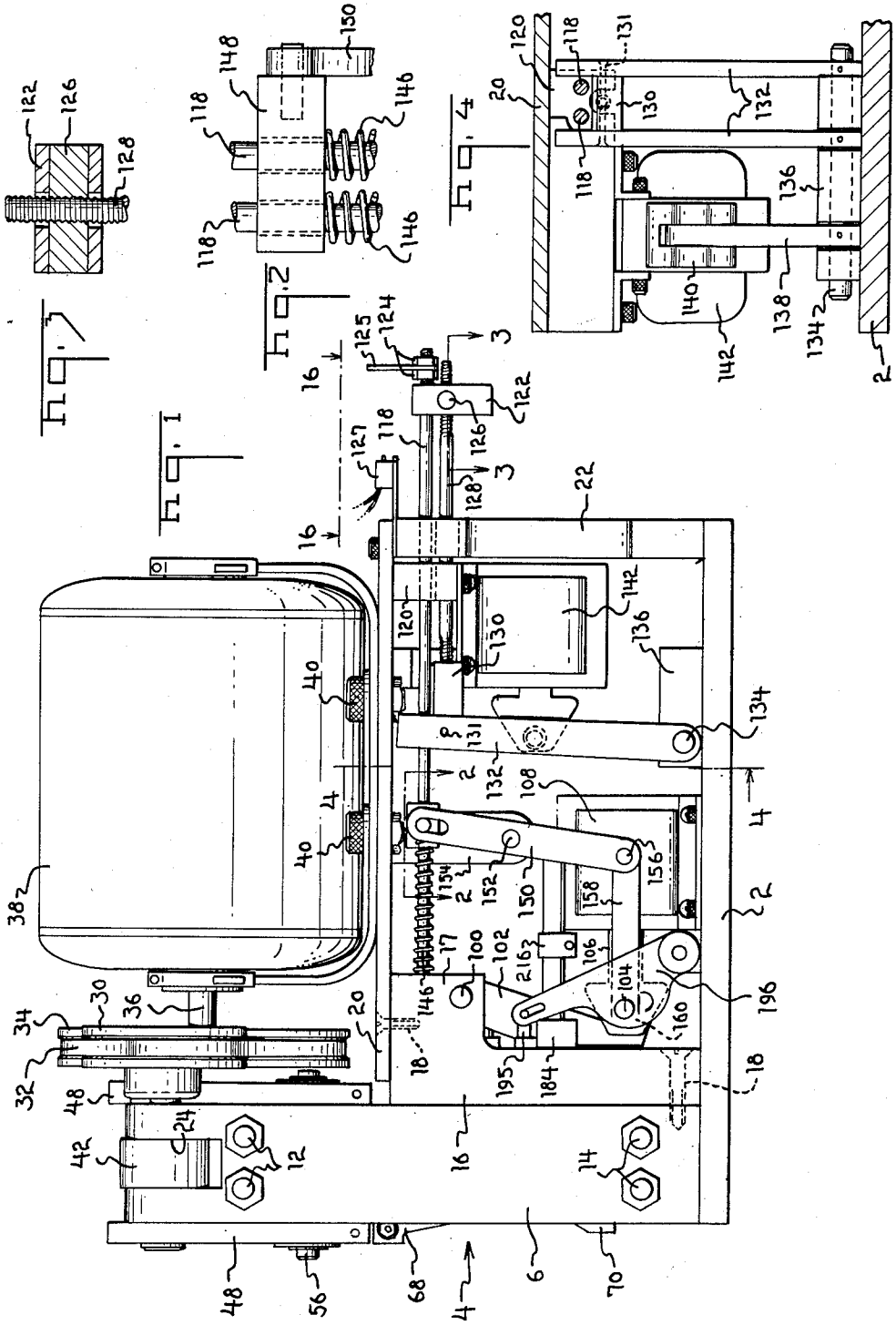
June 29, 1965 G. C. SITZ 3,191,411

COMPRESSING APPARATUS

Filed Aug. 16, 1962 6 Sheets-Sheet 1



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COMPRESSING APPARATUS

Filed Aug. 16, 1962 6 Sheets-Sheet 2

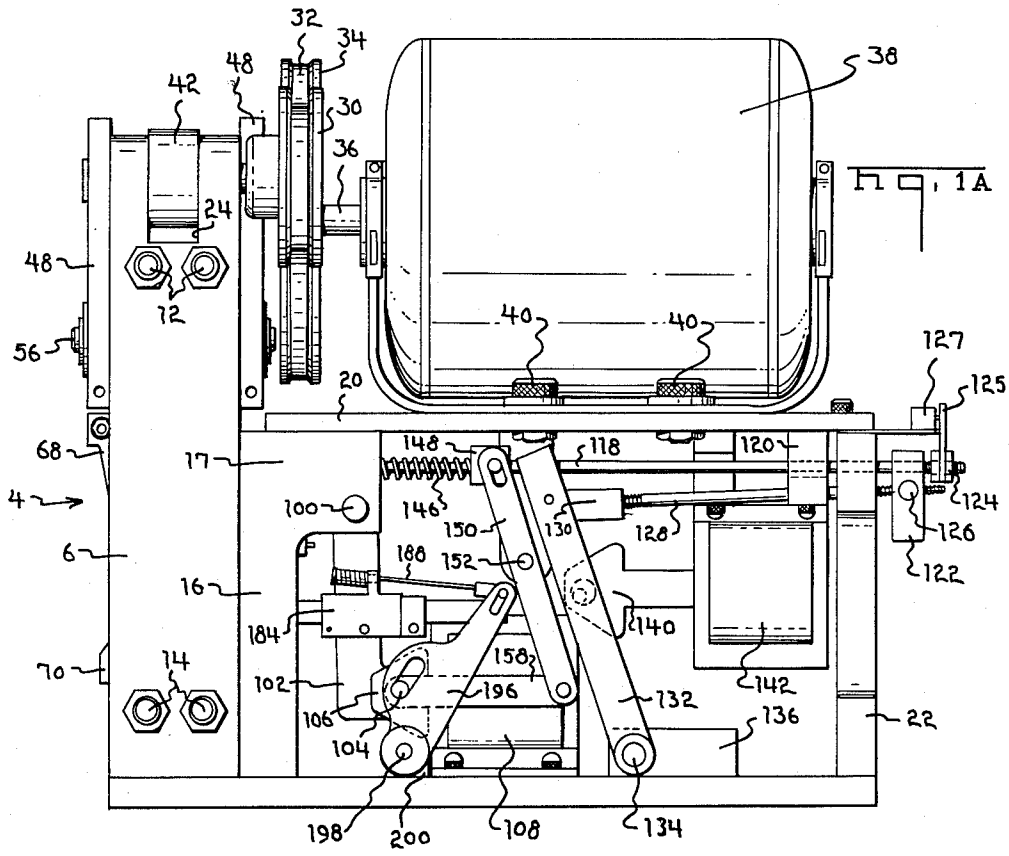

FIG. 1A

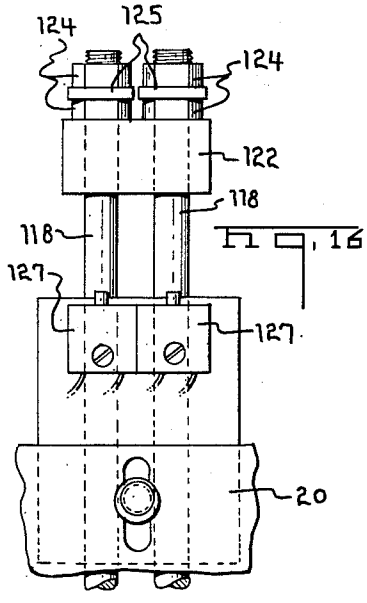

FIG. 1B

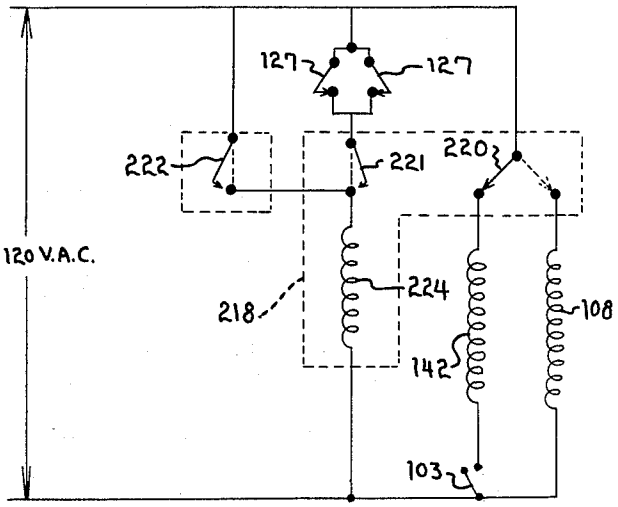

FIG. 17

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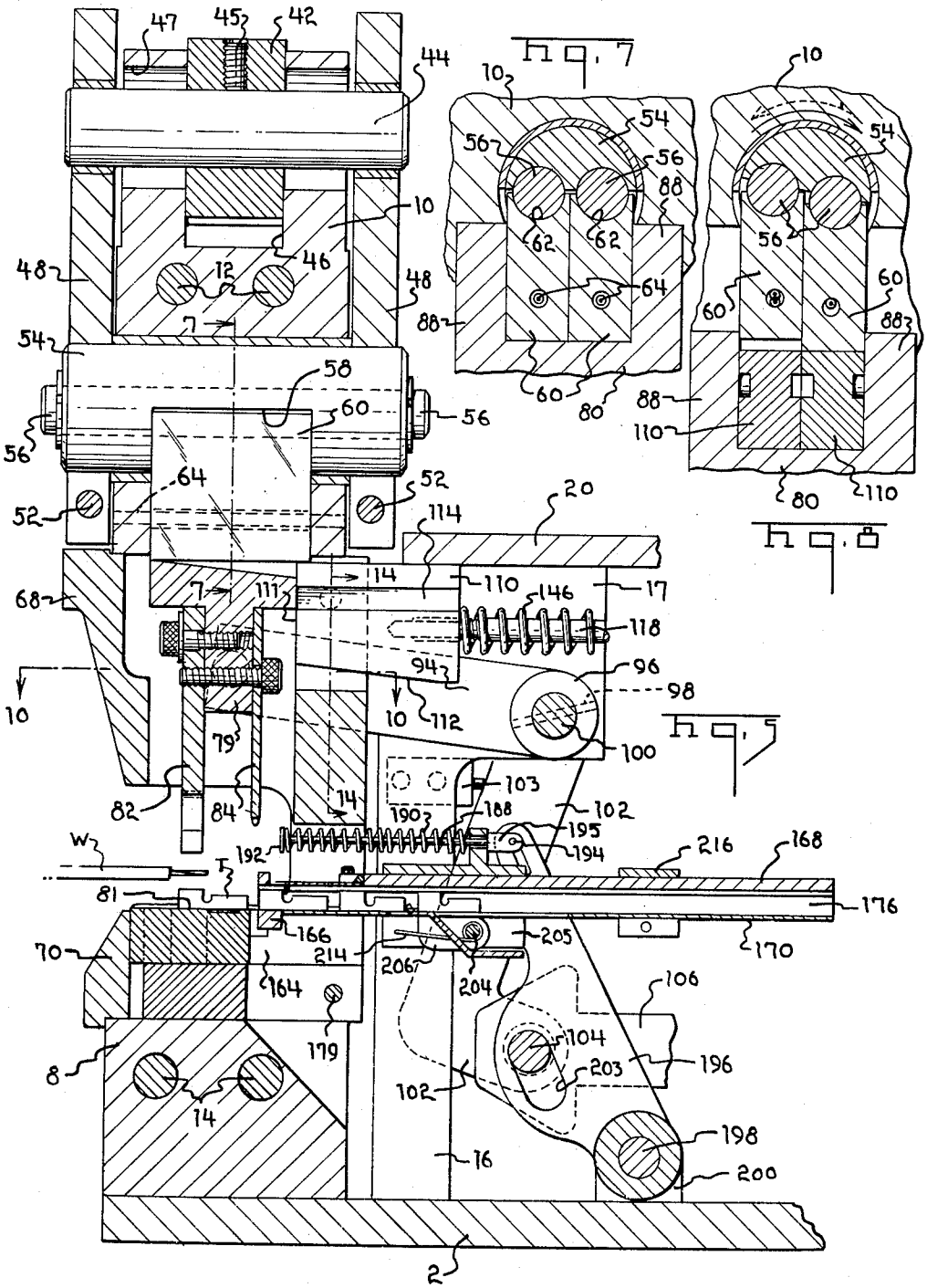

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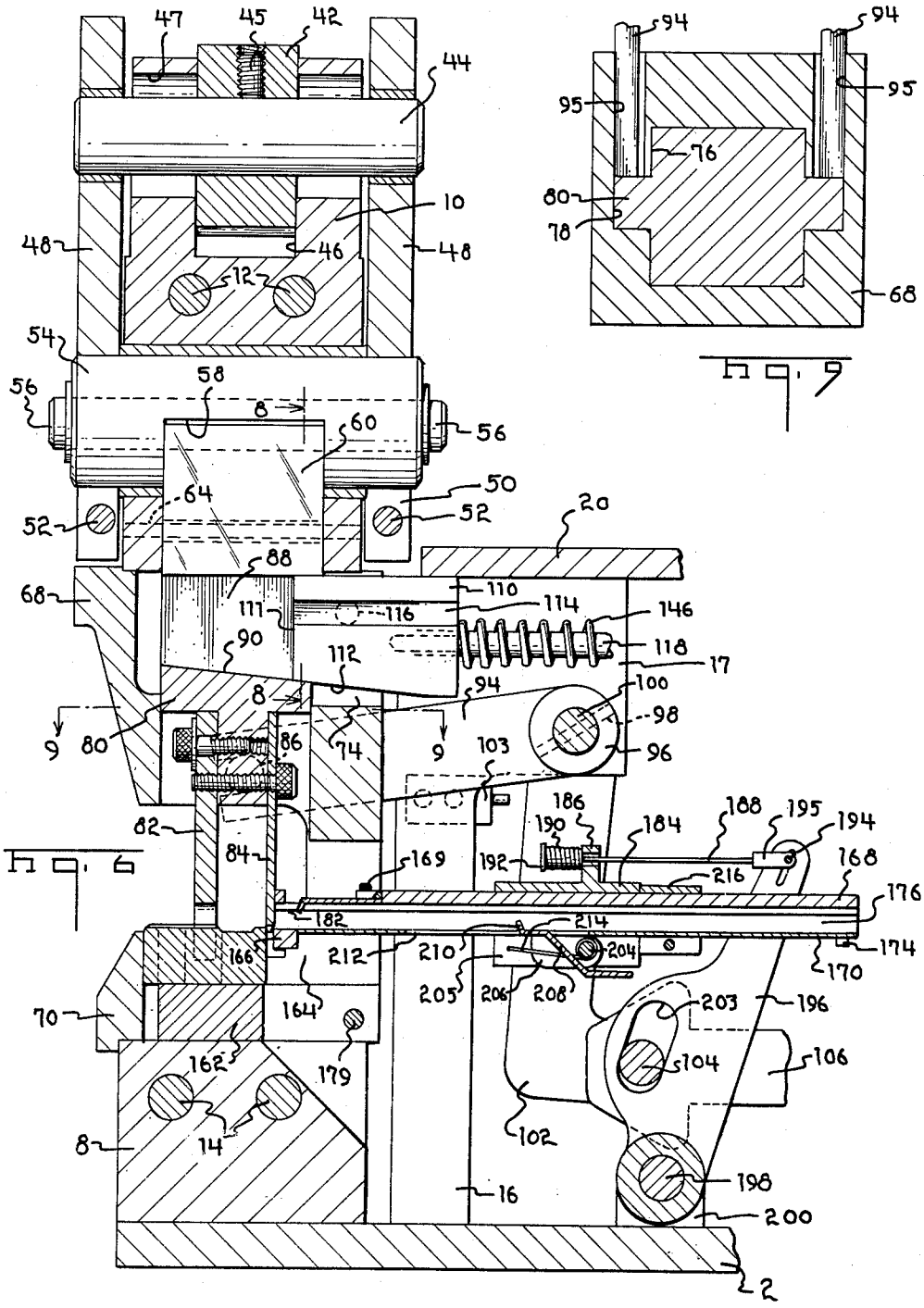

Fig. 6

Fig. 9

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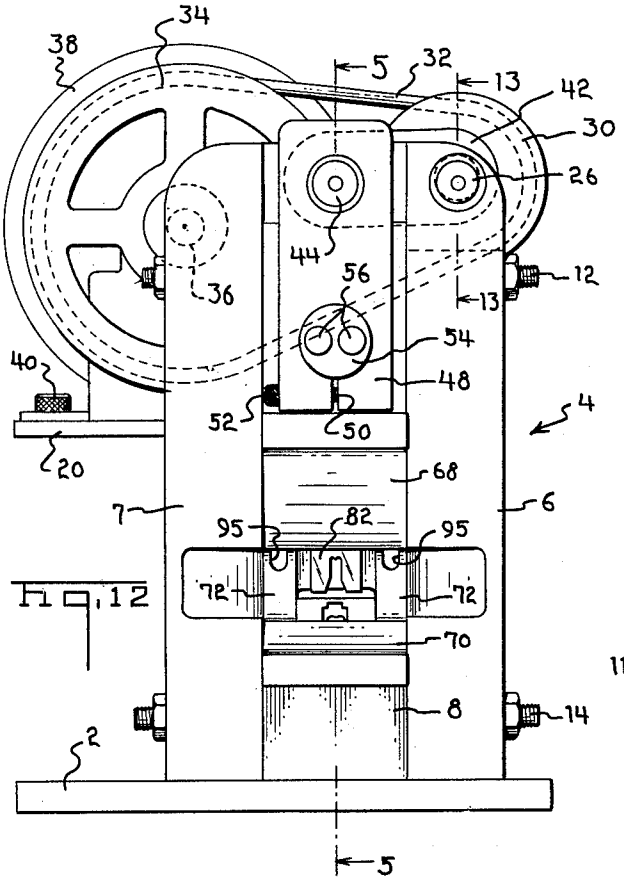

Fig. 12

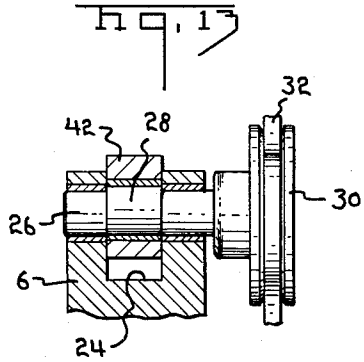

Fig. 13

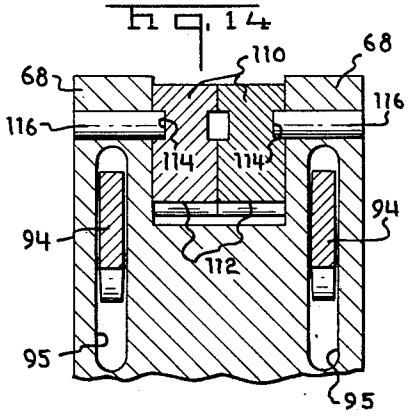

Fig. 14

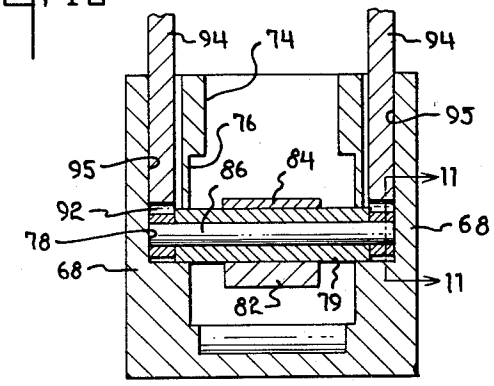

Fig. 10

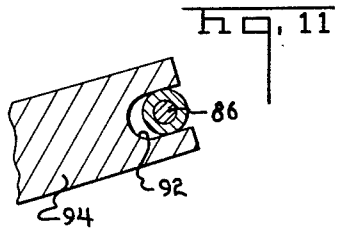

Fig. 11

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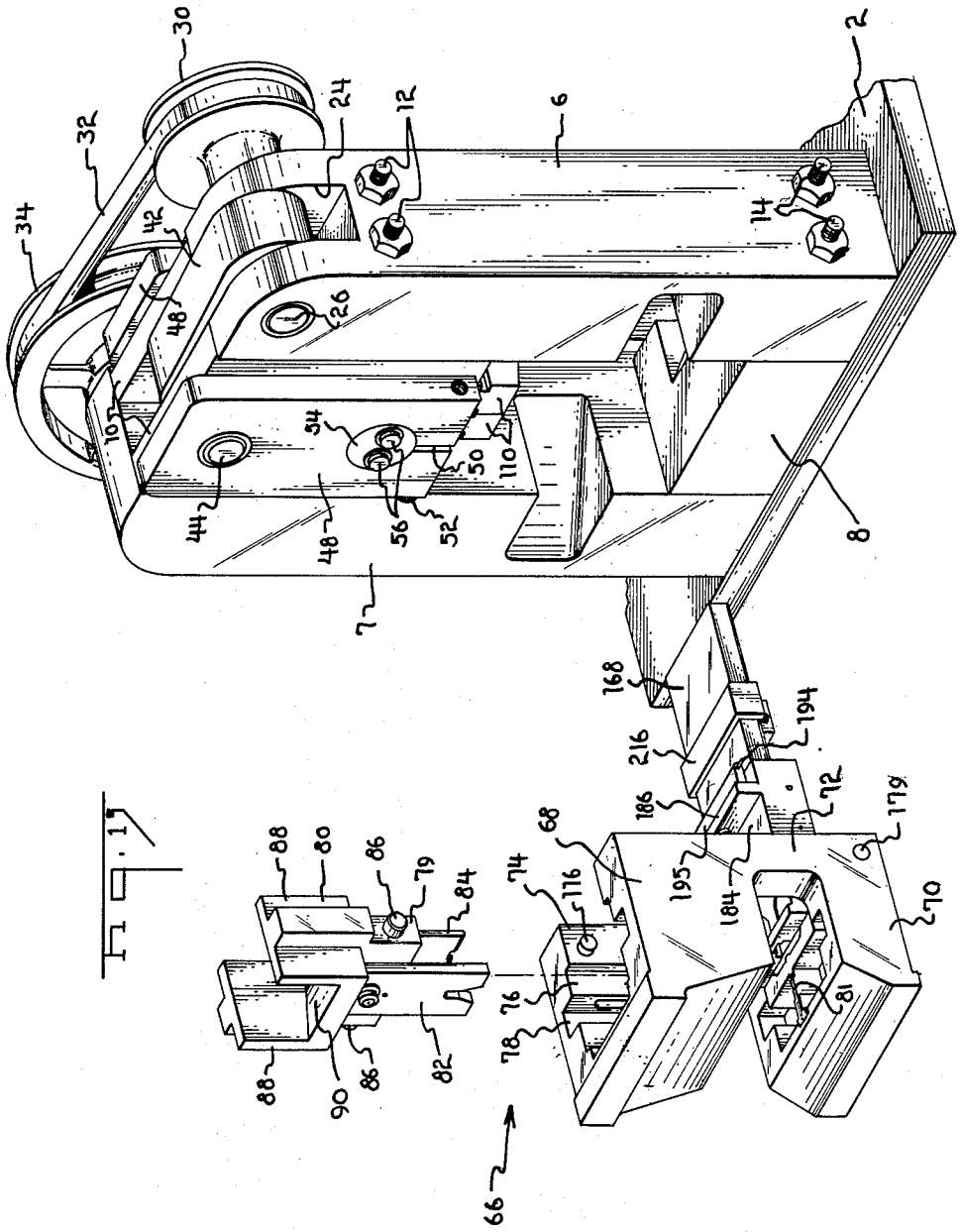

FIG. 17

United States Patent Office 3,191,411 Patented June 29, 1965

3,191,411

COMPRESSING APPARATUS

Gilbert C. Sitz, Harrisburg, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Filed Aug. 16, 1962, Ser. No. 217,435
23 Claims. (Cl. 72—22)

This invention relates to presses carrying out metal working operations such as the crimping of electrical connectors and terminals. The invention is herein disclosed in an embodiment comprising a relatively small bench press, however, it will be apparent that the principles of the invention are equally applicable to larger presses and to manually held tools.

A primary object of the invention is to provide an improved press or the like which is light in weight and compact in size relative to its capacity. A further object is to provide a press which can be constructed in a manner such that the possibility of serious injury to the operator is greatly reduced or entirely eliminated. A further object is to provide a metal working press constructed in a manner such that the possibility of damage to the press dies in the event of a foreign object being located therebetween is greatly reduced. A further object is to provide a press which permits close control over the shut height of the ram. A further object is to provide a press having an improved shut height adjustment feature. A still further object is to provide a crimping press for crimping electrical conectors and terminals onto the ends of wires having a simplified tooling and feed unit.

These and other objects of the invention are achieved in a preferred embodiment comprising a bench press for crimping connectors onto the ends of wires in which the press ram is moved through a substantial portion of its stroke by the action of a solenoid and in which the thrust for the final portion of the crimping stroke is provided by means of a pair of pulsating thrust blocks. The thrust blocks reciprocate at a relatively high rate and apply thrust to the ram intermittently and alternately on opposite sides of its axis. A pair of spring biased wedges move between the thrust blocks and the ram and function as a motion take-up device to drive the ram through the final portion of its stroke during which the thrust requirements for crimping the electrical connector are at the maximum level. The thrust blocks are caused to reciprocate along their limited amplitude paths by means of an oscillating shaft against which they bear and which is caused to oscillate by a relatively simple crank arrangement actuated by an electric motor. The invention thus eliminates the need for a relatively heavy flywheel or a relatively large fluid actuated piston cylinder as has been common in the prior art although the capacity achieved is comparable to the prior art devices. In this preferred embodiment, the electrical connector being crimped is compressed onto the wire end by means of a rapid series of compressive pulses and this method of crimping appears to yield substantially improved electrical results in the crimped connection.

The invention also contemplates an improved applicator unit which forms part of the preferred embodiment and which includes the tooling for crimping a specific electrical connector, the press ram, and the feeding mechanism for feeding the connectors. This applicator unit is contained between the columns of the press frame in a manner which permits its rapid removal so that separate applicators including the necessary tooling can be used for different terminals which are to be crimped.

In the drawing:

FIGURE 1 is a side view of a crimping press for electrical connectors in accordance with a preferred embodiment of the invention showing the parts in their normal positions.

FIGURE 1A is a view similar to FIGURE 1 but showing the positions of the parts at the end of the down stroke of the press ram.

FIGURES 2, 3, and 4 are views taken along the lines 2—2, 3—3, and 4—4 of FIGURE 1.

FIGURE 5 is a sectional side view showing the forward end of the press including the press frame with the ram in the raised position, this view being taken along the lines 5—5 of FIGURE 12.

FIGURE 6 is a view similar to FIGURE 5 but showing the positions of the parts after the downward stroke of the ram has started.

FIGURE 7 is a view taken along the lines 7—7 of FIGURE 5.

FIGURE 8 is a view taken along the lines 8—8 of FIGURE 6.

FIGURE 9 is a view taken along the lines 9—9 of FIGURE 6.

FIGURE 10 is a view taken along the lines 10—10 of FIGURE 5 and showing the lower portion of the ram and the crimping tooling.

FIGURE 11 is a view taken along the lines 11—11 of FIGURE 10.

FIGURE 12 is a frontal view of the embodiment of FIGURE 1.

FIGURE 13 is a view taken along the lines 13—13 of FIGURE 12.

FIGURE 14 is a view taken along the lines 14—14 of FIGURE 5 and showing the relationship of the thrust wedges to the applicator housing.

FIGURE 15 is a perspective partially exploded view showing the press frame, the applicator housing, and the applicator ram.

FIGURE 16 is a view taken along the lines 16—16 of FIGURE 1.

FIGURE 17 is a wiring diagram for the preferred embodiment of the invention.

Referring first to FIGURES 1, 5, and 12, the disclosed embodiment is mounted on a base plate 2 and has a crimping press frame generally indicated at 4 at its forward end. This press frame comprises a pair of upright columns 6, 7, a press bed 8 disposed between the columns on the base plate 2, and an upper cross member 10 which is contained between the columns at their upper ends. The press bed 8 and the cross member 10 are held in position by means of tie rods 12 and 14 which extend through aligned openings in the columns and through the respective members. A pair of spaced apart L-shaped supports 16 are disposed behind the columns 6, 7 and are secured to these columns, to the base plate, and to a motor support plate 20 by means of suitable fasteners 18. The motor support plate 20 is supported at its rearward end by means of an additional column 22 which may be secured in any suitable manner to the base plate and to the underside of the plate 20.

A shaft 26 is journaled in the upper end of column 6 and has a central eccentric or crank throw 28 disposed in a slot 24 in the column. Shaft 26 extends rearwardly of column 6 and has a pulley 30 mounted on its end which is coupled by means of a belt 32 to a larger pulley 34 on the end of the output shaft 36 of a motor 38 mounted by means of fasteners 40 to the plate 20.

The eccentric 28 of shaft 26 is rotatably contained in a bearing in a connecting rod 42 which extends into a slot 46 in cross member 10. A wrist pin 44 extends through an oversized opening 47 in cross member 10 and through the lefthand end of the connecting rod as viewed in FIGURE 12, a set screw 45 being provided in the connecting rod to retain the pin in position. The ends of wrist pin 44 extend beyond the surfaces of cross member 10 and into bearings in each of a pair of levers 48 which extend downwardly of the press frame between the col-

umns 6, 7. At their lower ends, these levers have circular openings into which extend the ends of an oscillating shaft 54. This shaft is clamped to the levers by means of slots 50 in the levers, which extend to the openings for the shaft, and clamping screws 52. The central portion of shaft 54 is rotatably supported in a bearing which is contained in an opening extending through cross member 10.

It will be apparent from the foregoing that operation of motor 38 will cause connecting rod 42 to move relatively inwardly and outwardly of the slot 46 and thereby oscillate the levers 48 and the shaft 54. The amplitude of these oscillations is relatively small as explained below and the speed is relatively high as indicated by the relative sizes of the pulleys 30, 34.

A pair of rods 56 extend through spaced-apart openings in the shaft 54 on opposite sides of, and equidistant from the axis of the shaft. These rods should fit snugly within the openings but should also be rotatable relative to the shaft without the development of unduly high frictional forces. Shaft 54 has a central recess 58 which intersects the diameters of the openings through which rods 56 extend so that the surfaces of the rods are partially exposed. A pair of thrust blocks 60 are disposed in the recess 58 and have semi-cylindrical upper surfaces 62 which bear against the exposed surface portions of the rods 56. These thrust blocks extend downwardly through an opening in cross member 10 and are maintained in position by means of pins 64 in the cross member 10 which extend through oversized openings in the thrust blocks. The function of these thrust blocks is to transmit thrust from the rods 56 through a pair of wedges 110 described below to the press ram contained within the applicator unit 66 which is described immediately below.

The applicator unit 66 (FIGURE 15) comprises generally a housing, a ram, and the feed mechanism for feeding electrical connectors to a position between the crimping dies. The housing is generally of C-shaped configuration having an upper section 68, a lower or base section 70 and integral upright portions 72. An opening 74 extends inwardly from the rearward side of the housing 66 and has on its opposed sides guide surfaces 76 which are centrally grooved at 78 for accommodation of the complementary sides of the ram 80. The ram has a depending tool holding portion 79 on one side of which there is mounted a crimping die 82 and on the opposite side of which there is mounted a shear blade 84. The crimping die and shear blade cooperate with a crimping anvil 81 and shearing bar 166 provided in an extension 164 of the anvil, this extension having an opening extending therethrough to permit passage of the shearing blade. The upper portion of the ram is generally U-shaped and has an inclined floor 90 contained between opposed sidewalls 88 for cooperation with wedges 110 (FIGURES 5, 7 and 8) in a manner described below.

The tool holder portion 79 of the ram has pins 86 on its opposite sides on which rollers are mounted. These pins are received in slots 92 in each of a pair of arms 94 which extend through oversized openings 95 in the housing portions 68 (see FIGURES 9–11). The rearward ends of the arms 94 have cylindrical bearing portions 96 and are nonrotatably mounted by means of pins 98 on a shaft 100 which in turn is rotatably journaled in the upper ends 17 of the brackets 16.

An L-shaped link 102 is nonrotatably secured to the end of shaft 100 adjacent to the outside surface of the left-hand one of the brackets 16. An elongated pin 104 extends through the lower end portion of link 102 and through the end of a plunger 106 of a solenoid 108 mounted on the upper surface of base plate 2. It can be seen from FIGURES 5 and 6 that as this solenoid plunger is retracted, the shaft 100 is partially rotated by link 102 to swing the arms 94 in a counterclockwise direction and lower the ram from the position of FIGURE 5 to the position of FIGURE 6. When the link 102 is in the position of FIGURE 5 it contacts a normally closed switch 103, and holds this switch open. The function of this switch is to de-energize an additional solenoid 142 when the press is not being cycled as will be apparent from the description given below of the control circuit.

After the ram is lowered by the solenoid 108 through a portion of its total stroke, a pair of wedges 110 move between the ram and the thrust blocks and transit the limited amplitude movement of these blocks to the ram thereby to drive it through the remaining portion of its stroke. These wedges are disposed beneath the mounting plate 20 with their forward ends 111 bearing against the ram prior to initiation of the press cycle. Each block has a lower surface 112 which has an inclination complementary to the inclined floor 90 of the ram and a groove 114 on its side which receives a guide pin 116 on the side of the opening 74 of the applicator housing thereby to guide the wedges forwardly and between the thrust blocks and the ram.

The wedges 110 are secured to the ends of rods 118 which extend rearwardly beneath the mounting plate 20, through oversized openings in a block 148 (FIGURE 2), thence through a fixed bearing block 120, and through oversized openings in a stop block 122. Nuts 124 are threaded onto the end of the rods to prevent their passage through the openings in the block 122 and contacting plates 125 are clamped between these stop nuts. The block 122 has a transverse opening beneath rods 118 in which a pin 126 is rotatably mounted (FIGURE 3) which has a centrally located threaded opening for reception of a rod 128. Rod 128 extends through oversized aligned openings in block 122 and pin 126 so that limited pivotal movement of rod 126 is permitted with respect to the block 122. Rod 128 extends forwardly through column 22, through bearing block 120 and has a block 130 on its end which is pivoted at 131 between a pair of arms 132. The lower ends of arms 132 are secured by means of pins to a shaft 134 extending transversely across base plate 2 and rotatably contained in a suitable bearing block 136. Shaft 134 is secured by means of a pin to a link 138 which at its opposite end is pivotally secured in the slotted end of a plunger 140 of a solenoid 142.

The wedges 110 are biased leftwardly in FIGURES 5 and 6 by means of a spring 146 which surrounds the rods 118 and are interposed between the wedges and the block 148. A lever 150 has a pin-slot connection at its upper end to block 148 and is pivoted intermediate its ends at 152 to an L-shaped bracket 154 which depends from the underside of the plate 20. The lower end of lever 150 is pivoted at 156 to a link 158 which extends forwardly towards the press frame. The forward end 160 of this link is pivotally connected to the pin 104. In addition to biasing the wedges, the springs 148 function to move the pin 104 leftwardly, during one portion of the cycle, from the position of FIGURE 1A by means of lever 152 and link 158. Such movement of the pin actuates the terminal feed mechanism which is described immediately below.

The terminal strip T is fed by a slide 184 which is reciprocably mounted on a block 168, this block having a cover plate 170 secured to its underside by means of fasteners 174. A centrally located groove 176 on the underside of block 168 provides an enclosed feed track for guiding the terminal strip to the crimping zone of the press. An opening is provided in the top section of block 168 at its forward end adjacent to the press frame and a sheet metal plate is mounted in this opening. This plate has a depending resilient finger 182 which extends into the terminal feed track and functions as a stop to prevent rearward movement of the strip while permitting forward movement thereof.

The reciprocal feed slide 184 which straddles the block or plate 168 has a centrally located transverse flange 186 on its upper side. A rod 188 extends through an oversized opening in this flange and a coil spring 190 sur-

rounds the rod. This spring is retained between the flange and a retainer **192** on the end of the rod and functions as a lost motion connection between the rod and the feed slide. The rearward end of rod **188** is enlarged at **195** and pivotally connected at **194** to a feed lever **196**. Feed lever **196** is pivotally mounted at its lower end **198** on a bracket **200** extending from the base plate **2** and intermediate its ends it has an oversized slot **203** through which the previously mentioned pin **104** extends so that upon movement of the solenoid plunger, the feed lever **196** will be oscillated thereby moving the feed slide **184**.

The particular type of feed slide shown in the preferred embodiment is described more fully in the copending application of Gilbert Sitz, Serial No. 142,270, filed October 2, 1961, for Connector Feeding Device. The movement of the strip of connectors is achieved by means of a finger **210** which extends through a slot **212** in the side of the plate **170** and pushes the strip forwardly. This finger extends from a plate **208** which is pivotally mounted by means of ears **206** on a shaft **204** extending between depending sides **205** of the feed slide **184**. A spring **214** normally biases this plate in a clockwise direction as viewed in FIGURE 5 but permits movement thereof in a counterclockwise direction thereby to permit retraction of the slide. The amplitude of the feed stroke is controlled by means of an adjustable stop **216** which limits rearward movement of the slide from the position of FIGURE 5 to the position of FIGURE 6. If the lever **196** continues to rotate in a clockwise direction after the feed slide has come to rest against the stop **216**, the lost motion connection between the rod **188** and the flange **186** permits such movement of the lever with accompanying compression of the spring **190**.

The end portion of block **168** is received within the opening **74** of housing **66** and is secured by means of fasteners **169** to extensions **164** of the crimping anvil. The anvil itself is supported on and secured to a block **162** by means of suitable fasteners. Clamping screws **179** extend through the lower portion **70** of the housing to secure the block **168**, the anvil block **81** and the feed block **184** in position. The applicator unit **66** of the disclosed embodiment has a snug fit in the space between the frame columns **6**, **7** and is of a width no less than that of the press bed block **8** so that the applicator can be securely clamped in position by merely tightening the nuts on the tie rods **14**.

An electrical circuit for the disclosed embodiment (FIGURE 17) comprises a foot switch **222** (not specifically shown in the previous figures) connected in series with a relay **218** so that closure of the foot switch energizes the coil **224** of the relay. This relay includes a holding circuit switch **221** which is closed upon energizing of coil **224** so that the relay will remain energized if foot switch **222** is closed only momentarily. The relay **218** also includes a switch **220** which is normally (when coil **224** is deënergized) in the position of FIGURE 17 and connected to a lead from solenoid **142**. Upon energizing the relay, switch **220** is shifted to disconnect solenoid **142** from the power supply line and to connect solenoid **108** to the line. Switches **127** are arranged in parallel relationship with respect to each other and in series with respect to relay coil **224**. These switches are normally closed but are opened by contacting plates **125** when the wedges move inwardly thereby to deënergize relay coil **224**. It will be apparent that both of the switches **127** must be opened before coil **224** will be deenergized. Switch **103**, which is connected in series with solenoid **142**, is normally biased to a closed position but is held open by the lever **102** when the parts are in the position of FIGURE 5. In other words, switch **103** is closed during the operating cycle of the press.

The operation of the disclosed embodiment is as follows. At the beginning of the cycle, the parts will be in the position of FIGURE 5. The operator positions a wire W between the leading terminal of the strip and the upper crimping die **82** and momentarily closes the foot switch **222** thereby to energize coil **224** of relay **218** which closes holding circuit switch **221** so that the relay coil remains energized until both switches **127** are opened at the end of the down stroke of the ram. When coil **224** is energized, switch **220** is shifted from the position of FIGURE 17 to its alternative position thereby to energize solenoid **108** causing plunger **106** and pin **104** to move rightwardly from the position of FIGURES 1 and 5 to the positions of FIGURES 1A and 6, and to swing the lever **102** and arms **94** in a counterclockwise direction as viewed in FIGURE 5. Such movement of the arms draws the ram **80** partially downwardly, to the position of FIGURE 6 so that the wedges are permitted to enter the space between the ram and the thrust blocks **60**. Rightward movement of plunger **106** also causes disengagement of lever **102** from switch **103**, so that this switch assumes its normal closed condition until the very end of the cycle, and causes lever **150** to swing counterclockwise, as viewed in FIGURE 1, about its pivotal axis **152** thereby moving block **148** leftwardly in this figure with respect to rods **118** to compress springs **146**. The energy stored in the springs by this movement of the block **148** is expended in driving the wedges inwardly between the press ram and the thrust blocks. The rightward movement of pin **104** in FIGURE 5 also swings lever **196** in a clockwise direction about its pivotal axis **198** to retract the terminal strip until an upstanding ear or other projection of one of the terminals comes to rest against stop **182**. This slight movement of the strip precisely positions the leading terminal on the anvil as explained in my copending application Serial No. 142,270.

After the parts have reached the positions of FIGURE 6, the ram is moved downwardly through the remainder of its stroke by means of the shaft **54**, the thrust blocks **60**, and the wedges **110**. The rapid oscillation of shaft **54** results in the application of thrust-pulses to the blocks **60** alternately and repetitively. The wedges **110** move in alternating order between the ram and thrust blocks and function as a motion take-up means to drive the ram downwardly. As shown in FIGURE 8, when the shaft **54** reaches the limit of its rotary travel in one direction, the maximum thrust developed is applied to one of the blocks **60** while no thrust is applied to the other one of the blocks and one of the wedges can move between this other block and the ram. In FIGURE 8, the maximum thrust is being applied to the block on the right and no thrust is being applied to the block on the left. In FIGURE 8, the wedge associated with the lefthand block is thus free to move inwardly and the wedge associated with the righthand block is under maximum compression.

After the ram has been driven downwardly to the required extent to crimp the terminal, the plates **125** will contact and open the switches **127** thereby to deenergize the relay coil **224**. When this coil is deenergized, switch **220** in the relay reverts to the position of FIGURE 17, its normal position, solenoid **142** is energized and solenoid **108** is deenergized. When solenoid **142** is energized and its plunger is retracted, the arms **132** are swung in a clockwise direction as viewed in FIGURE 1 by means of the lever **138** and shaft **134**. Arms **132** in turn move the block **130**, and rod **128**, and the block **122** rightwardly. As block **122** moves rightwardly, it pushes on the nuts **124** and retracts the wedges from between the ram and the thrust blocks. As the wedges are retracted, they transmit a rightward force on the block **148** by means of springs **146** thereby causing lever **150** to swing in a clockwise direction about its pivotal axis **152** to move the link **158** and the pin **104** leftwardly to the positon of FIGURE 1. Leftward movement of this pin causes leftward movement of plunger **106**, upward movement of the ram to the position of FIGURE 5, and counterclockwise movement of lever **196**. Lever **196**, in moving from the position of

FIGURE 6 to the position of FIGURE 5 moves the feed slide **134** towards the press frame to feed the strip of terminals. Movement of lever **102** which is also brought about by leftward movement of pin **104** opens the normally closed switch **103** thereby deenergizing solenoid **142** at the end of the cycle.

The disclosed embodiment of the invention has several advantages which will be apparent from the following discussion. In the first place, a press or hand tool in accordance with the invention can be made much more compact and light in weight than a conventional crank or similar type press without sacrifice of press capacity. The basis or reason for this advantage can be explained by the following example. To compare the instant press with a conventional crank press, when a connector is crimped in a conventional crank press, the work performed in making the crimp is carried out during a small portion of the press cycle, say the ⅛ of the cycle which occurs immediately before the press ram reaches bottom dead center. With a crank type press driven by an electric motor, it is usually necessary to provide a flywheel to store energy during the entire press cycle in order to provide the large amount of energy required for crimping during the short time interval (about ⅛ of the cycle) in which the energy is utilized for crimping. In the wedge type press of the instant invention, on the other hand, a large portion of the total cycling time, for example about 30–50%, can be utilized in performing the crimping operation, the remainder being used for the initial downward motion of the ram effected by solenoid **108** and for the withdrawal of the wedges and the raising of the ram by the springs **146**. It follows that if the cycling time of a wedge press in accordance with the invention is set at the same length as that of a conventional crank press, more time is available to transmit the energy supplied by the motor to the crimp and the use of a flywheel can be obviated and the motor, acting through the mechanical advantage supplied by the wedges and linkage, can supply the required energy directly. In other words, the instant wedge type press takes more time to perform the actual crimp than a crank press so that the power requirements are thereby reduced.

Another significant feature of the invention which contributes to compactness is that with the wedge mechanism for driving the press ram downwardly, the bearing loads (p.s.i.) can be maintained at a low level in the eccentric **28** which rotates at a high velocity. However, where the bearing loads are extremely high, as in the oscillating shaft **54** and the rods **56**, the velocity of movement is slow by virtue of the mechanical advantage afforded by the levers **48**. This situation of low bearing loads where high velocities are involved and low velocities where high bearing loads are involved is advantageous from the standpoint of bearing design in that it permits the use of smaller bearings and, therefore, contributes to the achievement of a compact press.

A further advantage of the disclosed embodiment is that extremely precise adjustment of the shut height of the ram can be achieved by merely moving the switches **127** horizontally towards or away from the contact plates **125** by means of the adjustable mounting platform shown in FIGURE 16. The edge of this platform functions as a mechanical stop for the rod **118** which first contacts its associated switch, an arrangement which prevents inward movement of either of the wedges beyond the desired position and thereby prevents overcrimping. It will be apparent that a substantial movement of these switches **127** must be affected to bring about an extremely small change in the shut height since the surfaces **112, 90** on the wedges and the ram respectively are inclined at a relatively gentle angle. The invention thus avoids the need for closely dimensioned shims or other adjusting devices which have previously been used to adjust the shut height of the press.

Since most of the stroke of the ram is brought about by the solenoid **108** and since this solenoid need not be an extremely powerful one it is apparent that the possibility of accidents involving the press operator or damage to the press tooling is largely avoided with the disclosed embodiment. If the operator should somehow close the foot switch and actuate the press cycle while his finger is beneath the crimping die, the crimping die would be brought down towards his finger but only under the influence of the solenoid **108** so that amputation of the finger would in all probability be avoided. By the same token, if the press should accidentally be actuated with a foreign object such as a screw driver between the crimping die and anvil, the crimping die would be brought downwardly against the foreign object but the tooling would not be shattered since the resistance of the foreign object would be sufficient to prevent further downward movement under the influence of the solenoid.

A still further advantage of the invention is that apparently improved results in the crimping of electrical connectors are obtained with the instant press by virtue of the repeated and intermittent applications of thrust to the connector during crimping. During each crimping cycle, the thrust is repeatedly built up and relaxed to some extent and the actual time spent in the crimping operation and particularly in the critical final stages of the crimping operation is relatively long although the total cycling time of the press may be no longer than is the case with a conventional press. The repeated applications of thrust are believed to permit the achievement of a higher degree of work hardening during the crimping operation with a resulting reduction in the amount of elastic recovery after the crimped connection is removed from the press.

The particular embodiment disclosed herein permits the achievement of an extremely compact terminal applicator unit **66** with self-contained crimping tooling and terminal strip feeding means. With this arrangement, when it is desired to change the size or type of terminal being applied, it is merely necessary to remove the entire applicator from the press and substitute one having the proper tooling and feed stroke for the new terminal.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective against the prior art.

I claim:

1. A compressing device comprising, a ram, means for applying thrust to one end of said ram intermittently and alternately on opposite sides of the axis of said ram, said thrust applying means having an amplitude substantially less than the stroke of said ram, and motion take-up means movable between said thrust applying means and said ram thereby to transmit thrust to said ram and drive said ram along its path of reciprocation.

2. A device as set forth in claim **1** wherein said motion take-up means comprises a wedge means movable between said thrust applying means and said ram.

3. A device as set forth in claim **1** wherein said means for applying thrust comprises a pair of reciprocable blocks, and including means for reciprocating said blocks in out-of-phase relationship.

4. A compressing device comprising, a ram pulsatory thrust applying means for applying thrust to one end of said ram intermittently and alternately on opposite sides of said ram, said thrust applying means having an amplitude which is substantially less than the stroke of said ram, and motion take-up means for transmitting motion from said thrust applying means to said ram, said take-up means being expansile between said ram and said thrust applying means during the intervals between applications of thrust thereby to drive said ram.

5. A device as set forth in claim 4 wherein said thrust applying means comprises a member disposed proximate to said one end of said ram, said member being oscillatory about an axis extending transversely of the axis of said ram whereby said thrust is applied by opposite sides of said member as each side moves towards said ram.

6. A device as set forth in claim 4 wherein said motion take-up means comprises wedge means movable between said thrust applying means and said ram.

7. A compressing device comprising, a ram, a shaft disposed adjacent to one end of said ram on an axis extending transversely of the path of reciprocation of said ram, means for oscillating said shaft, a pair of thrust transmission blocks in engagement with said shaft on opposite sides of the axis thereof and extending towards said ram, a pair of wedges movable along a path extending transversely of the path of reciprocation of said ram, one of said wedges being movable between one of said blocks and said ram and the other of said wedges being movable between the other of said blocks and said ram, and means for moving said wedges whereby, upon oscillation of said shaft, said blocks alternately move towards said ram and said wedges move between said blocks and said ram thereby to drive said ram along its path of reciprocation.

8. A device as set forth in claim 7 wherein said ram is normally disposed on one side of said wedges and said wedges are fully retracted from between said blocks and said ram, and including ancillary means for initially moving said ram along its path of reciprocation and away from said blocks a distance sufficient to permit said wedges to enter between said blocks and said ram.

9. A device as set forth in claim 8 wherein said ancillary means comprises a solenoid actuated linkage.

10. A device as set forth in claim 7 including solenoid means for retracting said wedges from between said ram and said blocks after completion of the stroke of said ram.

11. A compressing device comprising, a ram, a shaft disposed adjacent to one end of said ram on an axis extending transversely of said path of reciprocation of said ram, means for oscillating said shaft, a pair of thrust transmission blocks in engagement with said shaft on opposite sides of the axis thereof and extending towards said ram, a pair of wedges normally disposed on one side of said ram, resilient means biasing said wedges for movement between said ram and said thrust blocks, and a first solenoid means for moving said ram through a substantial portion of its stroke in one direction whereby upon energization of said solenoid means and initial movement of said ram, said wedges enter between said ram and said thrust blocks, and upon oscillation of said shaft, said thrust blocks are alternately reciprocated thereby to apply thrust to said ram on opposite sides of the axis thereof, and said wedges move further between said thrust blocks and said ram to drive said ram through the remaining portion of its stroke in said one direction.

12. Apparatus as set forth in claim 11 including a means for retracting said wedges from between said ram and said thrust blocks after completion of the stroke of said ram in said one direction thereby to permit return movement of said ram.

13. Apparatus as set forth in claim 11 including a second solenoid means for retracting said wedges from between said ram and said thrust blocks after completion of the stroke of said ram in said one direction and including resilient means for moving said ram through its stroke in the opposite direction.

14. A compressing device comprising a ram movable towards and away from a stationary anvil or the like, a relatively low-thrust solenoid means for moving said ram through a substantial portion of its stroke towards said stationary anvil, and high capacity thrust applying means engageable with said ram during a minor and terminal portion of its stroke towards said anvil thereby to apply a relatively high thrust to said ram during said terminal stroke portion.

15. A compressing device comprising, a ram movable along a straight line path, thrust applying means proximate to one end of said ram, said thrust applying means being oscillatory along a path which is substantially parallel to said path of reciprocation of said ram, motion take-up means disposed between said one end of said ram and said thrust applying means, said motion take-up means being expansile in the direction of said path of said ram thereby to transmit thrust to said ram and move said ram along said path, and means for limiting expansion of said motion take-up means thereby to limit the travel of said ram.

16. A device as set forth in claim 15 wherein said motion take-up means comprises wedge means movable between said thrust applying means and said one end of said ram.

17. A device as set forth in claim 15 wherein said motion take-up means comprises a wedge means movable between said thrust applying means and said one end of said ram along a path extending transversely of the path of movement of said ram, and said means for limiting expansion of said motion take-up means comprises a stop for limiting the movement of said wedge means.

18. A compressing device comprising, a ram movable along a straight line path, thrust applying means proximate to one end of said ram, said thrust applying means being oscillatory along a path which is substantially parallel to said path of said ram, electrically actuated means for oscillating said thrust applying means, wedge means movable between said thrust applying means and said one end of said ram along a path extending transversely of the path of movement of said ram thereby to transmit thrust to said ram and move said ram, and a switch means for deenergizing said electrically actuated means, said switch being engageable by said wedge means after a predetermined movement of said wedge means thereby to limit movement of said ram.

19. A compressing device comprising, a ram movable along a straight line path, oscillatory thrust applying means for intermittently applying a limited stroke thrust to one end of said ram, the stroke of said thrust applying means being substantially less than the stroke of said ram, electrically energized actuating means for actuating said thrust applying means, wedge means movable between said ram and said thrust applying means, said wedge means functioning as a motion take-up means thereby to drive said ram along said path, and switch means for deenergizing said electrically energized actuating means, said switch means being engageable by said wedge means after a predetermined movement of said wedge means thereby to limit the movement of said ram.

20. A device as set forth in claim 19 wherein said thrust applying means applies thrust intermittently and alternately on opposite sides of the axis of said ram, said wedge means comprising a pair of independently movable wedges, said wedges being alternately and intermittently movable thereby to take-up motion of said thrust applying means after each application of thrust.

21. A compressing device comprising, a ram, a shaft disposed adjacent to one end of said ram on an axis extending transversely of the path of movement of said ram, means for oscillating said shaft, a pair of thrust transmission blocks in engagement with said shaft on opposite sides of the axis thereof and extending towards said ram, a pair of wedges movable along a path extending transversely of the path of reciprocation of said ram, one of said wedges being movable between one of said blocks and said ram and the other of said wedges being movable between the other of said blocks and said ram, means for moving said wedges whereby, upon oscillation of said shaft, said blocks alternately move towards said ram and said wedges move between said blocks and said ram thereby to drive said ram along its path of recipro-

cation, and means engageable by said wedges after a predetermined movement for stopping oscillation of said shaft thereby to control the movement of said ram.

22. Apparatus as set forth in claim 21 wherein said means for oscillating said shaft is electrically actuated, and said means for stopping oscillation of said shaft comprises a switch.

23. A compressing device comprising, a ram, thrust applying means for applying thrust to one end of said ram intermittently and alternately on opposite sides of the axis of said ram, motion take-up means effective between said thrust applying means and said ram, and means for incrementally increasing the effective displacement of said motion take-up means after each application of thrust by said thrust applying means thereby to transmit thrust to said ram and to drive said ram along its path of reciprocation.

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