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C. L. DEWEY

2,347,175

MACHINE FOR END TAPERING METAL TUBING

Filed Aug. 29, 1942

3 Sheets-Sheet 1

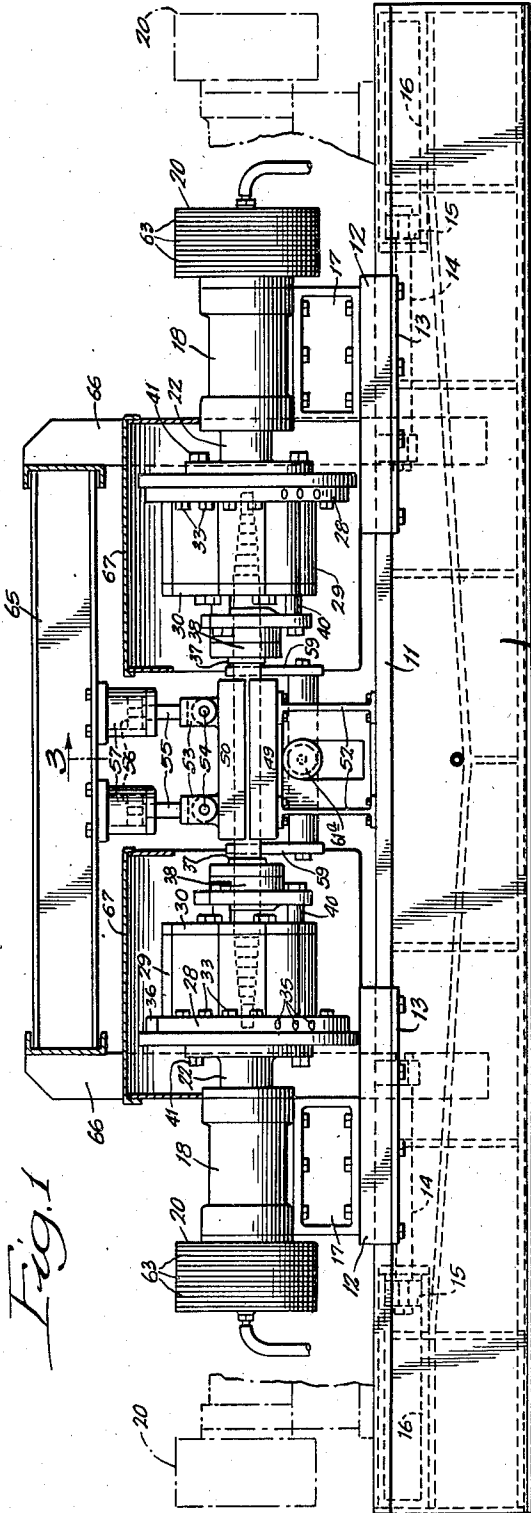


Fig. 1

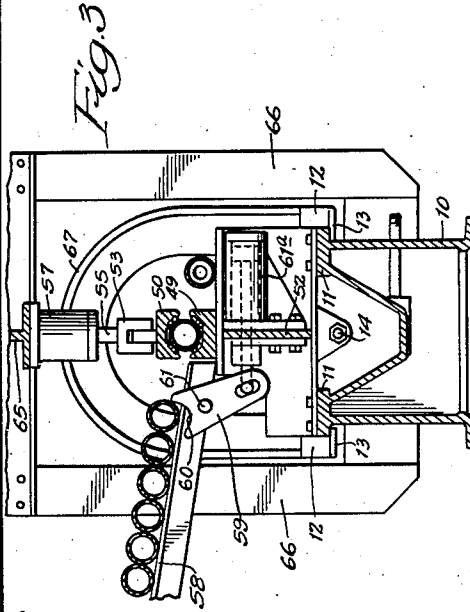


Fig. 3

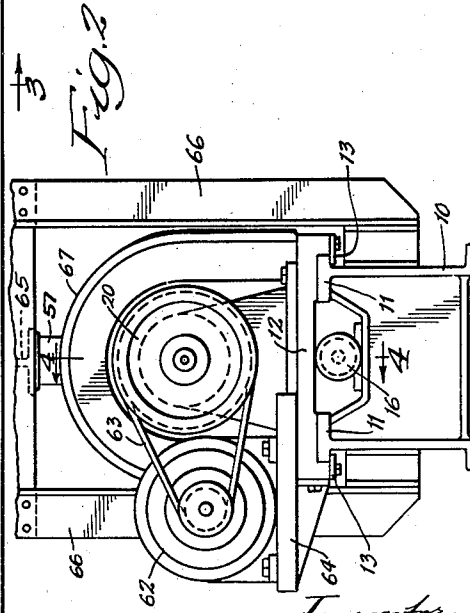


Fig. 2

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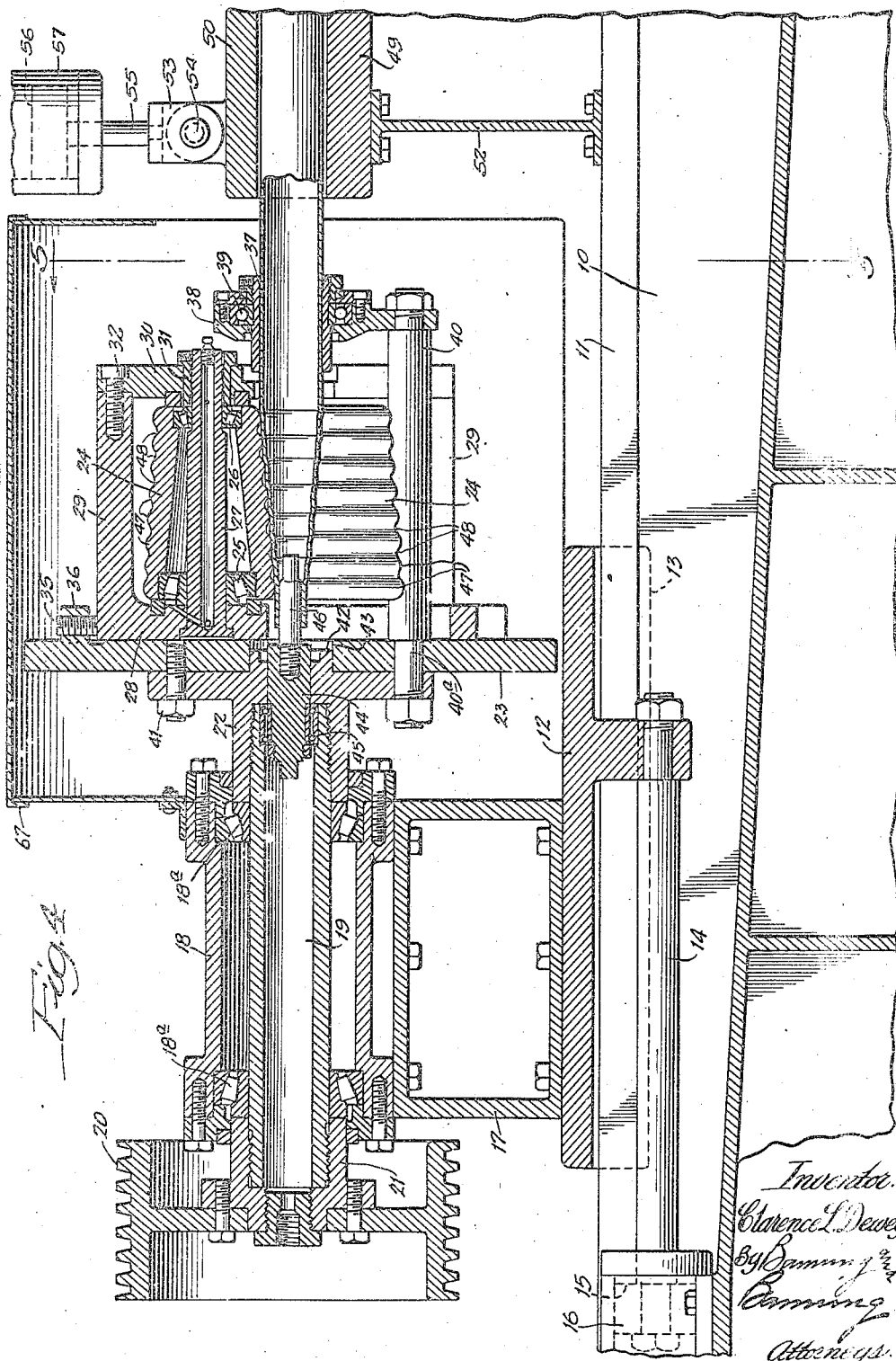
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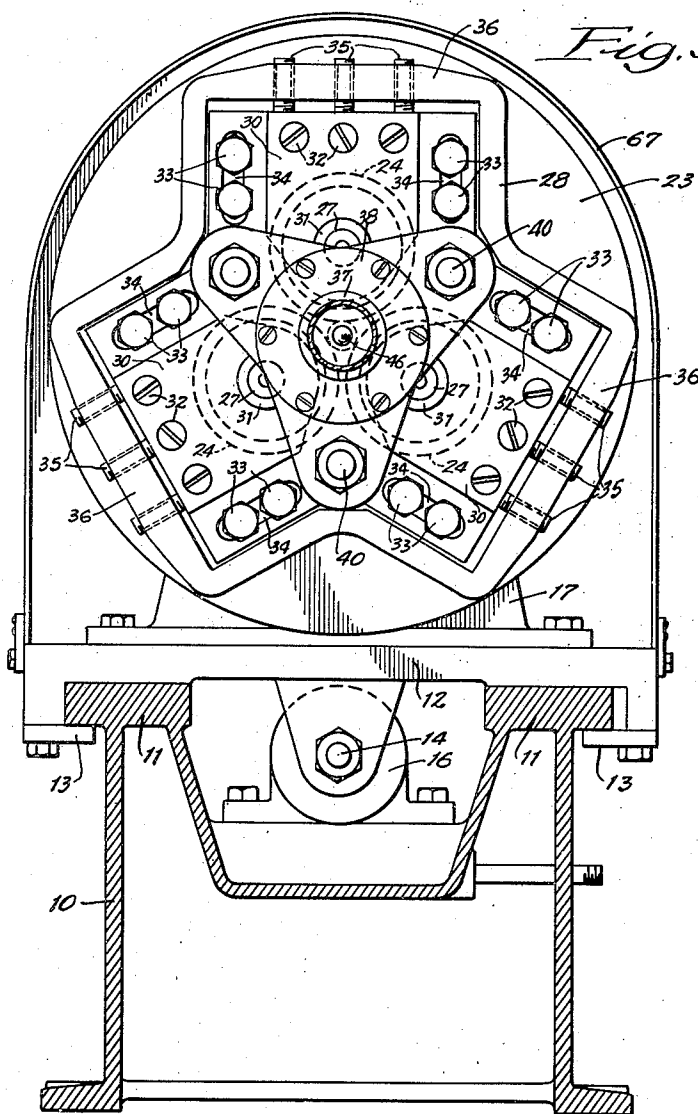
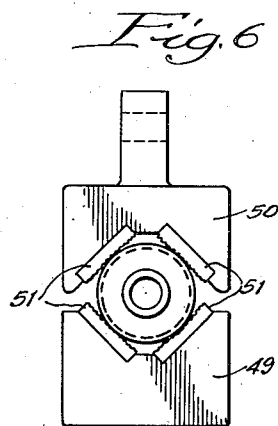
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MACHINE FOR END TAPERING METAL TUBING

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3 Sheets-Sheet 3



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MACHINE FOR END TAPERING METAL TUBING

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Application August 29, 1942, Serial No. 456,587

6 Claims. (Cl. 80—13)

The machine of the present invention is particularly designed to step-taper the ends of comparatively short sections of metal tubing of the character employed in the production of propeller shafts for use in motor vehicles, or the like, and in which compactness of structure and ease and rapidity in operation are highly desirable. In the production of shafts of the character in question it is desirable to taper only the ends of the shaft so that the range of movement required in the operation of the machine is relatively short and in view of the fact that such shafts are ordinarily tapered at both ends, it is desirable to make provision for the simultaneous operation of the two groups of reducing or deforming elements which move inwardly in unison toward one another and to make provision for rigidly clamping the shaft in the middle so that only the short end portions are exposed thereby so that the danger of deflection of the projecting end portions of the shaft may be entirely eliminated by so mounting the reducing elements that they will accurately center the opposite ends of the shaft during the deforming operation.

The invention also relates to the means employed for truing the interior of the extreme ends of the tapered shaft by the employment of pilot mandrels which enter the ends of the shaft thus smoothing out the inside and accurately centering the ends to align with the medial or undeformed portion of the tube.

The invention relates specifically to the configuring and mounting of the forming rolls in such a way as to produce a step-tapered shaft, although the general structure of the machine is such that it may be advantageously employed with rolls configured to produce a smooth or uninterrupted taper. Further objects and details will appear from a description of the invention in conjunction with the accompanying drawings wherein—

Figure 1 is a side elevation of the entire machine;

Fig. 2 an end view thereof;

Fig. 3 a cross-sectional elevation taken on line 3—3 of Fig. 1;

Fig. 4 a longitudinal-sectional elevation taken on line 4—4 of Fig. 2;

Fig. 5 a face view mainly in elevation showing the mounting for the forming rolls and associated parts; and

Fig. 6 a detail of the clamp for engaging the middle of a tube section.

The machine as a whole is mounted upon a

frame 10 which is provided along its upper edges with carriage slides or rails 11 which serve to slidably mount duplicate carriages 12, each of a like character, so that a description of one will suffice for both. Each of the carriages is provided along its edges with inwardly extending guide bars 13 which underlie the rails 11 and serve to hold the carriages in position for accurate in and out travel toward one another. As shown, each of the carriages is fed forwardly or backwardly by a ram 14 having mounted thereon a piston 15 located within a hydraulic cylinder 16, which arrangement permits the two carriages to be operated in unison at any desired rate of travel.

Each carriage has mounted thereon a riser block 17 which carries a spindle mounting 18 of cylindrical formation, which spindle mounting is provided at each end with roller bearings 19 which provide a mounting for a tubular spindle 19, which extends centrally through the spindle mounting with its ends projecting outwardly therefrom.

Each spindle is rotated by a motor-driven sheave 20 which is bolted to a sheave coupling 21 which screws onto the end of the spindle. The opposite end of the spindle is screwed into a flanged coupling 22 to the face of which is bolted a circular disk-shaped driving head plate 23.

The head plate serves as a carrier for the mounting of three corrugated tapered rolls 24 the acting surfaces of which are equally spaced outwardly from the axis of the clearance space to be occupied by the tubing and in circumferentially spaced relation to one another. Each roll is mounted upon outer and inner roller bearings 25 and 26 carried by a spindle 27. The outer end of each spindle is socketed within a radially adjustable slide plate 28 having an inwardly projecting overhanging arm 29 which has bolted thereto an inwardly projecting bracket plate 30 which supports the inner end of the spindle which is screwed into a bushing 31. The bracket plate is bolted to the end of the arm 29 by the headed bolts 32, and the slide plate 28 is clamped to the head plate by bolts 33 entered through slots 34 which permit in and out adjustment of the respective slide plates with the corrugated forming rollers carried thereby. The adjustment of the plates is maintained by screws 35 entered through a surrounding flange 36 having the three-armed contour shown in Figure 5.

The bracket plates 30 extend radially inward as shown in Figure 5 with their inner ends adjacent to the axis of the tube wall and rounded to afford adequate clearance.

In order to rigidly sustain and center the tube at a point closely adjacent to the projecting end undergoing deformation, a centering ring 37 is provided which is carried by a surrounding collar 38 being mounted for rotation on ball-bearings 39. The collar is of the triple armed formation shown in Figure 5, and each arm provides a point of connection for a bolt rod 40. The reduced ends 40a of the group of three bolt rods are entered through both the head plate 23 and the flanged head coupling 22 to supplement the connection afforded by bolts 41. This arrangement of the parts affords an extremely rigid and rugged rotatable frame for the mounting of the three forming rolls which is necessary by reason of the overhanging arrangement of the roll mountings and the necessity of maintaining the centering ring 37 in accurate concentric alignment and at a point distant from its base of support.

The head coupling 22 in its center is provided with a boss 42 which sockets within a center bore 43 in the head plate, and the boss affords a socket for a plug 44 carried by ball-bearings 45 which permit the spindle and roll frame to rotate without imparting rotation to the plug. The plug has screwed thereinto a center pilot mandrel 46 which is of a size to fit snugly within the end of the tube when reduced and smooth out or iron out any burrs or inequalities in the interior of the tube and true the tube end to concentric coincidence with the axis of the tube which is highly important in the reduction of tubing intended for power transmission purposes.

Each of the forming rolls 24 is of generally tapered formation and provided with concentric spaced corrugations or circumferential crests 47 separated by intervening valleys 48, the crests and valleys of the respective rolls being in common planes so that all will act equally upon the walls of the tube as the rolls are revolved around the tube axis and are rotated by frictional contact with the tube which is held fixed against both rotary and longitudinal movement during the deforming operation.

The middle portion of the tube is held by a clamp secured against longitudinal movement and comprising fixed and movable jaw-heads 49 and 50 respectively which jaw-heads are provided with opposed V-shaped channels which receive serrated jaws 51 adapted to grip the tube walls on four sides of the tube as shown in Figure 6. The fixed jaw head 49 is supported by standards 52 springing upwardly from the frame of the machine and the movable jaw-head is provided with lugs 53 which mount pintles 54 carried by rods 55 having pistons 56 operable within cylinders 57, which permits fluid pressure to be applied for clamping and releasing the tubes as occasion may require.

In order to feed the tube sections in position to be clamped by the jaws, an inclined stationary runway 58 is provided down which the tube sections roll, the foremost section being restrained by an arresting arm 59 recessed at its upper end 60 and pivoted at 61. A rocking movement is imparted to the arresting arm 59 by a cylinder and piston arrangement 61a, the parts being so arranged that when the lower end of the arresting arm is drawn inwardly as in Figure 3, the procession of the tubes will be arrested by contact with the projecting upper prong of the arm 59; but when the lower end of the arm is rocked outwardly, the tube at the head of the procession will be released to roll into the jaws and the

next tube will be arrested until it is released by a reverse movement of the arm.

As shown, each of the sheaves 20 is operated by a motor 62 and belt 63, the motor being mounted upon a shelf 64 carried by the carriage. As shown, the cylinders 57 are suspended from a beam 65 supported by standards 66 springing upwardly from the base of the machine, and the forming rolls and mountings are shielded and protected by arched housings 67 as shown in Figure 1.

Operation

With the carriages equally retracted, as shown in dotted lines in Figure 1, to the extent necessary, a tube section is rolled into place and centrally clamped by the jaws with its undeformed ends projecting equally in opposite directions. Power is thereupon applied to the spindle 19 which imparts rotation to the head plate 23 and the group of three rollers carried thereby, which are revolved around the tube axis as a center. Concurrently with the revolution of the rolls, the carriages will begin to move inwardly toward one another until the innermost ends of the rolls of each group engage the oppositely projecting ends of the tube. The innermost corrugations of the three rolls composing a group, being of a minimum diameter and affording the widest clearance, will effect a first step reduction in the tube wall and thereafter the succeeding corrugations of progressively greater diameter will each act to further reduce the preceding step in the tube so that ultimately the end of the tube will be reduced by a series of steps which divide the end of the tube into short cylindrical portions of progressively decreasing diameter with the extreme tip of the tube displaying the maximum reduction. As the carriage advances to bring the endmost corrugations of the series into acting engagement with the tip end of the tube, the pilot mandrel 46 will advance, and the interior of the tube will be held in snug frictional contact therewith so that it will be restrained against rotation while at the same time serving to smooth out and accurately center the minimum end bore of the tube.

The reducing operation causes a redistribution of the metal, resulting in an elongation of the tube or a thickening of the tube wall, or both of these effects, but the present invention is not concerned primarily with these results which are inherent in any tube reducing operation, howsoever performed.

It has been found from experience that the use of circumferentially corrugated rolls of the character here shown possesses distinct advantages in operation, since each of the corrugations affords a rounded periphery which advances against the shoulder evolving in the tube wall so that the metal is caused to flow down by minute increments in order to escape beneath the rounded periphery of the corrugation while the intervening channels afford clearance spaces which break the reducing contacts into a series of concurrent operations while affording clearance behind each corrugation, which assists in the redistributing of the metal and avoids chattering or galling of the metal surfaces which may occur if continuous contacts are maintained. Furthermore the provision of the intervening channels provides for the distribution of a suitable liquid coolant and lubricant which may be forced upon the rolls 24 and around the ends of the tube and onto the pilot mandrel thus lubricating the rolls

and holding the tube at a low temperature. This permits the cool rolling action of the rolls to greatly increase the tensile strength and hardness of the low carbon steel strip from which the electrically welded tube was made, it being advantageous to increase the strength and stiffness of the step-tapered tube ends when the tube is to be used as an automotive propeller drive shaft or the like.

By thus dividing the reducing operations into a series of small steps, each interrupted by a gap, it is possible to successfully perform the reducing operation and accurately center the tube without the provision of an inner mandrel or the like, which could not be advantageously employed in tubes having both of their ends reduced to the extent here indicated. It will also be understood that the present operation does not require that the tube be exteriorly reenforced at or near the region of deformation and that the centering ring 37 is not employed for the purpose of confining the deformation to the area in contact with the roll corrugations, but solely for the purpose of accurately holding the tube so that it will be concentrically reduced by the stepped forming rolls.

After the reduction of the tube has been completed, the tube is removed laterally by hand or by suitable mechanical means and the operations repeated while it is not necessary to stop the rotation of the head plates, which need only be drawn back to the extent required to introduce another tube into position.

By revolving the rolls around a stationary tube it is possible to secure a high rate of production at lower costs since complications involved in the chucking and rotating of the tube are avoided and there is no necessity for interrupting the continuity of the driving operation in order to permit the tubes to be introduced and removed.

As shown, the crests of the corrugations on the forming rolls in unison present a straight line of uniform tapering but, it will be understood that the crest lines may assume a convex or concave configuration, or combinations thereof, or variations in the angle of the taper line without departing from the principles of the invention.

Although the present machine has been designed in duplicate to operate upon both ends of a tube section simultaneously, it is not the intention, unless otherwise indicated, to limit the protection to a duplicate machine since a single group of forming rolls of the character described might be employed where a single end only of the shaft requires reduction.

I claim:

1. In a machine for concurrently tapering the opposite ends of a section of tubing, the combination of a clamp for engaging the medial portion of a section of tubing in position to allow the ends of the tube section to project oppositely outward from the clamp, duplicate sets of reducing mechanisms each carried by a carriage and power means for oppositely advancing the carriages in unison inwardly toward the projecting ends of the tubing and retracting the carriages in unison therefrom, each carriage supporting thereon a plurality of forming rolls of progressively increasing diameter in the direction away from the proximate end of the tube presented for tapering, the acting surfaces of the rolls being outwardly spaced from the axial center line of the tube to concurrently engage the tube wall along longitudinally converging lines in circumferentially spaced relation around the tube axis, a mounting

for each set of rolls and means for rotating the mountings to cause the rolls to revolve around an axis concentric with the tube axis concurrently with the advance of the carriage to progressively taper the end of tube, and feeding devices off-set laterally from the clamp for inwardly delivering the tubes laterally and singly into the bite of the clamp.

2. In a machine for tapering the ends of tubing, the combination of a clamp for engaging a tube at a point remote from the end to be tapered, a plurality of reducing rolls of progressively increasing diameter in the direction away from the end of the tube to be presented for tapering, the acting surfaces of the rolls being outwardly spaced from the axial center line of the tube to concurrently engage the tube wall in circumferentially spaced relation around the tube axis, a shaft for rotatably mounting each of the rolls, a head plate and inwardly extending arms secured thereto for supporting the opposite ends of the respective shafts, a spindle secured to the head plate and outwardly extending therefrom, and power means for rotating the spindle, a carriage for mounting the spindle and parts carried thereby, means for advancing and retracting the carriage, and a pilot mandrel concentric with the tube axis and entered through the head plate in position to enter the reduced end of the tube to true and smooth the same.

3. In a machine for tapering the ends of tubing, the combination of a clamp for engaging a tube at a point remote from the end to be tapered, a plurality of reducing rolls of progressively increasing diameter in the direction away from the end of the tube to be presented for tapering, the acting surfaces of the rolls being outwardly spaced from the axial center line of the tube to concurrently engage the tube wall in circumferentially spaced relation around the tube axis, a shaft for rotatably mounting each of the rolls, a head plate and inwardly extending arms secured thereto for supporting the opposite ends of the respective shafts, a spindle secured to the head plate and outwardly extending therefrom and power means for rotating the spindle, a centering ring adapted to surround the tube inwardly beyond the region contacted by the rolls and means for supporting the ring from the head plate, a carriage for mounting the spindle and parts carried thereby, means for advancing and retracting the carriage, and a pilot mandrel concentric with the tube axis and entered through the head plate in position to enter the reduced end of the tube to true and smooth the same.

4. In a machine for tapering the ends of tubing, the combination of a clamp for engaging a tube at a point remote from the end to be tapered, a plurality of reducing rolls of progressively increasing diameter in the direction away from the end of the tube to be presented for tapering, the acting surfaces of the rolls being outwardly spaced from the axial center line of the tube to concurrently engage the tube wall in circumferentially spaced relation around the tube axis, a shaft for rotatably mounting each of the rolls, a head plate and inwardly extending arms secured thereto for supporting the opposite ends of the respective shafts, a spindle secured to the head plate and outwardly extending therefrom and power means for rotating the spindle, a centering ring adapted to surround the tube inwardly beyond the region contacted by the rolls and means for supporting the ring from the head plate, a carriage for mounting the spindle and parts car-

ried thereby, and means for advancing and retracting the carriage.

5. In a machine for concurrently tapering the opposite ends of a section of tubing, the combination of a clamp for engaging the medial portion of a section of tubing in position to allow the ends of the tube section to project oppositely outward from the clamp, duplicate sets of reducing mechanisms each carried by a carriage and power means for oppositely advancing the carriages in unison inwardly toward the projecting ends of the tubing and retracting the carriages in unison therefrom, each carriage supporting thereon a plurality of forming rolls arranged in circumferentially spaced relation around the tube axis and presenting their acting surfaces in progressively closer relation to said axis from the receiving to the discharge ends of the rolls, a mounting for each set of rolls and means for rotating the mountings to cause the rolls to revolve around said axis concurrently with the advance of the carriage to progressively taper the end of the tube, and feeding devices for delivering the tubes laterally and singly into the bite of the clamp.

6. In a machine for tapering the ends of tubing, the combination of a clamp for engaging a tube at a point remote from the end to be tapered, a plurality of reducing rolls standing in circumferentially spaced relation around the tube axis and presenting their acting surfaces in progressively closer relation to said axis from the receiving to the discharge ends of said rolls, a shaft for rotatably mounting each of the rolls, a head plate and inwardly extending arms secured thereto for supporting the opposite ends of the respective shafts, a spindle secured to the head plate and outwardly extending therefrom, and power means for rotating the spindle, a carriage for mounting the spindle and parts carried thereby, means for advancing and retracting the carriage, and a pilot mandrel concentric with the tube axis and entered through the head plate in position to enter the reduced end of the tube to true and smooth the same.

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