to move along the axis of the tube with forming head 11.

Normally the forming head 11 is positioned adjacent to the head stock 6 at the beginning of the operation. The forming head 11 is then set in motion along the lathe bed 5 through the medium of screw 10 which is actuated by the variable speed drive and motor 15 set to drive the screw at a predetermined rate of speed. At the same time the tube 8 is rotated by the rotary head stock 6. Movement of the forming head 11 along the lathe bed causes the template follower 20 on arm 19 of the pantograph 18 to ride along the contour or profile of template 17. The movement of the template follower 20 along the profile of the template actuates through pantograph 18 the hydraulic valve 25 which in turn controls the oil from the hydraulic power system 30 to hydraulic cylinder 29. Movement of the piston in cylinder 29 actuates hydraulic valve 25 through piston rod extension 28 and pantograph 18 connected to the lower end of said extension at 27.

The above actions provide rotary movement of the cam member 33 through chains 56 and 57 connected between the cam member 33 and the piston extension 28 in the manner previously set forth. This rotary movement of cam member 33 acts upon the rollers 36 in the grooves 35 which serve to move the forming rolls 42 along radial lines toward or away from the central longitudinal axis of the rotating metal tube 8 so that the pressure that the forming rolls exert on the metal tube permits controlled shaping of the tube as the forming head 11 moves along the length of the tube.

The template 17 may be contoured or profiled to produce a variety of longitudinal profiles on the tube surface, such as conical tubes, or else of a cylindrical section, followed by a conical section, parabolic and/or other profile sections which may be suitable for light standards, conveyor rolls and the like.

Additionally the pantograph ratio may be changed by adjusting the relative positions of the arms thereof and/or of the template follower along the arm 19 by securing them together in different sets of holes along arms 19, 21 and link 31 according to a prescribed pattern. This allows variation of the pattern either with a template of the same or of another profile.

Then too, changing the attaching points of chains 56 and 57 on the cam member 33 will produce longitudinal profiles of different sizes with the use of the same template. Profiles of intermediate sizes to those given by the different chain positions, can also be obtained by the initial height adjustment of the hydraulic valve 25 in valve support collar 26*b*.

As will be seen in FIGS. 6 and 7, the threaded shank members 68 on one end of chains 56 and 57, extend through openings provided in the outer end member 58 and in the bracket 61 of piston rod extension 28. Nuts 69 screw-threaded on said shank members 68 permit adjustment of the chains to take up any slack in the chains under load and also provide fine adjustment on longitudinal profiles.

The detailed operation of the follow-up system is as follows: if the work-rolls 42 would roll a diameter smaller than required by the shape of template 17, the piston rod extension 28 and point 27 of pantograph 18 would be too high. The pantograph 18 being turned about the template follower 20, the valve follower at point 26, would press down on the valve stem 25*a*. The valve 25 would open to send oil under pressure, coming from hydraulic power system 30 to the upper end of cylinder 29 thus pressing down on the piston. As the piston rod extension 28 and point 27 are moving down, the pantograph 18 turning about template follower 20, the valve follower 26 moves up thus bringing the valve 25 back to neutral and stopping the oil flow to cylinder 29. When the piston of cylinder 29 is stopped in a position corresponding to the neutral position of valve 25, the forming rolls 42 are exactly at the position required by the template. Inversely, if the piston rod extension 28 and point 27 are too low, the valve follower at point 26 would be high and valve 25 would send oil under pressure to the lower end of cylinder 29. As the piston rod extension 28 and point 27 move up, the pantograph 18 turning about template follower 20, the valve follower at point 26 moves down, thus bringing the valve 25 to neutral and stopping the oil flow to the cylinder. Thus any error in the position of the work-rolls 42 automatically opens the valve 25 in such a way as to correct that error. As the template follower 20 is moved by template 17, minute openings of the valve 25 force the piston of cylinder 29 and the forming rolls 42 to follow the movement of template follower 20. When template follower 20 moves up, pantograph 18 turning about point

27, the valve follower at 26 moves up and opens valve 25 to send oil to the lower end of cylinder 29 thus pushing up the piston rod extension 28 and point 27. The pantograph 18 turning about template follower 20, the valve follower 26 moves down and valve 25 is brought back to neutral.

When template follower 20 moves down, valve follower 26 moves down and opens valve 25 to send oil to the upper end of cylinder 29, thus pushing down the piston rod extension 28 and point 27. The pantograph 18 turning about template follower 20, the valve follower 26 moves up and valve 25 is brought back to neutral. Thus, any movement of the template follower 20 is followed by a corresponding movement of the piston of cylinder 29 and the work-rolls 42. This mechanism is very sensitive even with high loads at the work-rolls.

What we claim is:

1. Apparatus for producing variations in the longitudinal profile of metal tubes including means operable for supporting a metal tube adjacent its opposite ends and for rotation about its longitudinal axis, a forming head about said tube and mounted for movement in a direction parallel to the axis of said tube, a cylindrical cam member mounted on said forming head, a series of cams on the inner peripheral surface of said cylindrical cam member, said forming head being provided with a plurality of forming rolls spaced about said tube for movement along lines radial to the axis of said tube towards and away from the axis of the tube, means operably connecting said cams with the said forming rolls to impart said radial movement to the forming rolls in response to movement of said forming head along the length of the tube so that pressure from the forming rolls on the tube produces predetermined variations in the longitudinal profile of said tube as the forming head is moved therealong, a template mounted on said apparatus, hydraulic means including a control valve on said forming head, the said hydraulic means being operatively connected with said cylindrical cam member for rotation of the said cam member about said tube, and a pantograph linkage provided with a template follower engaging with the said template, the said pantograph linkage being operatively engaged with the said control valve to actuate said valve according to the profile of the said template and effect rotation of the said cam member by said hydraulic means.

2. Apparatus as set forth in claim 1 in which said tube supporting means includes a lathe bed, a motor driven head stock at one end of said bed into which one end of said tube is secured for rotation about its longitudinal axis by said motor driven head stock, and tube supporting means mounted on said bed remote from the head stock for rotatably supporting said tube remote from its connection to the head stock.

3. Apparatus as set forth in claim 2 in which said tube supporting means comprises at least one steady rest mounted for sliding movement on said lathe bed parallel to the longitudinal axis of the tube to selected positions of adjustment enabling said steady rest to support the tube at various places along the length thereof.

4. Apparatus as set forth in claim 2, including a tail stock mounted at the end of said lathe bed remote from the head stock, means mounting said forming head for sliding movement along said lathe bed parallel to the longitudinal axis of said tube, means carried by said tail stock for operative engagement with said forming head and a variable speed drive and motor mounted to drive said forming head operative means for movement of said forming head along said lathe bed at predetermined rates of speed.

5. Apparatus as set forth in claim 4 in which said

forming head operative means comprises a screw, said variable speed drive and motor being mounted on said tail stock to rotate said screw about a longitudinal axis parallel to the longitudinal axis of the tube, and a half nut carried by said forming head in operable engagement with said screw.

6. Apparatus for producing variations in the longitudinal profile of metal tubes, including a lathe bed and means operable for supporting a metal tube adjacent its opposite ends and for rotation about its longitudinal axis, a forming head mounted for movement in a direction parallel to the axis of the tube, said forming head being provided with a plurality of forming rolls spaced about said tube for movement along lines radial to the axis of the said tube towards and away from the axis of the tube, means operable to impart said radial movement to the forming rolls in response to movement of said forming head along the length of the tube, said latter means including a cylindrical cam member mounted on said forming head about said tube to rotate about an axis coinciding with the longitudinal axis of said tube, said cam member having a web inside the periphery thereof provided with a central opening through which the tube extends and provided with a plurality of identically contoured grooves equally spaced about the axis of said cam member, rollers mounted in said grooves to rotate about axes parallel with the axis of said tube, a spindle extending along the axis of each roller and one of said forming rolls being mounted on the free end of said spindle for rotation about the axis thereof, means operably connected to said cam member for rotation of the same, said latter means including a template mounted along one side of said lathe bed, a hydraulic system including a hydraulic cylinder and piston device and a control valve, a pantograph having one arm operably connected to the said control valve and another arm connected to the piston of said cylinder and piston device, the said pantograph having a template follower mounted on said template so that during movement of the forming head along the lathe bed said template follower will move along the profile of the template causing the arm of the pantograph connected to the control valve to actuate the said valve according to the profile of the template and cause the said piston of the cylinder and piston device to rotate the cam member in one direction in response to outward movement of the piston and in the other direction in response to inward movement of the piston.

7. Apparatus as set forth in claim 6, in which said pantograph is adjustable to transmit to the forming rolls variations in the patterns produced on the profile of the template.

8. Apparatus as set forth in claim 6, in which said means connecting the cam member to the piston are adjustable to vary the relative positions between the forming rolls in relation to the profile of the template.

9. Apparatus as set forth in claim 6, in which said control valve is adjustable to vary the relative positions between forming rolls in relation to the profile or the template.

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