Aug. 27, 1935. R. D. HULSLANDER 2,012,565

TUBE SPLICING MACHINE

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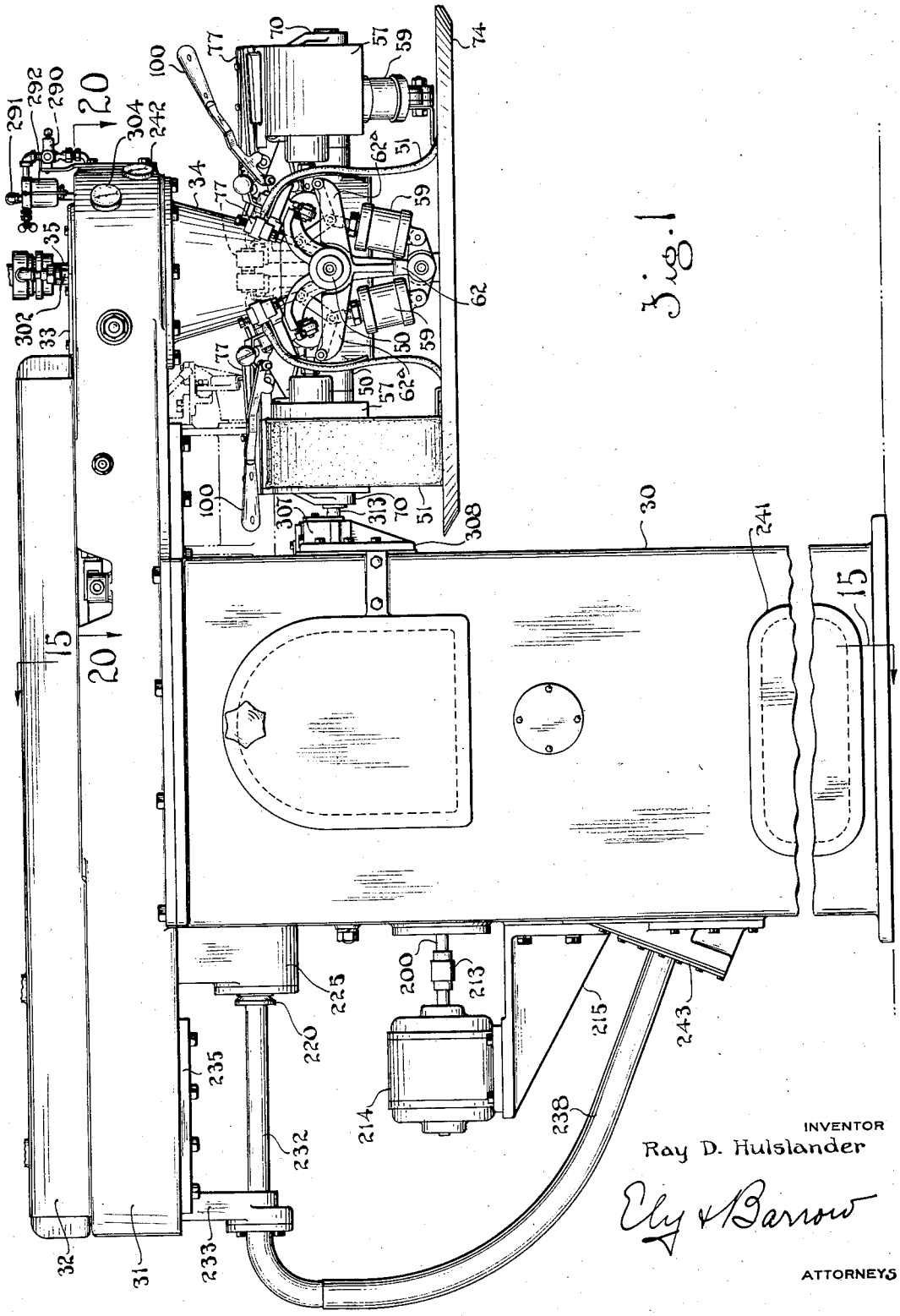

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TUBE SPLICING MACHINE

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Fig. 2

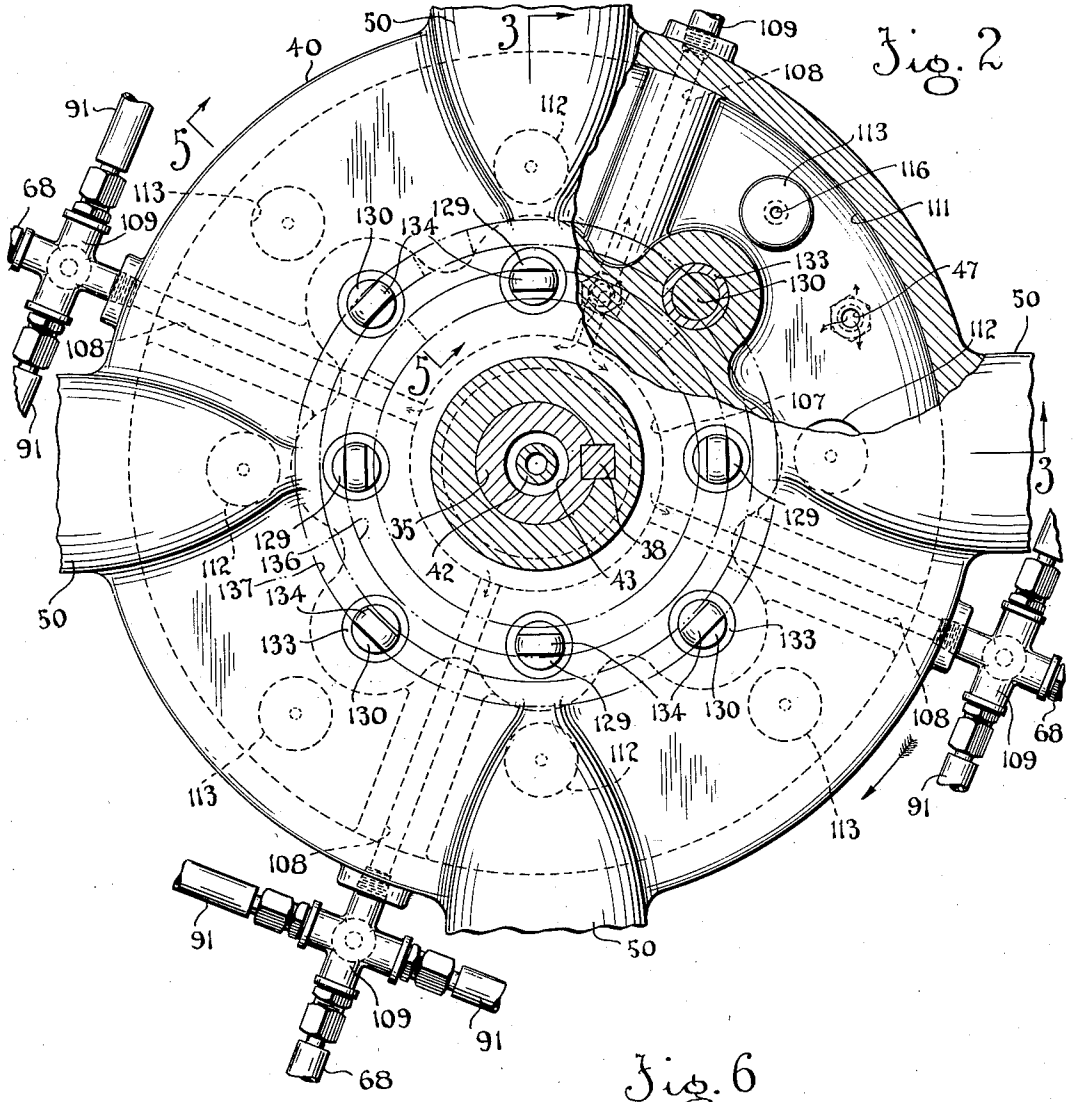
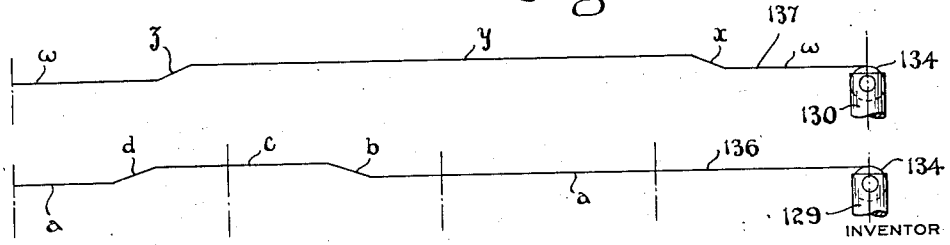


Fig. 6



INVENTOR

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Aug. 27, 1935. R. D. HULSLANDER 2,012,565

TUBE SPLICING MACHINE

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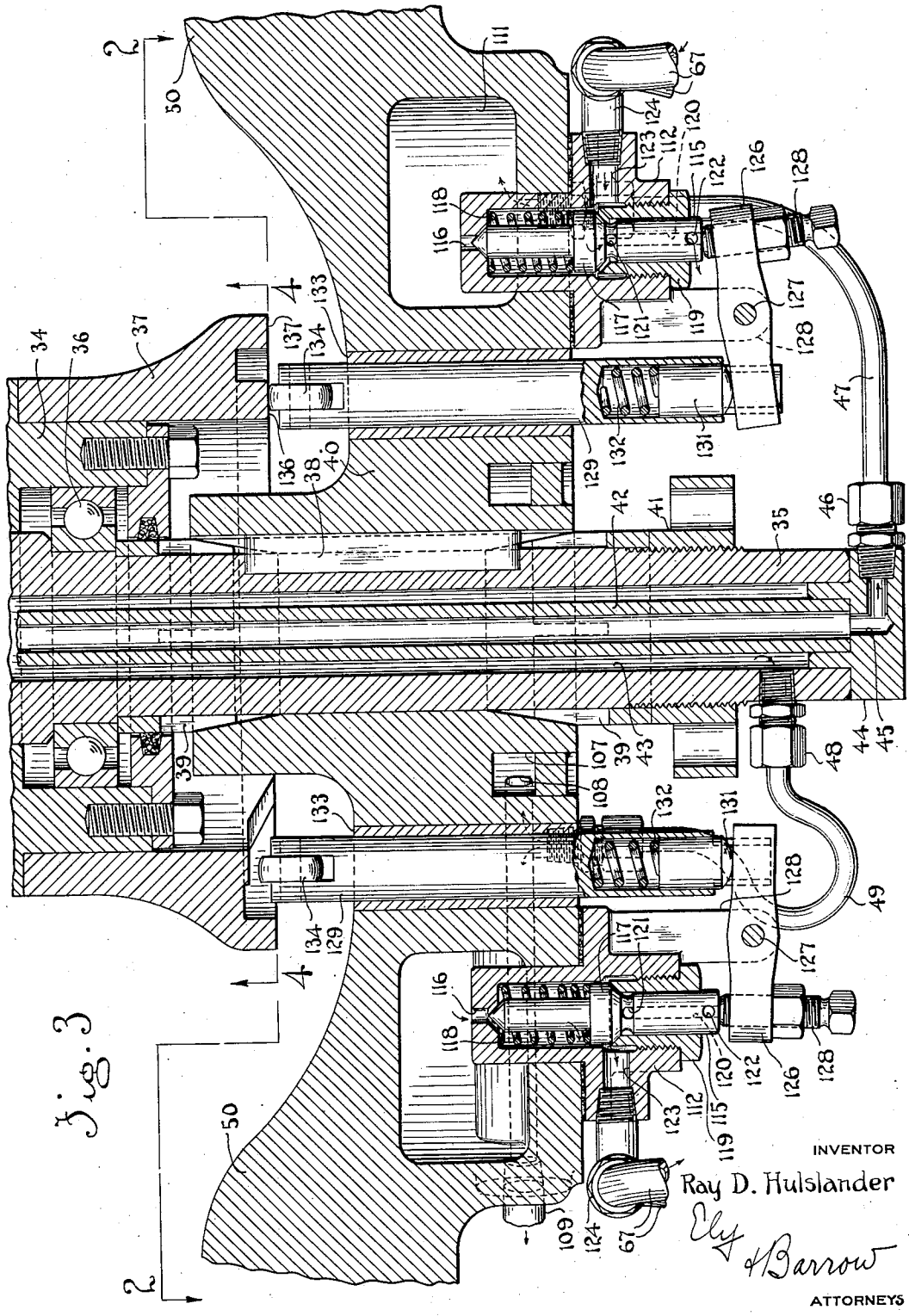

Fig. 3

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TUBE SPLICING MACHINE

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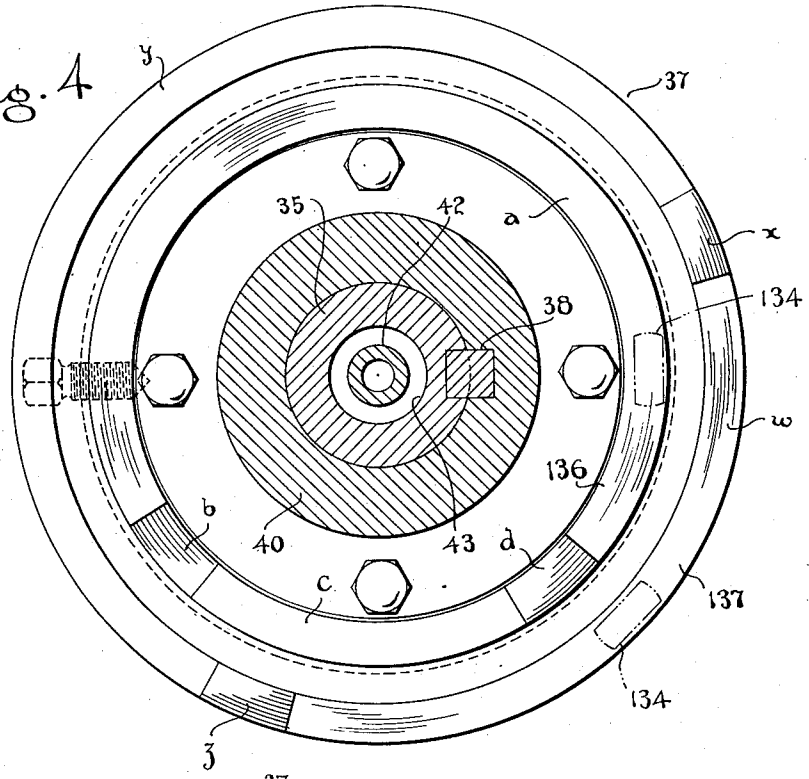
Fig. 4



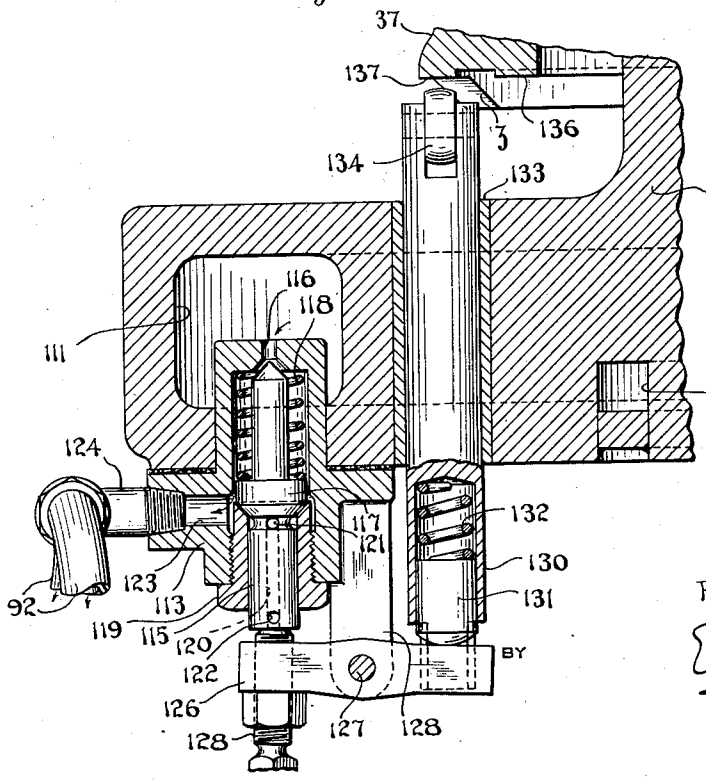


Fig. 5

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Aug. 27, 1935. R. D. HULSLANDER 2,012,565

TUBE SPLICING MACHINE

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Fig. 7

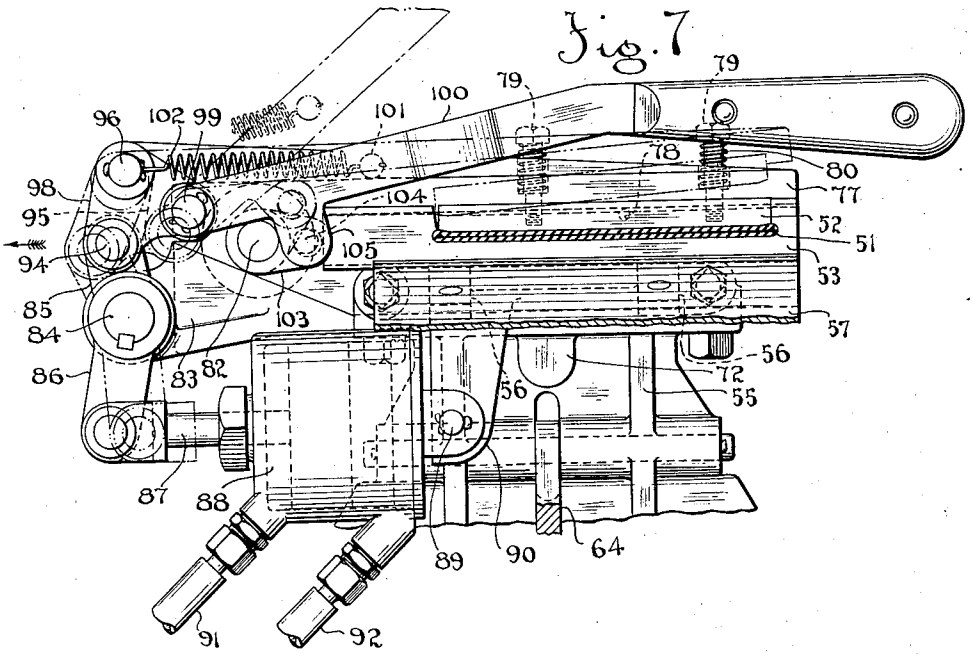


Fig. 8

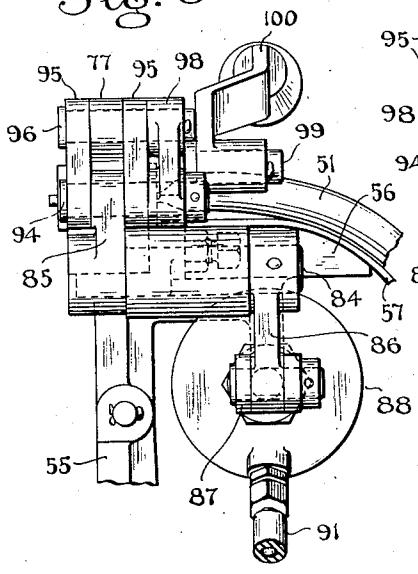
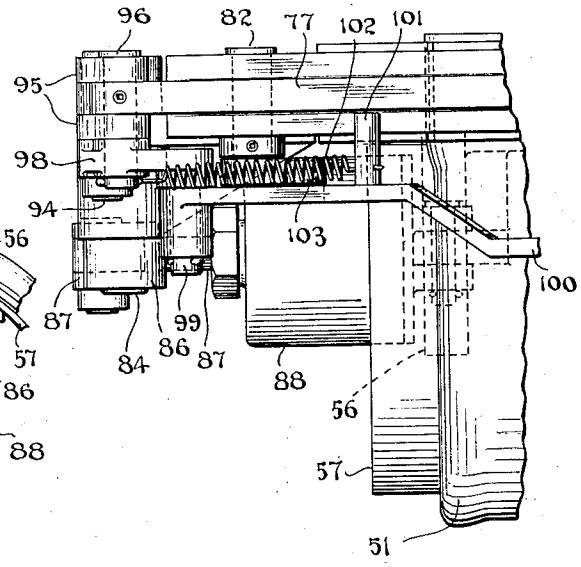


Fig. 9



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Aug. 27, 1935. R. D. HULSLANDER 2,012,565

TUBE SPLICING MACHINE

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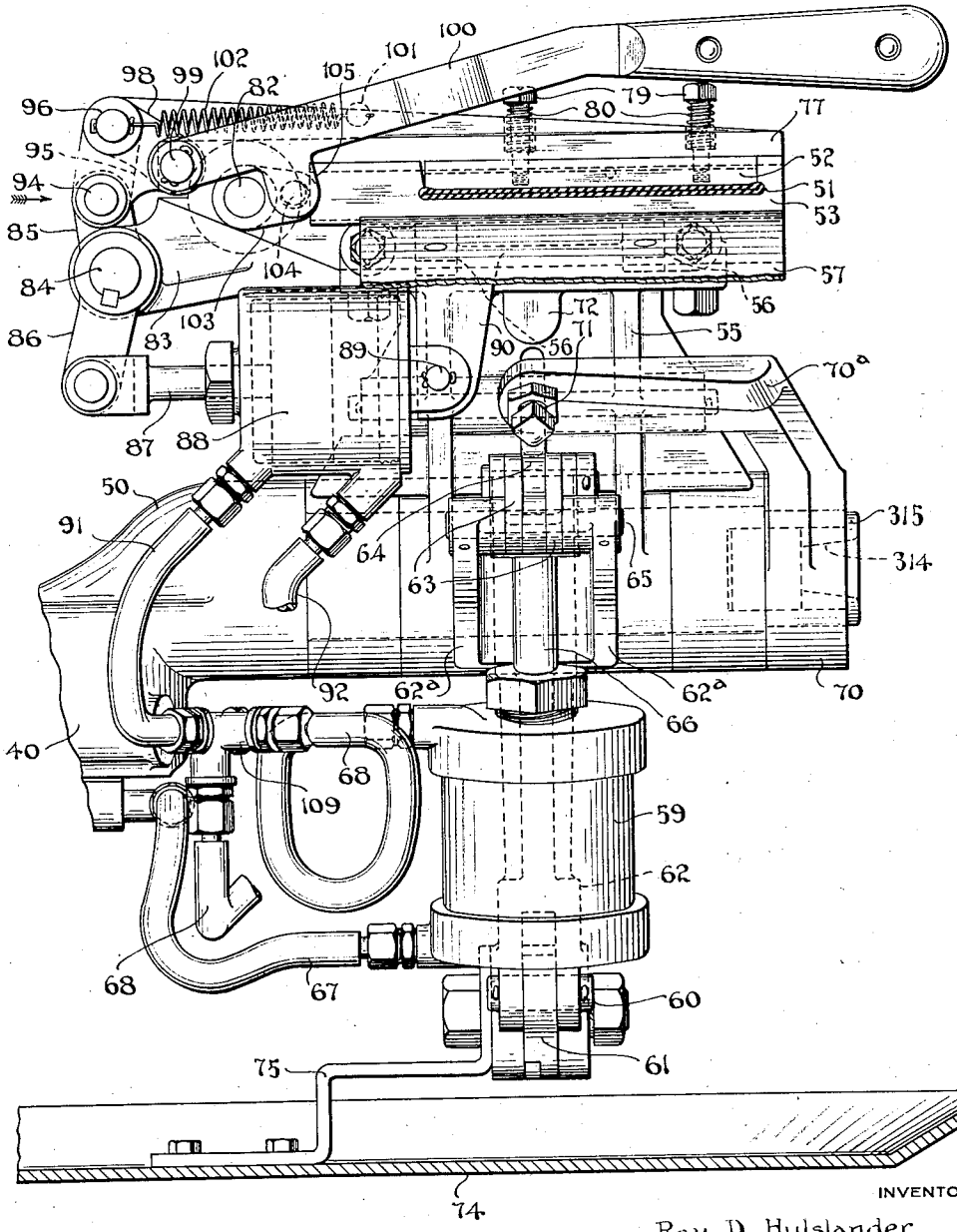
Fig. 10



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Aug. 27, 1935. R. D. HULSLANDER 2,012,565

TUBE SPLICING MACHINE

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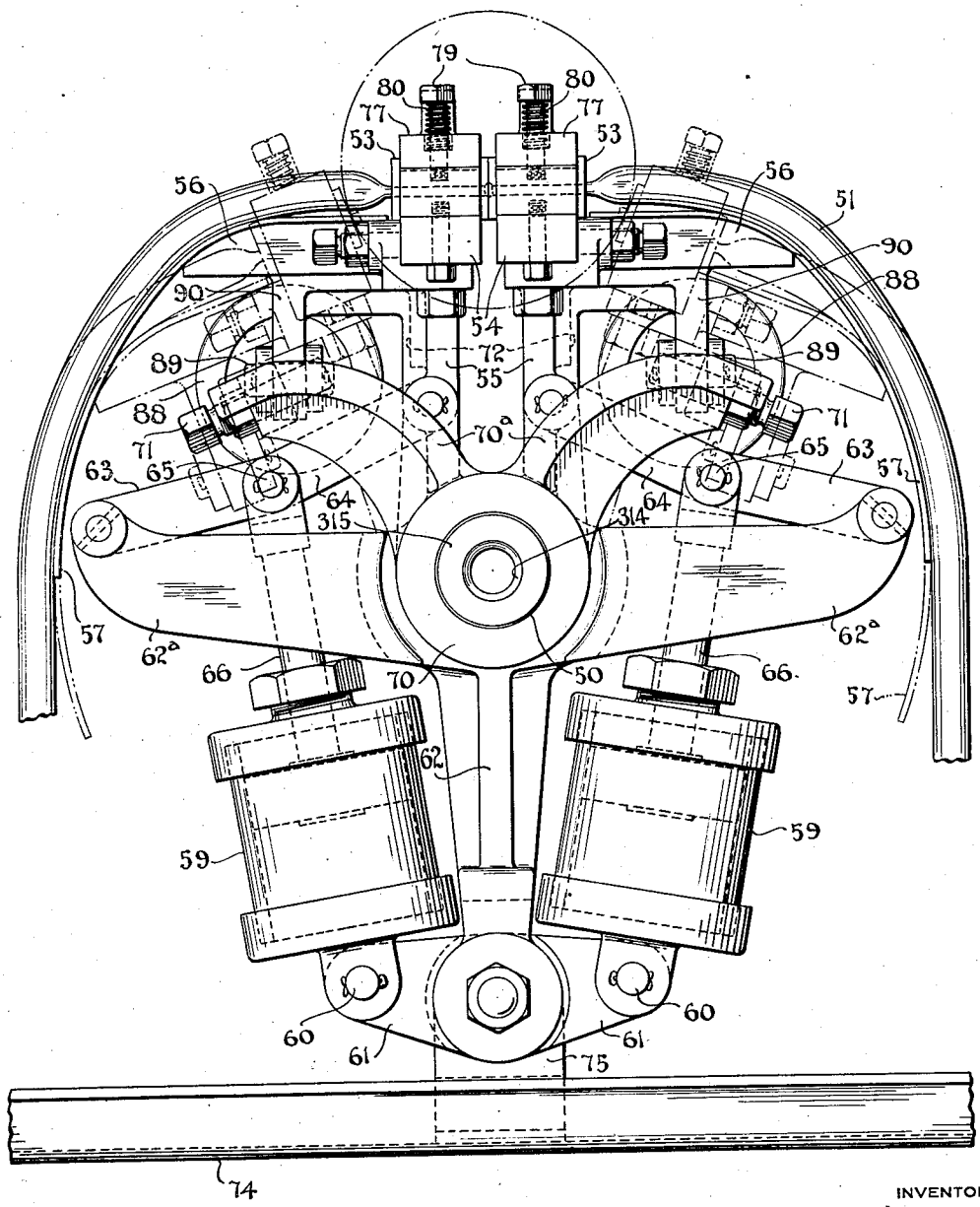
Fig. 11



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TUBE SPLICING MACHINE

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Fig. 12

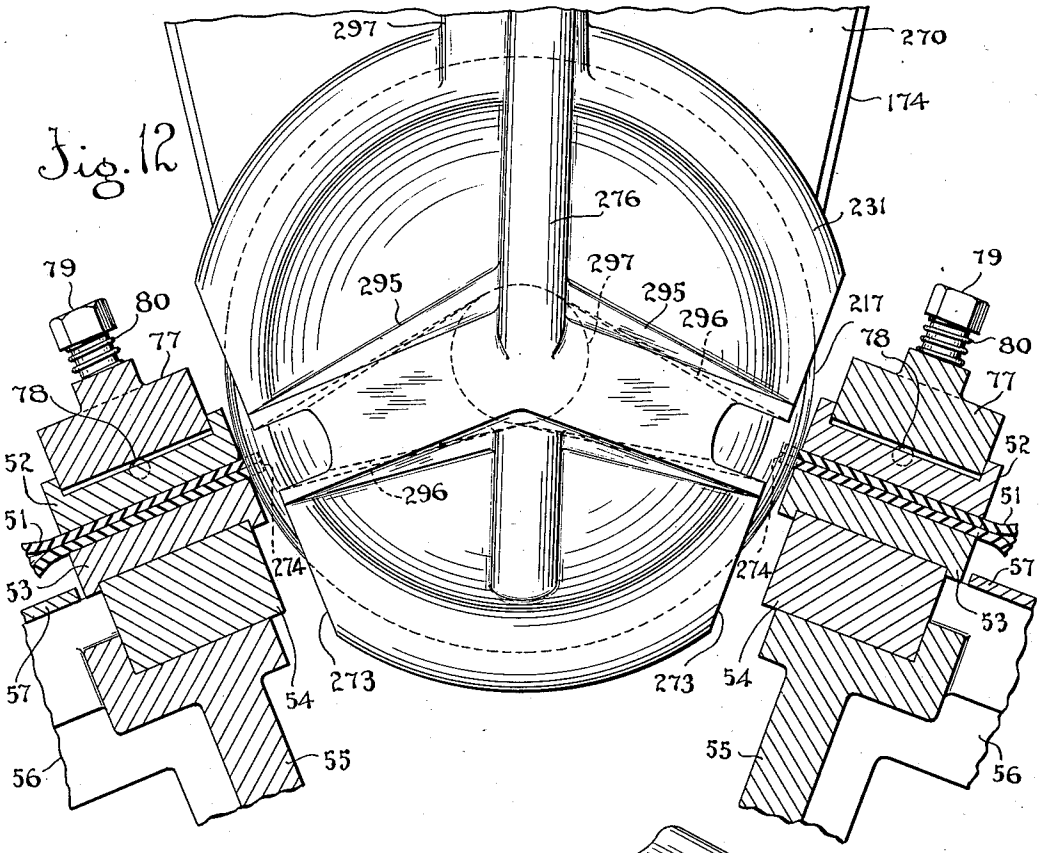


Fig. 13

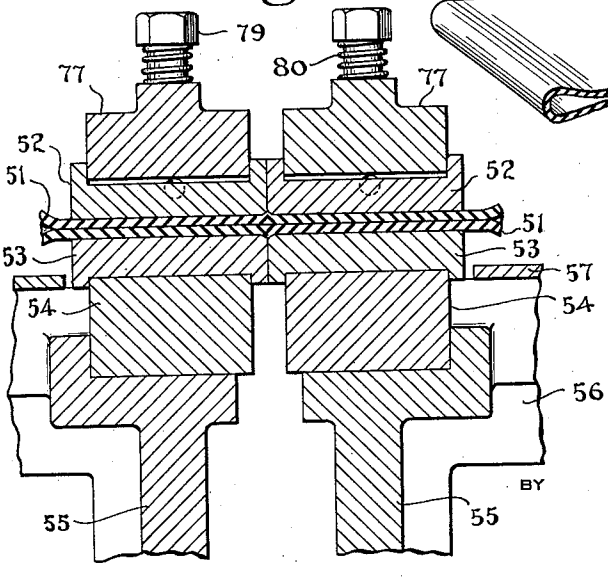
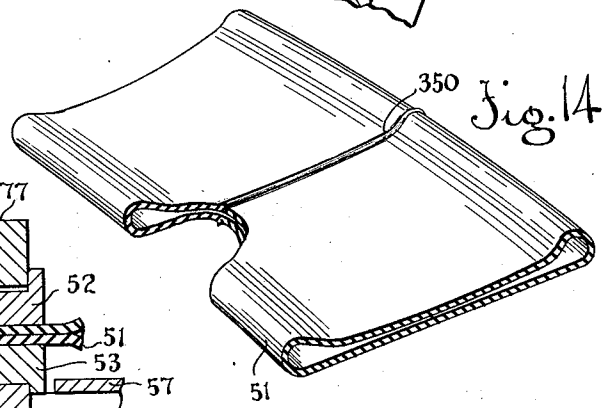


Fig. 14



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TUBE SPLICING MACHINE

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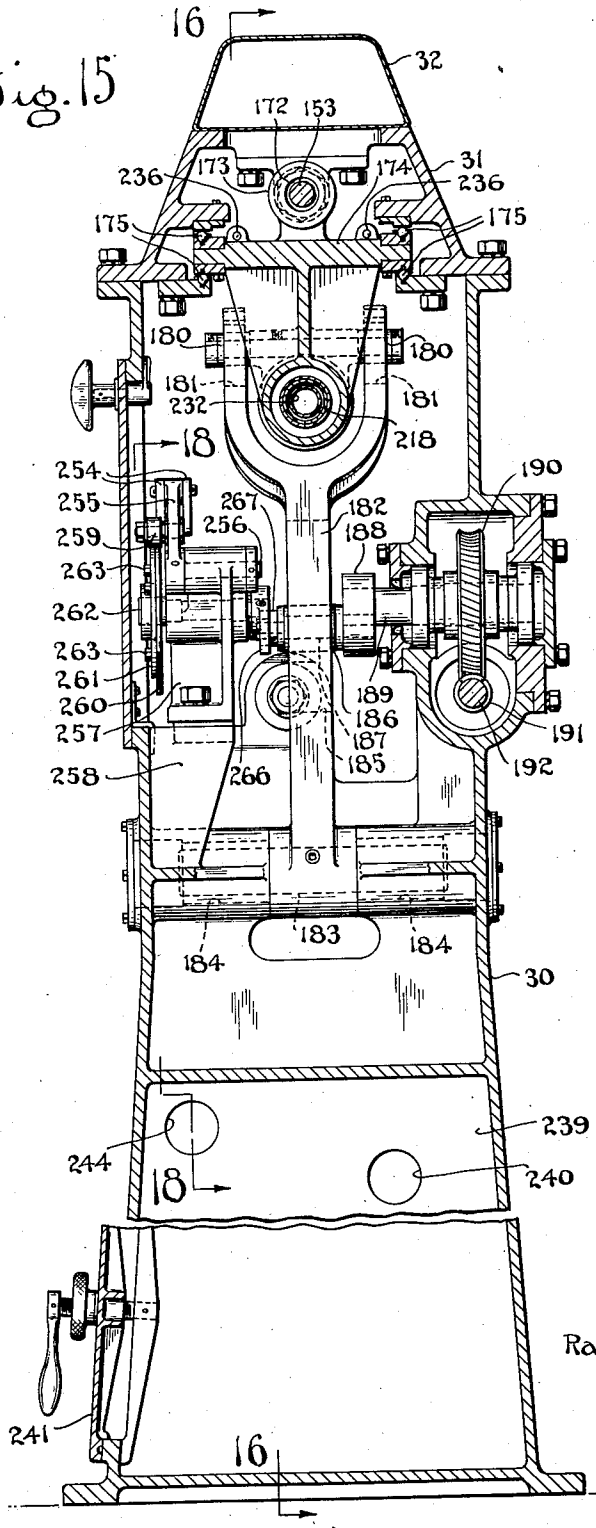
Fig. 15



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TUBE SPLICING MACHINE

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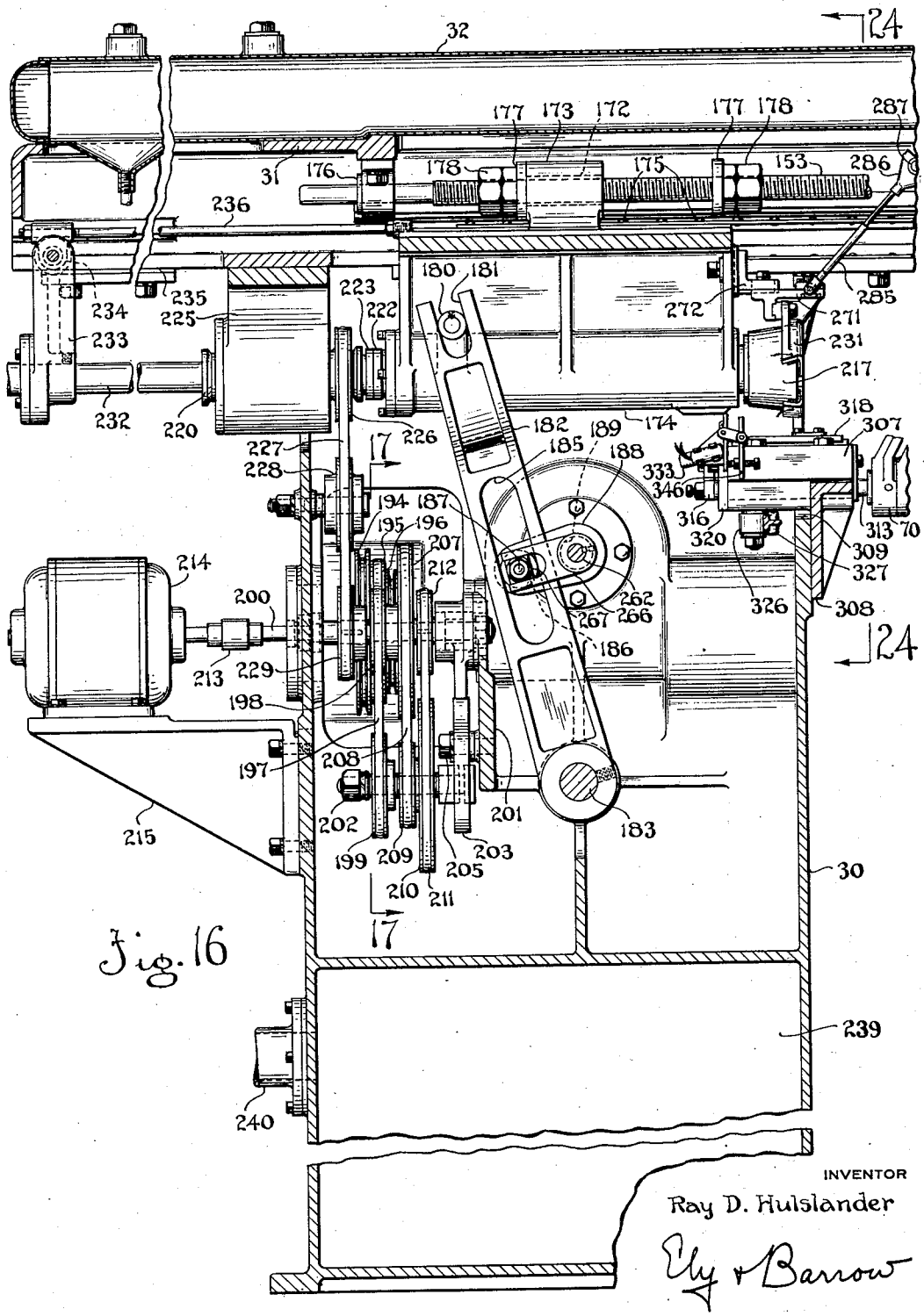

Fig. 16

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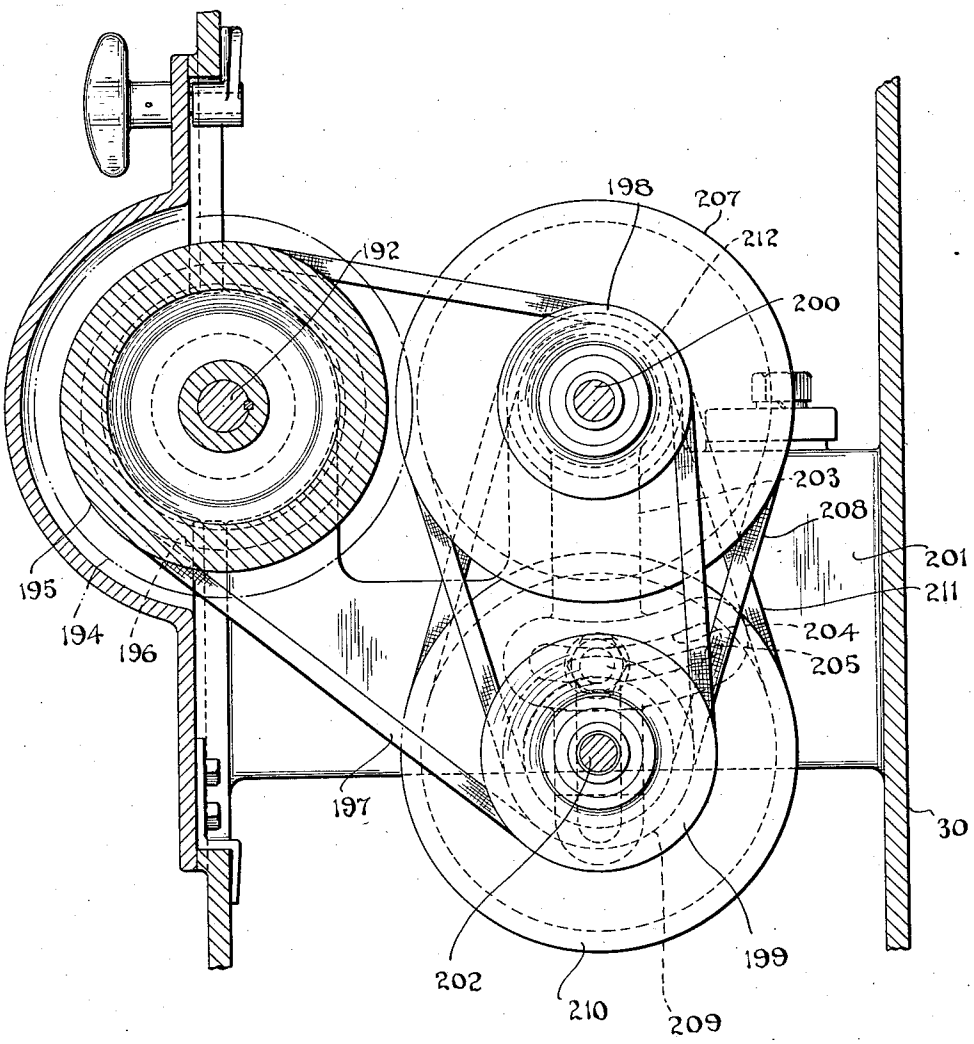

Fig. 17

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TUBE SPLICING MACHINE

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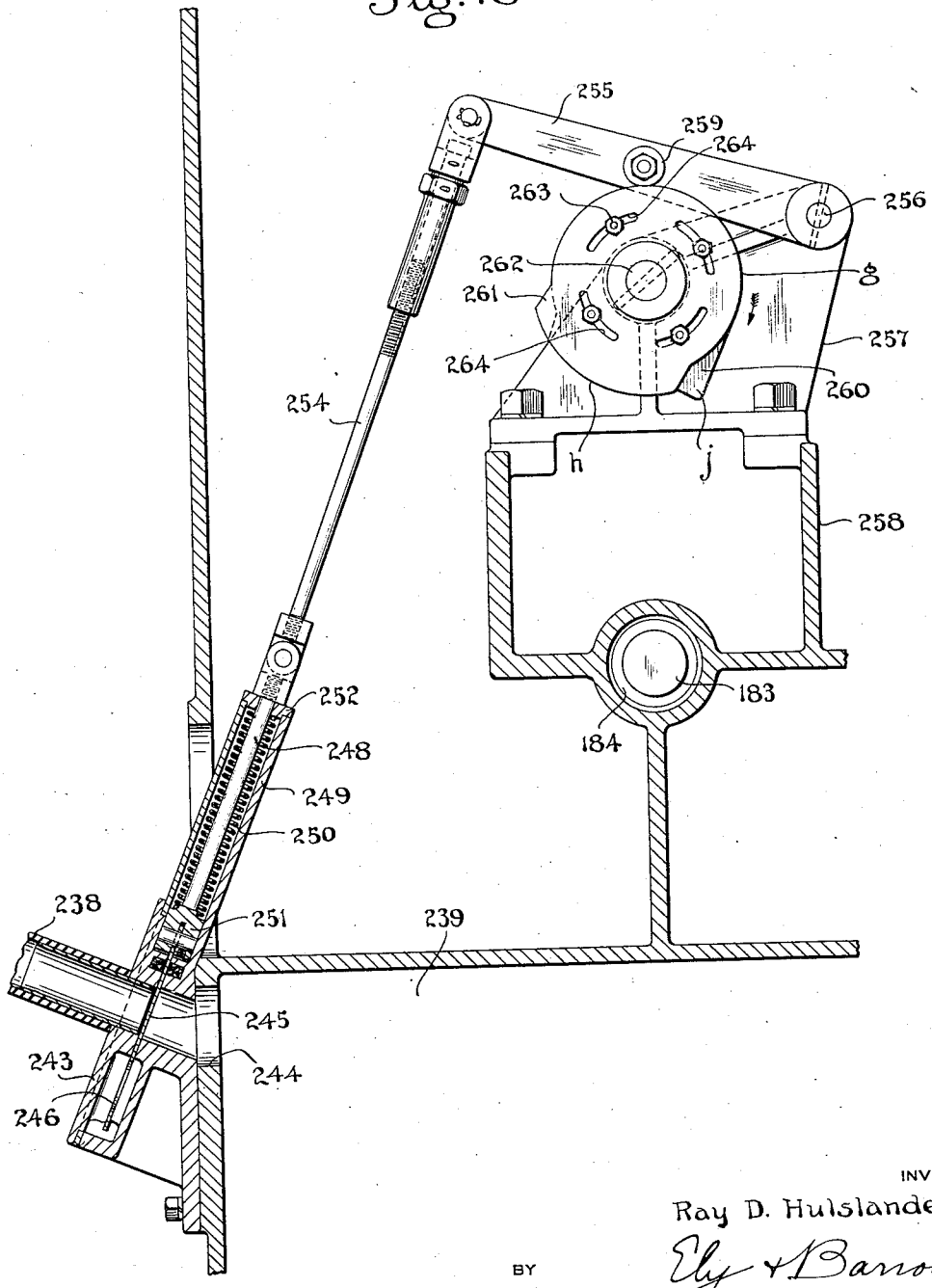
Fig. 18



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TUBE SPLICING MACHINE

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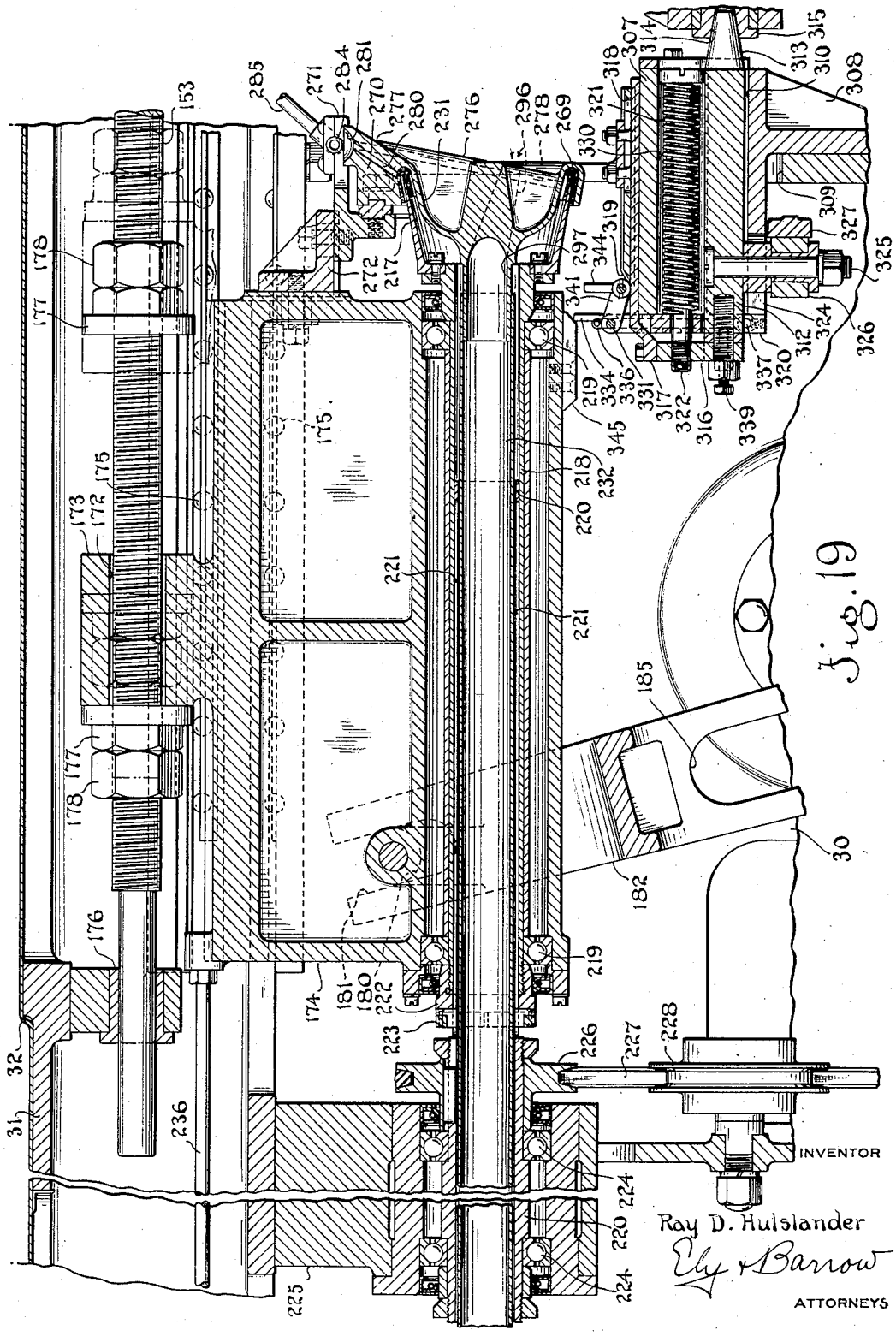

Fig. 19

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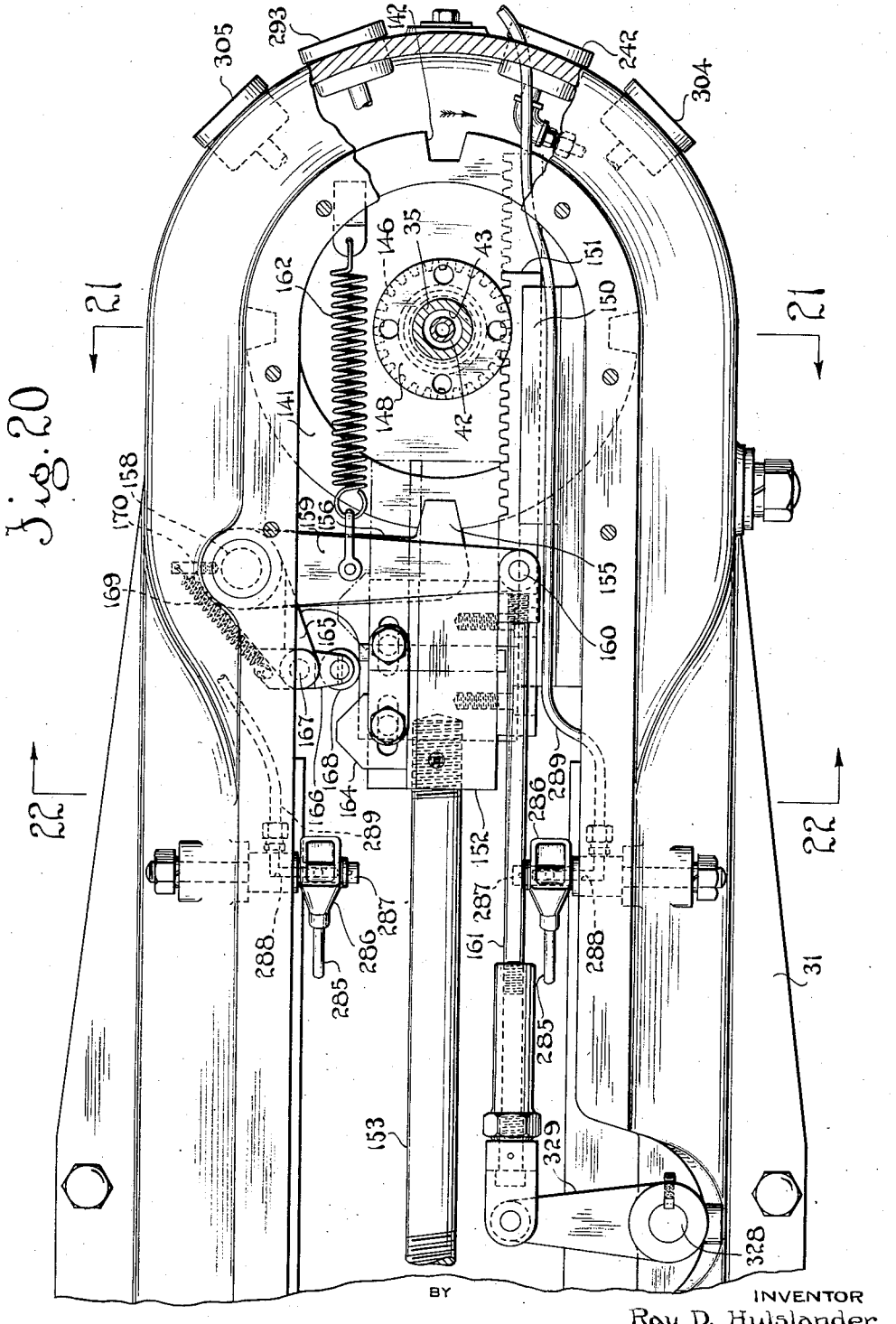
Fig. 20



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TUBE SPLICING MACHINE

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Fig. 21

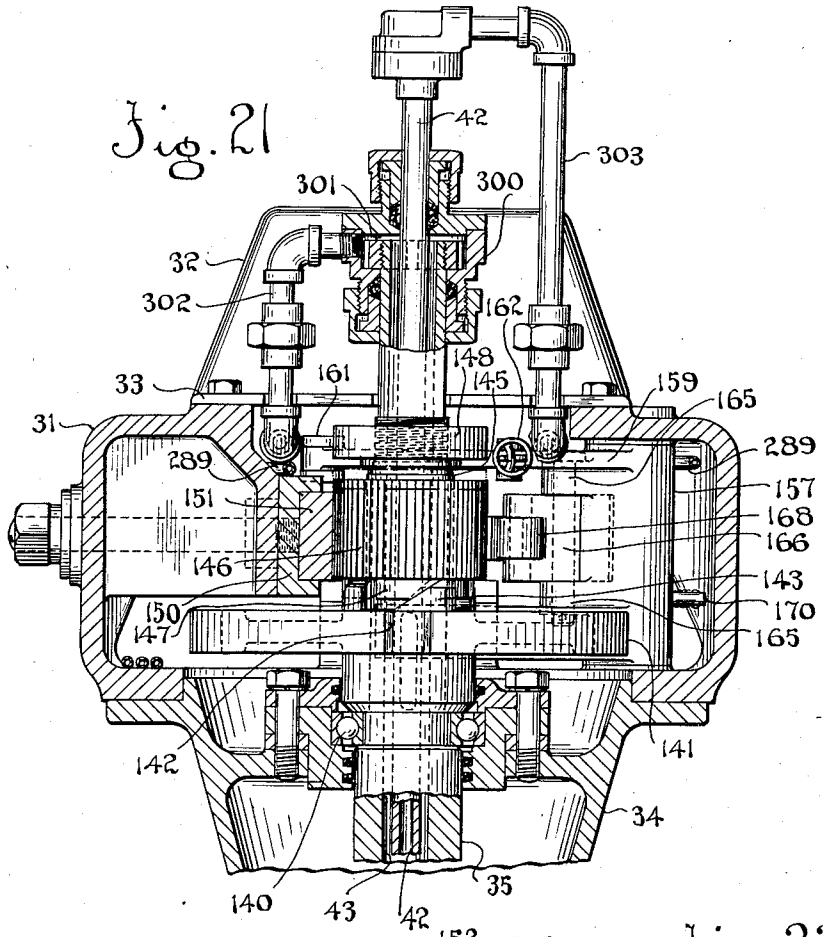
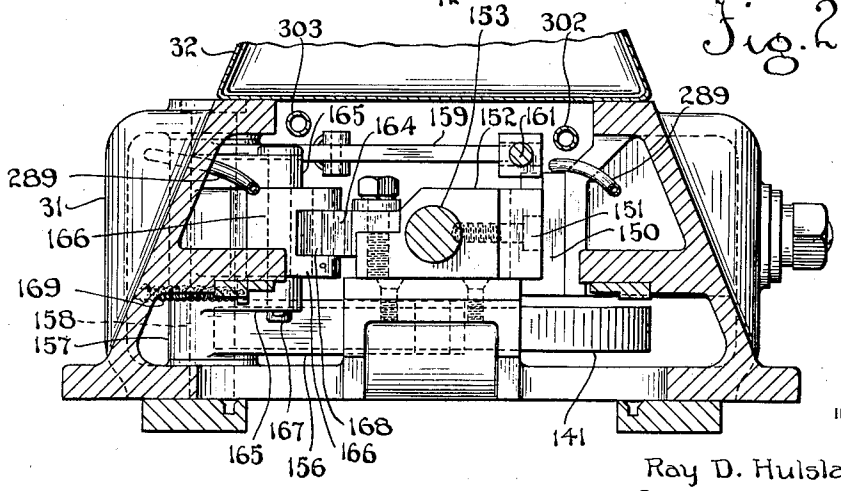


Fig. 22



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TUBE SPLICING MACHINE

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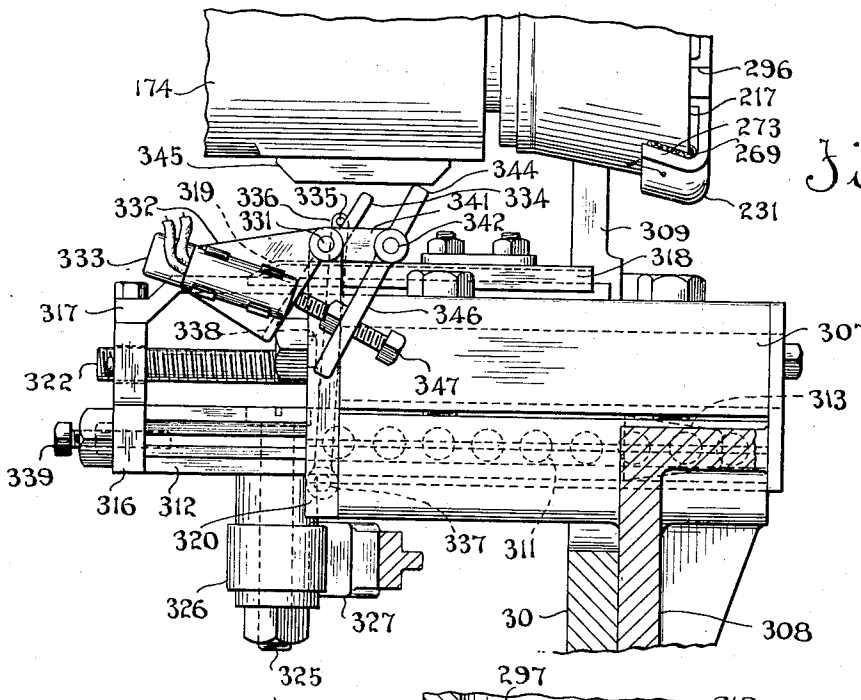

Fig. 28

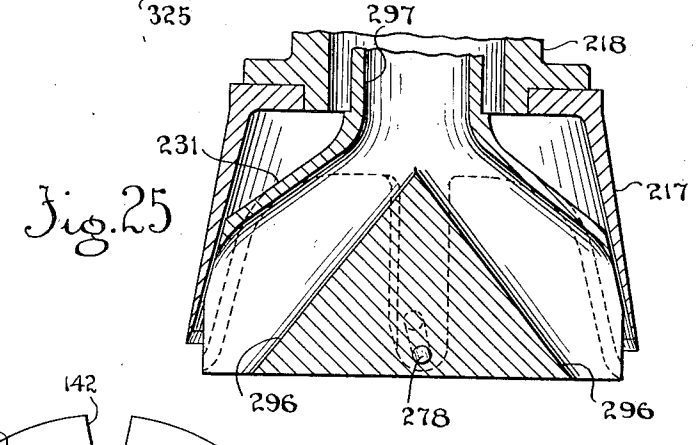

Fig. 25

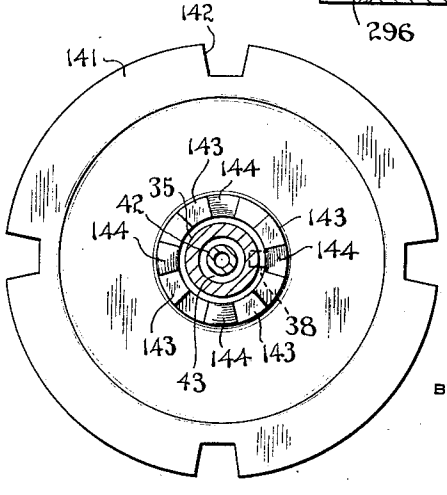

Fig. 23

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TUBE SPLICING MACHINE

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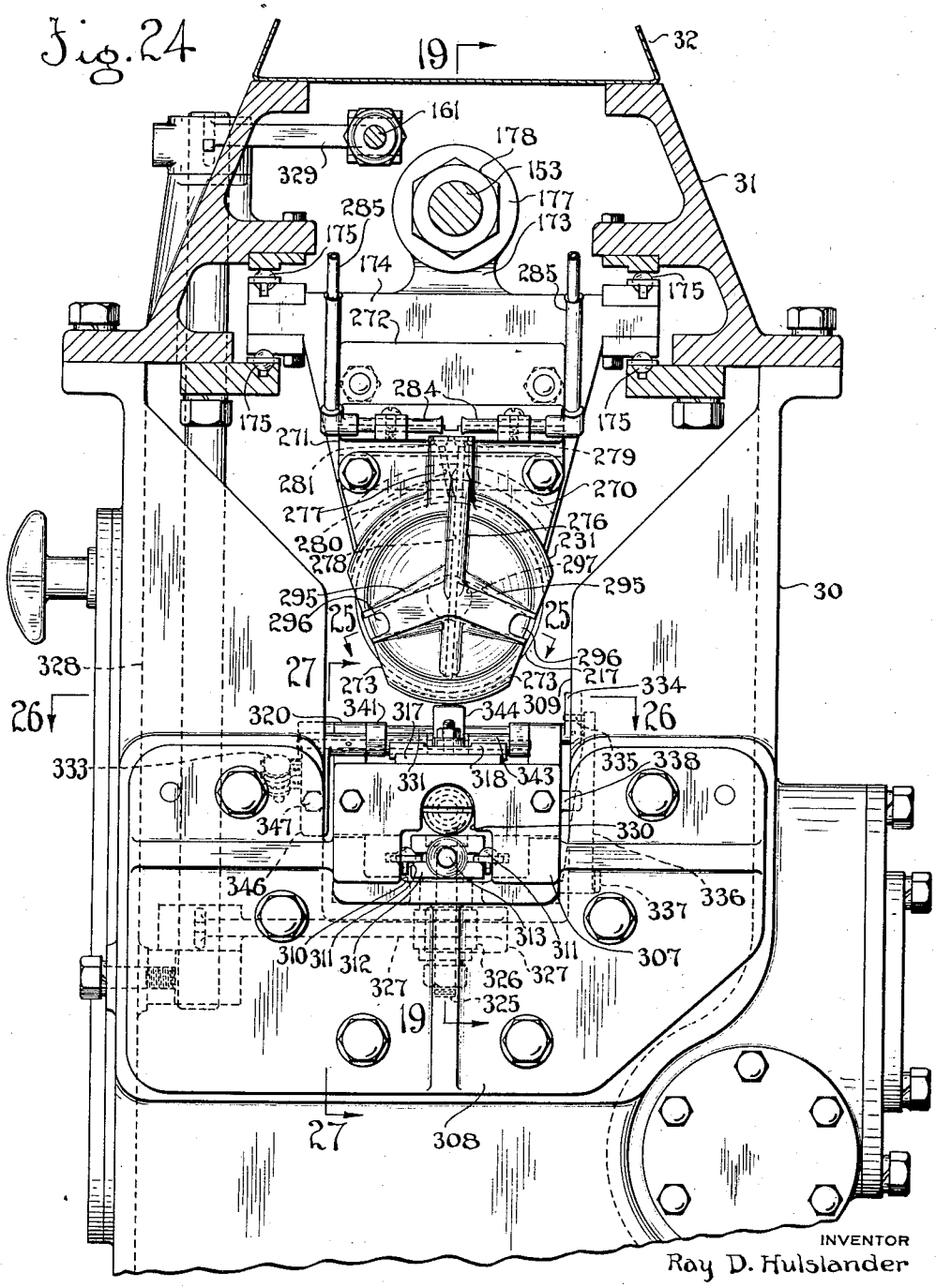
Fig. 24



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TUBE SPLICING MACHINE

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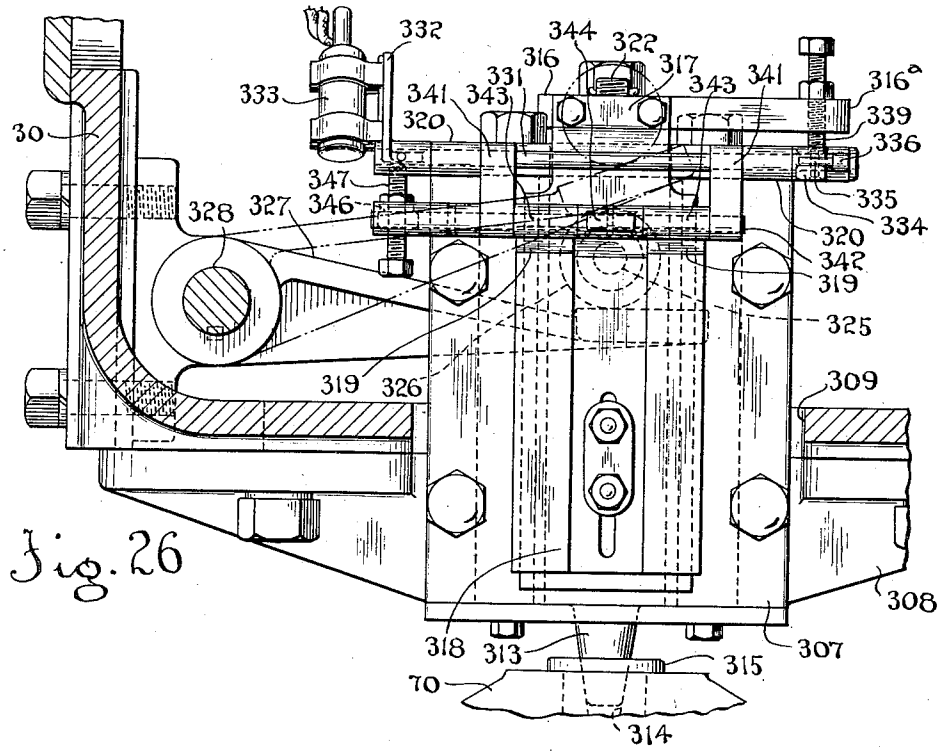

Fig. 26

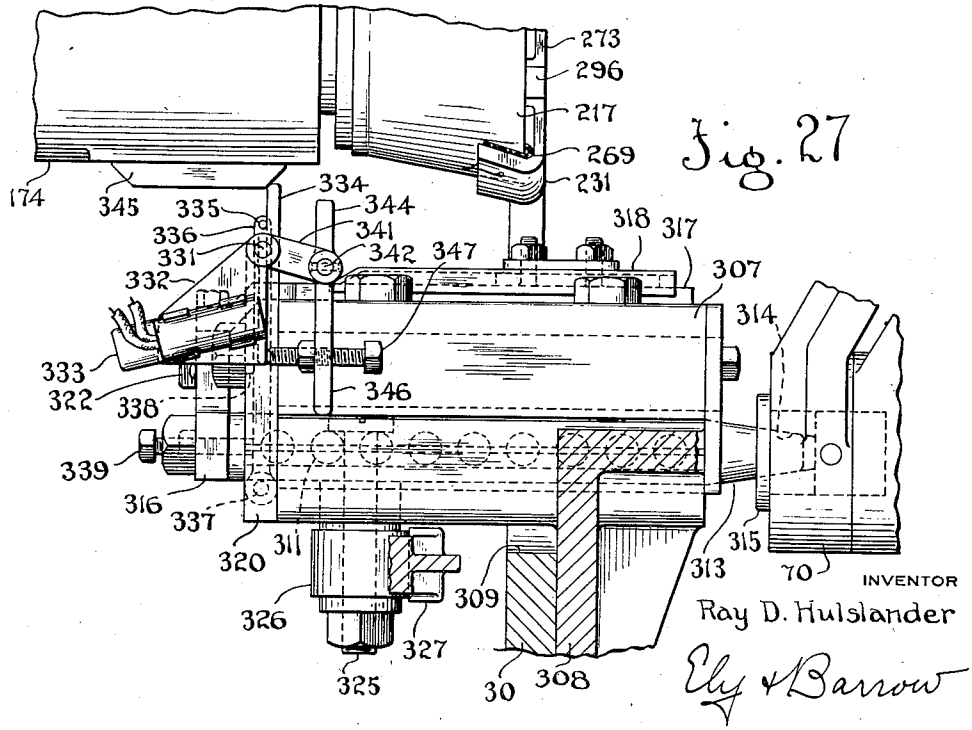

Fig. 27

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Patented Aug. 27, 1935 2,012,565

UNITED STATES PATENT OFFICE

2,012,565

TUBE SPLICING MACHINE

Ray D. Hulslander, Akron, Ohio, assignor to The Firestone Tire & Rubber Company, Akron, Ohio, a corporation of Ohio

Application June 21, 1933, Serial No. 676,773

18 Claims. (Cl. 154—9)

This invention relates to tube splicing machines, and more especially it relates to machines for butt-splicing inner tubes composed of unvulcanized rubber composition.

The chief objects of the invention are to provide a machine of the character mentioned that will be fully automatic in operation except for the manual mounting and removal of the work; that will be continuous in operation; that will trim the tube-ends before butt-splicing them, and dispose of the trimmings; and that will not distort the tube-ends during the trimming operation. Other objects will be manifest.

In general, the machine comprises a rotatable turret that carries four work-holding mechanisms or units. The turret is intermittently indexed or angularly rotated through 90 degrees, and during the periods of rest finished work is removed and new work is mounted in one of the units at one station, and at the diametrically opposite station the two ends of the work are being trimmed. Other operations comprising the clamping of the work in the unit, the butting together of the trimmed ends of the work, and the subsequent opening of the unit to release the work are performed during the intervals that the turret is in motion, between the periods of rest.

The two tube-ends of each tube are trimmed concurrently by means of a rotatable cup-shaped knife that moves forward to cutting position after the tube has been properly positioned by the rotation of the turret. The trimmings from the ends of the tubes are sucked through a hollow spindle that carries the trimming knife, and are deposited in the main housing of the machine. Suitable safety means is provided for preventing injury to the knife in the event that the work-holding units are not properly positioned when the knife moves toward trimming position.

Of the accompanying drawings:

Figure 1 is a side elevation of apparatus embodying the invention, in its preferred form;

Figure 2 is a section on the line 2—2 of Figure 3, showing part of the turret in plan;

Figure 3 is a section on the line 3—3 of Figure 2;

Figure 4 is a section on the line 4—4 of Figure 3;

Figure 5 is a section on the line 5—5 of Figure 2;

Figure 6 is a developed diagrammatic view of two associated cams;

Figure 7 is a detail elevation of a portion of a work-holding unit;

Figure 8 is an end elevation of the mechanism shown in Figure 7, as viewed from the left thereof;

Figure 9 is a plan view of the mechanism shown in Figure 8;

Figure 10 is a side elevation of a complete tube-splicing unit in splicing position, and the work therein;

Figure 11 is an end elevation of the apparatus shown in Figure 10, as viewed from the right thereof;

Figure 12 is a detail sectional view of the work-holding mechanism, and the work therein, and a trimming knife, as they appear during the tube-trimming operation;

Figure 13 is a detail sectional view of the work-holding mechanism, and the work therein, as they appear during the tube-splicing operation;

Figure 14 is a fragmentary sectional perspective view of a spliced inner tube at the splice thereof;

Figure 15 is a section on the line 15—15 of Figure 1;

Figure 16 is a section on the line 16—16 of Figure 15;

Figure 17 is a section on the line 17—17 of Figure 16;

Figure 18 is a section on the line 18—18 of Figure 15;

Figure 19 is a section on the line 19—19 of Figure 24;

Figure 20 is a section on the line 20—20 of Figure 1;

Figure 21 is a section on the line 21—21 of Figure 20;

Figure 22 is a section on the line 22—22 of Figure 20;

Figure 23 is an elevation of a lost-motion ratchet associated with the turret indexing mechanism;

Figure 24 is a section on the line 24—24 of Figure 16;

Figure 25 is a section on the line 25—25 of Figure 24;

Figure 26 is a section on the line 26—26 of Figure 24;

Figure 27 is a section on the line 27—27 of Figure 24; and

Figure 28 is a view similar to Figure 27 showing the operation of safety mechanism thereon.

Referring to the drawings, the machine comprises a main housing 30 upon the top of which is mounted a head casting 31 that overhangs the main housing 30 at front and rear thereof. The head casting 31 is open at its bottom to the interior of the main housing, and has its top closed for the major part by a solvent tank 32, there

being a cover plate 33 over a portion of the head casting at the front of the machine. Depending from the front end of the head casting 31 is a downwardly tapered spindle-housing 34 within which is disposed a hollow, vertical, indexing spindle 35 that is arranged to be periodically indexed or angularly rotated through 90 degrees by mechanism subsequently to be described.

As is most clearly shown in Figure 3, the lower end of the spindle housing 34 carries a lower bearing 36 for the spindle 35, and also carries a double cam structure 37 disposed concentrically about said spindle. Secured on the lower end of spindle 35 by key 38, between tapered collets 39, 39 on said spindle, is a turret 40, a nut 41 being threaded onto the end portion of the spindle to retain the collets 39 and turret 40 in assembled relation. Disposed interiorly of the hollow spindle 35, and spaced from the wall thereof, is a pipe 42 for conveying an elastic fluid, such as air, under high pressure, from a source of supply subsequently to be described, the space between the pipe 42 and the spindle wall constituting a passage or conduit 43 for fluid under low pressure from a source of supply subsequently to be described. The lower end of the pipe 42 is mounted in a cap 44 that seals the lower end of passage 43, said cap being formed with a suitable bore 45 into which is threaded a coupling 46 for a flexible delivery tube 47. A similar coupling 48 for a flexible delivery tube 49 is threaded through the wall of spindle 35 into low pressure passage 43 therein. The turret 40 is formed with four radial arms 50, 50 that are disposed at right angles to each other, said arms supporting respective work-holding units.

The construction of the respective work-holding units will best be understood by reference to Figures 7 to 13 inclusive. The work, herein designated 51, consists of a length of unvulcanized rubber tubing, and in the splicing of the ends thereof to form an endless tube, the end portions thereof are flattened as shown in Figures 11 to 13. To this end there is provided for each tube end an upper die block 52 and a lower die block 53, which die blocks, when in juxtaposed position, define a relatively long and narrow recess wherein the tube ends are securely held in flattened condition as shown in Figures 7 and 10. The lower die blocks 53 are mounted upon respective die holders 54, and the latter are carried upon the upper ends of respective opposed vise-jaws or arms 55 to which they are adjustably secured. The vise-jaws 55 are pivotally mounted at their lower ends upon a radial arm 50 of the turret 40. Each of the vise-jaws 55 is formed at its top with a laterally extending bracket portion 56, and carried thereon is a transversely flat, arcuate metal plate or apron 57 for supporting the work 51 clear of the vise-jaws and their operating mechanism.

The vise-jaws 55 are angularly movable about their pivotal support 50 so as to be spread apart, as shown in Figure 1, for the mounting and removal of the work, and to permit trimming of the tube-ends, as shown in Figure 12, and to be brought toward each other so that the respective die blocks 52, 53 are in abutting relation, as shown in Figures 11 and 13, to effect the butt-splicing of the trimmed tube-ends. For swinging the vise-jaws 55 as described, there are provided respective double-acting fluid pressure operated cylinders 59, each of which has its lower head pivotally connected at 60 to an adjustable, horizontal arm 61 that is secured to and projects laterally from the lower end of a T-shaped bracket 62 that is fixedly secured to the arm 50 of turret 40. The bracket 62 is formed with pairs of oppositely extending, horizontal arms 62*a*, 62*a*, and between the outer ends of each pair of arms is pivotally mounted one arm 63 of a toggle of which the other arm 64 thereof is connected to the vise-jaw 55. The adjacent ends of toggle arms 63, 64 are pivotally connected at 65 to the outer end of the piston rod 66 of a fluid pressure cylinder 59. When the lower ends of cylinders 59 are charged, the vise-jaws 55 are in the positions shown in full line in Figure 11, and they are in the broken line positions of said figure when the upper ends of said cylinders are charged. As is most clearly shown in Figure 10, the lower ends of cylinders 59 are charged upon occasion, with high pressure fluid through pipe 67 and the upper ends of said cylinders normally are charged with low pressure fluid through pipe 68.

Mounted upon the outer end portion of each radial arm 50 is a yoke 70 that is formed with a pair of arcuate, divergent bracket-arms 70*a*, 70*a*, the end portions of the latter being angular so as to be disposed parallel to the arm 50 and to each other, as shown in Figures 10 and 11. In the parallel portions of said bracket arms 70*a* are mounted respective adjustable stop-screws 71 that are so positioned as to be engaged with abutments 72 on the outer faces of vise-jaws 55, in the open position of the latter, and thereby determinately to limit the opening of said jaws under the power of cylinders 59.

Positioned below the turret and the work-holding units is a pan or tray 74 that is supported from the brackets 62 by respective hangers 75. This tray supports the major portion of the work while the respective end portions of the work are being butt-spliced.

The upper die blocks 52 hereinbefore mentioned are carried by respective upper die holders 77, each die block being spaced from its holder by means of a ball bearing 78, Figures 12, 13, and yieldingly connected to said holder by a pair of bolts 79, 79, there being a spring 80 disposed between each bolt-head and the die holder. The arrangement permits universal movement of the upper die blocks with relation to their holders so as to conform to any inequalities in the work.

The upper die holders 77 are hingedly mounted, and means is provided for manually closing the die blocks lightly upon the work to hold it in the work-holders, and for subsequently applying power to confine the work tightly within the die holders during the tube-trimming and butt-splicing operations. The power means also is utilized for opening the die-blocks to permit removal of the finished work.

As is most clearly shown in Figures 7 to 10 inclusive, the upper die holder 77 is pivotally mounted upon a hinge pin 82 in a bracket-like rearward extension 83 of the lower die holder 54. Rearwardly of and somewhat below hinge pin 82 the extension 83 is formed with a bearing for a rock shaft 84 that is formed with an upwardly extending arm 85 constituting one element of a toggle. Keyed to the rock shaft 84 is a downwardly extending crank arm 86 that has its free end pivotally connected to the outer end of the piston rod 87 of a double acting, fluid pressure operated cylinder 88. The rear end of the latter is pivotally mounted at 89 upon a downwardly extending portion 90 of the bracket 56 of the vise-jaw 55. The front end of the cylinder 88 normally is charged with low pressure fluid delivered thereto

through fluid conductor pipe 91. The rear end of the said cylinder is charged, upon occasion, with high-pressure fluid through an inlet and outlet pipe 92.

Pivotally connected at 94 to the free end of toggle arm 85 are toggle links 95, 95 that have their other ends pivotally connected at 96 to a rearward extension of the upper die holder 77. The arrangement is such that the fluid pressure cylinder 88, with its piston rod drawn in by reason of the low pressure fluid normally present in its front end, normally holds the upper die holder 77 in raised or open position as shown in broken lines in Figure 7. When high-pressure fluid is admitted to the rear end of the cylinder 88 through pipe 92, the piston rod 87 of said cylinder is projected outwardly, against the low pressure fluid in the front end of the cylinder, to close the upper die holder with a powerful toggle action, as is most clearly shown in Figure 10.

Mounted upon pivot pins 94 and 96 is a triangular link 98 that has a forwardly extending portion carrying a pivot pin 99, and pivotally mounted upon the latter is an operating lever 100 for manually closing the upper die holder 77. The lever 100 is provided with a laterally projecting stud 101 that overlies a portion of the upper die holder 77, and a tension spring 102 is connected to said stud and to pivot pin 96, the arrangement being such that the spring normally urges said lever to raised or open position as shown in broken lines in Figure 7. Journaled upon the pivot pin 82 is a link 103, and the latter has a loose pivotal connection 104 with an ear 105 formed on the lower margin of the operating lever 100.

The operation of manually closing the upper die holder 77 by means of lever 100 is as follows. The parts being in the broken line positions shown in Figure 7, the lever 100 is manually grasped and pulled downward to the full line position of said figure, the lever stud 101 engaging the top of upper die holder 77 in the closed position of the latter to prevent further movement of said lever. The closing of the upper die holder as described is against the normal low pressure in the cylinder 88 since the pivot pin 96 is moved upwardly and thereby straightens the toggle arms 95, 85 and so moves the toggle crank 86 as to pull the piston rod 87 outwardly a short distance. In the closed position of the lever 100 the pivot point 104 thereof is over center or below the plane of pivot points 82, 94, in which plane the force of the low pressure in cylinder 88 is directed, in the direction indicated by the arrow in Figure 7, with the result that the lever 100 is locked in closed position.

Upon occasion, when it is desired to grip the work more firmly by the use of power means to hold the upper die holder 77 in closed position, high-pressure fluid is admitted to the rear end of cylinder 88 through pipe 92 with the result that the piston rod 87 is moved outwardly to the position shown in Figure 10. This straightens the toggle arms 85, 95 and, by urging pivot pin 96 upwardly, forcibly urges the upper die holder 77 toward closed position. Straightening of the toggle also moves link 98 so that pivot pin 99 thereon is raised, which by raising that end of the lever 100, causes the latter to fulcrum about stud 101 and thereby to lift the pivot point 104 on said lever above the plane of pivot points 82, 94. This unlocks the lever and the spring 102 acts to lift it about fulcrum 99, but the rise of the lever is limited to the position shown in Figure 10 by reason of the link 103, which binds on the pivot pin 104 since the radius between points 82, 104 is less than that between points 99, 104. The lever is in position, however, to open fully with the upper die holder 77 when the high pressure fluid in cylinder 88 is exhausted and the low pressure fluid therein once more moves the parts to the broken line position shown in Figure 7.

As hereinbefore stated, the turret 40 is intermittently progressively indexed or rotated through 90 degrees, each work holder stopping at four stations of which one station is a work loading and removal station and the diametrically opposite station is a work trimming station. Low pressure fluid normally in cylinders 59 holds the vise-jaws 55 normally apart and low pressure fluid in cylinders 88 normally holds the upper die holders 77 in raised position to permit mounting and removal of the work. At determinate points in the orbit of the work-holding units, between stopping stations, high pressure fluid is admitted to the respective cylinders 59, 88 to overcome the force of the low pressure fluid therein and thereby to close the vise-jaws and upper die holders respectively.

Admission of high-pressure fluid to the cylinders is controlled by valves, and the latter are controlled by stationary cams presently to be described, which operate the valves as the turret rotates. As is best shown in Figure 3, fluid of low pressure that comes through the spindle 35 is conducted by the delivery pipe 49 to a concentric manifold or passage 107 formed in the turret 40. Four fluid passages 108, 108 in said turret extend radially from the manifold 107 to the periphery of the turret, beside the respective arms 50 thereof, and respective four-way distributor heads 109 are threaded into the outer ends of said passages. To each of said distributor heads is connected two conductor pipes 68 from the two cylinders 59 of a work-holding unit and two conductor pipes 91 from the two cylinders 88 of the same work-holding unit.

High-pressure fluid from the pipe 42 in spindle 35 is delivered by delivery pipe 47 (Figure 3) to an annular passage or manifold 111 formed in the turret 40, concentrically thereof and outwardly of the manifold 107. Extending through the bottom wall of the turret 40 and in communication with manifold 111 are eight valves of identical construction, four of the valves 112, 112 being aligned with the turret arms 50, and the other four valves 113, 113 being positioned intermediate valves 112, the valves 113 being disposed at somewhat greater distance from the axis of the turret than valves 112.

As is most clearly shown in Figures 3 and 5, each of the valves 112, 113 comprises a housing in which is slidably mounted a plunger 115 that has a conical upper end constituting a valve that is adapted to engage a complemental valve seat formed at the inner end of an inlet port 116, where fluid from the manifold 111 enters the valve. In its medial portion the plunger 115 is formed with an enlarged flange 117, and a compression spring 118 positioned between said flange and the upper wall of the valve housing normally urges the plunger downwardly against a gland 119 that is threaded into the bottom of the valve housing, the lower face of the flange 117 being tapered to constitute a valve that cooperates with a complementally tapered valve seat formed on the upper end of gland 119. The lower half of the plunger 115 is formed with an axial bore 120 and communicating therewith is a trans-

verse bore or passage 121 disposed just below the flange 117, and a transverse bore 122 positioned adjacent the lower end of the plunger, which end is disposed below and exteriorly of the gland 119. Centrally, the valve housing is formed with a port 123 in the outer end of which is threaded a two-way distributor head 124. The distributor heads of valves 112 have conductor pipes 67, 67 connected thereto and the distributor heads of valves 113 have conductor pipes 92, 92 connected to them.

The operation of valves 112, 113 is best shown in Figure 3 wherein the valve at the left of the figure is open and the valve at the right is closed. In the open position of the valve, fluid from manifold 111 passes through port 116 and past flange 117, passing out through port 123 into pipes 67. In the closed position of the valve shown at the right, the plunger 115 has closed port 116 and fluid in the pipes 67 is forced backward through port 123 whence it passes between flange 117 and gland 119 and thence through passages 121, 120, and 122 to vent into the atmosphere.

Operation of the valves 112, 113 is effected by means of respective valve tappets 126 that are pivotally mounted at 127 upon bracket arms 128 formed on each valve housing. In one end of each tappet 126 is an adjustable screw 128 that engages the lower end of the plunger 115 of the valve. The other end of each tappet is engaged by a push rod, which in the case of valves 112 is designated 129 and in the case of valves 113 is designated 130. Each of the push rods 129, 130 has its lower end bifurcated so as to straddle the tappet-end, and said lower end is axially bored to slidingly receive a plug 131 backed by a compression spring 132, said plug bearing against the tappet-end. The push rods 129, 130 are slidingly mounted for vertical movement in respective bushings 133 in the turret structure 40, and in the upper end of each push rod is journaled a cam-roller 134.

The bottom of the double cam structure 37 is formed with two annular, concentric, cam tracks 136, 137 of which the inner track 136 is engaged by the cam rollers 134 of push rods 129 controlling valves 112, and the outer track 137 is engaged by the cam rollers of push rods 130 controlling valves 113. The cam tracks 136, 137 are so constructed and arranged as to elevate and depress the push rods 129, 130 at determinate time intervals as the turret is indexed, and thereby to control the opening and closing of the upper die holders 77 and the opening and closing of the vise-jaws 55 of the respective work-holding units.

The cam tracks 136, 137 are shown in place in Figure 4 and in developed diagrammatic elevation in Figure 6. As will be seen therein, the cam track 136 has a long flat reach *a*, an upward slope *b*, a flat reach *c* from the top of slope *b*, and a downward slope *d* at the end of flat reach *c*, the lower end of slope *d* connecting with the flat reach *a*. The angular position of cam structure 37 is such that cam rollers 134 of push rods 129 move along cam reach *a* from the first or front station of the work-holding units to a point midway between third and fourth stations thereof, where they move up slope *b* to reach *c* on which they continue to move until a point midway between the fourth and the first station, whereat they move down slope *d* and onto reach *a* again. The arrangement is such as to actuate and open valves 112 to admit high-pressure fluid to cylinders 59 to cause closing together of the vise-jaws 55 of the respective work-holding units, in succession, as said units move between stations three and four, and to open said vise-jaws when said units are between stations four and one.

The cam track 137 has a flat reach *w*, an upward slope *x*, a long flat reach *y* from the top of slope *x*, and a downward slope *z* from the end of flat reach *y* connecting with flat reach *w*. The cam track 137 is so arranged that the rollers 134 of push rods 130 move along cam reach *w* while their respective units are moving from the first station to a point between first and second stations, and then move up slope *x* onto reach *y* on which they remain until after the unit passes the fourth station, whereat they move down slope *z* onto reach *w* again. The arrangement is such as to actuate and open valves 113 to admit high-pressure fluid to cylinders 38 to cause power closing of the upper die holders 77 of the work-holding units, in succession, as said units move away from the first station, and to open said die holders when said units have passed the fourth station, slightly before the vise-jaws 55 are opened by the operation of cam track 136.

The mechanism for indexing the turret 40 and work holders thereon 90 degrees at a time is best shown in Figures 16, 20, 21, 22 and 23, to which attention now is directed. As is most clearly shown in Figure 21, the upper end portion of the spindle 35 is journaled in a thrust bearing 140 carried in the upper portion of spindle housing 34, and keyed to the said spindle immediately above said bearing 140 is a ratchet gear 141. As is shown in Figure 23, the perimeter of the latter is formed with four recesses 142, 142 that are trapezoidal in shape and spaced 90 degrees apart. Concentric with the axis of the ratchet gear, on the upper surface thereof is an annular series of four ratchet teeth 143, 143 each of which has one sloping end-wall 144. Journaled upon a bearing bushing 145 on the spindle 35, above the ratchet gear 141, is a pinion 146, the lower face of which is formed with four ratchet teeth 147, 147 that are shaped complemental to the teeth 143 and are in engagement therewith. The bushing 145 is formed on its upper end with a flange to limit the upward movement of the pinion 146 as it ratchets over teeth 143, and a nut 148 is threaded onto the spindle 35 to retain the bushing 145 in place.

Supported by the head casting 31, interiorly thereof, is a slideway or bearing 150 for a rack 151 that is meshed with pinion 146, said rack being connected at its rear end to a mounting block or crosshead 152 that is connected to the forward end of a rod or shaft 153 that is longitudinally reciprocated by mechanism subsequently to be described. The forward position of the rack 151 and crosshead 152 is indicated in broken lines in Figure 20 and their rearward positions are shown in full lines in the same figure. Forward movement of the rack 151 rotates the pinion 146 counter-clockwise as viewed in Figure 20, thus causing the teeth 147 of said pinion to ratchet over teeth 143 of ratchet gear 141. This movement of pinion 146 is somewhat greater than 90 degrees so that the flat or driving faces of the ratchet teeth 143, 147 are somewhat separated, as shown in Figure 21, at the time the pinion 146 begins its reverse or clockwise movement. This provides an interval of lost motion so that after the ratchet teeth 143, 147 are operatively engaged, the ratchet gear 141 will be angularly

rotated exactly 90 degrees in the direction indicated by the arrow in Figure 20. The period of lost motion is utilized to disengage latching mechanism from the ratchet gear 141, which mechanism is provided for preventing over-run of the ratchet gear as it is driven, and for assuring accurate stopping of the ratchet gear, after it has advanced exactly 90 degrees.

Said latching mechanism comprises a dog or latch 155 shaped complemental to the recesses 142 of the ratchet gear 141, said dog being formed on the free end of a latching lever 156 that has a relatively large hub 157 that is pivotally mounted at 158 in the head casting 31. Formed on the upper portion of the hub 157 is a lever 159 that is parallel to lever 156, and which extends over the crosshead 152 and has its free end connected at 160 to one end of a rod 161 that is connected to a turret-registering and safety mechanism subsequently to be described.

A tension spring 162 is connected to lever 159 and to a fixed point at the front of the head casting 31, the arrangement being such as normally to urge the dog 155 toward the ratchet gear 141. The dog 155 of the latching mechanism is withdrawn from the ratchet gear during the initial rearward movement of the cross-head 152, and to this end a cam 164 is adjustably mounted upon the lateral face of the cross-head adjacent the hub 157. A pair of bracket arms 165 formed on the hub 157 between the levers 156, 159 carry a trip lever 166 that is pivotally mounted at 167 in such a manner as to be angularly movable about said pivot in one direction only. Journaled in one end of trip lever 66 is a cam roller 168 positioned in the path of cam 164. A tension spring 169 is connected to the other end of said trip lever and to a stud 170 projecting from hub 157. The arrangement is such that in the forward movement of the crosshead 152, the cam 164 moves under and past the cam roller 168 by tilting the trip lever 166 against the tension of spring 169. During the rearward movement of the crosshead the cam 164 engages cam roller 168 and, because the trip lever 166 cannot be moved about pivot 167 in both directions, causes rotation of the hub 157 and angular movement of levers 156, 159, against the tension of spring 162, whereby the dog 155 is withdrawn from engagement with the ratchet gear 141 and the rod 161 is longitudinally moved rearwardly. This permits subsequent rotation of the ratchet gear.

Reciprocation of the turret-indexing shaft 153 is effected in determinate timed relation to the operation of the trimming knife that severs the surplus stock from the respective ends of the work, before said ends are butt-spliced together. To this end the shaft 153, near the rear thereof, is extended freely through a horizontal bore 172 formed in a bracket 173 that is formed on the top of a reciprocatory knife-carrying carriage 174, the latter being formed with lateral flanges that are supported between respective horizontal series of bearings 175, 175 carried by the head casting 31, as is most clearly shown in Figures 15, 16, 19 and 24. At its extreme rear end the shaft 153 is mounted in a bearing bushing 176 carried by head casting 31. Adjacent the bracket 173 the shaft 153 is threaded to receive a pair of control nuts 177 backed by lock nuts 178, said control nuts being disposed on opposite sides of the bracket 173 so as to be engaged by the latter, during its reciprocating movement, to impart similar movement to shaft 153. The control nuts 177 are so spaced with relation to the bracket 173 as to provide an interval of lost motion between the movement of the carriage 174 and the movement of the shaft 153, during which interval the trimming knife is moved out of the orbit of the work-holding units, before the turret 40 is indexed.

For reciprocating the carriage 174, the latter is provided on its opposite sides with laterally projecting roller trunnions 180, 180 that are engaged in respective slots 181, 181 formed in the free end of a forked swinging arm 182, the latter having its opposite end provided with a hinge pin 183 that is journaled in bearings 184, 184 in the opposite lateral walls of the main housing 30. In its medial portion the swinging arm 182 is formed with an elongate slot 185 in which is a crank roller 186 that is journaled upon a crank pin 187 in the free end of a crank 188. The latter is mounted upon one end of a shaft 189, Figure 15, that is journaled in a wall of the main housing 30, said shaft carrying a worm gear 190 that is meshed with a driving worm 191 that is mounted upon a countershaft 192, the latter being journaled in the wall of the main housing 30, at right angles to the shaft 189.

The driving means for the countershaft 192 is best shown in Figures 16 and 17. In Figure 16 it will be seen that the countershaft 192 carries three grooved pulleys 194, 195, and 196, which pulleys are of graduated diameters to provide for various speeds of operation of the machine. As shown in the drawings, pulley 195 is being driven by a V-shaped belt 197 that is trained about a driving pulley 198 and an idler belt-tightening pulley 199, the pulley 198 being journaled upon a shaft 200 that is journaled in the rear wall of the main housing 30 and in a portion 201 interiorly of the housing. The belt-tightening pulley 199 is journaled upon a spindle 202 that projects from the free end of an arm 203 that is pivotally mounted at its other end upon shaft 200. The spindle 202 is adjustable longitudinally of arm 203, and the latter is angularly adjustable about its pivot by means of an arcuate slot 204 formed in its structure, through which slot extends a retaining bolt 205 for retaining the arm in proper angular position.

Also journaled in shaft 200 and fixed to pulley 198 is a pulley 207 that is connected by a belt 208 to the smaller pulley 209 of a pair of laterally-connected idler pulleys 209, 210 that are journaled on the spindle 202. The larger pulley 210 of the pair of pulleys has driving connection through belt 211 with a driving pulley 212 keyed to the shaft 200. The shaft 200 extends through the rear wall of the main housing 30 and is connected, through a suitable coupling 213, to the shaft of a driving motor 214 that is mounted upon a bracket 215 on the rear of the machine. The arrangement is such as to provide suitable speed reduction between the motor 213 and the crank 188.

Surplus stock on the respective ends of a tube 51 to be spliced is concurrently severed by a rotatable cup-shaped trimming knife 217 that is mounted at the front end of a sleeve 218 (see Figure 19) that is journaled in bearings 219, 219 in opposite ends of the carriage 174. Slidably telescoped with sleeve 218, interiorly thereof, is a tubular driving sleeve 220, the forward end portion of which is formed with two or more elongate slots 221, 221. Threaded onto the rear end of the sleeve 218 is a drive nut 222, and secured to the latter is an annular drive key 223 that is formed with suitable projections extending into respective slots 221, thus providing driving con-

nection between sleeves 220 and 218. At its rear end portion the driving sleeve 220 is journaled in bearings 224, 224 in a bracket 225 secured to and extending downwardly from the head casting 31, the arrangement being such as to restrain said driving sleeve against axial movement. Keyed to the driving sleeve 220 adjacent bracket 225 is a pulley 226 driven by a belt 227 that is trained over an idler pulley 228 and about a driving pulley 229, the latter being keyed to the drive-shaft 200 hereinbefore described. The arrangement is such that the knife 217 is constantly driven, and is moved forwardly and rearwardly with the carriage 174.

During the tube-trimming operation low pressure suction is applied locally to the trimming knife 217 to facilitate the trimming operation, and immediately the stock is completely severed high pressure suction is applied to remove and dispose of the severed pieces. Suction is applied to the knife through a knife-guard and suction head 231 presently to be described in detail. Connected to and extending rearwardly from the suction head 231 is a suction tube 232 that is positioned interiorly of the driving sleeve 220 and knife sleeve 218. The suction tube 232 projects from the rear end of driving sleeve 220 and has its own rear end supported by a V-shaped yoke 233 that is provided with rollers, such as the roller 234, that support the yoke upon respective trackways 235 on the under side of head casting 31. A pair of tie rods 236, 236 connect the yoke 233 to the carriage 174 so that the yoke and suction tube are moved in unison by and with the carriage 174.

The rear end of suction tube 232 has communication, through a flexible pipe 238, with a closed chamber 239 in the bottom of main housing 30, there being a constant sub-atmospheric pressure in said chamber by reason of high pressure suction applied thereto through a conduit 240 that extends to suitable air-evacuating mechanism (not shown). A gauge 242 for indicating the magnitude of the sub-atmospheric pressure in chamber 239 may be mounted on the front of head casting 31. Thus trimmings from the work are drawn through suction tube 232 and pipe 238 and are deposited on the floor of chamber 239. A sealed door 241 to said chamber is provided for the removal of the trimmings.

In order that both low and high suction may be created in suction tube 232, a valve structure 243, Figure 18, to which pipe 238 is connected, is mounted on the wall of the main housing 30 in communication with chamber 239 therein through a port 244 in said wall. The valve structure 243 comprises a valve 245 consisting of a plate having an aperture 246 therein, said plate being mounted for slidable movement so that the aperture 246 may be moved into registry with port 244 and the outlet to pipe 238 whereby the high-pressure suction in chamber 239 is transmitted to the latter. When the aperture 246 is out of registry with said port and pipe, as shown in Figure 18, there is no suction in said pipe. When said aperture is partly in register with said port and pipe there is low pressure suction in the pipe.

Operation of the valve 245 is accomplished by means of a pull-rod 248 that is connected to the upper end thereof, said pull-rod extending through a sleeve 249 and having a compression spring 250 mounted on its structure between a flange 251 at the lower end thereof and an apertured closure 252 at the upper end of said sleeve. The spring 250 normally urges the valve 245 to closed position.

Pivotally connected to the outer end of pull-rod 248 is a link 254 that has its other end adjustably connected to the free end of a lever arm 255 that is pivotally mounted at its other end at 256 upon a bearing bracket 257 that is mounted upon a bracket 258 formed interiorly of the main housing 30 upon a lateral wall thereof. In its central portion the lever arm 255 carries a cam roller 259 that rides on the perimeter of a cam structure comprising cam plates 260, 261, of which the rear cam 260 is secured upon one end of a shaft 262 that is journaled in bearing bracket 257. Front cam 261 is mounted upon the front face of cam 260, being secured thereto by bolts 263, 263 that extend through respective arcuate slots 264 in said cam 261. The arrangement is such that cam plates 260, 261 may be adjusted angularly relatively of each other. Both cams 260, 261 have a relatively long low reach *g* and relatively long high reach *h*, and in addition cam 260 has a sharp rise and decline *j* that is disposed at the trailing end of high reach *h*, and is higher than the latter. The arrangement is such that when cam roller is on reach *g* the valve 245 is in closed position, when it is on reach *h* said valve is partly open, and when the cam roller is engaged by the rise *j*, the valve is fully open. By adjusting the relative positions of cam plates 260, 261, the beginning and duration of the partial opening of the valve 245 can be controlled.

For rotating the shaft 262 and cam structure, in the direction indicated by the arrows in Figure 18, the rear end of said shaft is provided with a crank 266, Figures 15, 16, that has a forked free end in which rides a crank-block 267 that is mounted upon crank pin 187 of crank 188. The arrangement is such that the valve 245 is operated in determinate time relation to the forward and rearward movements of the knife-carriage 174 effected by means of the swinging arm 182.

The knife guard and suction head 231 comprises a generally cup-shaped casting that fits within the knife 217 in spaced relation thereto, the outer margin of the casting being curved around the cutting edge of the knife to protect the latter. An absorbent packing 269 such as felt is positioned between the cutting edge portion of the knife and the suction head for the purpose of applying fluid rubber-solvent to the knife to lubricate the same and to render the severed ends of the work sufficiently tacky readily to adhere together. The suction head is exteriorly formed on its upper side with a flange 270 that is bolted to a bracket 271 that in turn is adjustably secured to a bracket 272 that is adjustably bolted to the front end of the carriage 174, whereby the suction head is held securely in position, but capable of adjustment so as accurately to fit the trimming knife. As is most clearly shown in Figures 12 and 24, the suction head is cut away at opposite sides on non-parallel, chordal lines to expose the cutting edge of the trimming knife, as shown at 273, 273, whereby said knife is enabled to sever the projecting end portions 274, 274 of the work, held in a work-holding unit, during the forward movement of the knife.

For conveying solvent to the packing 269, the concave, front portion of the suction head is formed with a vertical web or rib 276 that merges, at the top of the head, with an outwardly extending buttress 277 formed on the head-flange 270. A bore or passage 278 formed in web 276 extends from the recess formed by the curved edge of the suction head, at the bottom of the latter, to the upper face of the buttress 277 where

it terminates in an enlarged hemispherical recess 279. In like manner a bore 280 is formed in buttress 277 extending from the curved margin of the suction head, at the top thereof, to a recess 281 positioned beside recess 279 in the top face of the buttress. Passages 278 and 280 are adapted to convey solvent, dropped into recesses 279, 281, to the packing 269 at top and bottom of the suction head.

Solvent is brought to the suction head and dropped into recesses 279, 281 by respective pipes, the delivery end portions 284, 284 of which are pivotally mounted on a horizontal axis upon bracket 271, over the buttress 277. Extending obliquely upwardly at right angles to the end portions 284, are telescopic pipes 285, 285, the upper ends of which are provided with respective funnel-shaped terminal portions 286 that are swivelled upon pivot pins 287, Figure 20, in the head casting 31, interiorly of the latter and substantially midway between the extreme forward and rearward positions of the trimming knife. The pivot pins 287 are formed with respective axial bores 288 that have outlet ports within the funnel portions 286, and inlet ports having communication with solvent-conducting pipes 289. The pipes 289 extend to a feed valve 290, Figure 1, on the front of the head casting 31, to which valve solvent from the tank 32 is conducted through pipe 291, there being a filter 292 in the latter. The solvent in tank 32 is under pressure, and a gauge 293, Figure 20, may be mounted upon the front of the head casting so as visibly to register said pressure.

As is most clearly shown in Figures 12, 19 and 24, the concave front portion of the suction head 231 is formed with two radial webs or ribs 295, 295 that are disposed normal to the two chordal, cut-away portions 273 of said head. Interiorly of ribs 295 are respective passages 296 that unite at their inner ends in an axial passage 297, Figures 19, 25, that is in communication with the suction tube 232. At their outer ends the passages 296 terminate at the cutting edge of knife 217, being sufficiently large and spaced from the knife to permit trimmings from the respective ends of the work to enter said passages as the work is trimmed. Suction created in said passages, by mechanism hereinbefore described, assures the conveying of such trimmings to the chamber 239 in the main housing.

As is shown in Figure 21, the upper end of the indexing spindle 35 of the turret 40 is provided with a double stuffing box 300 that engages said spindle and the high pressure inlet pipe 42 that extends through said spindle. Said stuffing box is suitably formed to provide a single inlet 301 to the low pressure passage 43 surrounding pipe 42. A supply pipe 302 for low pressure fluid is in communication with inlet 301, and extends downwardly and rearwardly through head casting 31 to a source of fluid supply (not shown). A supply pipe 303 for high pressure fluid is connected to the upper end of pipe 42 and extends downwardly and rearwardly through the head casting 31 to a suitable source of high pressure fluid (not shown). Respective air gauges 304, 305 for the low and high pressure fluid lines are mounted upon the front end of head casting 31.

It is essential that the work-holding units be accurately positioned at the time the knife 217 moves forward to trim the work, to assure accuracy of the trimming operation and to avoid possible damage to the knife. Because of backlash and lost motion in the gearing that drives the turret 40, it is desirable to have supplemental means for assuring accurate positioning of the turret, and said means also is provided with safety mechanism adapted to stop the drive of the machine if the turret is so far out of registry as to be incapable of proper positioning by said supplemental means, or upon the breakage of certain parts of the machine.

The supplemental turret-positioning means comprises a housing or frame structure 307 that is mounted upon a bracket 308 that is secured to the outside of the front wall of the main housing 30, the said bracket and housing structure thereon extending rearwardly into the said main housing through a large opening 309 in the front wall thereof. Mounted in a longitudinally extending slot 310 in the top face of bracket 308, upon laterally disposed bearings 311, 311, is a slide 312 that is formed with a forwardly extending, tapered nose or dowel 313, the latter being adapted to enter complementally shaped recesses 314 formed in plugs 315 that are mounted in the ends of the respective turret-arms 50 for retaining the yokes 70 thereon. Secured to the rear end of slide 312 is a bracket 316 to the upper margin of which is attached a plate 317 that slides upon the top of the housing 307, and adjustably mounted upon the top of plate 317 is a cam-plate 318, the rear end portion of which is formed with sloping cam surfaces 319, 319 as is most clearly shown in Figures 19 and 26. The rear end of the housing 307 is provided with an end-plate 320 that is H-shaped to permit movement of the slide 312 and top-plate 317 thereof.

The slide 312 normally is urged forwardly in its housing by means of a compression spring 321, Figure 19, that is mounted upon a bolt 322 that is disposed in a slot 330 in the bottom of housing 307, directly over slot 310, and extends through end-plate 320 and is secured to bracket 315, the spring 321 bearing against said end-plate and the head of bolt 322. The slide 312 is moved forwardly and rearwardly in determinate time relation to the indexing of turret 40. To this end a slot 324 is formed in bracket 308, and through said slot extends a stud 325 that is carried by slide 312, the lower end portion of said stud having a roller 326 journaled thereon. Engaging the roller 326 is the free end of a lever arm 327 that is mounted upon the lower end of a vertical rock-shaft 328, Figures 20, 24, said rock-shaft being journaled in suitable bearing brackets mounted on the walls of main housing 30 and head casting 31, and having its upper end provided with a rocker arm 329, the free end of which is connected to rod 161. The arrangement is such that when the rod 153 and crosshead 152 move rearwardly to index the turret 40, movement of the levers 156, 159 which withdraws dog 155 from engagement with ratchet gear 141 also angularly moves rock-shaft 328 to move slide 312 from its forward position shown in Figures 16, 19, 26 and 27 to its retracted position shown in Figure 28. At the termination of the rearward movement of the crosshead 152, when the spring 162 again pulls the levers 156, 159 forwardly to engage dog 155 with the ratchet gear 141, the slide 312 is likewise moved forwardly so that its nose 313 enters recess 314 in the end of one of the turret arms, so as accurately to position the turret and work-holding units thereon. This occurs before the subsequent forward movement of the knife 217 so that the work is properly positioned to be engaged by said knife.

Journaled in the top of the H-shaped end plate 320 is a shaft 331 upon one end of which is mounted a switch support 332 that carries a mercury switch 333, the latter controlling the operation of motor 214 that drives the machine. Normally the switch 333 is in the closed position shown in Figures 16, 24, 26 and 27, at which time the motor is running. The opposite end of shaft 331 carries an upwardly projecting finger 334 that is engaged on its rear face, by a pin 335 that projects laterally from the upper end of an arm 336 that is pivotally mounted at 337 upon the lower part of end plate 320. A lug 338 projecting from the side of the latter prevents arm 336 from falling rearwardly, the finger 334 preventing it from falling in the opposite direction. The slide bracket 316 is formed near its lower margin with a lateral extension 316*a*, Figure 26, in which is mounted a set screw 339 adapted, upon occasion, to engage the arm 336 and, by swinging it forwardly, rock the shaft 331 by means of finger 334 and thereby to tilt the switch 333 upwardly to open position to stop the motor 214. Normally when the slide 312 is in forward position with its nose 313 engaged in a recess 314, it is still spaced somewhat from its extreme forward position, and the set-screw 339 is so adjusted as just to make contact with arm 336 under these conditions. The arrangement is such that if the turret is so inaccurately positioned that there is nothing in front of nose 313 and the slide 312 moves to its extreme forward position, the set-screw 339 engages and moves arm 336 forwardly as described to stop the motor 214.

Swivelled upon shaft 331 is a pair of forwardly extending spaced-apart links 341 in the free ends of which is journaled a shaft 342. Journaled upon shaft 342, between links 341, are cam-rollers 343, 343 that normally rest upon slide-plate 317 in alignment with the respective cam surfaces 319 of cam plate 318. Fixed to shaft 342 between cam-rollers 343 is a finger 344 that projects upwardly, said finger being disposed in a vertical plane with a cam 345 mounted upon the bottom of carriage 174 near the front thereof. On one end portion of shaft 342 is mounted a downwardly projecting lever 346 that carries a set-screw 347 that contacts with the front face of switch support 332. The arrangement is such that when the slide 312 is in its rearward position, as shown in Figure 28, the cam plate 318 is beneath cam-rollers 343, and thus the links 341 are raised substantially to horizontal position which lifts the finger 344 of shaft 342 into the path of cam 345 on carriage 174. If, because of breakage or other circumstance, the slide 312 is not moved forwardly before the forward movement of carriage 174, cam 345 on the latter will engage and rock finger 344 and thus, by rocking lever 346, cause the latter to tilt switch 333 to open position to stop the machine, as is most clearly shown in Figure 23. The mechanism protects the knife 217 from breakage under any circumstances arising from the operation of the machine.

Operation

In the operation of the machine, the motor 214 is constantly running so that the turret 40 is intermittently indexed 90 degrees and the knife 217 is moved forwardly and rearwardly in timed relation to the rotation of the turret. Rotation of the turret carries the four work-holding units in succession to the four stopping stations of the turret, of which the first or loading station is at the front of the machine (the right end thereof as viewed in Figure 1), and it is here that the single operator of the machine is stationed.

The work-holding units come to the first station in open position, as shown in Figure 1 and in broken lines in Figure 7, the vise-jaws 55 being spread apart as shown in Figure 12. The operator mounts each end portion of a tube 51 between the die blocks 52, and 53, and manually clamps them between said blocks by pulling down the levers 100, as shown in full lines in Figure 7. In mounting the tube ends in the die blocks surplus tube stock 274 is left in projecting position on the inner faces of the pairs of die blocks as shown in Figure 12. This completes the manual operation of mounting the work.

In the next indexing of the turret the loaded work-holding unit moves to the second station, but before reaching said station its die blocks are clamped together by fluid pressure, as shown in Figure 10, through the agency of cam 137 which causes high pressure fluid to enter cylinders 88 against the normal low pressure fluid therein. The work thus being securely held, the next indexing of the turret carries the loaded work-holding unit to third station adjacent trimming knife 217. The latter then moves forwardly and severs the surplus tube stock 274 as shown in Figure 12, leaving a small portion of the stock projecting from the respective die blocks.

Low pressure suction through passages 296 in suction head 231 assists the trimming operation by drawing the stock as it is cut lightly into said passages. Immediately the stock is completely severed, high pressure suction draws the severed pieces back through the suction pipe 232 and deposits them in chamber 239 in the main housing. The knife then moves rearwardly, and as soon as it is clear of the turret's orbit the latter is again indexed to carry the unit with the trimmed tube to the fourth station.

During the travel of the work-holding unit to the fourth station, the vise-jaws 55 are brought together as shown in Figure 11 through the agency of cam 136 which causes high pressure fluid to enter cylinders 59 of the unit against the normal low pressure fluid therein. Thus the respective pairs of die blocks are brought into face to face relation, and the projecting, trimmed ends of the work brought forcibly together, as shown in Figure 13, to join them in a butt-splice 350, Figure 14.

The next indexing of the turret moves the work-holding unit to point of starting at the first station. Immediately after leaving station four the die blocks open, as shown in broken lines in Figure 7, through the agency of cam 137 which exhausts high pressure fluid from cylinders 88 and permits the normal low pressure fluid therein to reverse the position of its piston. Immediately after the die blocks open, the vise-jaws 55 are spread apart through the agency of cam 136 which exhausts high pressure fluid from the cylinders 59 and permits the low pressure fluid to said cylinders to restore them to normal inoperative position. The finished work may then be lifted from the unit, which is done by the operator at the first station, before the mounting of new work in the unit. This completes a cycle of operations.

It will be seen that the operation of the machine is continuous and is fully automatic except for one operator to mount new work and remove the finished work, these operations keep-

ing him fully occupied since the time interval between indexing movements of the turret may be adjusted by means of the change-speed belt drive to the speed and ability of the operator.

Modification may be resorted to without departing from the spirit of the invention or the scope of the appended claims, which are not limited to the specific construction shown and described.

What is claimed is:

1. In a tube splicing machine, the combination of a turret, means for intermittently indexing the same, a plurality of work-holding units on the turret, a trimming knife, and means for moving the knife into and out of operative relation to the work in the work-holding units in timed relation to the indexing of the turret.

2. A combination as defined in claim 1 including means for accurately positioning the turret after it is indexed, and means for stopping the operation of the machine if the turret is not accurately positioned.

3. In a tube splicing machine, the combination of a rotatable turret, a plurality of work-holding units thereon, a trimming knife, and means common to the turret and trimming knife for intermittently indexing the turret, and for advancing and retracting the trimming knife into and out of operative relation with work in the work-holding units in timed relation to the indexing of the turret.

4. A combination as defined in claim 3 including a lost motion connection between the turret and the knife structure to permit withdrawal of the knife from the orbit of the work-holding units before the turret is indexed.

5. In a tube splicing machine, the combination of a turret, a plurality of work-holding units thereon, means for intermittently indexing the turret, a trimming knife movable into and out of the orbit of the work-holding units for removing surplus stock from the ends of tubes in said units, and power means actuated at certain regions of the said unit's orbit for clamping the work in each unit before said work is trimmed, and for butt-splicing the ends of the work after it is trimmed.

6. A combination as defined in claim 5 in which each unit is provided with individual power-operated means for clamping and butt-splicing the work.

7. In a tube splicing machine, the combination of a work-holding unit, a rotary knife, means for moving the same axially into and out of engagement with the work to remove excess stock therefrom, and means for applying low suction to said excess stock during the stock-severing operation and high suction thereto as soon as it is severed.

8. In a tube splicing machine, the combination of a pair of clamping mechanisms for engaging the respective end portions of a tube to be spliced, manually-operated means for operating said clamping mechanisms so as lightly to hold the work, power-operated means for causing said clamping mechanisms firmly to grip the work, a rotary knife, and means for relatively moving the clamping mechanisms and the knife to cause the latter to sever excess stock from the ends of the work.

9. A combination as defined in claim 8 including means for automatically operating the power means at a determinate time during the relative movement of knife and work-holding mechanism.

10. A combination as defined in claim 8 in which the power means operates with low pressure fluid normally to maintain the clamping mechanisms in open position, and operates with high pressure fluid, against the force of the low pressure fluid, to close said clamping mechanisms firmly upon the work.

11. Tube splicing apparatus comprising a work-holding unit comprising a pair of clamping mechanisms for engaging the respective end portions of a tube to be spliced, manually-operated means for operating said clamping mechanisms so as lightly to hold the work, and power-operated means for causing said clamping mechanisms firmly to grip the work, said power-operated means being so connected to the manually-operated closing means as to alter the position of the latter whereby both closing mechanisms may be concurrently released for opening the clamping devices.

12. Tube splicing apparatus comprising a work-holding unit comprising a pair of clamping mechanisms for engaging the respective end portions of a tube to be spliced, respective fluid pressure-operated cylinders normally operating under low pressure for holding the clamping mechanisms in open, work-receiving position, respective manually-operable levers for lightly closing the clamping mechanisms, against the low pressure fluid, said levers maintaining a locked condition because of an over-center condition of a portion of their structures, and means for admitting high pressure fluid to the fluid pressure cylinders to cause the clamping members firmly to engage the work.

13. In a tube splicing machine, the combination of an intermittently indexed turret, a plurality of work-holding dies mounted about said turret, and a work trimming knife movable into and out of operable cutting relation successively with respect to each of said work-holding dies, said turret being immovably fixed while said knife is operating on the work in one work-holding die and while the work-holding die at another position is being simultaneously loaded.

14. Tube splicing apparatus comprising a work-holding unit comprising opposed vise-jaws, means for mounting the end portions of a tube to be spliced in the vise-jaws, means for imparting orbital movement to the work-holding unit, means for severing stock from the tube-ends at one region of the orbit of the unit, and means for closing the vise-jaws at another region of the orbit of the unit to butt-splice the tube-ends.

15. A tube splicing machine comprising a rotatable intermittently indexed turret, a trimming knife, a plurality of work-holding dies mounted about said turret, means for clamping the work in said dies at a loading station, means for indexing the turret to a successive station for the operation of said trimming knife, and means for clamping said work-holding dies together at a splicing station, the work in the work-holding dies being operated upon progressively about the series of stations.

16. Tube splicing apparatus comprising a rotatable turret, work-holding units carried by said turret, each of said work-holding units comprising respective fluid pressure operated cylinders for clamping tube-ends in the device and for bringing said tube-ends together to butt-splice the same, respective valves for said fluid pressure cylinders, and respective stationary cams for operating said valves as the latter are moved by the rotation of the turret.

17. A combination as defined in claim 12 in-

cluding a connection between each lever and power-operating mechanism adapted to alter the over-center condition of the lever when high pressure fluid is admitted to the cylinder, so that the work-clamping mechanism will open when the high pressure fluid is exhausted and a low pressure condition is restored to the cylinder.

18. A combination as defined in claim 14 in which the means for closing the vise-jaws is power-operated and is brought into operation by the orbital movement of the work-holding unit.

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