March 22, 1960 K. H. ANDREN 2,929,433

ART OF ATTACHING TERMINALS TO ELECTRIC CONDUCTORS

Filed Oct. 17, 1958 5 Sheets-Sheet 1

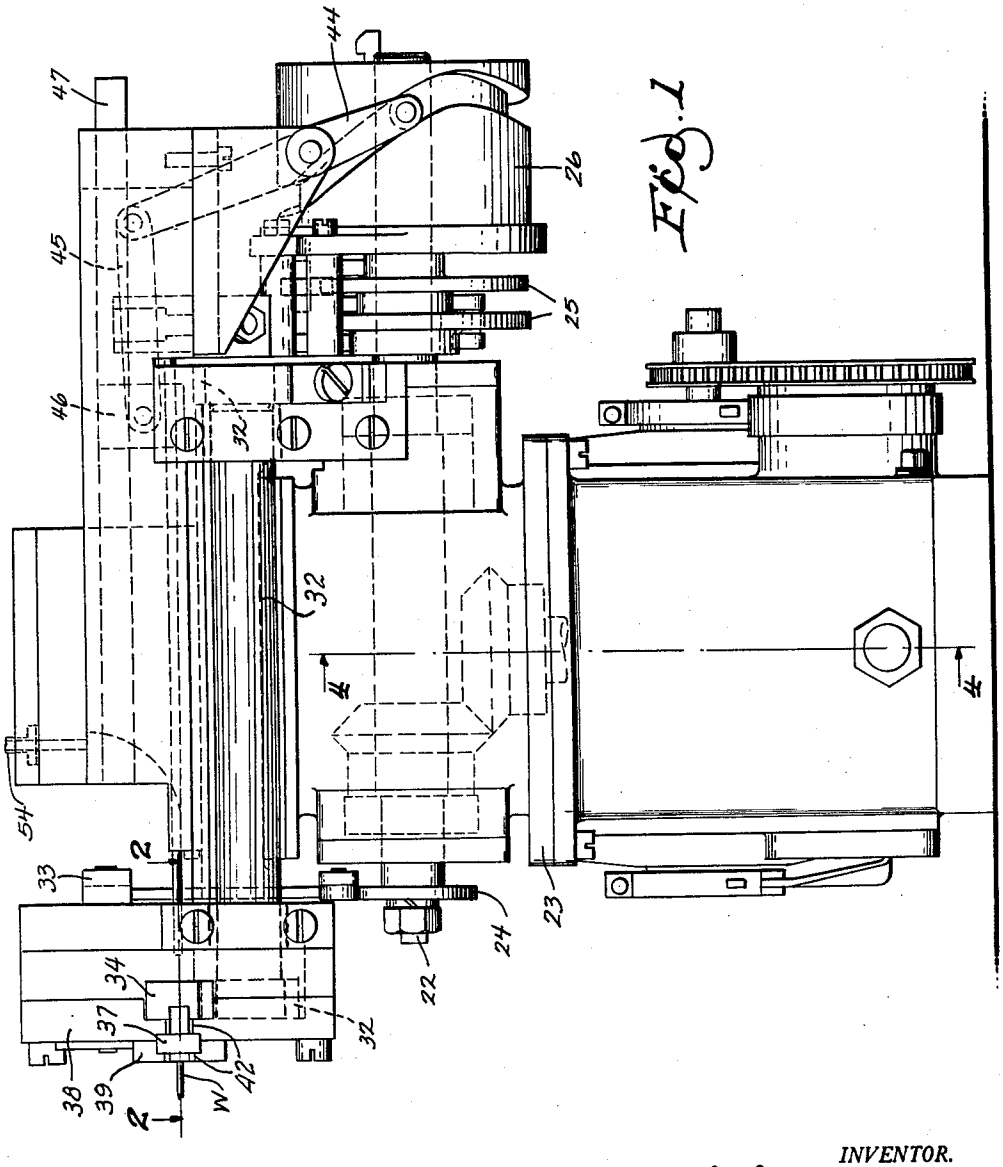


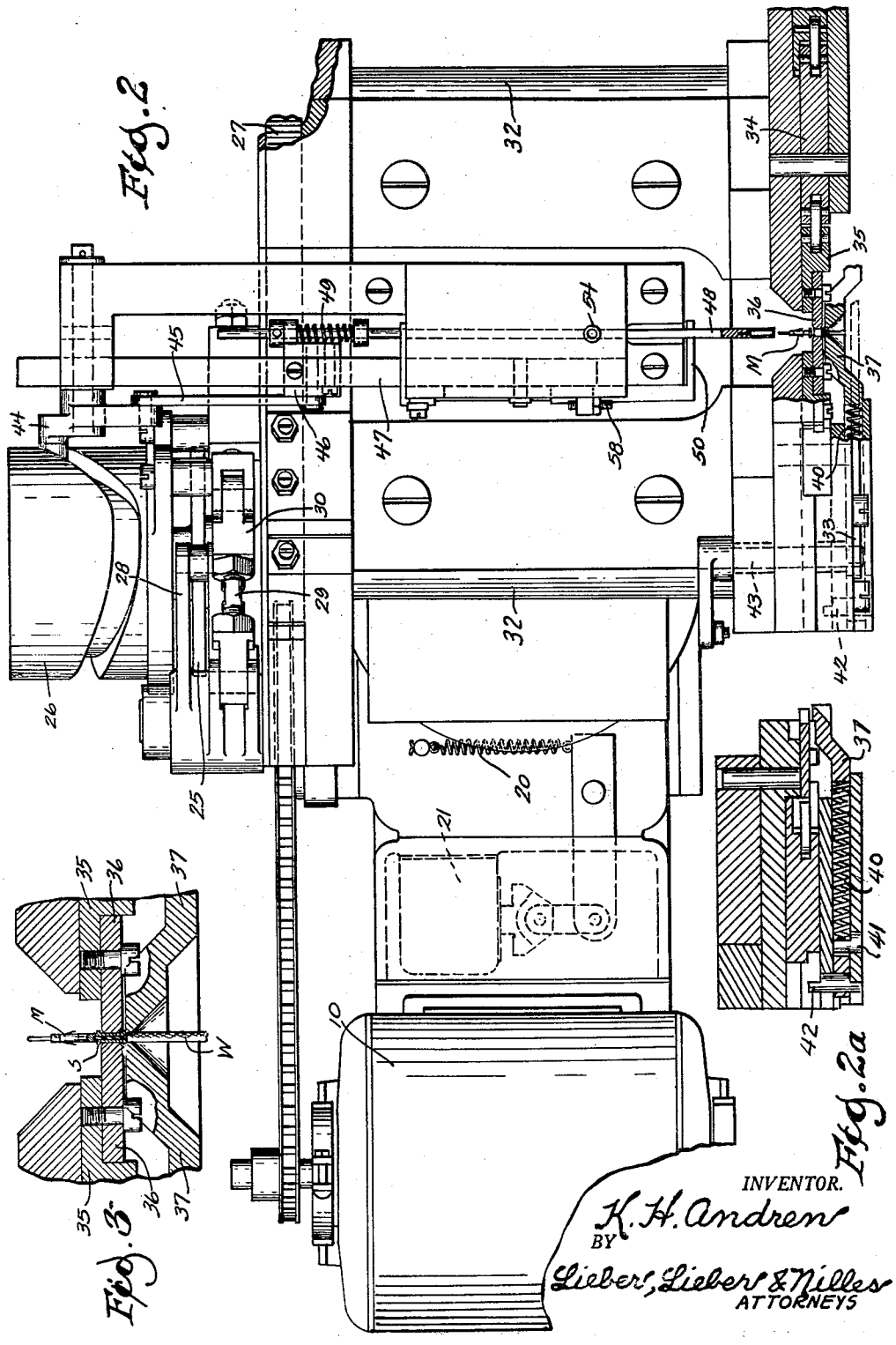
Fig. 1

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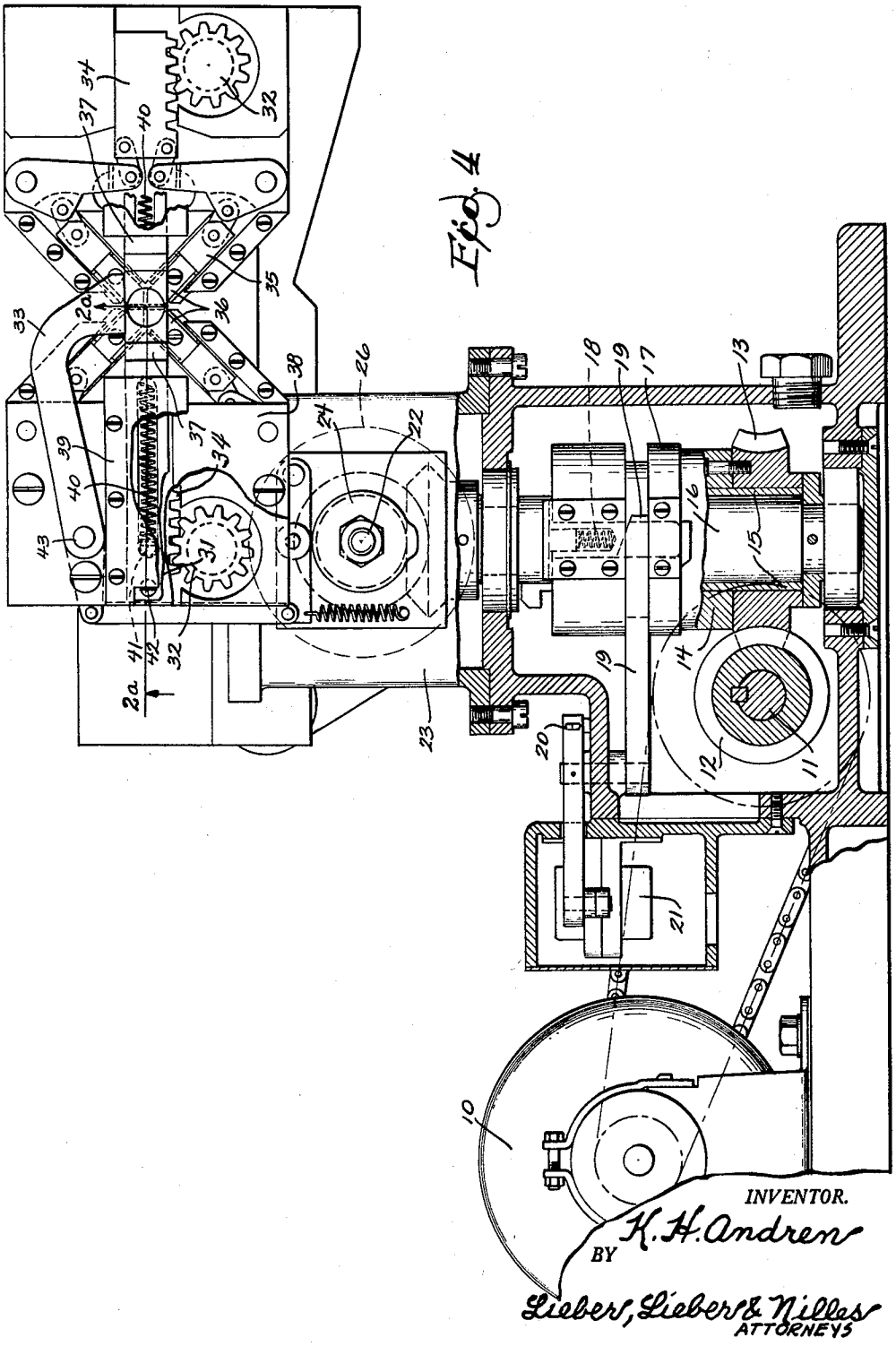


Fig. 4

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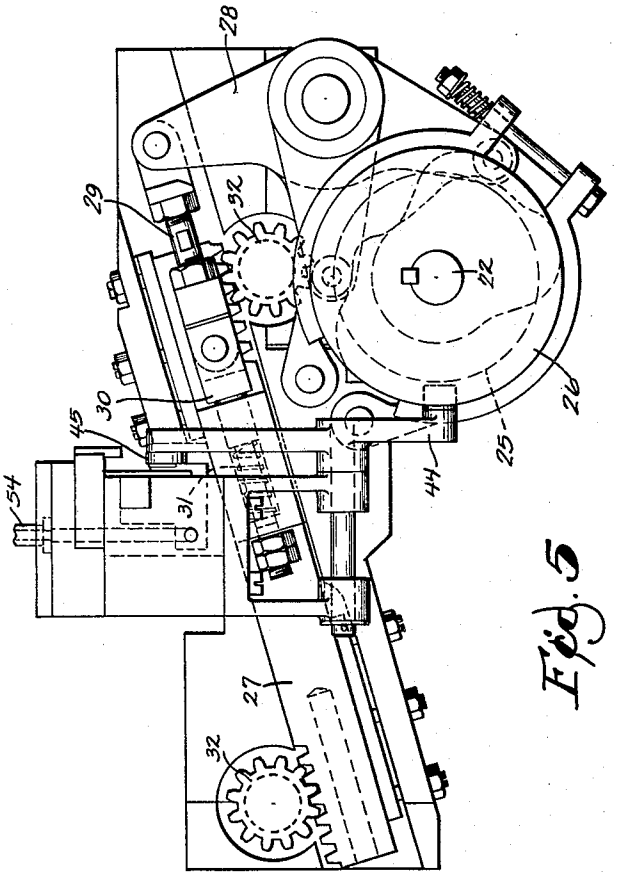


Fig. 5

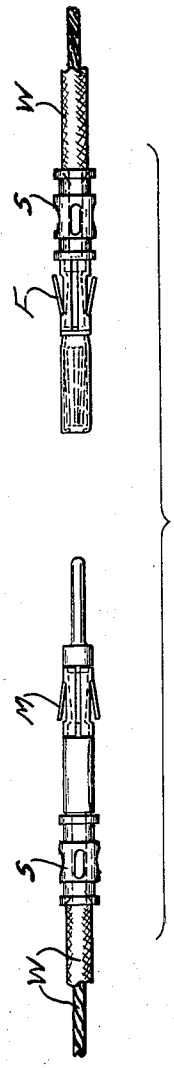


Fig. 9

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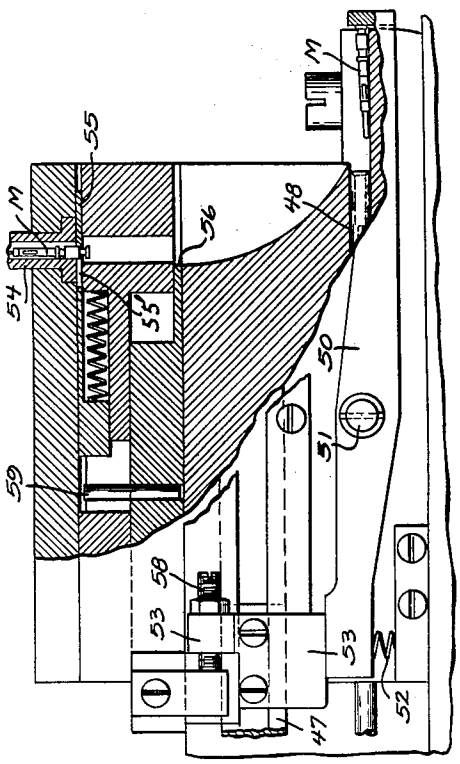
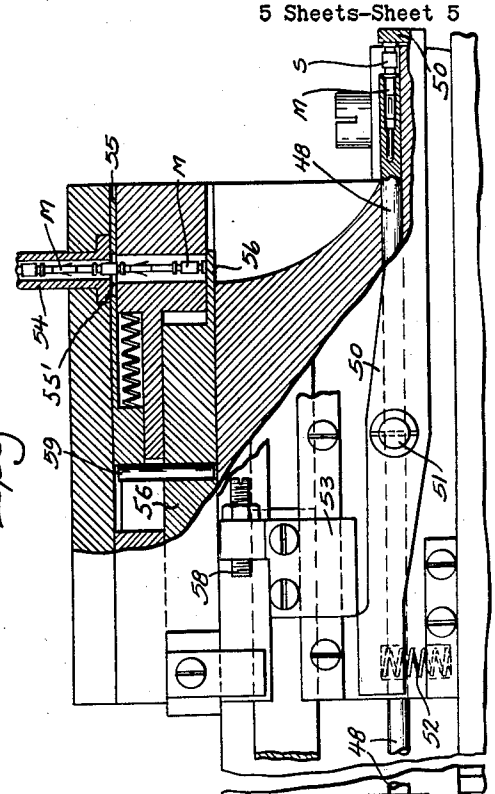


Fig. 6



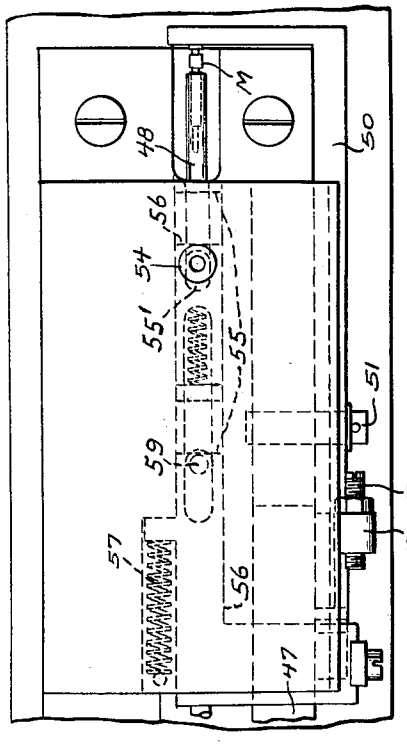


Fig. 8

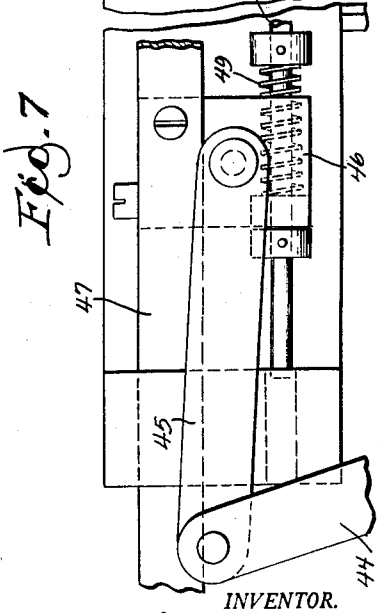


Fig. 7

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2,929,433

ART OF ATTACHING TERMINALS TO ELECTRIC CONDUCTORS

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Application October 17, 1958, Serial No. 767,899

8 Claims. (Cl. 153—1)

This invention relates generally to improvements in the art of producing electric current conductors each having a terminal attached to at least one end thereof, and it relates more specifically to an improved method of an apparatus for attaching individual socketed terminals to the ends of elongated conductors or wires.

The primary object of the present invention is to provide an improved method of rapidly and effectively attaching tubular terminals to the ends of elongated current conductors such as metallic wires.

Many different methods and mechanisms for producing electrical conductors each having an attaching terminal secured to one or both of the extreme ends of a wire, have heretofore been proposed and used commercially. In most cases, the terminals have been formed of flat sheet metal strips with the successive flattened terminals laterally interconnected by reduced portions adapted to be severed or broken so as to separate each terminal from the supply strip while the terminal is being fastened to an end of a conductor. This procedure was quite satisfactory when applying such flat terminals to the conductor ends, but for certain types of work, it is desirable to have the terminals formed of tubular stock with each terminal having an open end socket within which the end of the conductor must be inserted axially of the tube and subsequently clamped therein. This difference in terminal formation requires an entirely different method of feeding and attaching the tubular terminals to the conductors than was heretofore utilized when applying the flat laterally united terminals to the wire ends.

It is therefore an important object of this invention to provide a simple but highly efficient method of applying and clamping tubular terminals having open end sockets to the ends of elongated conductors such as wires, with utmost precision.

Another important object of the invention is to provide improved mechanism for effecting rapid and effective terminal attachment in accordance with the improved method.

These and other more specific objects and advantages of the invention will be apparent from the following description.

A clear conception of the several steps involved in the improved terminal attaching method, and of the construction and operation of one type of apparatus for facilitating the commercial exploitation of the method, may be had by referring to the drawings accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a side view of an electric motor driven relatively portable unit for carrying on the several steps of the present improved method of terminal attachment;

Fig. 2 is a part sectional top elevation, the section being taken along the line 2—2 of Fig. 1, showing the

normal starting and stopping position and with a terminal gripped in the tools ready to receive a wire end;

Fig. 2*a* is a section similar to that of Fig. 2, taken along the line 2*a*—2*a* of Fig. 4;

Fig. 3 is a fragmentary enlarged section through the terminal applying and attaching zone of the unit, similar to the section shown in Fig. 2, but with a wire W inserted into the terminal M and the machine just starting a new cycle, and showing the crimping tools in action;

Fig 4 is a part sectional front view of the terminal attaching unit, the section having been taken along the line 4—4 of Fig. 1, and the detailed showing of the chain drive having been omitted;

Fig. 5 is a rear view of the upper portion of the unit in which the terminal applying zone and crimping mechanism are located;

Fig. 6 is enlarged fragmentary and part sectional view taken vertically and centrally through the terminal supply and positioning mechanism of the unit, and showing a tubular terminal in position preparatory to being injected into the attaching zone;

Fig. 7 is a view similar to that of Fig. 6 but showing the initially positioned terminal engaged by the injecting plunger;

Fig. 8 is a top view of the terminal injecting mechanism positioned as in Fig. 7; and

Fig. 9 is a greatly enlarged side elevation of a pair of complementary tubular male and female terminals separated but attached to fragments of the attached wires.

While the improved apparatus has been shown and described herein as having been embodied in an electric motor driven relatively portable bench type machine into which the successive wires are manually inserted, it is not intended to limit the invention to this specific type of unit; and it is also contemplated that specific descriptive terms employed herein be given the broadest possible interpretation consistent with the actual disclosure.

As indicated hereinabove, the gist of the present invention involves an improved method of attaching a tubular or socketed terminal to an end of an elongated current conductor such as a stranded wire, by initially injecting the terminal axially of its socket and with the open socket foremost in one direction into an attaching zone to locate and hold the terminal end in precise position centrally and longitudinally relative to the clamping dies, by subsequently gathering the strands and inserting an end of the wire axially of the terminal socket but in the opposite direction into the prepositioned open socket end, and by finally permanently fastening the terminal socket to the inserted wire end within the attaching zone while the terminal is free from any influence which might distort the terminal or cause imperfect attachment of the terminal. In order to expedite the exploitation of the improved method with utmost precision, the initially injected tubular terminal should be yieldingly held against its locating means while the crimpers function to radially clamp same, after which the injecting device will be withdrawn, and the holding force should also be utilized but augmented to effect the final attachment of the terminal, while provision should also be made to promptly deliver the completed conductors from the zone.

In the accompanying drawings is shown one type of apparatus for effectively and expeditiously carrying on the improved method, and this apparatus comprises in general, feeding means for supplying and injecting successive tubular end-socketed terminals axially in one direction into a fixed attaching zone, together with means for locating each terminal in proper position with ut-

most precision, means within this zone for frictionally holding the injected terminals while the injection means is being withdrawn, means for gathering and guiding successive stranded wires while being axially inserted in the opposite direction into the sockets of the frictionally-held terminals within the attaching zone, means for actuating the terminal holding means to clamp the terminals to the inserted wire ends, and power means for driving the various terminal feeding and attaching mechanisms. The tubular terminals may be either of the type M or of the complementary type F shown in detail in Fig. 9, and each of these terminal types is provided with an open end socket S within which the stripped end of an insulated multi-strand wire W is insertable and adapted to be clamped or crimped.

The improved terminal attaching unit may be driven by an electric motor **10** through a chain drive which is adapted to rotate a horizontal power shaft **11** having a worm **12** keyed thereto, see Figs. 1, 2 and 4. The worm **12** drives a worm wheel **13** which is bolted to a clutch driving plate **14** and a bushing **15** is pressed firmly within the plate **14** and worm wheel **13** so that when the main clutch is disengaged, the clutch drive assemblage is freely rotatable about an upright shaft **16**. The clutch body **17** is firmly secured by a key to the shaft **16** directly above the drive plate **14** and a spring loaded clutch pin **18** is disposed within an upright groove in the body **17**. The spring coacting with the clutch pin **18** tends to force this pin against the adjacent surface of the clutch plate **14**; and this plate is provided with a slot of somewhat greater width than that of the pin **18** so that whenever the plate **14** is rotating, the clutch pin will drop into this slot unless the pin is otherwise restrained, and will thus engage the clutch to rotate the upright shaft **16**.

The main clutch is adapted to be disengaged by a jackknife lever **19**, the swinging end of which is constantly urged toward a horizontal annular groove in the body **17** by a tension spring **20** as depicted in Figs. 2 and 4; but an electric solenoid **21**, when energized, is operable to pull the knife lever **19** out of this groove. The swinging end of the knife lever **19** is chamfered to correspond with the inclined surface at mid-portion of the clutch pin **18**, and when the lever **19** is riding in the clutch body groove and the clutch is engaged, the clutch pin **18** will be retracted and lifted out of the slot in the clutch plate **14** whenever it engages the chamfered end of the lever **19**. The drive plate **14** will then continue to rotate, but since the clutch is disengaged, the clutch body **17** and the shaft **16** to which it is keyed will stop. However, by momentarily energizing the solenoid **21**, the main clutch may again be engaged to rotate the shaft **16**.

Located above the upright shaft **16** is a horizontal cam shaft **22**, which is journalled for rotation in a gear box **23** secured to and supported by the main clutch housing. The cam shaft **22** is drivingly connected at its mid-portion to the upper end of the upright shaft **16** by intermeshing bevel gears as shown in Figs. 1 and 4, while both ends of this shaft project outwardly beyond the box **23** as in Fig. 1. One of the projecting shaft ends carries a small plate cam **24** which functions to operate a knockout for the final conductors produced by the unit, while the opposite protruding shaft end carries a pair of conjugate disk cams **25** for operating the terminal crimping mechanism and also carries a barrel cam **26** for operating the terminal transfer mechanism. A rack and pinion assembly is also mounted upon the gear box **23** as illustrated in Figs. 4 and 5 and positive movement in both directions is imparted to the rack bar **27** from the conjugate cams **25** by a cam lever **28**.

The cam lever **28** is connected to the rack bar **27** by an adjusting stud **29** and plunger **30** which is spring-loaded by a stiff compression spring **31** as depicted in Fig. 5. The initial portion of the rack movement is transmitted through the spring **31** since the plunger **30** is spaced slightly away from the rack bar **27** when this bar is in its extreme position toward the right as viewed in Fig. 5, for reasons to be later explained. The rack bar **27** coacts with and simultaneously transmits rotary motion to two parallel pinion shafts **32** as shown in Figs. 1 2, 4 and 5 which also serve to reciprocate a pair of racks **34** shown in Fig. 4 back and forth in opposite directions relative to the terminal attaching zone of the unit. The terminal holding and crimping head, which is located within this fixed zone, is symmetrical relative to its vertical central plane, except for the presence of a wire knockout **33**, as illustrated in Fig. 4.

Four tool holders **35** each carrying an identical crimping tool **36** are slidable radially in milled grooves in the box **23** disposed 90 degrees apart, and are retained in the grooves by gibs, and these tool holders **35** are simultaneously movable in opposite direction by links and levers connected to the racks **34** as depicted in Fig. 4 which also provide a toggle action for effecting final crimping of the terminal sockets S to the inserted ends of the stranded wires W. A pair of funnel-shaped guides **37** for properly gathering the strands and for inserting the ends of the wires W into the sockets S of the successive terminals M injected into the attaching zone, are also provided, and these guides **37** are slidable in alined grooves formed in the rack cover **38** and in the guide cover **39** secured thereon within which helical compression springs **40** reacting against pins **41** are confined, thus spring-loading these guides **37** and urging them toward each other.

A pin **42** secured to each wire guide **37** is adapted to engage an end surface of the rack cover **39** to limit the travel of the guides toward each other and to insure proper axial alinement of the wire guiding surfaces with the terminal sockets. These pins **42** project inwardly somewhat beyond the inner surfaces of the guides **37** so that when the racks **34** are retracted, the ends of these racks will engage the pins and force the wire guides apart against the springs **40**. The wire knockout **33** is swingable about a pivot shaft **43** and derives its swinging motion from the disk cam **24** carried by the shaft **22** through linkage and a lever which is urged against the cam surface by a tension spring as clearly shown in Figs. 1, 2 and 4.

The terminal supply and feed mechanism is best illustrated in Figs. 5, 6, 7 and 8, and is operable by the barrel cam **26** and a lever **44** coacting at one end with the cam groove as in Figs. 1 and 2. The medial portion of the lever **44** is pivoted on the box **23**, and the opposite swinging end thereof is connected by a link **45** to a reciprocable crosshead **46**. The crosshead **46** is fastened to a square longitudinally movable slide **47** which serves to produce rectilinear motion of the crosshead and the latter also reciprocates an elongated spring-loaded terminal transfer rod **48**. In Fig. 6, the transfer rod **48** is shown in fully retracted position with a terminal M deposited in front of the road end ready to be picked up and injected into the terminal attaching zone between the tools **36**. When the transfer rod **48** is advanced by the cam **26**, lever **44** and crosshead **46**, the end of the terminal M remote from its socket S, will enter a counterbore in the leading rod end and while the terminal is being inserted into same as in Fig. 7, and is backed up against a stop lever **50**, and further forward movement of the crosshead **46** is compensated for by a spring **49** interposed between the crosshead and a collar attached to the rod **48** and which embraces the latter. The complete insertion of the end of each terminal M within the end counterbore of the rod **48** is thus assured without subjecting the terminals to excessive end pressure.

The stop lever **50** is swingably suspended from a pivot pin **51**, and a coil spring **52** coacts with the lever and constantly tends to make it inactive as a terminal stop but is prevented from doing so by a plate **53** attached to the square slide **47**. Any forward movement of the slide

beyond the position shown in Fig. 7, enables the spring 52 to raise the adjacent end of the lever 50 and to simultaneously lower the opposite lever end sufficiently to permit the rod 48 to continue its movement and to inject the engaged terminal M in one direction into the attaching zone and with its socket portion S properly positioned relative to the four holding and crimping tools 36. When a terminal M has been thus properly positioned, and is pressed by spring 49 against the inside face of the wire guides 37, the terminal M will be frictionally grasped by the tools 36 as will be later explained, and the transfer rod 48 must then be retracted immediately into the position shown in Fig. 2, and the socketed end of the properly positioned and temporarily held terminal will be located against the closed wire guides 37 so that the end of a wire W may be inserted in the opposite direction into the terminal socket, and a new cycle started.

The successive tubular terminals M are stacked endwise upon each other within an upright feed tube 54 carried by the box 23 and the lower end of which is communicable with a curved guideway for transferring the terminals from vertical to horizontal disposition in front of the rod 48, see Figs. 6 and 7. The lowermost terminal M of the stack normally rests on the shelf or shuttle blade 56 as in Figs. 2, 7 and 8. The shuttle blade 56 is actuated by a spring 57 tending to urge it forwardly and is activated in reverse direction by a set screw 58 carried by the plate 53, and is also located beneath a latch 55 which has a slot 55' through which the terminals M pass as in Fig. 7. When the slide 47 begins its forward movement, the plate 53 and set screw 58 will advance forwardly thus permitting the spring 57 to move the shuttle blade 56 forwardly so as to close the terminal feed opening beneath the tube 54, and as this forward movement continues, the pin 59 carried by the blade 56 engages the rear of the spring-pressed latch blade 55 and urges it forward so as to release the now lowermost terminal M of the stack to drop upon the lower blade 56. This latch 55 is normally spring pressed against a pin 59 extending upwards from the shuttle blade 56 and is so located that when the latch 55 is actuated, the inside edge of the slot 55' will clamp the terminal M resting upon the lowermost terminal M against the inside of the tube 54, thus freeing the lowermost terminal M whenever shuttle blade 56 is withdrawn. During the return stroke of the slide 47, the latch blade 55 will again clamp the terminal M in the feed tube 54 in position, and immediately thereafter, the shuttle blade 56 will be withdrawn to allow the terminal M resting thereon to drop freely by gravity along the arcuate guide into proper position to be picked up by the transfer rod 48.

With the motor 10 operating but while the main clutch has been disengaged by the lever 19, the unit has stopped with the elements in the position shown in Figs. 2, 4 and 5 with the wire guides 37 closed and the crimping tools 36 frictionally holding a terminal M under pressure from the spring 31 acting upon the rack 27. The terminal transfer rod 48 has started its return stroke after releasing the terminal to the tools 36, and the stripped end of a wire W may then be inserted through the closed wire guides 37 into the socket S of the frictionally held terminal M. The solenoid 21 may then be energized with the aid of a foot-actuated switch or the like, to cause the knife lever 19 to be pulled out of the groove in the clutch body 17, thereby permitting the clutch pin 18 to drivingly engage the clutch plate 14 and to thereby rotate the upright shaft 16 and the upper horizontal shaft 22 through the interconnecting bevel gears.

As the shaft 22 is thus rotated, the cams 25 pass the dwell section as shown in Fig. 5, and the spring 31 is further compressed until the plunger 30 contacts the rack bar 27 and this bar continues to move until the tools 36 are fully closed by toggle action, after which the crimping tools 36 separate and the wire guides 37 also begin to separate or open. All of these movements are effected by the conjugate disk cams 25 mounted upon the shaft 22 and coacting with the bell crank lever 28, and when the tools 36 and the wire guides 37 have been separated sufficiently, the cam disk 24 becomes effective to swing the knockout 33 downwardly so as to positively eject the completed conductor and to subsequently return the knockout to inactive position. While the final advancement and subsequent separation of the tools 36 and guides 37 and removal of a finished conductor by the knockout 33 is being effected, the drum cam 26 coacting with the lever 44, link 45, and crosshead 46 returns the rod 48 thereby causing the shelf 56 to drop another terminal M at the end of the return stroke of rod 48, as shown in Fig. 6. Then while the crimping tools 36 and the wire guides 37 have started to close again, the now advancing rod 48 picks up and injects the new terminal M into the attaching zone, holding said terminal with spring pressure by spring 46 against the insides of guides 37, and the tools 36 continue to move inwardly so as to frictionally engage the injected and properly positioned terminal M, while the rod 48 retracts and the machine stops. During this stoppage of the machine, the momentary frictional holding of the terminal M within the attaching zone is effected by the spring 31 coacting with the plunger 30 of the rack assemblage 27 shown in Fig. 5, and after the tools 36 have engaged the terminal socket S, the cam-actuated lever 28 dwells.

After another wire W has been inserted within the socket S, the clutch is again tripped by the solenoid 21 and the lever 28 starts to move in order to cause the tools 36 to firmly crimp the terminal to the wire end. The rod 48 of the transfer mechanism thereafter continues its return stroke to pick up another terminal M as shown in Fig. 6, and to deliver it to the tools 36 and the operating cycle will be repeated again.

From the foregoing detailed description of the construction and functioning of the terminal attaching unit, it will be apparent that this unit provides simple but effective mechanism for quickly carrying on the successive steps of the present improved method with utmost precision. The relatively delicate tubular terminals which are shown greatly enlarged in Fig. 9 may be either of the type M at the left or of the type F at the right, since the above-described mechanism will function equally well when handling either of these types, and the wire stock is composed of numerous strands which are gathered by the guides for proper insertion within the terminal sockets. When the machine is operating, the stop lever 50 functions to properly position the terminals M within the end of the rod 48, and the guides 37 properly locate the terminals within the attaching zone, as well as locate and guide the wire strands into the terminals, while the knockout 33 positively removes the final conductor without bending or marring the same. The various parts of the improved machine are also conveniently adjustable so as to insure accurate performance, and the invention has gone into highly satisfactory and successful operation for the production of diverse types of conductors having tubular terminals M or F secured to wires W as in Fig. 9.

It should be understood that it is not desired to limit this invention to the exact steps of the method or to the precise details of the apparatus shown, for various modifications within the scope of the appended claims may occur to persons skilled in the art.

I claim:

1. The method of attaching a socketed terminal to an end of an elongated multi-strand current conductor, which method comprises, projecting each terminal axially in one direction into and holding the terminal within an attaching zone, gathering the end strands and threading the gathered end of the wire axially in the opposite direction within the socket of the held terminal within said zone, thereafter augmenting the holding force to clamp the terminal socket to the inserted wire end, and finally

releasing and knocking the completed conductor laterally from within the attaching zone.

2. The method of attaching successive socketed terminals to ends of elongated current conductors, which method comprises, projecting each individual terminal axially in one direction into and holding the terminal within an attaching zone, threading an end of the wire axially in the opposite direction within the socket of the held terminal within said zone, thereafter augmenting the initial holding force to clamp the terminal socket to the inserted wire end, and finally releasing and knocking the completed conductor laterally from within the attaching zone.

3. Apparatus for attaching a tubular terminal to an end of a stranded wire, a reciprocable rod having an end for injecting the terminal axially in one direction into an attaching zone, a set of tools operable to frictionally hold the injected terminal in a fixed position within said zone, guides operable to gather the end strands of a wire inserted therebetween in the opposite direction and to thread the gathered strands into the terminal within said zone, and means for actuating said tools to clamp the terminal to the inserted wire end.

4. Apparatus for attaching a tubular terminal to an end of a wire, means for injecting the terminal axially in one direction into an attaching zone, means for frictionally holding the injected terminal in definite position within said zone, means for guiding the end of a wire in the opposite direction into the tubular end of the held terminal within said zone, means for actuating said terminal holding means to finally clamp the terminal to the inserted wire end, and a knockout device for positively removing the completed terminal and wire assemblage laterally from within said attaching zone.

5. Apparatus for attaching a tubular terminal to an end of a wire, a reciprocable rod having an end for injecting successive terminals axially in one direction into an attaching zone, a set of tools operable to frictionally hold each injected terminal in fixed position within said zone, guides operable to conduct the end of a wire inserted therebetween in the opposite direction into the tubular end of the terminal within said zone, means for actuating said tools to finally clamp the terminal to the inserted wire end, and a device for positively removing the wire and terminal assemblage laterally from within said attaching zone.

6. Apparatus for attaching a tubular terminal to an end of a wire, a reciprocable rod having a counter-bored end formed to receive and inject the terminal axially in one direction into an attaching zone, a stop cooperable with the terminal to insure proper insertion of the terminal within said counter-bored rod end, means for releasing said stop to permit said rod to advance the terminal into said zone, wire guides cooperable with the injected terminal to definitely position the latter within said zone, and a set of tools cooperable with the terminal within said zone to frictionally hold the terminal while said rod is being retracted and to thereafter clamp said terminal to the end of a wire inserted through said guides.

7. Apparatus for attaching a tubular terminal to an end of a wire, a reciprocable rod having an end formed to inject the terminal axially in one direction into an attaching zone, a stop cooperable with the terminal to insure proper cooperation of the terminal with the rod, means for releasing said stop to cause said rod to advance the terminal into said zone, wire guides cooperable with the injected terminal to definitely position the latter within said zone, a set of tools cooperable with the terminal within said zone to frictionally hold the terminal while said rod is being retracted and to thereafter clamp said terminals to the end of a wire inserted through said guides, and a knockout for positively removing the wire and terminal assemblage laterally from within said zone.

8. Apparatus for attaching successive individual tubular terminals to ends of stranded wires, a reciprocable rod formed to inject each terminal in one direction into an attaching zone, a stop cooperable with each terminal to insure proper coaction with said rod, means for releasing said stop to cause said rod to advance the terminal into said zone, a wire strand gathering guide for conducting the gathered wire end into the terminal within said zone, tools cooperable with the terminal within said zone to frictionally hold said terminal in fixed position while said rod is being retracted and while the stranded wire end is being threaded into the held terminal in said zone, and means for actuating said tools to clamp the terminal to said wire end.

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