July 11, 1950 P. MUELLER 2,514,507

METHOD AND MACHINE FOR POINTING TUBES

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Fig. 1.

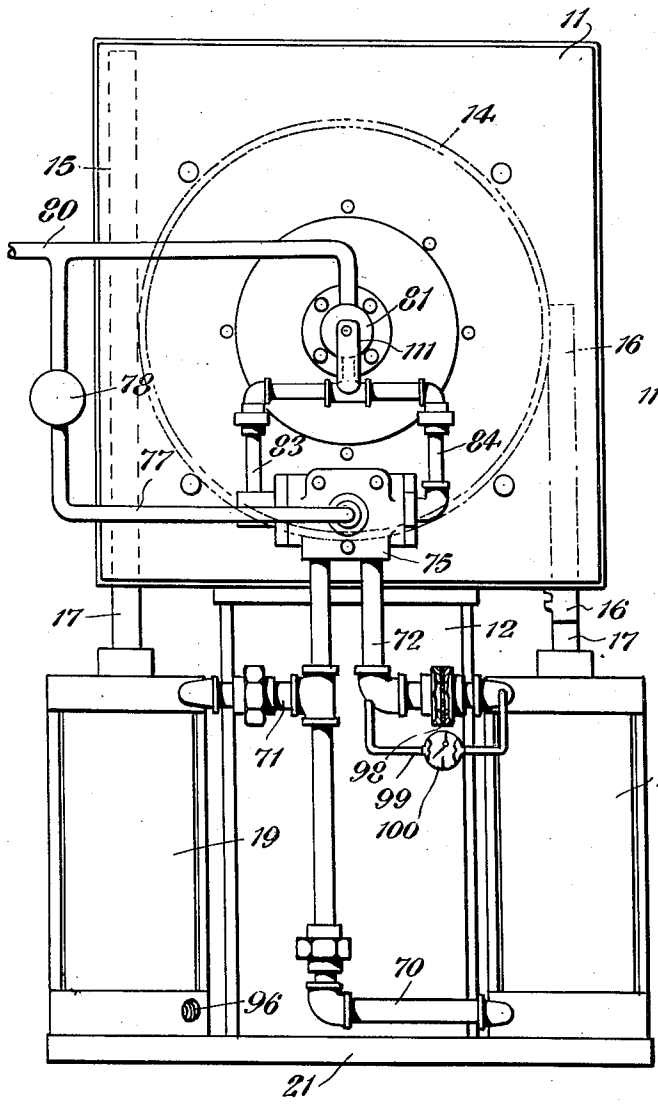

Fig. 2.

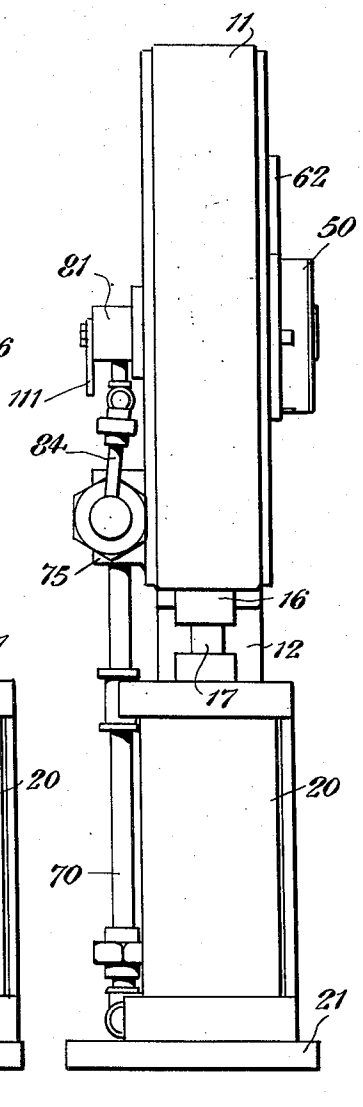

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Fig. 3.

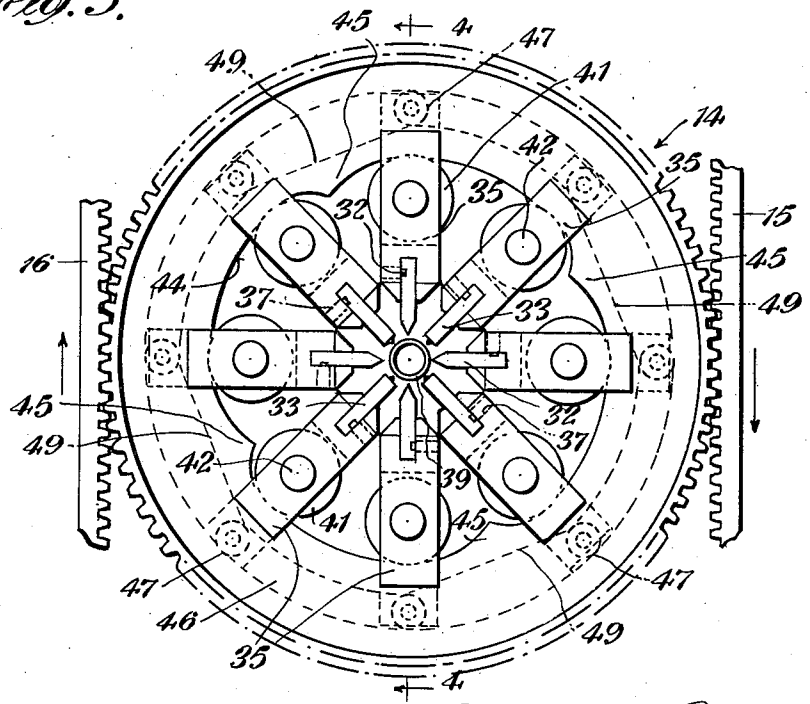

Fig. 4.

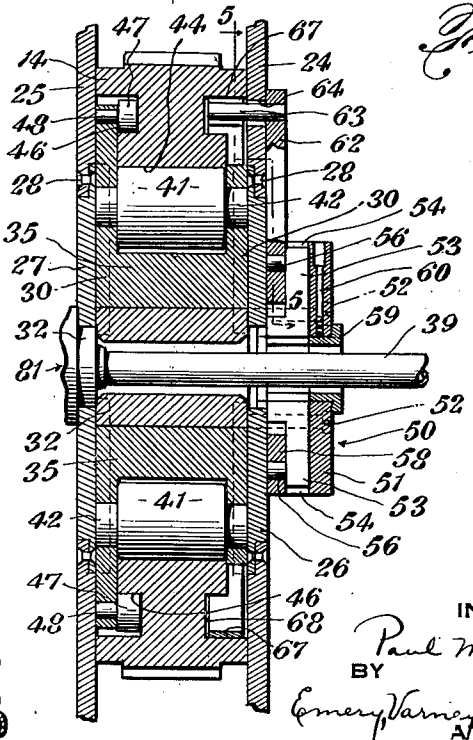

Fig. 5.

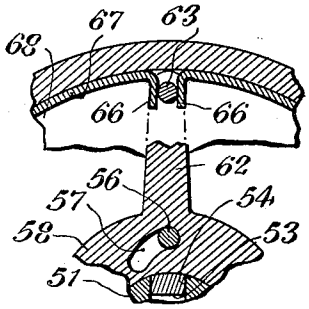

Fig. 6.

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METHOD AND MACHINE FOR POINTING TUBES

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Fig. 7.

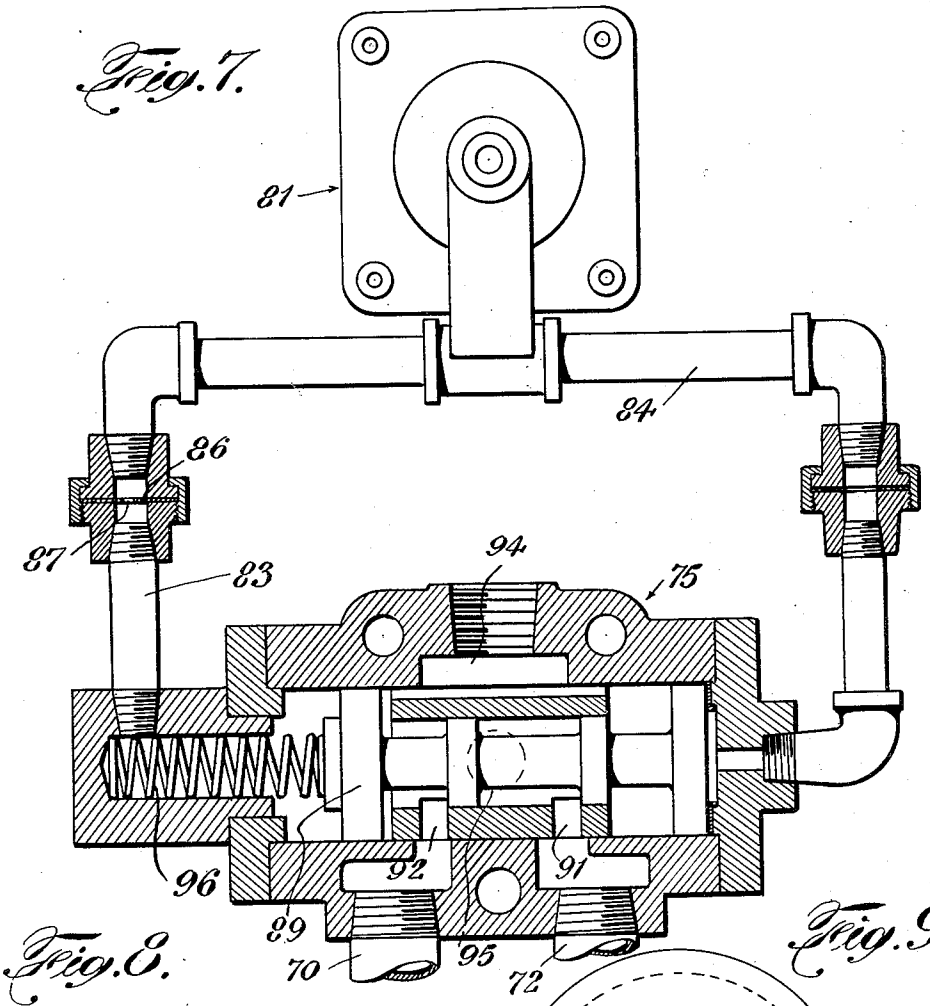

Fig. 8.

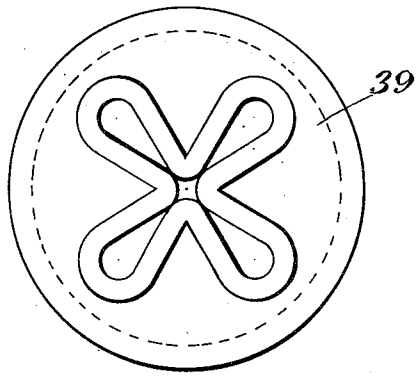

Fig. 9.

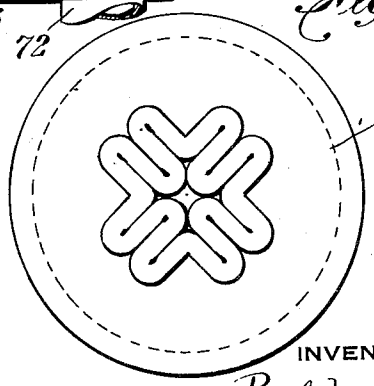

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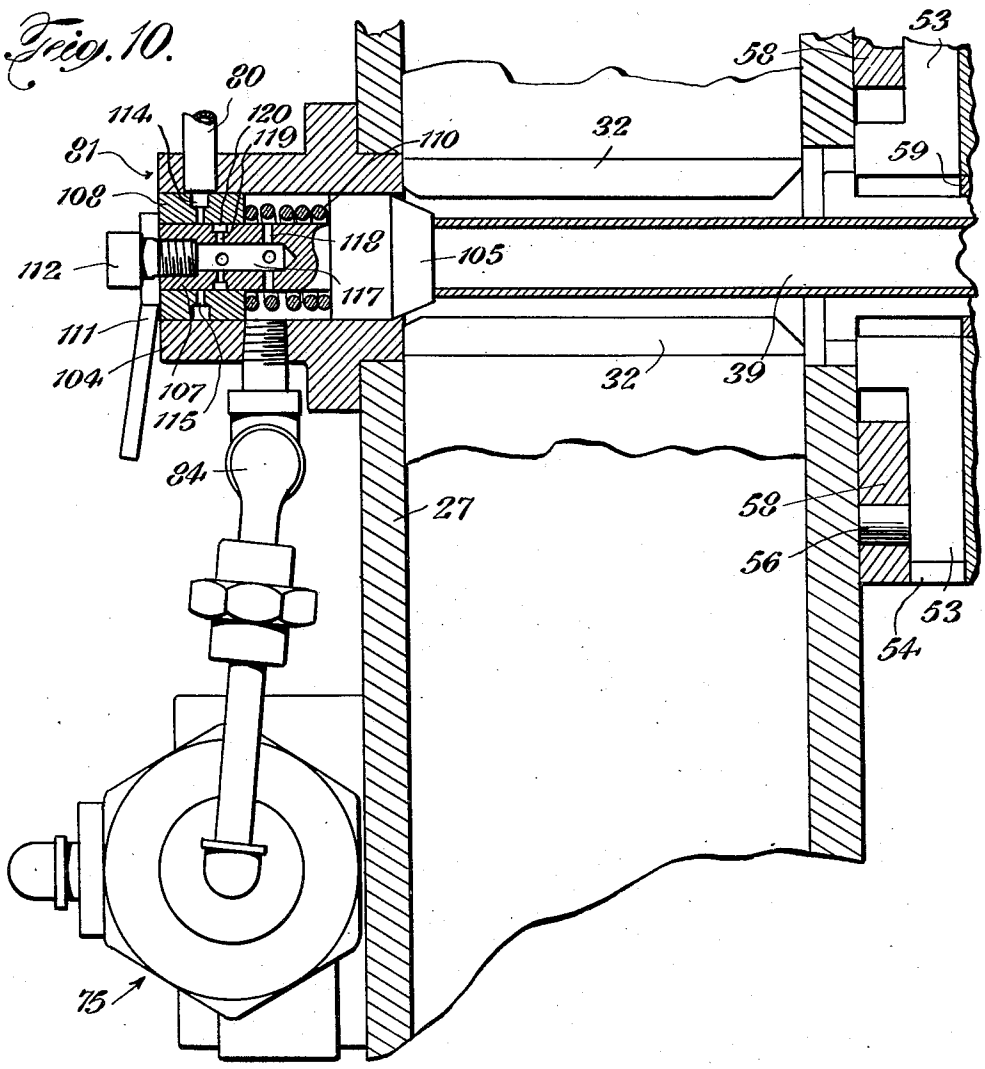
Fig. 10.



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UNITED STATES PATENT OFFICE

2,514,507

METHOD AND MACHINE FOR POINTING TUBES

Paul Mueller, Rome, N. Y.

Application December 8, 1944, Serial No. 567,287

10 Claims. (Cl. 153—70)

1

This invention relates to method and apparatus for pointing tubes that are to be drawn.

One object of the invention is to provide a more efficient and more effective method for pointing tubes. The invention collapses the end portion of a tube by the application of pressure at a number of spaced points around the circumference of the tube, and the pressure for the complete pointing operation is applied in successive stages. In the preferred method of applying the invention the tube is collapsed by pressure at four equally spaced points to form a cross section that has four lobes, that is, a clover leaf shape. In a second stage of the pointing operation pressure is applied to the lobes to fold them inward so that the final point has eight lobes folded in upon each other to make a point that is substantially solid. The invention is not limited to forming with four and eight lobes, but such forming produces a point of minimum transverse dimensions and one that is of generally square section which fits readily into alligator jaws such as commonly employed with drawing tongs.

An important advantage in this invention is that the point formed is of such small cross section that two draws can be made before repointing. This not only saves time, but it reduces the scrap losses because the end of the tube has to be cut-off prior to each subsequent pointing.

Another object of the invention is to provide improved apparatus for pointing tubes by means of punches that squeeze the tube from several directions instead of hammering from opposite ends of one diameter. Both noise and maintenance are reduced.

Other objects are to provide pointing apparatus that can be used on tubes having different wall thicknesses and a wide variety of diameters, without adjustment or change of parts, and to provide apparatus for pointing tubes at higher rates of production.

Other features of the invention relate to mechanism for operating the punches of the pointing die, to automatic control means responsive to the insertion of a tube into the die, and to adjustments for controlling the force that the die exerts against the tube.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawings forming a part hereof in which like reference characters indicate corresponding parts in all the views:

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Figure 1 is a rear elevation of a tube pointing machine embodying this invention.

Figure 2 is a side elevation of the machine shown in Figure 1.

Figure 3 is a fragmentary front elevation of the die and part of the operating mechanism of the machine shown in Figure 1, the centering chuck and its operating mechanism being omitted.

Figure 4 is a sectional view taken on the line 4—4 of Figure 3, with a tube in place and ready to be pointed.

Figure 5 is a detail sectional view taken on the line 5—5 of Figure 4.

Figure 6 is a side elevation of the tube of Figure 4 after the tube has been pointed.

Figure 7 is an enlarged view, mostly in section, of the cycle control valve shown in Figure 1.

Figure 8 is an enlarged end view of the tube after the first collapsing operation of this invention.

Figure 9 is an enlarged end view of the tube shown in Figure 6, this figure being also a view of the end of the tube of Figure 8 after the tube has been subjected to the second stage of the pointing operation, the position of the tube being turned 45° in Figure 9 from the position shown in Figure 8.

Figure 10 is a fragmentary sectional view taken on a vertical plane coincident with the axis of the work receiving opening of the machine.

The machine shown in Figure 1 includes a housing 11 supported by a pedestal 12. Within the housing 11 there is a cam wheel 14 with gear teeth around its periphery. These gear teeth mesh with the teeth of racks 15 and 16 located on opposite sides of the cam wheel 14. The racks 15 and 16 slide in stationary bearings in the housing 11 and are connected at their lower ends with piston rods 17. These piston rods are moved up and down by motors 19 and 20. The pedestal 12 and the motors 19 and 20 are all connected to a common base 21.

The housing 11 includes a front face plate 24 (Figure 4) and a rear face plate 25. Ram guides 26 and 27 are connected to the face plates 24 and 25 respectively by fastening means such as rivets 28. The outside surface of the ram guides 26 and 27 are flush with the outside surface of the face plates 24 and 25, but the ram guides extend inward beyond the face plates 24 and 25 and have channels 30 in which are guided the rams that hold the punches for pointing the end of a tube.

Figure 3 shows the tube-pointing die and the relative positions of the punches and rams with respect to the wall of a tube. There are two sets of punches, and four punches in each set. The punches of the first set are indicated by the reference characters **32**, and the punches of the second set by the reference characters **33**. All of the punches are carried by similar rams **35**. There is a channel in the end of each of the rams **35**. Each of the punches fits into the channel of its corresponding ram **35** and bottoms against the end of the channel. Retaining pins **37** merely prevent the punches from dropping out of the channels. These retaining pins fit loosely into recesses in the punches and do not take any shearing stress.

In the operation of the apparatus, the punches **32** move inward simultaneously against the side of a tube **39** and deform the tube into a four lobe or clover leaf form such as shown in Figure 8. The original full diameter of the tube is shown in the background. The punches **32** are returned to their original positions, shown in Figure 3, and the second set of punches **33** are then moved against the surface of the tube at points intermediate the regions where the force was applied by the first set of punches **32**.

The punches **33** have center points that strike the lobes of the tube end and indent the mid portions of each lobe and push down also on the metal of the lobe to either side of the center point so as to crush the lobe and force its outer sides into contact with the outer sides of the adjacent lobes so as to obtain the deep and closed folds shown in Figure 9. The same crushing pressure applied to the lobes forces the outside surfaces of the indented portions into contact with the inside surfaces of the respective lobes on which the indented portions are folded back, to produce the cross section shown in Figure 9.

In Figure 8 the tube is folded to a contour in which the collapsed walls are in contact with one another. Whether or not the first stage of the pointing operation brings the inside walls of the tube into contact depends upon the wall thickness of the tube. The second stage of the pointing operation always collapses the tube to a substantially solid section, that is, a section in which the various folds are brought as close together as possible.

The rams **35** are guided on both sides by the channels or guides **30** of the ram guides **26** and **27**. Each of the rams **35** has a roller **41** supported from the ram by an axle **42**. The force for moving the rams **35** inward to exert pressure against the tube is applied to the rollers **41** by a cam face **44** on the inside surface of the cam wheel **14**. The contour of this inside surface is shown in Figure 3. The surface is circular, with its center of curvature coincident with the axis of the tube **39**, except for four cam sections **45**.

As the cam wheel **14** rotates clockwise (Figure 3), the cam sections **45** first strike the rollers **41** of the rams **35** that carry the first set of punches **32**. The cam sections **45** displace these rollers **41** and cause the first set of punches **32** to move inward simultaneously far enough to collapse the tube into the clover leaf contour. It is a feature of the invention that the first set of punches **32** do not move to their limit of travel before the highest points of the cam sections **45** pass over the rollers **41** of the rams that operate the first set of punches. This means that the length of the punches **32** must be so chosen with respect to the maximum wall thickness with which the die is intended to be used that the sides of the tube are not bent into contact with one another before the highest portions of the cam sections **45** have passed over the rollers **41**.

Further clockwise movement of the cam wheel **14** causes the cam sections **45** to pass to the rollers **41** of the rams by which the second set of punches **33** are carried. During this continued movement of the cam wheel **14**, the rams that carry the punches **32** of the first set are returned to their original positions, by means which will be explained, and the cam sections **45** displace the rollers **41** which control the movement of the second set of punches. It is a feature of the invention that punches **33** are of such length that they collapse the end of the tube as solidly as possible before the high points of the cam sections **45** have fully displaced the rollers **41** that control this second stage of the pointing operation. The cam wheel **14** is therefore stalled by the pressure of the punches **33** against the tube **39**; and the cam wheel **14** is made with a heavy section so that it operates as a flywheel and transmits a substantial amount of energy for crushing the tube in the final stage of the pointing operation.

The invention is not limited to the use of four punches for each stage. Three punches may be employed in each set, but the result is not as satisfactory as with four because the size of the final point is larger when three punches are used in each set, and the shape of the point is not as well adapted to use in conventional alligator jaws such as commonly employed for tube drawing tools. One of the principal advantages of the use of four punches for each stage of the pointing operation is that the final point, as shown in Figure 9, has a square outline that is easily and effectively gripped by alligator jaws. This form has four lobes with each lobe folded inward at its mid-point to make the original lobes double.

The structure for returning each of the rams **35** to its original position, after the punches have been thrust inward against the tube, is shown in Figure 3 and 4. The cam wheel **14** has a cam track **46** in its rearward face and each of the rams **35** has an extension on one side that supports a cam follower roller **47** that runs in the cam track **46**. An axle **48** connects the cam follower **47** to the ram **35**. The portions of the cam track **46** that overlie the cam sections **45** are chords of the cam track circle. The cam followers **47** receive no support from the middle portions of these chord sections **49** of the cam track **46** and the rams **35** are, therefore, free to move inward when displaced by the cam sections **45**.

The portions of the cam track **46** intermediate the chord sections **49** are circular about the axis of the tube as a center and these circular portions of the cam track **46** hold the rams **35** back from the tube **39**. As the end portions of the chord sections **49** pass under the rollers **47** after the punches have been thrust inward against a tube, the rollers and their associated rams **35** are pulled back away from the tube and reach fully retracted positions when the circular portions of the cam track **46** are under the cam follower rollers **47**.

The tube is held in a centering chuck **50** during the pointing operation. This centering chuck includes a body portion **51** (Figure 4) that is fastened to the ram guide **26** by fastening means such as screws **52**. Chuck jaws **53** slide in guides **54** in the body portion of the chuck and are

moved radially by cam followers 56 that extend into cam slots 57 (Figure 5) in a cam plate 58. The chuck 50 has a hub portion that serves as the supporting bearing for the cam plate 58. Extending into the front end of the center opening through the chuck is a bushing 59 into which the tube fits. This bushing is retained in the end of the chuck as a holder by detachable fastening means comprising a set screw 60, and when the machine is to be used for tubes of different diameters, a bushing 59 to fit the particular size of tube is preferably put into the end of the chuck and secured in place by the set screw 60. No other change or adjustment is necessary, and this bushing is not essential if the tubes are inserted carefully.

The cam plate 58 has a limited angle of movement and this movement is imparted to it by an arm 62 that extends upward from the cam plate 58. A pin 63 attached to the upper end of the arm 62 extends through a slot 64 in the face plate 24. The end of the pin 63 extends between downwardly extending lugs 66 of a friction band 67 which is made of spring material and confined in a groove 68 in the front face of the cam wheel 14 opposite the cam track 46.

The friction band 67 rotates with the cam wheel 14 through a limited angle and further rotation is prevented by the pin 63 which can move only as far as the limits of movement imposed by the travel of the chuck jaws 53. This means that initial rotation of the cam wheel 14 turns the cam plate 58 to make the jaws 53 grip the tube when the cam wheel is making its working stroke and release the tube when the cam wheel 14 begins to turn in the opposite direction.

As soon as the jaws 53 have reached their limit of movement, the pin 63 cannot move further and the friction band 67 slips with respect to the cam wheel 14 during the remainder of the rotation of the cam wheel in the same direction. This construction has the advantage of operating the centering clutch 50 during the first part of the rotary movement of the cam wheel 14 no matter which way the cam wheel turns, and regardless of how far the cam wheel has turned before being stalled by the second state of the pointing operation.

The cam wheel 14 is turned clockwise in Figure 3 by downward movement of the rack 15 and upward movement of the rack 16. Movement of the racks in the opposite direction causes counterclockwise rotation of the cam wheel 14. In the illustrated embodiment of the invention the cam wheel 14 turns clockwise during the working stroke, that is, the operation of the punches 32 and 33 by clockwise movement of the cam sections 45 applies force to the tube to form the point. The first set of punches 32 are also operated through an idling stroke during the return movement of the cam sections 45 but this idle operation does not take place until after the tube is removed from the apparatus, special provision being made for returning the cam wheel 14 at a slower rate than its movement during the pointing operation.

Working fluid flows to and from the head end of the motor 20 through piping 70. Working fluid flows to and from the crank end of the cylinders of motors 19 and 20 through piping 71 and 72 respectively. A valve element for controlling the flow of working fluid, preferably compressed air, is located in the housing of a cycle control valve 75.

The supply of air for operating the motors 19 and 20 comes to the cycle control valve 75 through an air supply line 77 in which there is a pressure reducing valve 78. Air at high pressure is supplied from a compressed air tank or other source through a conduit 80. The conduit 80 communicates directly with a master valve 81 and has a branch through which high pressure air is supplied to the pressure reducing valve 78. The master valve 81 communicates with opposite ends of the housing of the cycle control valve 75 through piping 83 and 84.

By regulating the delivery pressure at which air is supplied to the cycle control valve 75 from the pressure reducing valve 78, the speed and pressure of the motors 19 and 20 can be adjusted to govern the striking force of the cam wheel 14 in operating the punches for the second stage of the pointing operation. It is this second stage that stalls the cam wheel. A heavy wall tube of maximum diameter for which the apparatus is intended may require the full line pressure of 80 lbs. per square inch, but a $\frac{7}{16}$ x .020 tube can be pointed in the same apparatus with air pressure of only 15 lbs. per square inch.

The control air supplied to the master valve 81 is always kept at high pressure in order to give rigidity to the automatic stop and to avoid changing the timing of the cycle of the pointing machine.

Figure 7 shows the construction of the cycle control valve 75. The piping 84 which connects the right-hand end of the cycle control valve with the master valve 81 is unobstructed and permits rapid flow of air. The piping 83 which connects the other end of the cycle control valve with the master valve 81 is obstructed by a disc 86 in which there is an orifice 87 for permitting a reduced flow of air to the left-hand end of the cycle control valve 75. The disc 86 can be replaced with another disc having a smaller or larger orifice 87 if it becomes desirable to change the timing of the cycle of the machine. A needle valve can be used in place of the disc 86.

Within the housing of the cycle control valve 75 there is a valve element 89 of the piston type with several sections of reduced diameter for controlling the flow of air to the various ports in the wall of the valve housing. There are ports 91 and 92 which communicate with the piping 72 and 70 respectively, and there is a center port 94 at the top of the valve housing through which air from the motor is exhausted to the atmosphere.

Air supplied to the cycle control valve 75 by the piping 77 enters the cycle control valve housing through the inlet port 95 which is ahead of the plane of section of Figure 7 but indicated by dot and dash lines. In the left-hand end of the housing of the control valve 75 there is a spring 96 that urges the valve element 89 toward the right.

When the master valve 81 is operated to supply air to the cycle control valve 75, air flows through the piping 84 faster than it flows through the piping 83 and builds up sufficient pressure behind the right-hand end of the valve element 89 to move this valve element to the left against the pressure of the spring 96 and puts the valve port 91 in communication with the exhaust port 94, and an inlet port 95 in communication with the port 92 through which air flows to both motors 19 and 20. With the valve element 89 at the left-hand end of its housing,

therefore, the motors 19 and 20 operate the apparatus through its working stroke.

When the valve element 89 is moved back to the position shown in Figure 7, air from the inlet 95 flows through the port 91 to the piping 72. This supply of air causes the piston rod 17 of motor 20 to move downward. Such motion resets the machine to initial or starting position. The valve element 89 in Figure 7 is in position to permit exhaust air from the piping 70 to flow through the port 92 and out through the exhaust port 94.

The motor 19 is only single acting and does not work during the return movement of the apparatus.

In the head-end of the cylinder of motor 19, there is a port 96 through which that end of the cylinder is in communication with the atmosphere at all times. Much less work is required for the return stroke of the apparatus than for the working stroke and the power of one motor is sufficient.

It is desirable that the return stroke be made slowly enough so that the operator will have time to remove the tube before the first set of punches are operated through an idling stroke by the returning cam sections. No production time is lost by this slow return stroke because the operator must be given time to remove one tube from the machine, place the pointed tube on a conveyer or otherwise dispose of it, and then reach for a new tube and insert the new tube into the machine.

The working stroke of the machine requires approximately one second, and experience has shown that a period of five seconds is satisfactory for the return stroke. These figures are given as illustrative only, and the machine can be made to operate with different timing.

Figure 1 shows a disc 93 for obstructing the flow of air to the crank-end of the cylinder of motor 20. There is an orifice in this disc just large enough to permit the motor 20 to make its return stroke in five seconds, or such other time as is selected for the return stroke. In order to prevent the disc 93 from obstructing the exhaust air from motor 20 during the power stroke, a by-pass 99 is provided around the disc 93. A check valve 100 prevents air from flowing into the motor 20 through the by-pass 99.

After the valve element 89 (Figure 7) has been pushed to the left, against the pressure of the spring 96 by the initial flow of air through the piping 84, air will continue to bleed through the orifice 87 and build up the pressure behind the left-hand end of the valve element 89 until the air pressure difference at opposite ends of the valve is sufficiently reduced for the spring 96 to push the valve element 89 back to the right-hand end of the housing. This time interval between the movement of the valve element 89 to the right, and its subsequent return, is long enough to permit the apparatus to make its working stroke.

Figure 10 shows the construction of the master valve 81. This valve includes a housing 104 secured to the front of the ram guide 27. Within the housing 104 there is a piston 105 that has a conical end which extends into the path of the punches 32 and 33. The piston 105 is connected to one end of a valve element 107 that extends forward and through a plug 108 that forms the front wall of the housing 104.

A spring 110 urges the piston 105 toward the right. There is a handle 111 attached to the left-hand end of the valve element 107 by a screw 112 and this handle contacts with the outside face of the plug 108 and limits the movement of the piston 105 to the right under influence of the spring 110. The handle 111 is used to pull the valve element 107 and piston 105 to the left, against the pressure of the spring 110, when operating the master valve by hand. In the ordinary operation of the machine, however, the piston 105 is moved to the left automatically, first by the insertion of a tube and second by the punches 32 when they move inward and strike against the conical face at the end of the piston 105. This conical face acts as a cam surface when subjected to pressure by the punches, and the left-hand end portion of each of the punches is sloped so as to cooperate with the conical end of the piston 105 in thrusting the piston toward the left against the pressure of the spring 110.

There is an annular recess 114 in the peripheral face of the plug 108 and this annular recess 114 registers with an inlet port that opens through the valve housing and communicates with the compressed air supply line 80. The annular recess 114 has a number of ports 115 opening through the wall of the bore in which the valve element 107 slides. Within the valve element 107 there is a hollow chamber 117. This chamber 117 communicates with the interior of the housing 104, behind the piston 105, through ports 118. The chamber 117 has other ports 119 that open into an annular groove 120 in the outside surface of the valve element 107.

When the valve element 107 is in its normal position, as illustrated in Figure 10, no air can flow from the ports 115 into the interior of the valve housing 104. When a tube 39 is inserted into the machine, the operator pushes the tube forward until it strikes the piston 105.

After the tube 39 strikes the piston 105, the operator continues to push the tube forward until the piston 105 and the valve element 107 have moved back far enough to bring the annular groove 120 into register with the ports 115. When the valve element 107 reaches this position, air from the supply line 80 flows through the ports 115 and 119 into the chamber 117 within the valve element and out through the ports 118 into the space behind the piston 105. This air pressure prevents the piston 105 from moving back any further unless the piston is subjected to considerably more force than that exerted by the operator pushing the tube into the machine.

The compressed air supplied to the interior of the valve housing 104 behind the piston 105 flows through an outlet at the bottom of the housing and into the piping which leads to the cycle control valve 75. This supply of air operates the cycle control valve, as explained in connection with Figure 7, and causes the motors to operate the machine and move the punches 32 inward against the tube 39. Inward movement of the punches 32 brings the end portions of the punches into contact with the conical surface of the piston 105 and pushes the piston further to the left and entirely out of the path of the dies 32. The annular groove 120 is made sufficiently wide so that this additional movement of the piston 105 and valve element 107 does not move the annular groove 120 beyond the ports 115. When the punches 32 return to their original starting position, the spring 110 moves the piston 105 back against the end of the partially-pointed tube, but the piston is again pushed back, without

affecting the compressed air supply to the motors, by the second set of punches 33.

One important advantage of the piston 105 as a stop for the tube is that the end of the tube is located in a position back from the sides of the punches and there is, therefore, no enlargement or flare at the tube point such as would occur if the tube extended to the ends of the punches.

The preferred embodiment of this invention has been described, but changes and modifications can be made and some features of the invention used without others without departing from the invention as defined in the claims.

I claim:

1. A tube-pointing machine including a die with punches for collapsing the walls of a tube, mechanism for moving the punches against the tube, gas-operated motor means for actuating said mechanism, a cycle control valve for supplying working fluid to the motor means and for controlling the direction of movement of the motor means, apparatus actuated by the insertion of a tube into the machine for moving the control valve in one direction, and timing apparatus for causing the control valve to move in the opposite direction.

2. A tube-pointing machine including a die with punches for collapsing the walls of a tube, mechanism for moving the punches against the tube, gas-operated motor means for actuating said mechanism, a cycle control valve for supplying working fluid to the motor means and for controlling the direction of movement of the motor means, master valve means for supplying compressed gas to the cycle control valve to operate said cycle control valve, a compressed gas conduit leading to the master valve means, a branch conduit for supplying compressed gas to the motor means through the cycle control valve, and a pressure regulator in the branch conduit for regulating the speed and power of the motor means.

3. Apparatus for pointing tubes of various diameters, said apparatus comprising a centering chuck, a holder with detachable fastening means for gripping a bushing of a size to fit a particular diameter of tube, jaws in the centering chuck for gripping the tube, cam mechanism for moving the jaws, an operating arm for the cam mechanism, face plates comprising a frame with an opening through which an end of the tube extends, fastenings connecting the centering chuck to the outside of the frame in line with said opening, ram guides connected to the inside of the frame and extending radially from the axis of the tube at angularly spaced regions around the outside of the tube, rams slidable in the guides, a punch carried by each ram at its inner end, cam followers on the rams, a flywheel within the frame and surrounding a portion of each of the rams including said cam followers, gear teeth around the periphery of the flywheel, cam surfaces on the inside surface of the flywheel for thrusting the cam followers and rams inward to move the punches against the tube, racks in mesh with the teeth of the flywheel, cylinder and piston motors for moving the racks to rotate the flywheel, a friction connection between the flywheel and the operating arm of the clutch jaw cam mechanism for moving said arm to operate the clutch jaws in response to the initial movement of the flywheel in either direction, a stop against which the end of the tube abuts when pushed through the jaw clutch and into the frame, valve means operated by displacement of the stop for supplying working fluid to the motors, and means for reversing the position of the valve means after a predetermined lapse of time.

4. The method of pointing a tube in preparation for a drawing operation, which method comprises applying pressure to the sides of a tube at regions spaced angularly around the circumference of the tube, and by such pressure deforming the wall of the tube with inwardly extending bends that are adjacent to one another near the center of the tube and that are separated from one another circumferentially by lobes of the tube wall, and then indenting the lobes by applying pressure to them at points intermediate said regions and with sufficient force to make permanently deformed inwardly extending bends at the mid portions of the lobes, and simultaneously applying pressure to all of the lobes on opposite sides of the points of indentation with sufficient force to bring the sides of all of the bends substantially into contact with their next adjacent bends to obtain a point of minimum cross section.

5. In the pointing of tubes for drawing, the improvement that comprises collapsing the tube wall by a plurality of forces applied at spaced regions around its periphery to make inwardly extending bends with lobes of the tube wall between them, performing the final pointing operation by indenting the center portions of the lobes inwardly into bends and applying crushing force to all of the lobes at regions on both sides of the points of indentation with sufficient force to bring the sides of adjacent bends together into a substantially solid point.

6. The tube pointing process comprising collapsing the end of a tube to form a clover leaf section, and then reducing the section by indenting the middle portions of the lobes and crushing the lobes until their sides come into contact with one another, and applying pressure against the tube wall of both sides of the indentation and until the indented portion of the lobe is forced into contact with the confronting inside surface of the lobe.

7. The method of making a substantially solid point of generally square cross section on an end of a round tube preparatory to a drawing operation, which method comprises applying force to the outside of the tube at four spaced locations and by such force deforming the tube wall to a clover leaf cross section with inwardly extending bends that substantially touch one another near the center of the tube and that are circumferentially separated by lobes of the tube wall, then applying force simultaneously to each of the lobes, first at the mid point of each lobe of the clover leaf to indent the lobe into a shallow bend and thereafter to the portions of the tube wall on both sides of the indentation until the metal is collapsed far enough to bring the outside walls of adjacent lobes into contact with one another and to bring the walls of the indentations into contact with the inside walls of the lobes.

8. Tube pointing apparatus comprising a device into which a tube end is inserted, pointed punches at spaced regions around the tube, mechanism for moving the punches against the tube and through a stroke that deforms the side walls into deep bends in the first stage of the pointing operation, other punches pointed at

regions intermediate the first punches, said other punches including points that indent the portions of the tube wall between the bends into other bends of less depth than the bends made by the first punches, and said other punches also having surfaces that apply pressure on both sides of the indentations in directions to collapse the portions of the tube between the bends and bring the sides of the adjacent bends together, and mechanism for moving said other punches into contact with the tube.

9. A tube pointing machine including two sets of punches, one set comprising angularly spaced devices with pointed ends for deforming the tube wall into inwardly extending bends circumferentially spaced by lobes of the tube wall between them, and the other set comprising devices angularly spaced from one another and located substantially midway between the punches of the first section, each of the devices having a point that imparts a reverse bend to the lobe beneath it and each of said devices having surfaces that contact with the surfaces of the lobe on both sides of the point that imparts the reverse bend, mechanism for moving the punch devices of the second set through a stroke that collapses the lobes and brings the confronting inside surfaces of adjacent bends into substantial contact with one another.

10. Tube pointing apparatus comprising a set of punches movable inward against a tube at spaced points around the circumference of the tube, mechanism for moving the punches through a stroke sufficient to deform deep bends in the tube wall separated by lobes, a second set of punches angularly spaced from one another and located substantially midway between the punches of the first set, each of the punches of the second set including a point that indents a bend in the lobe beneath it and including surfaces that contact with the metal on both sides of the lobe for collapsing said lobe so that the sides of adjacent lobes are forced together, mechanism for operating the second set of punches including a flywheel and cam wheels that thrust the punches inward against the tube, the throw of said cam wheels being so correlated with the cross section and wall thickness of the tube that the sides of the bends made by the first set of punches are pressed together and the portions of the lobes indented by the second set of punches are pressed into contact with the inside surfaces of the lobes before the punches of the second set have moved through a stroke corresponding to the full throw of the cam wheels, and the apparatus is thus stalled by the resistance encountered by the second set of punches.

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