June 5, 1945. J. L. VAILL 2,377,829

AUTOMATIC FERRULE ATTACHING MACHINE

Filed July 26, 1943 5 Sheets-Sheet 1

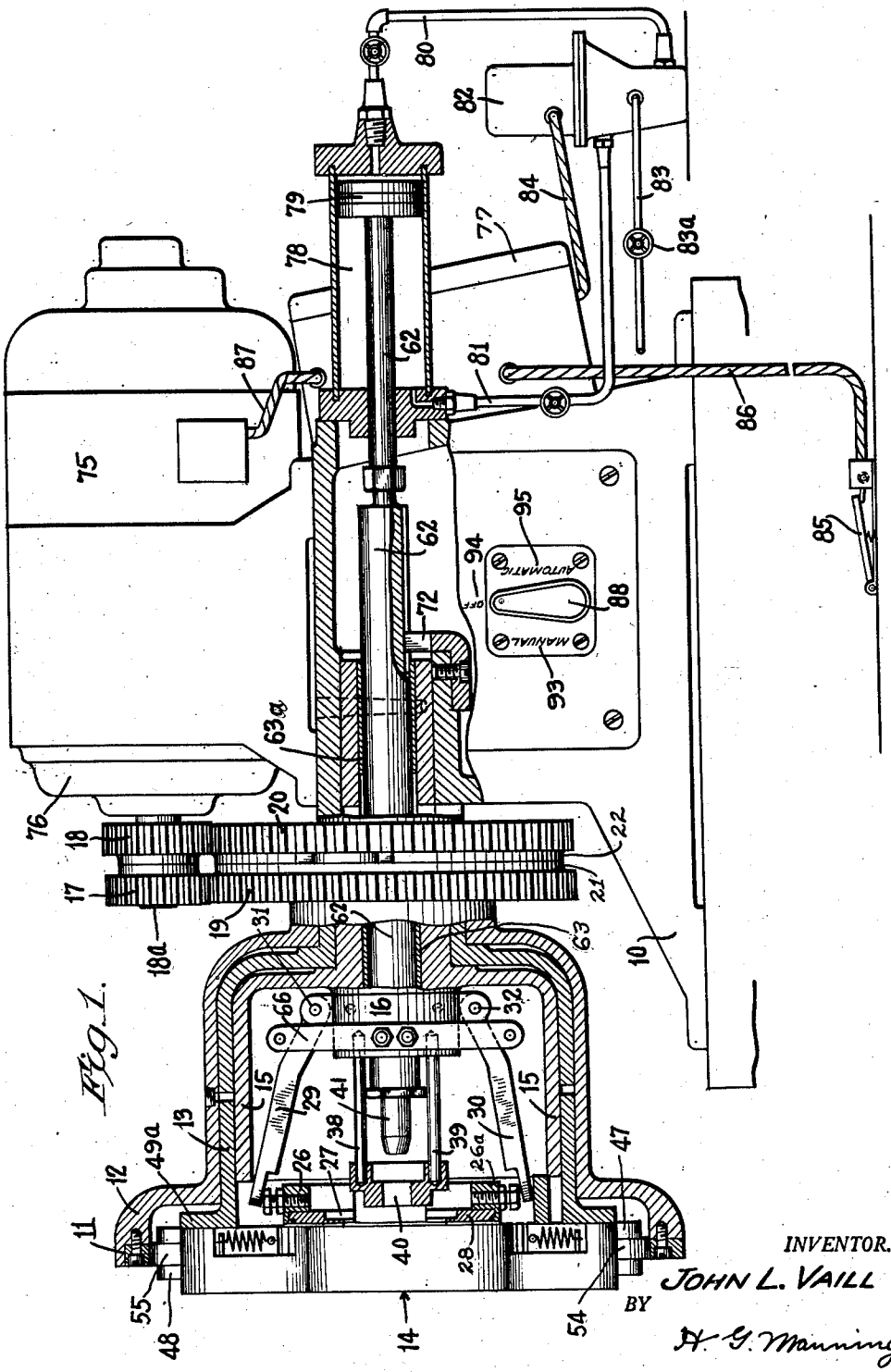


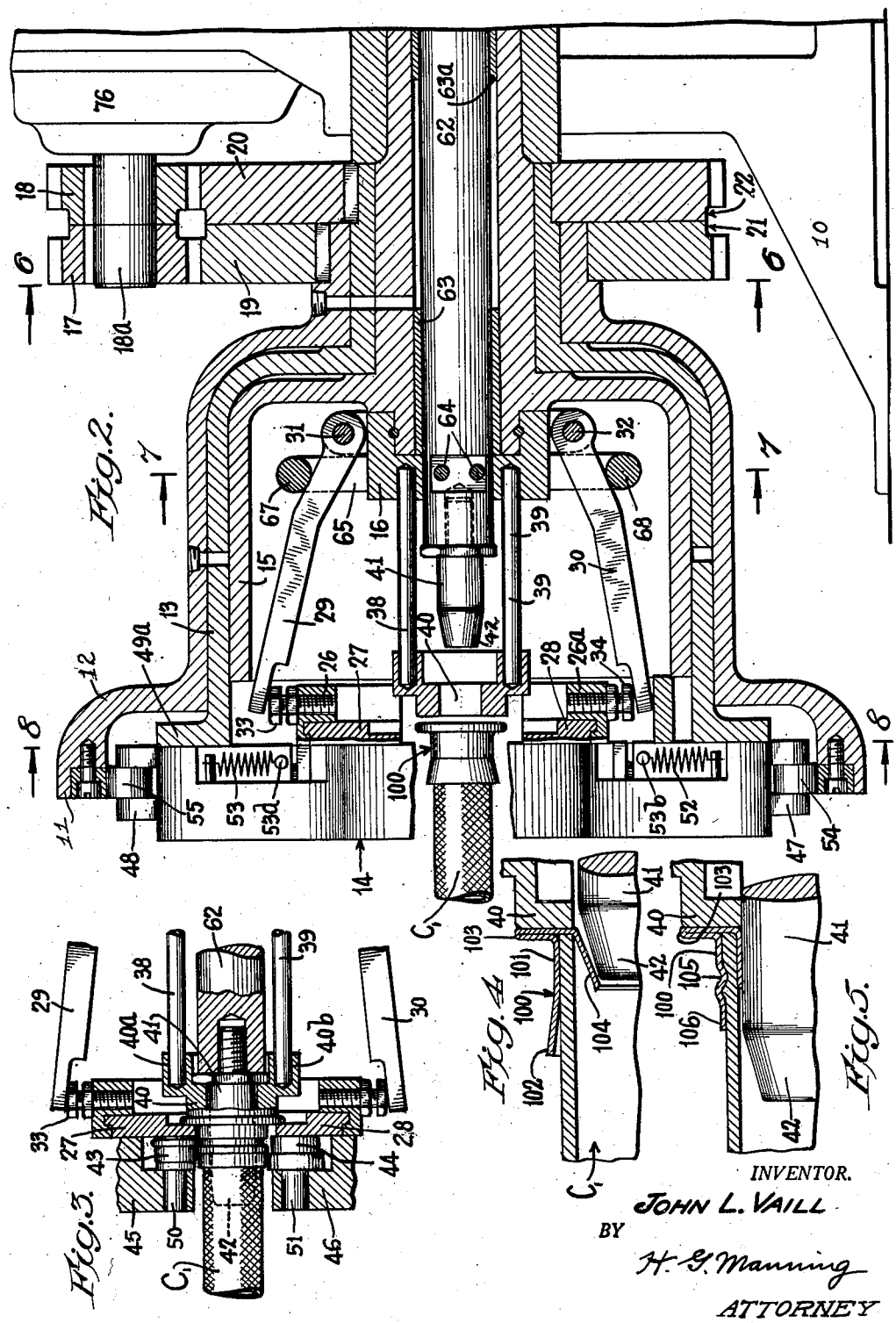
Fig. 1.

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Fig. 6.

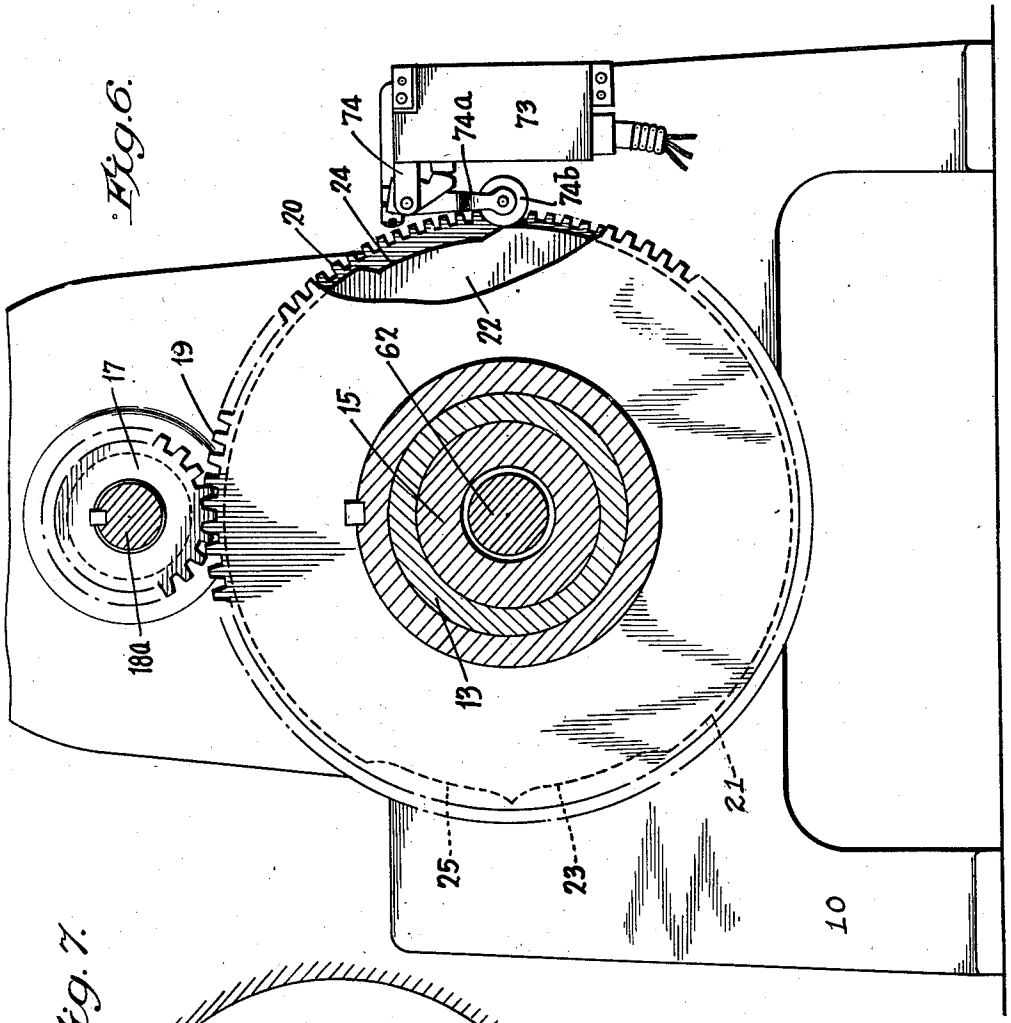
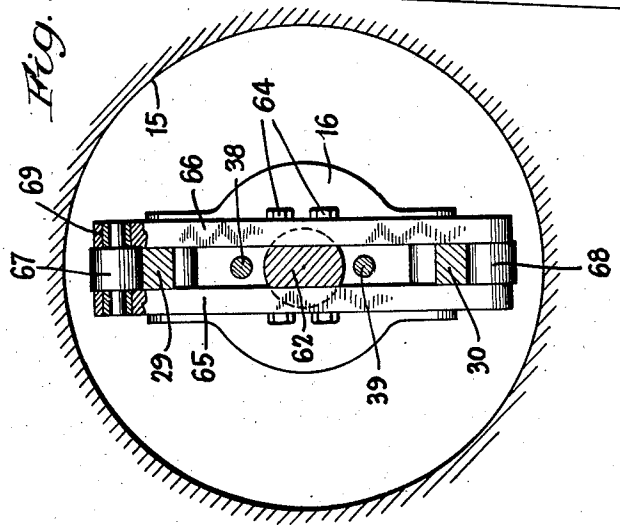


Fig. 7.

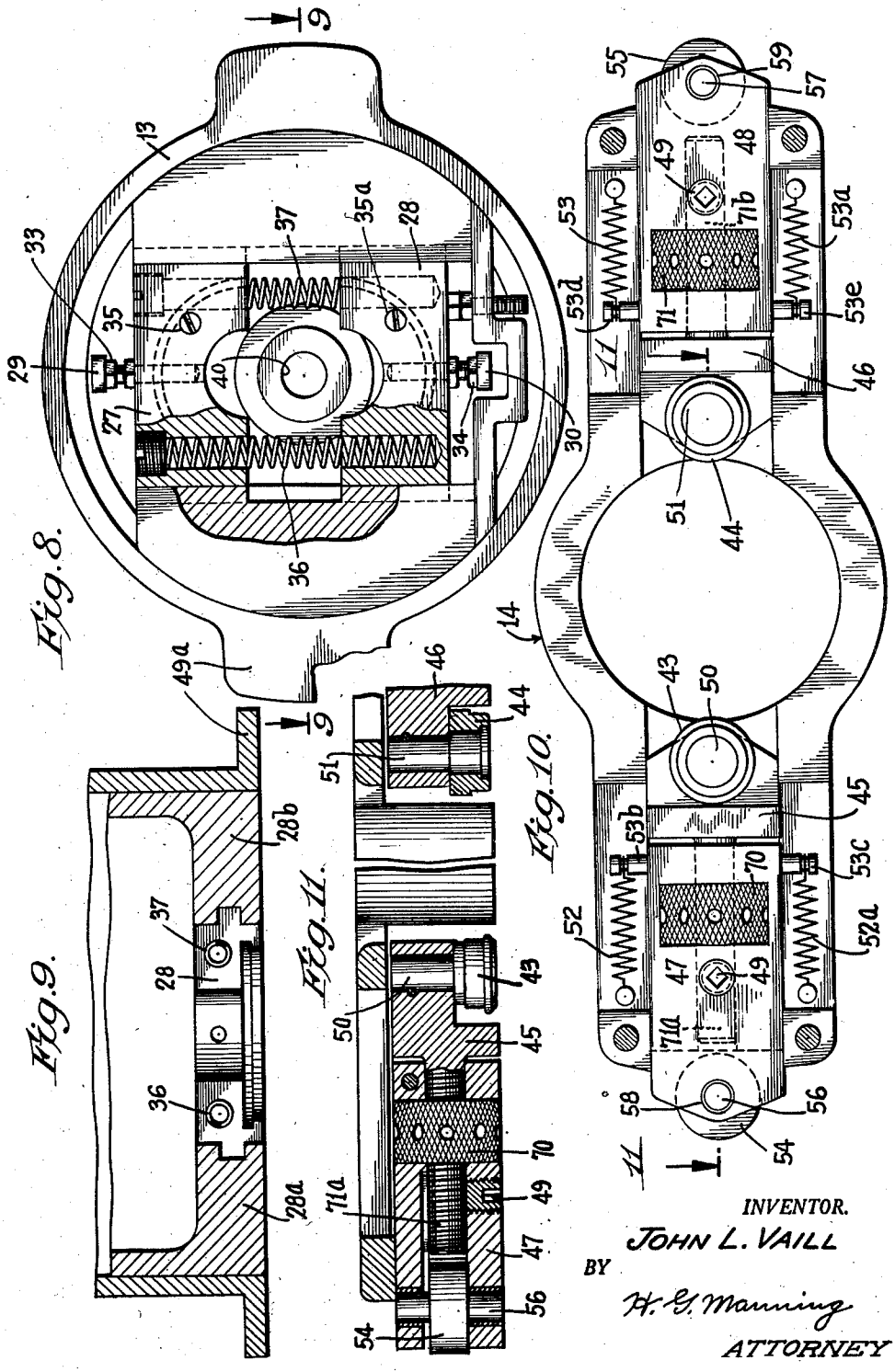


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AUTOMATIC FERRULE ATTACHING MACHINE

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AUTOMATIC FERRULE ATTACHING MACHINE

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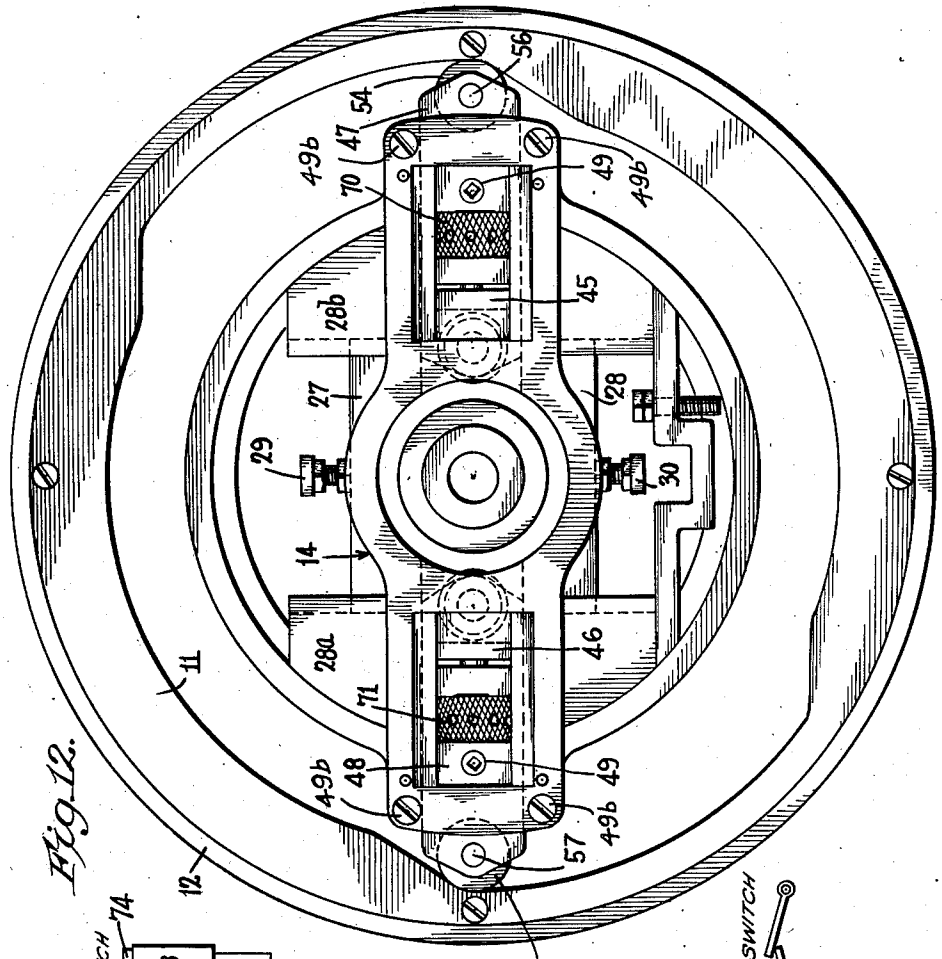


Fig. 12.

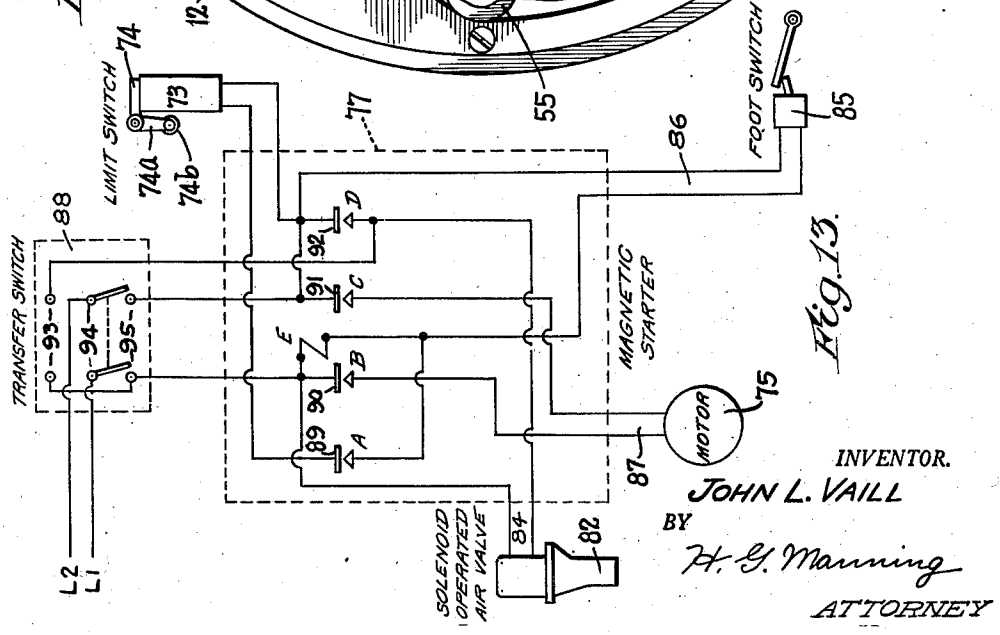


Fig. 13.

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UNITED STATES PATENT OFFICE

2,377,829

AUTOMATIC FERRULE ATTACHING MACHINE

John L. Vaill, Middlebury, Conn.

Application July 26, 1943, Serial No. 496,227

18 Claims. (Cl. 153—1)

This invention relates to flexible tubes or tubing, and more particularly to a machine for automatically attaching upon the end of such a tubing a circular hollow fitting having an end shoulder, an interior conical lip, and an exterior flared extremity.

One object of the present invention is to provide a machine of the above nature which will expand rapidly and automatically an interior lip of a ferrule against the inside of the tubing, and thereafter form a plurality of inwardly-extending beads on the exterior portion of the ferrule for clamping upon said tubing.

A further object is to provide a machine of the above nature having pneumatic means for forcing a punch within the interior of the ferrule to expand the lip outwardly against a flexible conduit, and having motor-operated means to subsequently force a pair of revolving beading rolls inwardly against the exterior of the ferrule to clamp it upon said conduit at a pair of spaced points.

A further object is to provide a machine of the above nature, in which the ferrule will first be pressed against a floating stripper member, and then clamped by a pair of cooperating die members for positioning it during the subsequent lip-expanding and beading operations.

A further object is to provide a machine of the above nature, which will perform automatically the ferrule-attaching operations in a fraction of the time required by the former methods of attachment, and which enables the attaching operation to be performed by relatively unskilled labor on a mass production basis.

A further object is to provide a machine of the above nature, in which the beading operations are performed by a pair of beading rolls carried by a crosshead mounted on a rotor which is concentric with a hollow holder for an exterior roll-actuating plate cam.

A further object is to provide a machine of the above nature, in which the cam holder and crosshead rotor are driven in the same direction, said crosshead being caused to travel at a different speed than said plate cam so as to cause said rolls to revolve about the ferrule to produce grooves and beads thereon, and to thereafter revolve one or more additional turns to iron out any irregularities which may initially be formed in said grooves and beads.

A further object is to provide a machine of the above nature, in which a limit switch is provided to stop the machine when the beading operation is complete, said limit switch being opened whenever a pair of slots in a cam holder gear hub and a cross-head rotor gear hub come into alignment, and permit a spring-pressed roller on said limit switch to drop into the aligned slots and thus automatically open all circuits including that of a solenoid for permitting a spring-actuated pneumatic air piston to return the lip expanding punch to its original position.

One advantage of the present invention is that the double-beaded mechanical bonds between the ferrule and the tubing produced by this automatic machine are much stronger and more uniform than those obtained by ordinary swaging processes, and are more quickly achieved than by the former soldering methods.

A further advantage of this machine is that the beading cycle is "controlled" automatically, and produces absolutely uniform work—each succeeding assembly being exactly like the first.

A further advantage is that the automatically controlled mechanism of this invention positively determines the contact time between the beading rolls and the ferrules, so that they are engaged just long enough to secure a tight grip, but not so long as to injure either the ferrule or the tubing.

It has been found in practice with the present invention that ferrules may be attached to flexible shielding conduits, or other forms of tubing, many times faster than by any previously known machine.

The attaching operation is extremely simple, for it is merely necessary for the operator to sit in front of the machine and manually insert the work through an opening in the casing thereof against the stripper within the dies and beading rolls, and to then press the foot switch, whereupon all further steps of the attaching operation will be performed automatically by the machine.

When the beading operation has been completed—a matter of a few seconds—the machine will stop automatically, and the completed assembly may be easily removed by the operator, as both of his hands are left free to handle the work.

A further advantage of the present invention is that all moving parts of the machine may be inclosed by a casing, thus making it completely safe for the operator.

A further feature of advantage is that after the attaching operation has been started by the depression of the foot switch, the machine will automatically coast to a stop after completing the working cycle, and will not start again until the foot switch is again depressed.

A further object is to provide a machine of the above nature, which will be simple in construction, inexpensive to manufacture, easy to install and manipulate, compact, ornamental in appearance, safe to operate, and very efficient and durable in use.

While the present machine is particularly designed for attaching interior-lipped flanged ferrules to flexible aluminum shielding conduits for use on aircraft, it will be understood that the

machine is not limited to such uses, but may readily be adapted to attach other styles of fittings or couplings mechanically to flexible tubing or conduits of other materials and constructions, within the spirit and scope of the invention; in fact, the machine is so constructed that by a simple changing of the tools it may operate upon any style of fitting which may be gripped in the dies and held securely during the attaching operation.

With these and other objects in view there has been illustrated upon the accompanying drawings one form in which the invention may conveniently be embodied in practice.

In the drawings,

Fig. 1 represents an assembly view of the entire machine, shown partly in section.

Fig. 2 is a sectional view, on a larger scale, of the working head located at the forward part of the machine.

Fig. 3 is a sectional view showing the position of the beading rolls during the attaching operation.

Fig. 4 is a sectional view showing the relative arrangement of the ferrule, the expanding punch, the stripper, and the flexible tube, before the attaching operation.

Fig. 5 is a similar sectional view of the same, after the attaching operation.

Fig. 6 is a front view, with certain parts broken away, illustrating the relative shapes of the differential gears on the cam holder and the crosshead rotor, and showing the slots in the adjoining hubs of said gears, which are adapted to be entered by the limit switch roller for opening said switch when said slots come into alignment at the end of the attaching operation.

Fig. 7 is a front view showing the appearance of the plunger yoke bracket, which actuates the die-closing fingers, said view being taken on the line 7—7 of Fig. 2.

Fig. 8 is a front view of the working head, showing the dies in open position, taken substantially on the line 8—8 of Fig. 2.

Fig. 9 is a sectional view of the die holders and associated parts, taken along the line 9—9 of Fig. 8.

Fig. 10 is a rear view of the crosshead showing the beading roll slides in open position.

Fig. 11 is a sectional view of the same, taken along the line 11—11 of Fig. 10.

Fig. 12 is a front view of the working head of the machine, with the beading rolls, shown by dotted lines, in open position.

Fig. 13 is a wiring diagram of the electrical circuits for controlling the operation of the machine.

Referring now to the drawings in which like reference numerals denote corresponding parts throughout the several views, the numeral 10 indicates the base of the machine, which may be bolted down to any suitable bench, as shown in Fig. 1.

The numeral 11 indicates an annular plate cam for controlling the in-and-out movements of the beading rolls 43, 44, said cam being detachably connected, as by screws, to a cam holder 12 within which is located a hollow rotor 13 which carries a crosshead 14 within which said beading rolls are slidably mounted.

Within the rotor 13, provision is made of a hollow stationary stator 15 which serves as a guide bearing for the rotor 13 and cam holder 12. The numeral 16 indicates a stationary finger yoke to which are pivoted a pair of die-closing fingers 29, 30, to be hereinafter more fully described.

The plate cam 11 and the crosshead 14 are adapted to be rotated in the same direction at different speeds by means of a pair of differential pinions 17, 18 respectively, which are secured rigidly to a horizontal shaft 18a projecting out of a gear head 76 of a motor 75 mounted upon the top of the machine.

The pinions 17, 18 are adapted to mesh with a cam holder gear 19 and a crosshead rotor gear 20 respectively, said gears also being of slightly different diameters, as shown in Figs. 1, 2 and 6.

The relative number of teeth of the pinions 17, 18 and the gears 19, 20 may be so arranged, for example, that the beading roll crosshead 14 will make ten turns while the cam holder 22 is making only nine and one-half turns, thus causing the beads and grooves to be formed on the ferrule 100 by the revolution of the rolls 43, 44 around the ferrule.

The cam holder gear 19 is provided with a reduced hub 21 which is adapted to abut against a similar reduced hub 22 on the crosshead rotor gear 20. The hub 21 is provided with a pair of elongated arcuate slots 23, 24, spaced 180 degrees apart around the circumference of said hub (see Fig. 6), which slots are adapted to intermittently come into alignment with a single arcuate slot 25 of the same length formed in the rotor gear hub 22, for a purpose to be hereinafter described.

In order to maintain the ferrule tightly in position during the attaching operation, provision is made of a pair of holders 26, 26a for a pair of dies 27, 28, preferably located one above the other, and adapted to slide vertically in a pair of laterally spaced guides 28a, 28b, (see Fig. 12). As previously mentioned, the dies 27, 28 are adapted to be automatically closed by means of the pair of die-closing fingers 29, 30, said fingers being pivotally secured to the yoke 16 by a pair of horizontal pins 31, 32. The forward ends of the fingers 29, 30 are reduced in width, as shown, and are adapted to engage a pair of adjustable headed screws 33, 34 located in the top and bottom respectively of the die holders 26, 26a. The dies 27 28 are adapted to be secured to the die holders 26, 26a by means of a pair of holding screws 35, 35a (as clearly shown in Fig. 8), and said dies 27, 28 are pressed outwardly at all times by a pair of elongated helical compression springs 36, 37 (see Fig. 8).

In order to permit the attached ferrule and conduit assembly to be easily removed from the machine after the attaching operation has been completed, provision is made of a pair of parallel stripper rods 38, 39, located one above the other and secured at their rear ends rigidly to the stationary finger yoke 16. The forward ends of said stripper rods 38, 39 are adapted to receive a stepped detachable circular stripper 40 which contains a pair of rear sockets 40a, 40b which are adapted to have a sliding fit upon the forward ends of the stripper rods 38, 39 (Figs 1 and 2).

The shape of the ferrule 100 before attachment is clearly shown in Fig. 4, said ferrule 100 having a cylindrical barrel portion 101, and a flared end 102 which facilitates placing the ferrule over the end of the flexible conduit C1. The ferrule 100 is also provided with an end flange 103 and a conical interior lip 104.

The appearance of the ferrule 100 and the conduit C1, after the attaching operation, is shown in Fig. 5, in which numeral 105 indicates a front

inwardly extending bead or groove, and the numeral 106 the inwardly flattened end at the rear of the barrel of the ferrule 100.

In order to expand the interior lip 104 of the ferrule 100 against the end of the conduit, (which operation takes place immediately prior to the beading operation), provision is made of a longitudinally movable expanding punch 41 having a conical rounded point 42.

The bead 105 and flat end 106 are adapted to be formed on the ferrule 100 by means of the pair of beading rolls 43, 44 (most clearly shown in Fig. 3), said rolls being carried by holder members 45, 46 mounted in slides 47, 48 (see Fig. 10). The holders 45, 46 and slides 47, 48 are mounted to reciprocate in the transverse crosshead 14 which is rigidly secured as by screws 49b, 49b to the exterior flange 49a of the rotor 13, previously described.

The beading rolls 43, 44 are mounted to rotate in the holders 45, 46 on a pair of pins 50, 51, and are pulled outwardly by means of two pairs of helical tension springs 52, 52a, and 53, 53a, connected at their inner ends to pins 53b, 53c, and 53d, 53e respectively, the outer ends of said springs being secured to the crosshead 14, as shown in Fig. 10.

In order to intermittently move the beading rolls 43, 44 inwardly at the proper time in the attaching cycle, provision is made of a pair of cam rolls 54, 55 mounted to rotate on a pair of pins 56, 57 and bushings 58, 59, carried rigidly by the outer ends of the slides 47, 48, said cam rolls 54, 55 being adapted to have a rolling engagement with the interior surface of the plate cam 11, previously described.

For the purpose of moving the expanding punch 41 forwardly into engagement with the interior lip 104 of the ferrule 100 and also to cause the die-closing fingers 29, 30 to swing inwardly, after the unattached ferrule and conduit assembly has been inserted into the machine by the operator, provision is made of a plunger 62 mounted to slide within a pair of bushings 63, 63a.

The fingers 29, 30 are adapted to be moved inwardly automatically, from the position shown in Fig. 2 to that shown in Fig. 3, by means of a pair of movable finger roll brackets 65, 66 secured to the plunger 62 by cross bolts 64, and carrying on their outer ends a pair of roller members 67, 68, which are mounted to rotate within a pair of bushings 69, 69.

Whenever it is desired to adjust the position of the beading rolls 43, 44 with respect to the slides 47, 48, provision is made of a pair of adjusting nuts 70, 71 mounted in said slides 47, 48 and engaging a pair of screw members 71a, 71b integral with the beading roll holders 45, 46. The holders 45, 46 are adapted to be locked in adjusted position by set screws 49, 49.

The plunger 62 is held against rotation in its housing by an augular key 72, (as clearly shown in Fig. 1).

To stop automatically all operations of the machine whenever an attaching cycle is completed, provision is made of a limit switch 73, (see Figs. 6 and 13), having mounted thereon a bracket 74 to which is pivoted a spring-actuated limit switch lever 74a carrying a roller 74b. The roller 74b is adapted to be moved inwardly to open the limit switch whenever either of the arcuate slots 23, 24 comes into alignment with the slot 25 and said roller 74b.

The mechanism for operating the machine automatically includes a magnetic starter 77 (see Figs. 1 and 13), a solenoid-operated air valve 82, a motor 75, and a foot switch 85. The plunger 62 is adapted to be driven forwardly by means of a piston 79 in an air cylinder 78 by the pressure of air on the right hand side of said piston delivered to said cylinder 78 by an air pipe 80. When the attaching cycle is completed, the piston 79 will be retracted rearwardly by the pressure of air on the left hand side of the piston 79 delivered through an air pipe 81, such latter action being caused automatically by the action of a spring (not shown) in said solenoid-operated air valve when the solenoid is deenergized by the opening of the limit switch 73.

Air is admitted to the valve 82 through a supply pipe 83 under the control of a globe valve 83a, and air is adapted to be exhausted to the atmosphere from the valve 82 during both strokes of the piston 79 through an aperture (not shown) located in the side of said valve.

The magnetic starter 77 is connected to the solenoid-operated air valve 82 by a cable 84. The foot switch 85 is connected by a two-wire cable 86 to the magnetic starter 77, which starter is also connected by a cable 87 to the motor 75.

In order to set the machine for "manual," "off," or "automatic" operations, provision is made of a transfer lever switch 88 which may be shifted selectively as desired to the three operating positions 93, 94, 95 respectively (see Fig. 1).

In the electrical diagram shown in Fig. 13, the letter E indicates a solenoid coil which, when energized by depression of the foot switch 85, will cause the fixed contacts A, B, C, D to be engaged by the movable contacts 89, 90, 91, 92 of the magnetic starter 77 to close the circuits of the machine.

Operation

In operation, when the operator steps on the foot switch 85, all four contactors 89, 90, 91, 92 in the magnetic starter 77 will be closed by the solenoid E. Energy is thus supplied simultaneously to the motor 75 and the solenoid-operated air valve 82, which admits air to the right hand side of the cylinder 78 and exhausts it from the left hand side of said cylinder. The differential gears 19 and 20 in the head of the machine will then start to rotate, and the plunger 62, actuated by the piston 79, will advance. The forward movement of the plunger 62 will cause the rollers 67, 68 to force the fingers 29, 30 inwardly and close the dies 27, 28 about the barrel 101 of the ferrule 100. After the dies 27, 28 have thus been closed, the plunger 62 will continue to advance and will force the expanding punch 41 into the inside of the ferrule 100, expanding the inner lip 104 thereof securely against the inside of the conduit C1. Pressure will then be applied against the flange 103 of the ferrule 100 by the shoulder of the expanding punch 41, acting through the stripper 40, and the ferrule 100 will thus be held securely during the beading phase of the attaching cycle.

As the cam holder 12 and crosshead rotor 13 are rotated in the same direction at different speeds by means of the differential gearing, the crosshead 14 will travel faster than the cam holder 12, as a result of which action the cam rolls 54, 55 on the beading roll slides 47, 48 will travel along the inner surface of the plate cam 11. The beading rolls 43, 44 will thus be forced into the barrel 101 of the ferrule 100 and will produce a double bead therein, the rolls continuing to revolve around the ferrule until the beads have been completely ironed out.

At the proper time, the two arcuate slots on the hubs of the gears **19** and **20** will come into alignment with each other and with the limit switch roller **74b**, permitting the limit switch roller **74b** to swing into said slots and break the maintaining-circuit through the magnetic starter **77**, thus allowing the cam holder and beading roll rotor to coast to a stop. The spring in the solenoid air valve **82** will at the same time automatically admit air to the left hand side of the piston **79** and exhaust it from the right hand side of the cylinder **78**, withdrawing the plunger **62** to the right, stripping the punch **41** from the ferrule **100**, and causing the dies to be opened automatically by the action of the springs **36**, **37**. The attaching cycle is now complete, and the operator may manually remove the attached conduit and ferrule assembly from the machine and replace it with a new unattached assembly.

Each machine will preferably be provided with a tool box containing a plurality of sets of interchangeable split dies, strippers and expanding punches of various sizes, together with the necessary wrenches for permitting tool changes to be made rapidly whenever desired.

While there has been disclosed in this specification one form in which the invention may be embodied, it is to be understood that this form is shown for the purpose of illustration only, and that the invention is not to be limited to the specific disclosure but may be modified and embodied in various other forms without departing from its spirit. In short, the invention includes all the modifications and embodiments coming within the scope of the following claims.

Having thus fully described the invention, what is claimed as new, and for which it is desired to secure Letters Patent, is:

1. In a machine for permanently attaching upon the end of a flexible conduit a ferrule shaped to loosely embrace the end of said conduit, a pneumatically-operated punch to expand the interior of said ferrule into clamping engagement with the inside surface of said conduit, a mechanically-operated beading roll to form an inwardly extending bead on the exterior of said ferrule and force it into clamping engagement with the exterior surface of said conduit, means to cause said beading roll to subsequently iron out irregularities initially formed in said bead, and means to stop said machine automatically when the attaching cycle has been completed.

2. In a machine for permanently attaching upon the end of a flexible tube a ferrule shaped to loosely embrace the end of said tube, means to expand the interior of said ferrule and force it into clamping engagement with the inside surface of said tube, a beading roll to form an inwardly extending bead on the exterior of said ferrule for clamping it upon the exterior surface of said tube, means to cause said beading roll to travel around the entire circumference of said ferrule, comprising a crosshead for supporting a sliding carrier for said beading roll, said carrier having a cam roller located at the outer end thereof, an annular plate cam surrounding the rotary path of said cam roller, and means to cause relative rotation between said crosshead and said plate cam to cause said beading roll to move inwardly into engagement with said ferrule to form the bead thereon.

3. The invention as defined in claim 2, in which provision is made of a hollow holder for said plate cam and a hollow holder for said crosshead, and means to cause a differential relative rotation of said holders.

4. A machine as defined in claim 2, in which said plate cam is mounted upon a gear-driven holder member and said crosshead is mounted upon a gear-driven rotor member, a pair of pinions mounted upon a single motor-driven shaft for driving said gears simultaneously in the same direction, said gears and pinions having different numbers of teeth so as to produce a differential driving action and cause said beading rolls to revolve completely around said ferrule during each cycle of the machine operation.

5. In a machine for permanently attaching upon the end of a flexible tube a ferrule shaped to loosely embrace the end of said tube, a crosshead carrying a pair of beading roll slides, a hollow rotor for supporting said crosshead, a plate cam surrounding said crosshead, a hollow holder for said plate cam, each slide having a cam roll located at the outer end thereof for engagement by said plate cam to force the beading rolls carried by said slides into engagement with said ferrule as said crosshead rotates with respect to said cam plate, said cam holder and said rotor being provided with pinion-driven gears of different diameters, each of said gears having a reduced hub connected thereto, said hubs having arcuate slots which are adapted to come into alignment with each other, a roller riding upon the periphery of said hubs, the width of said roller being such that it will normally remain on the periphery of said hubs but will move inwardly into said arcuate slots when they come into alignment with said roller, and a limit switch responsive to the inward movement of said roller to stop the operation of the machine automatically.

6. In a machine for permanently attaching upon the end of a flexible tube a ferrule shaped to loosely embrace the end of said conduit, a stripper member for engaging the end of said ferrule during the attaching operation, a pair of upper and lower dies for embracing and holding the sides of said ferrule during the attaching operation, a pneumatically operated punch to expand the interior of said ferrule into clamping engagement with the inside surface of said tube, a pair of pivoted die-closing fingers adapted to engage the exterior of said dies, and means responsive to the movement of said punch for forcing said fingers inwardly to close said dies and hold said ferrule during the attaching operation.

7. In a machine for attaching upon the end of a flexible tube a ferrule shaped to loosely embrace the end of said tube, a punch for expanding the interior of said ferrule into clamping engagement with the inside surface of said tube, fluid-actuated means for operating said punch, a spring-return solenoid valve for operating said means, and means responsive to the completion of said attaching operation for deenergizing the solenoid so as to permit the spring mechanism thereof to restore the punch to its original inactive position.

8. In a machine for attaching upon the end of a flexible tube a shouldered tubular fitting shaped to loosely embrace the end of said tube, means for expanding the interior of said ferrule into clamping engagement with the inside surface of said tube, means for clamping the exterior of said ferrule into locking engagement with the exterior surface of said tube, foot-operated means for electrically starting the operation of the mechanisms for expending the interior of the ferrule and clamping the exterior of the ferrule upon said tube, and automatic means responsive to the completion of the attaching operation for stopping the machine.

9. In a machine for permanently attaching upon the end of a tube a ferrule shaped to loosely embrace the end of said tube, a plate cam, a rotor carrying a beading roll, means engaging said plate cam for forcing said beading roll inwardly into engagement with said ferrule, a pair of gears for rotating said plate cam and said rotor at different speeds, each of said gears having a reduced hub connected therewith, said hubs having circumferential slots which are adapted to come into alignment with each other, a roller riding upon the periphery of said hubs and being of such width that it will normally remain on said periphery but will move inwardly into said slots when they both come into alignment with said roller at the same time, and means responsive to the inward movement of said roller to stop the operation of said machine automatically.

10. In a machine for permanently attaching upon the end of a flexible tube a ferrule having an interior conical lip and an outer end section adapted to embrace the end of said tube, a collapsible chuck to hold said ferrule upon the end of said tube, means to expand said lip into clamping engagement with the inside surface of said tube, a roll to form a plurality of inwardly extending grooves around the periphery of said ferrule and force said grooves into clamping engagement with the exterior surface of said tube, and means to disengage said roll and said chuck from said ferrule automatically after a predetermined rotation of said roll around said ferrule.

11. In a machine for permanently attaching upon the end of a flexible tube a ferrule having an interior conical lip and an outer end section adapted to embrace the end of said tube, a collapsible chuck to hold said ferrule upon the end of said tube, means to expand said lip into clamping engagement with the inside surface of said tube, a roll to form an inwardly-extending groove around the periphery of said ferrule and force said groove into clamping engagement with the exterior surface of said tube, and means to disengage said roll and said chuck from said ferrule automatically after a predetermined rotation of said roll around said ferrule.

12. In a machine for permanently attaching upon the end of a flexible tube a ferrule initially having a U-shaped cross section shaped to loosely embrace the end of said tube, means to temporarily hold said ferrule upon the end of said tube, means to expand the interior of said ferrule into clamping engagement with the inside surface of said tube, means to simultaneously roll an inwardly extending bead on said ferrule and flatten the end of said ferrule into clamping engagement with the exterior surface of said tube, and means to stop said machine and release said holding means automatically when the attaching cycle has been completed.

13. In a machine for permanently attaching upon the end of a flexible conduit a ferrule shaped to loosely embrace the end of said conduit, means to temporarily hold said ferrule upon the end of said conduit, a mechanically-operated beading roll revolving around said ferrule to force an inwardly extending bead into clamping engagement with the exterior surface of said conduit, means to cause said beading roll to subsequently iron out irregularities initially formed in said bead, and means to stop said machine and disengage said holding means automatically when the atttaching cycle has been completed.

14. In a machine for permanently attaching upon the end of a flexible tube a ferrule shaped to initially loosely embrace the end of said tube, means to hold said ferrule against rotation, a rotating beading roll for forming an inwardly extending bead on the exterior of said ferrule and embed said bead in the exterior surface of said tube, means to cause said beading roll to travel around the entire circumference of said ferrule, comprising a crosshead for supporting a sliding carrier for said beading roll, said carrier having a cam roller located at the outer end thereof, an annular plate cam surrounding and engaging said cam roller, and means to cause relative rotation between said crosshead and said plate cam to cause said beading roll to move inwardly into engagement with said ferrule to form the bead thereon.

15. In a machine for permanently attaching upon the end of a flexible conduit a ferrule shaped to embrace the end of said conduit, means to hold said ferrule from rotation, a rotating beading roll located outside said ferrule, means to revolve said rotating roll around said ferrule and press it into engagement therewith to form a groove on the exterior of said ferrule, and means responsive to the completion of a predetermined revolution of said beading roll around said ferrule to automatically simultaneously disengage said roll from said ferrule and release said ferrule holding means.

16. In a machine for attaching upon the end of a tube a ferrule having a barrel section adapted to surround said tube, chucking means to rigidly hold said ferrule against rotation, a rotatable roll, means to revolve said roll around said barrel section and press it into engagement therewith to uniformly reduce the diameter of said ferrule where it is engaged by said roll, and means to disengage said roll and said holding means from said ferrule automatically after a predetermined revolution of said roll around said barrel, to permit the withdrawal of said tube from said machine.

17. In a machine for permanently attaching upon the end of a tube a ferrule having an interior lip and an outer sleeve adapted to embrace the end of said tube, means to hold said ferrule upon said tube against rotation, means to expand said lip into clamping engagement with the interior of said tube, a rotatable roll, means to revolve said roll around said sleeve and press it into engagement therewith to uniformly reduce the diameter of said sleeve where it is engaged by said roll, and means to automatically disengage said roll and said holding means from said sleeve after a predetermined revolution of said roll around said sleeve so as to permit the withdrawal of said tube and attached ferrule from said machine.

18. In a machine for forming an inwardly-extending groove in a circular tubular member, chucking means to rigidly hold said member against rotation, a rotatable roll, means to automatically force said roll into engagement with said member and revolve said roll around said tubular member uniformly throughout the circumference thereof, and means to disengage said roll and said holding means from said tubular member automatically after a predetermined revolution of said roll.

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