(19) Canadian Intellectual Property Office / Office de la Propriété Intellectuelle du Canada

An Agency of Industry Canada / Un organisme d'industrie Canada

(11) CA 655353 (13) A

(40) 08.01.1963

(12)

(21) Application number: 655353D

(22) Date of filing: ..

(51) Int. Cl:

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(54) **TUBE TAPERING MACHINE**

(57) **Abstract:**

This invention relates to a tapering machine primarily designed for tapering tubes.

A primary object of the invention is to provide an improved machine which will produce tapered tubes from cylindrical tubular stock, which tapers may be from the diameter of the tubular stock to a smaller diameter and/or back out, if desired from a smaller diameter to any diameter up to the diameters of the original tubular stock, or any combination of these tapers.

Heretofore, certain types of tube tapering machines or reducing machines have been devised wherein tubular metal stock has been rotated about its longitudinal central axis and wherein spinning rolls or shoes have worked on the exterior of the tube to deform it from its initial cylindrical shape and initial diameter to a smaller diameter of either straight or tapered shape. The surface presented against the workpiece or tubular stock by the rolls or shoes each of which has been convex, tends to bend or flex the metal of the tube wall in a direction opposed to its circumferential curve or configuration. This flexing which is repeated revolution after revolution of the tube as the rolls or shoes progress along the tube length, has a tendency to produce longitudinal cracks or to propogate insignificant scratches on the tube wall into cracks. This is particularly true on the inner surface of the tube.

An object of the present invention is to provide an improved machine of this character wherein the tool which works on the metal of the workpiece to deform it is in the form of an annular ring presenting a concave surface or line of contact toward the convex surface of the tubular stock. By having the forming

ring that deforms the tubular stock from its cylindrical to its smaller diameter or tapered shape in rolling contact with the tubular stock dangers of cracking the surface of the stock are eliminated, the angle between the forming ring and the surface of the stock is materially reduced, and lubricant when used, is more easily retained or replaced between the forming ring and the stock.

Still another object of the invention is to provide a tube tapering machine having the above-mentioned characteristics wherein backup rings bearing on the stock in opposition to the forming ring can serve to steady the stock and properly support it while the metal of the stock is being deformed by the forming ring.

Other objects of the invention are to provide a tube tapering or reducing machine having the above-mentioned characteristics wherein provision is made for causing the backup rings to properly bear upon the tubular stock and which is of such a design that the machine may be readily adapted to following a template which will govern the nature of the taper produced upon the tubular stock, thus rendering the machine to a large extent automatic.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a top plan view of the essential parts of the machine embodying the present invention;

Fig. 2 is a vertical section taken substantially upon the line 2--2 upon Fig. 1;

Fig. 3 is a sectional view taken substantially upon the line 3--3 upon Fig. 2;

Fig. 4 is a partial view in vertical section taken substantially upon the line 4--4 upon Fig. 3 in the direction indicated;

Fig. 5 is a top plan view of an alternative form of construction illustrating the manner in which the machine may be converted for automatic operation in following a template;

Fig. 6 is a sectional view taken substantially upon the line 6--6 upon Fig. 5;

Fig. 7 is a sectional view taken substantially upon the line 7--7 upon Fig. 5; and

Fig. 8 is a view similar to Fig. 3, but illustrating another alternative form of construction.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the improved machine consists of a suitable base or bed on which there are ways or rails 10 and 11 at one end of which there is a headstock, not shown, that rotates a chuck 12 or equivalent rotating means which rotates the metal tubing T that is to be tapered or reduced about its longitudinal central axis. On the ways or rails 10 and 11 there is a carriage 13 which is driven longitudinally on the rails by means of a feed screw 14 that is driven off of the headstock so that the progress of the carriage 13 with respect to the rails bears a definite relationship to the rotation of the tube T by the chuck 12. A reverse gear mechanism, not shown, similar to that employed on a machine lathe is associated

with the feed screw 14 so that the carriage 13 can be driven either toward or away from the chuck 12 as desired in forming the required taper on a tube.

The carriage 13 provides transversely extending ways 15 and 16 for the top and bottom of upright standards 17 and 18 through which feed screws 19 and 20 extend. These feed screws have right and left-hand threads at their ends engageable with corresponding threads in the standards 17 and 18 so that as the feed screws are rotated the standards 17 and 18 will be moved simultaneously toward or away from each other in a direction transverse to the axis of rotation of the tubing T.

As a means for rotating the feed screws 19 and 20 each feed screw is equipped with a gear, the gears being indicated at 21 and 22. These gears mesh with a central pinion 23 that can be rotated by means of a handwheel 24 or the equivalent. This mechanism is merely one of several mechanisms that may be designed for simultaneously rotating the feed screws 19 and 20 and thus causing the standards 17 and 18 to move toward or away from each other.

The uprights that compose the standards 17 are connected by a pin 25 on which there is mounted a forming ring holder 26 that is held centrally thereof by means of spacers 27 and 28. The forming ring holder 26 has disposed therein a forming ring 29 which is rotatably mounted in the holder 26 by means of an anti-friction bearing 30. The forming ring 29 is arranged to be in encircling relationship to the tubing T or the workpiece that is to be tapered.

The uprights composing the standard 18 are connected by means of a rockershaft 31 on which are mounted two backup ring holders 32 and 33. Within these backup ring holders there are rotatable backup rings 34 and 35, these being rotatably mounted by means of anti-friction bearings

36.and 37, respectively. The backup rings 34 and 35 are arranged on opposite sides and in side by side relationship to the forming ring 29, and preferably present rather blunt interior surfaces toward the tubing T as compared with the interior surface of the forming ring 29.

The rocker shaft 31 can be rotatably adjusted to any desired position such as by a handle 38 and has an eccentric portion 39 on which one of the backup ring holders, such as the backup ring holder 33, is mounted. By rotating the rocker shaft 31 by means of its handle 38 the eccentric portion 39 can advance or retract the backup ring 35 with relation to the backup ring 34.

The operation of the above-described construction is as follows:

Cylindrical tubing stock T can be chucked in the chuck 12 and rotated about its longitudinal central axis. By rotating the handwheel 24 the standards 17 and 18 can be moved towards each other causing the forming ring 29 to engage the tubing on one side and the backup rings 34 and 35 to engage the tubing on the opposite side.

As the carriage 13 is moved at constant speed on the rails 10 and 11 by means of the feed screw 14 the forming ring 29 is urged against the tubing with sufficient force to deform it from its initial cylindrical condition during its rotation. The forming ring 29 rotates sympathetically with the tubing T and as it presents an internal concave surface opposed to the convex exterior of the tubing, there is a greater area of contact between the forming ring and the tubing than in prior devices wherein the spinning rolls or shoes present convex surfaces toward the tubing that is being worked on. This relatively large area of contact between the concave interior of the

forming ring 29 and the convex exterior of the tubing T is conducive to the maintenance of lubrication between the engaging surfaces to a greater extent than where spinning rolls or shoes present convex surfaces toward the convex exterior of the tubing. The same observations may be made with respect to the backup rings 34 and 35 which encircle the tube T and also rotate sympathetically with the tubing. These backup rings serve primarily to support and steady the tubing in opposition to or in reaction to the action of the forming ring 29 while the tubing is being deformed or tapered by the forming ring.

The construction as illustrated in Fig. 3 illustrates the forming ring 29 as moving from the top of the tubing shown in this figure toward the bottom in tapering the tubing from its initial or larger diameter toward the smaller diameter. In the course of this tapering the handwheel 24 is rotated as the carriage progresses to slowly move the standards 17 and 18 towards each other and consequently to move the engaging surfaces of the forming ring 29 toward the opposed engaging surfaces of the backup rings 34 and 35. This procedure of gradually and continually rotating the handwheel 24 to move the standards 17 and 18 towards each other is continued if the taper is a continuous taper, from the initial large diameter to the small diameter. However, it sometimes occurs that it is desired to taper a tube from an initial large diameter to a small diameter and then from the small diameter back to a larger diameter which may be of the size of the initial diameter. Under these circumstances, when the carriage has carried the forming

ring 29 to the location of the small diameter the handwheel 24 is then reversely rotated as the carriage progresses to gradually separate standards 17 and 18 and consequently allow the forming ring 29 and the backup rings 34 and 35 to recede with respect to the axis of the work.

It will be observed that the engaging surface of the backup ring 34 in Fig. 3 is in advance of or closer to the axis of the tubing T due to the fact that the backup ring 35 is bearing upon a portion of the tubing that has not as yet been deformed by the forming ring 29. Backup ring 34 is in engagement with the tubing T after it has been deformed by the forming ring 29. The relationship of the two backup rings 34 and 35 with relation to each other is governed or determined by the rotation of the rockershaft 31 by its handle 38 to cause the eccentric portion 39 to advance or retract the backup ring holder 33 with relation to the tubing. Ordinarily, the movement of the carriage is away from the headstock, in which case the two backup rings may assume the relationship illustrated in Fig. 3. However, if the carriage is being moved toward the headstock the relationship of the two backup rings may be reversed which is accomplisable by the rotation of the eccentric 39.

The improved construction is quite versatile in producing tapered tubular forms. It will be appreciated that with a given length of stock by proper manipulation of the handwheel 24 the tubing T can be deformed and tapered from its initial cylindrical diameter to a smaller diameter. Then, if desired, the taper may be a reverse taper on the same tubing from a smaller diameter to a larger diameter. Or, there may be any combination or succession of these tapers. If the tapers are severe, several passes of the carriage with respect to a given piece of tubing or workpiece may be required. In some instances, it may be necessary to maintain

a given internal diameter along the tapered length of the tubing, and when this is necessary or desired, a tapered mandrel whose external diameter conforms to the internal diameter desired on the tapered tube may be chucked within the tubing T preventing deformation of the metal of the tubing inwardly beyond the exterior of the mandrel.

It will be appreciated from the above-described construction that as the forming ring and backup rings are in encircling relationship to the tubing and roll in their anti-friction bearings sympathetically to the rotating tubing that tendency to gall the surface of the tubing is eliminated. Furthermore, the arrangement is such as to feed and constantly replenish lubricant between the surface of contact of the forming and backup rings and the exterior of the tubing whenever lubricant is employed.

It is, of course, desirable to have the two backup rings 34 and 35 press against the wall of the tubing T with equal force regardless of the degree of taper that is being formed on the tubing, and to this end in lieu of the rocker arm 31 which enables the backup ring 35 to be advanced or retracted relative to the backup ring 34, a suitable equalizer may be employed between the two backup ring holders 32 and 33. This equalizer may be merely in the form of a lever pivotally mounted centrally on the standard 18 and having its two ends pivotally connected to the back-up ring holders 32 and 33. Reactionary forces on either backup ring in excess of the reactionary forces exerted on the other can be instantly equalized through such a lever, or in lieu thereof, a construction may be employed as depicted in Fig. 8. Therein, the forming ring is illustrated at 29a and is rotatably mounted in a forming ring holder 26a that has a slotted connection with the pin 25a. The holder 26a is advanced or retracted with relation to the tubing T by means of a hydraulic or pneumatic ram 40 that

is pivotally connected to the holder 26a and to a part 41 on the carriage. In a similar manner, the holders 32a and 33a for the backup rings 34a and 35a are advanced or retracted with relation to the tubing T by means of hydraulic or pneumatic rams 42 and 43 which are pivotally connected to the holders and to parts 44 and 45 on the carriage.

By supplying the rams 42 and 43 with fluid pressure from the same source or of equal magnitude, both of the backup rings 34a and 35a will be urged against the tubing with the same force in opposition to the forming ring 29a regardless of the degree of taper imparted to the tubing T. As illustrated on Fig. 8, the rockershaft 31 is dispensed with and is replaced by a pin 46 with which the backup ring holders 32a and 33a have a pin and slot connection.

The improved construction is so designed that it may be rendered automatic as illustrated in Figs. 5, 6, and 7. As therein illustrated a template 50 which may have a single taper, a double taper, or any combination of tapers, can be mounted stationary with respect to the rails 10 and 11. The carriage 13 under these circumstances, is equipped with a tracer 51 of a servomechanism whose motor is indicated at 52 and serves to drive pinion 53 that is in mesh with the gear 21. As the tracer roller 54 of the tracer mechanism 51 follows the edge of the template it causes the motor 52 of the servomechanism to rotate the pinion 53 to drive the gears 21 and 22 to move the standards 17 and 18 either towards each other or away from each other and thus cause the forming ring 29 to move in and out in following the contour of the template. The handle 55 on the motor of the servo-mechanism may serve to merely disengage pinion 53 from the gear 21 for manual operation when desired or for purposes of setting.

It will be appreciated by those skilled in the art that various other devices may be devised to advance and retract the forming ring 29 and the backup rings 34 and 35 with

relation to the work or tubing T to produce tapers of various characters and various configurations.

While it is not necessary to have the tubing T under any axial stress in the course of its tapering other than that generated by the action of the forming ring on the tubing, it is of course possible to chuck the ends of the tubing into a power-driven headstock and tailstock which will turn both ends of the tubing synchronously and also maintain the tubing under axial stress, such as tension. An apparatus for maintaining the tubing under such axial tension is disclosed in my United States Patent No. 3,019,678, issued February 6, 1962. The tension can be variably adjustable and when it is variably adjustable it provides a control over wall thickness buildup. The tension also permits of heavier passes over the tubing and tends to hold the tubing straighter and permits of passes in either direction eliminating any tendency of the tubing to twist.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A device of the class described comprising in combination, means for rotating a workpiece about its axis, annular forming means disposed in encircling relationship to the workpiece, means for rotatably mounting the annular forming means, backup means engageable with the workpiece on both sides of said annular forming means, and means for moving said annular forming means and backup means in opposition to each other in a direction transverse to the axis of the workpiece to deform the workpiece as it rotates.

2. A device of the class described comprising in combination, means for rotating a workpiece about its axis, annular forming means disposed in encircling relationship to the workpiece, means for rotatably mounting the annular forming means, backup means engageable with the workpiece on both sides of said annular forming means, and means for moving the annular forming means and backup means in opposition to each other in a direction transverse to the axis of the workpiece and axially of the workpiece to deform the workpiece as the workpiece rotates.

3. A device of the class described comprising in combination, means for rotating a workpiece about its axis, annular forming means disposed in encircling relationship to the workpiece, means for rotatably mounting the annular forming means, backup means engageable with the workpiece on both sides of the annular forming means, said backup means being also annular and in encircling relationship to the workpiece, means

for rotatably mounting the backup means, and means for moving the annular forming means transverse to the axis of the workpiece and the annular forming means and backup means axially of the workpiece.

4. A device of the class described comprising in combination, means for rotating a workpiece about its axis, annular forming means disposed in encircling relationship to the workpiece, means for rotatably mounting the annular forming means, backup means engageable with the workpiece on both sides of the annular forming means, said backup means being also annular and in encircling relationship to the workpiece, means for rotatably mounting the backup means, means for moving the annular forming means transverse to the axis of the workpiece, means for moving the annular forming means and backup means axially of the workpiece, and means for moving one of the backup means relatively to the other in a direction transverse to the axis of the workpiece.

5. A tube tapering machine comprising means for axially rotating a tube, annular forming means disposed in encircling relationship to the tube, means for rotatably mounting the annular forming means, annular backup rings in encircling relationship to the tube on opposite sides of the annular forming means, means rotatably mounting the annular backup rings, means for moving the annular forming means and the backup rings in opposition to each other in directions transverse to the tube, and means for causing relative movement to take place between the tube and the forming means and backup rings in a direction axially of the tube.

6. A tube tapering machine comprising means for axially rotating a tube, annular forming means disposed in encircling relationship to the tube, means for rotatably mounting the annular forming means, annular backup rings in encircling relationship to the tube on opposite sides of the annular forming means, means rotatably mounting the annular backup rings, means for moving the annular forming means and the backup rings in opposition to each other in directions transverse to the tube, means for causing relative movement to take place between the tube and the forming means and backup rings in a direction axially of the tube, and means whereby one annular backup ring may be adjusted in a direction transverse to the tube relative to the other backup ring.

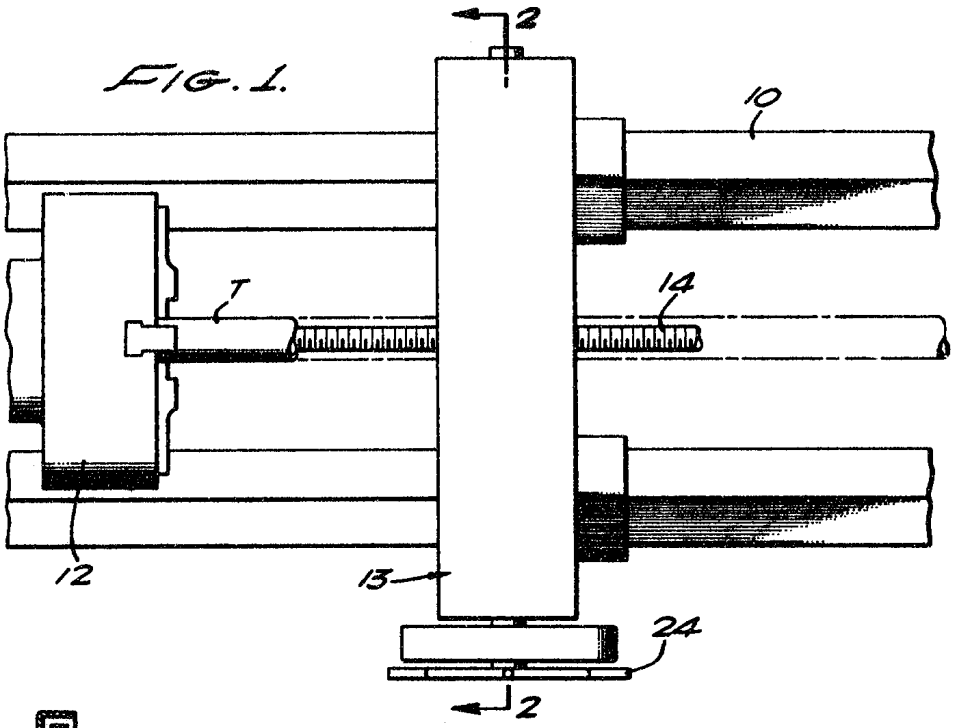
7. A tube tapering machine comprising means for axially rotating a tube, annular forming means disposed in encircling relationship to the tube, means for rotatably mounting the annular forming means, annular back-up rings in encircling relationship to the tube on opposite sides of the annular forming means, means rotatably mounting the annular backup rings, means for moving the annular forming means and the backup rings in opposition to each other in directions transverse to the tube, means for causing relative movement to take place between the tube and the forming means and backup rings in a direction axially of the tube, and means for adjusting the mounting means for one backup ring relative to the other in a direction transverse to the tube.

8. A tube tapering machine comprising means for axially rotating a tube, annular backup rings in encircling relationship to the tube, forming means disposed between the annular backup rings, means rotatably mounting the annular backup rings, means for moving the forming

means and the backup rings in opposition to each other in directions transverse to the tubes, and means for causing relative movement to take place between the tube and the forming means and backup rings in a direction axially of the tube.

*

FIG. 1.



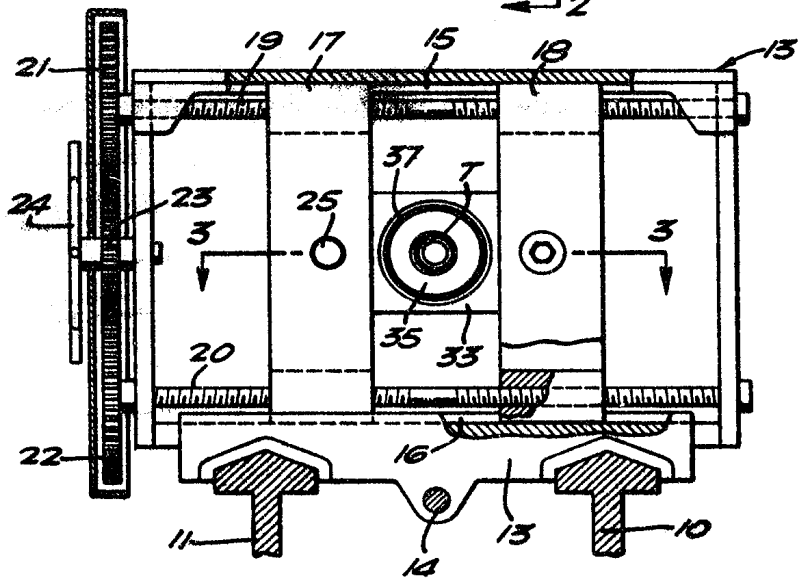


FIG. 2.

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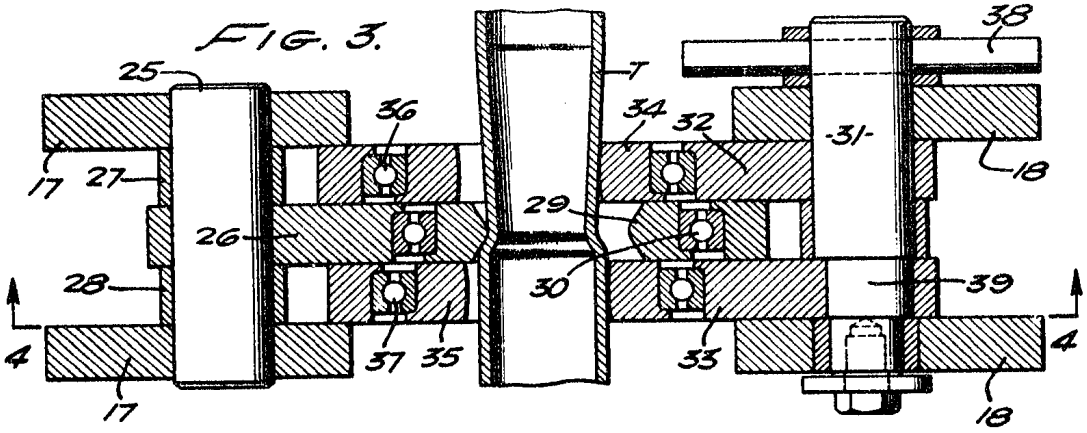
FIG. 3.



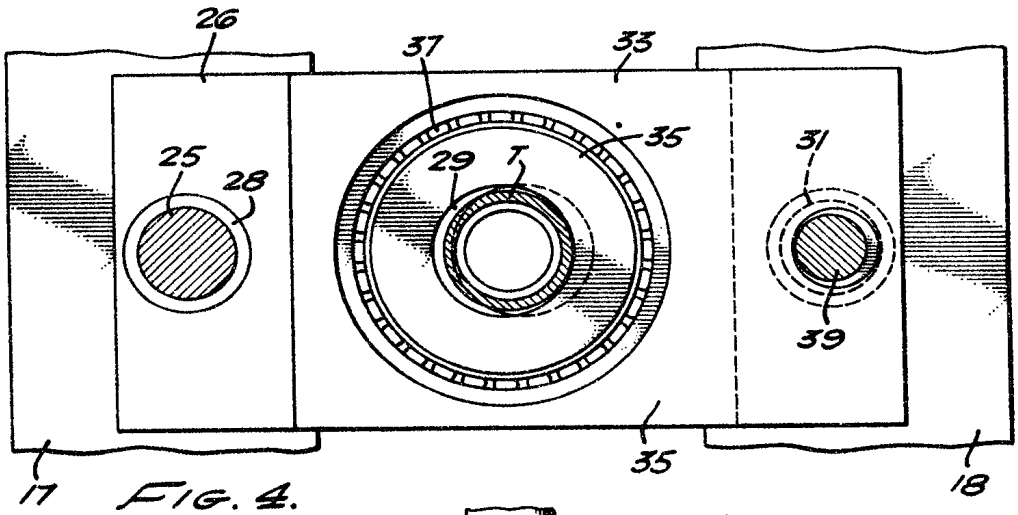


FIG. 4.

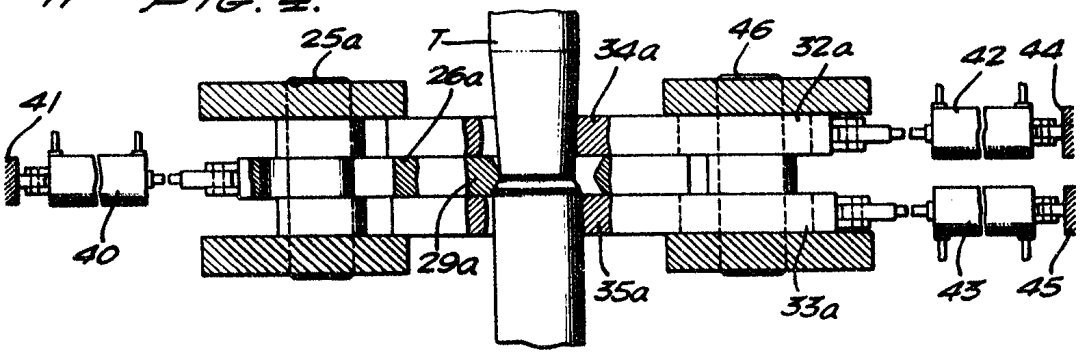


FIG. 8.

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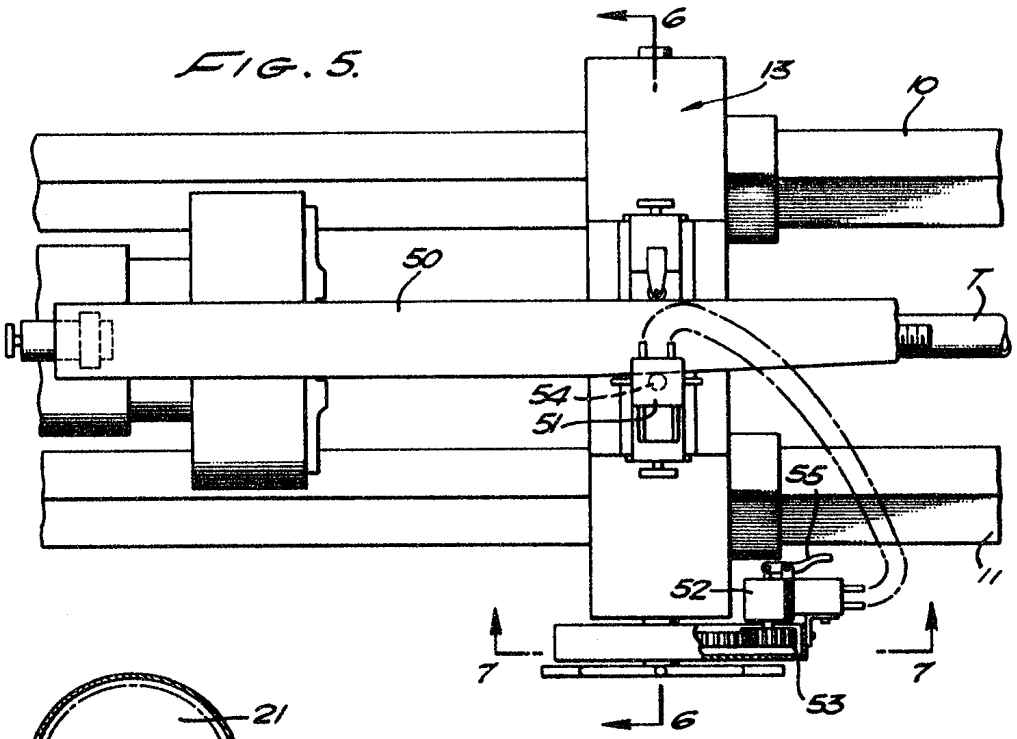
FIG. 5.



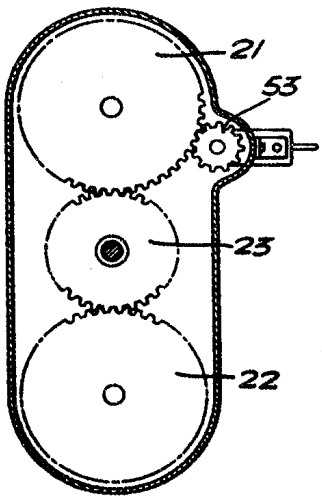


FIG. 7.

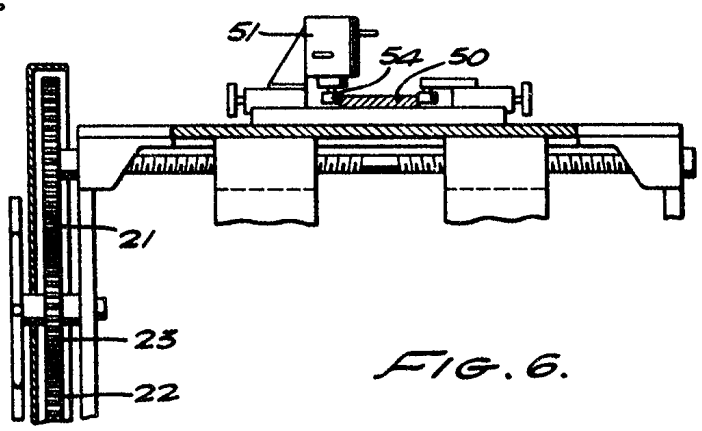


FIG. 6.

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