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3,466,730

FASTENER DRIVING MACHINE

Original Filed July 29, 1964

6 Sheets-Sheet 1

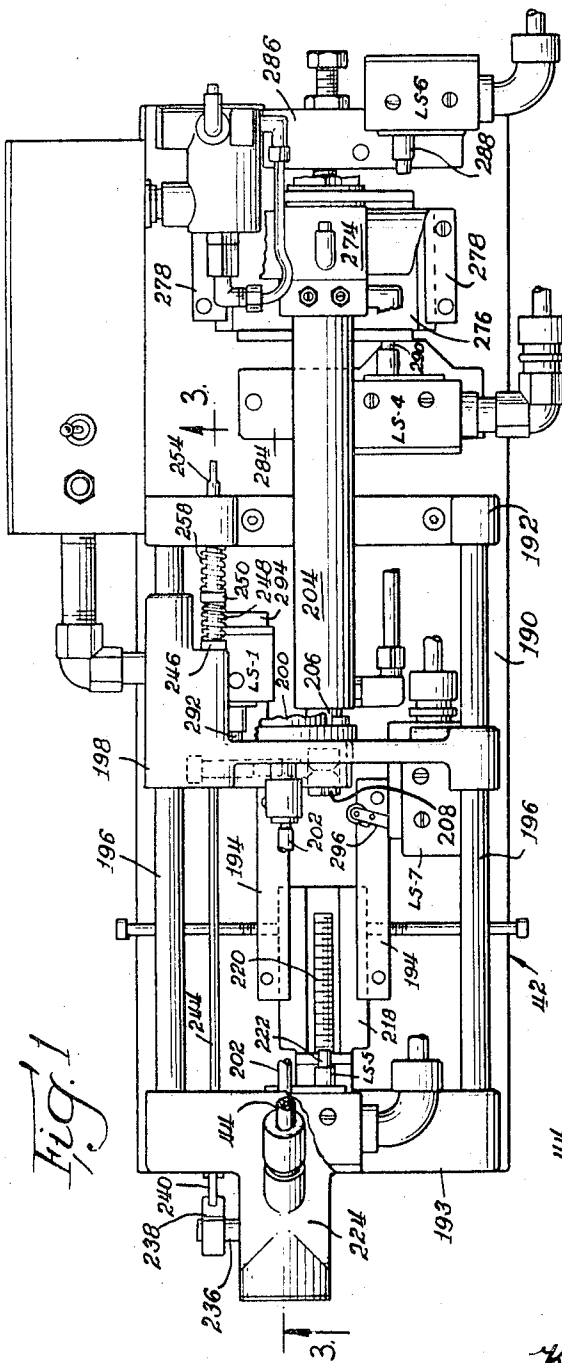


Fig. 1

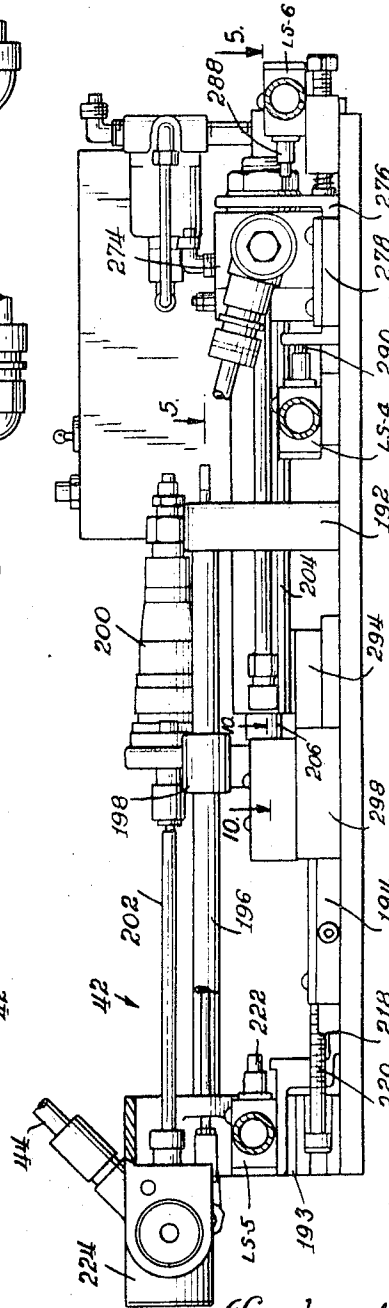


Fig. 2

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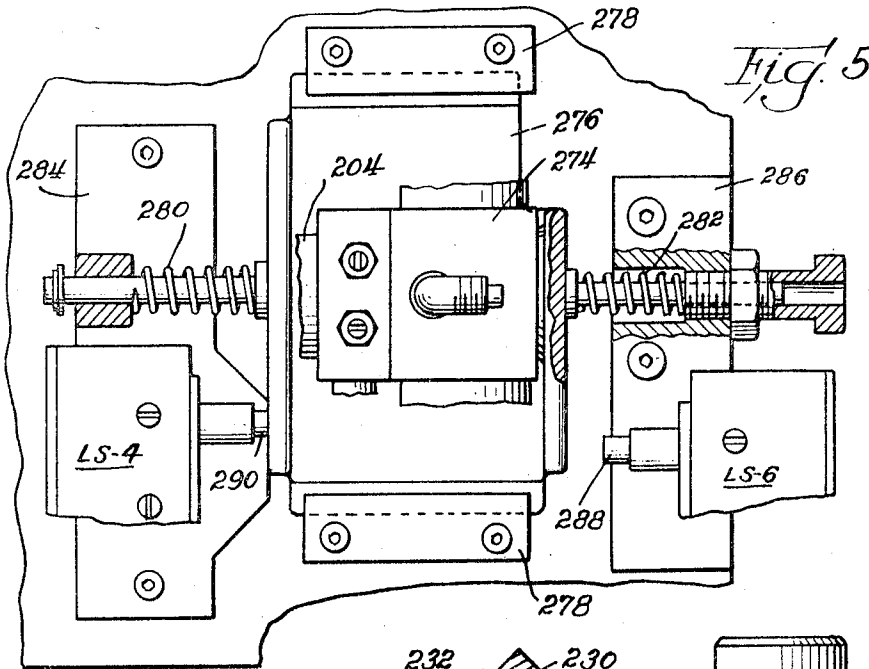
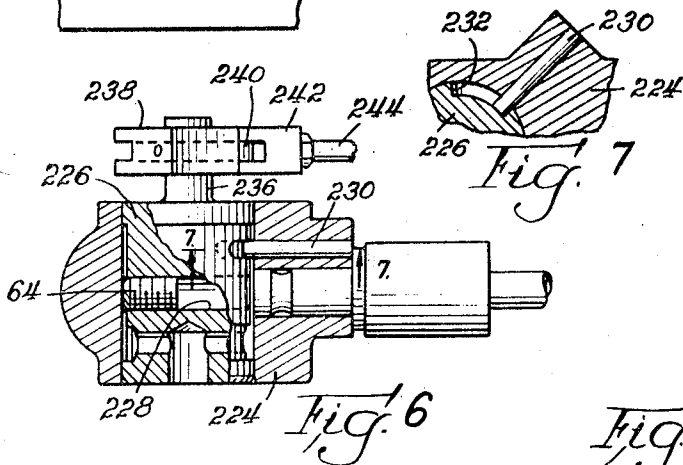
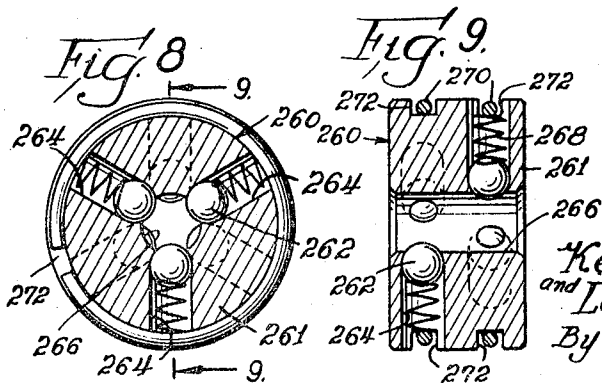
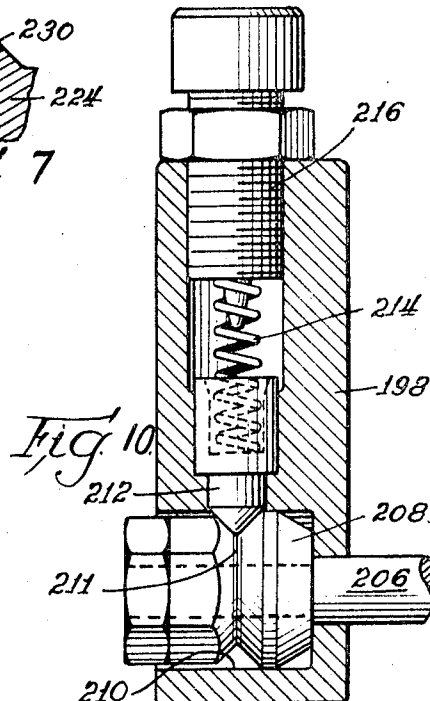
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Fig. 12

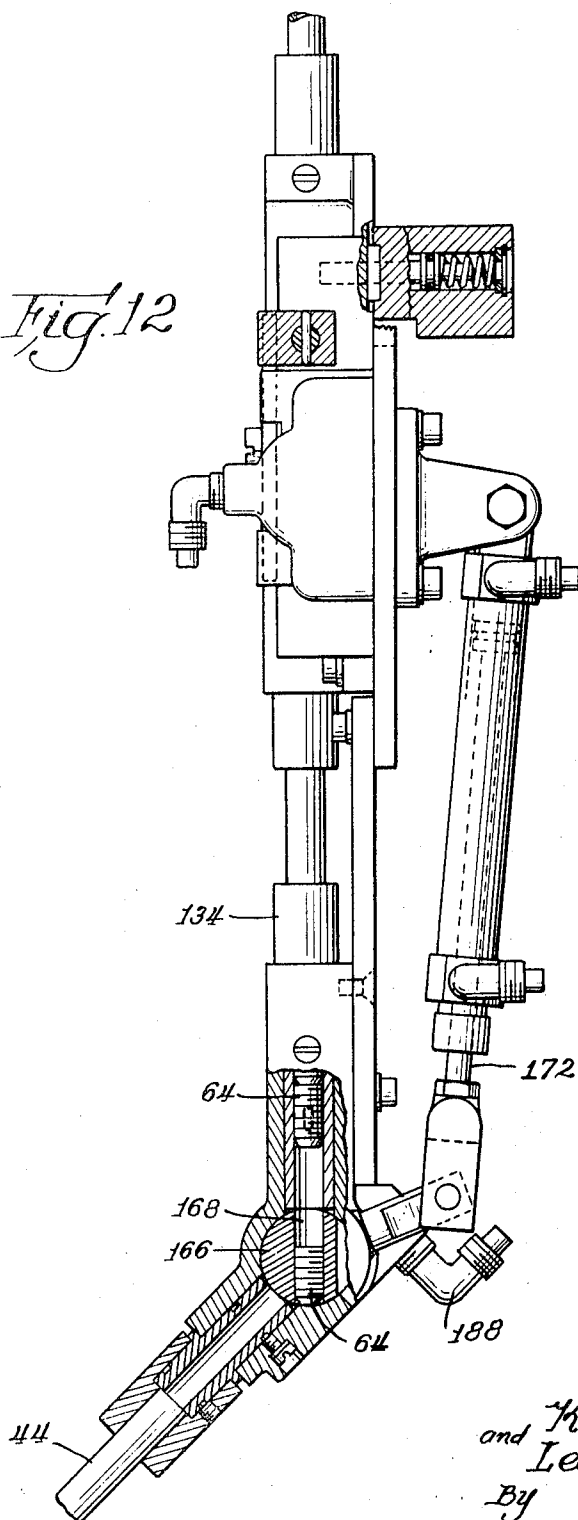
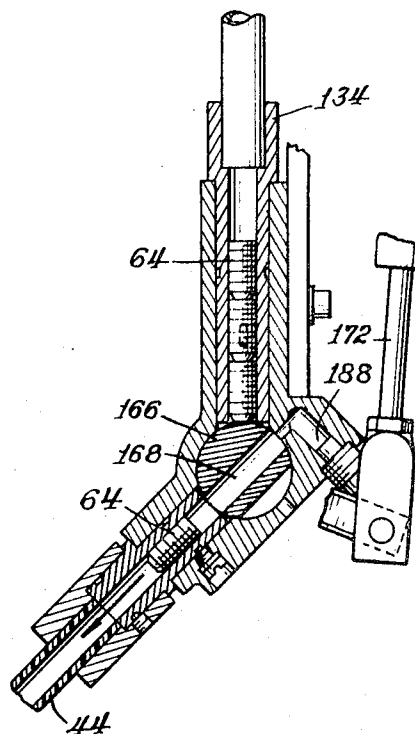


Fig. 11



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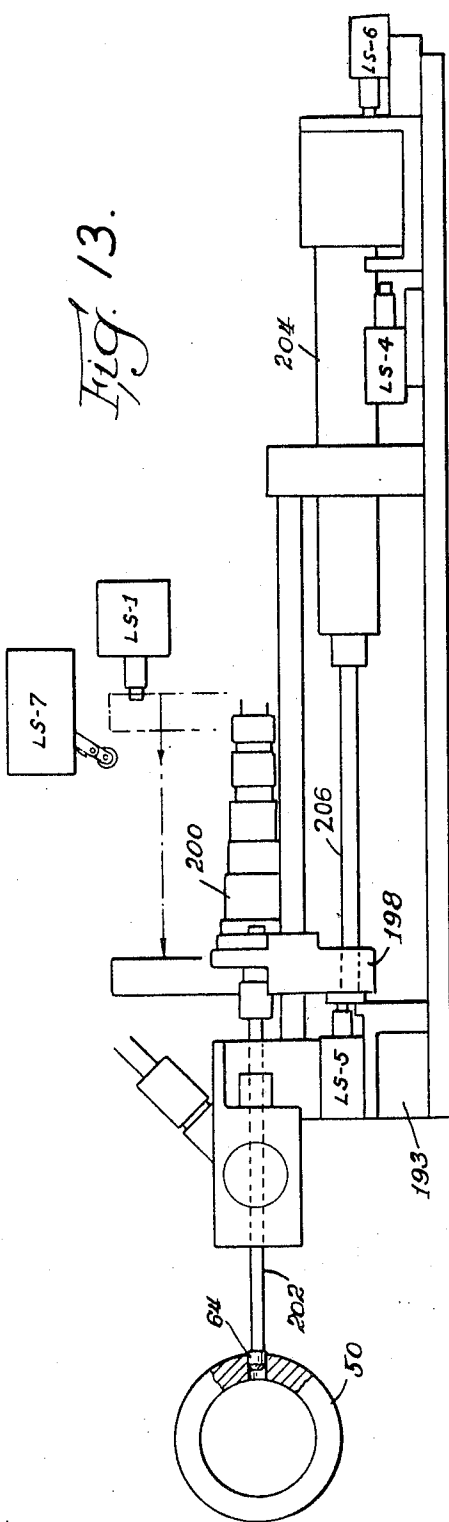
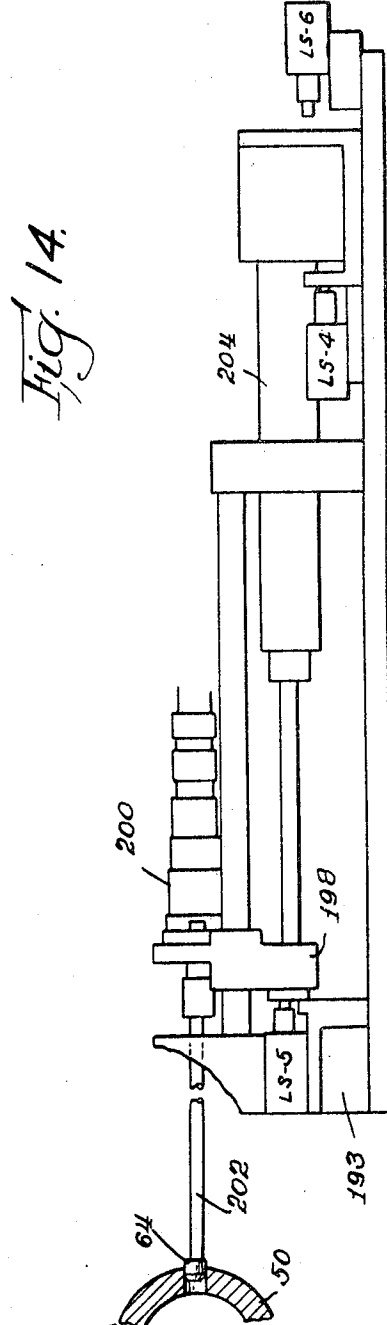
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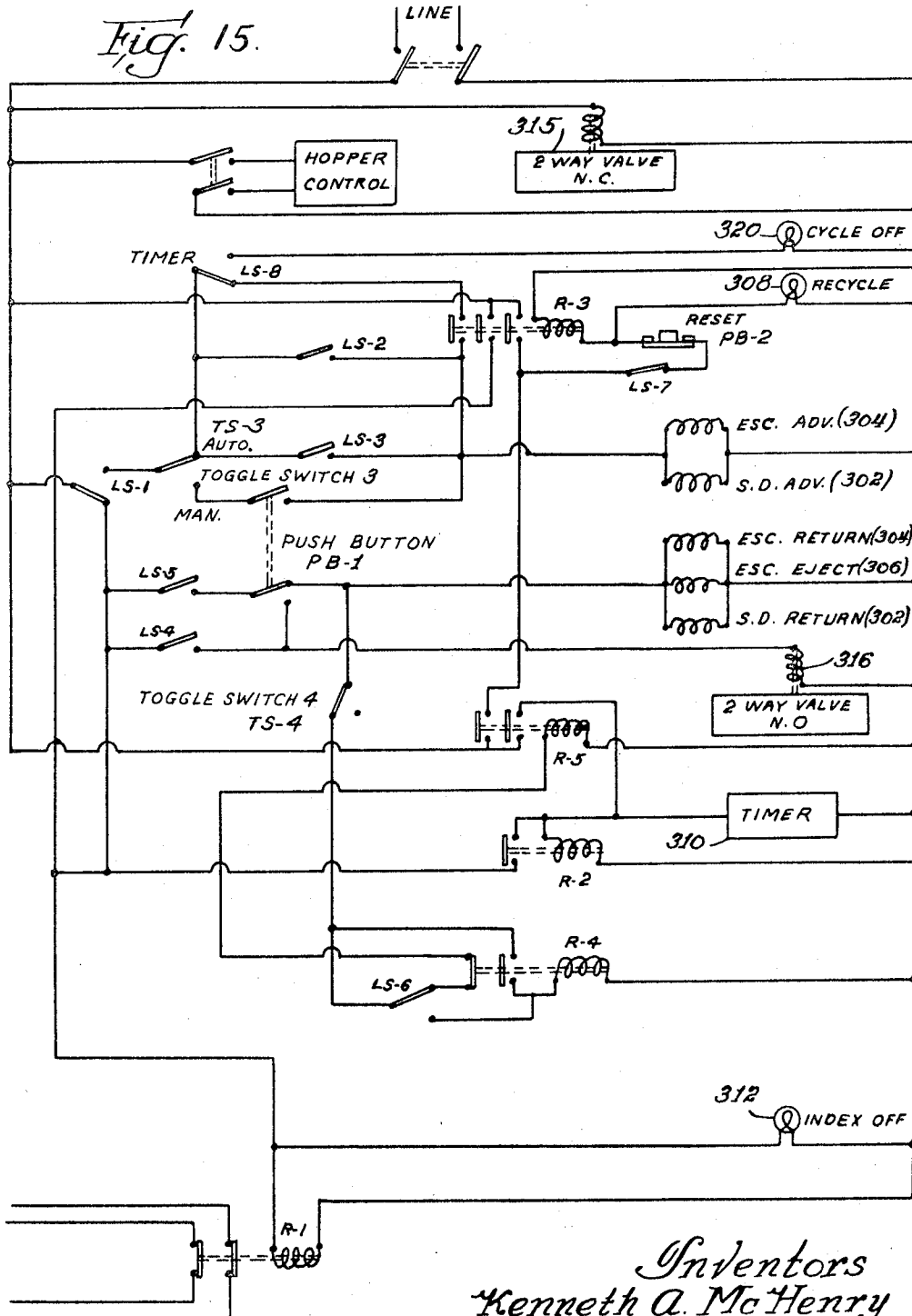
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Fig. 15.



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3,466,730

FASTENER DRIVING MACHINE

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Original application July 29, 1964, Ser. No. 386,037, now Patent No. 3,317,990, dated May 9, 1967. Divided and this application Jan. 26, 1967, Ser. No. 611,994

Int. Cl. B23p 19/00; B25b 23/00

U.S. Cl. 29—208

5 Claims

ABSTRACT OF THE DISCLOSURE

A machine in which set screw fasteners are received in sequential and intermittent manner into a positioning device and are set into workpieces by a motor powered rotary wrench. The wrench is mounted upon a carriage connected to a piston rod of a pneumatic cylinder. The carriage is caused to be reciprocated by the piston rod so as to carry the wrench toward and away from a workpiece. A fastener receiving and positioning means is operatively connected by linkage to the carriage so that it is caused with each cycle of the carriage to position a fastener for engagement by the wrench. An electrical circuit controlling operation of the motor and reciprocation of the carriage includes various control switches which are caused to be operated as the carriage is reciprocated. An advance limit switch is caused to be operated to effect return of the carriage after the carriage and wrench have advanced a predetermined distance. The piston cylinder is mounted upon a slide block which is adapted to move a limited distance and operate a control switch due to a reactionary force developing when the wrench engages a fastener with a workpiece.

This application is a division of original application, Ser. No. 386,037, filed July 29, 1964, now Patent No. 3,317,990, dated May 9, 1967.

BACKGROUND OF THE INVENTION

The invention relates to the art of fastener rotating and driving apparatus.

The object of the invention is to provide a fastener driving machine by means of which fasteners are received in sequential and intermittent manner and are properly set in workpieces by means of a reciprocable rotary power driven wrench under the control of an electrical circuit.

Apparatus having a circuit controlled reciprocable rotary power wrench is known from Patent 3,120,053. This known device has a structure and mode of operation which is distinct from that of the present invention.

In accordance with the invention, there is provided a fastener driving machine for receiving fastener elements in sequential and intermittent manner and for driving said fasteners into workpieces, including: a motor means, a wrench element driven by the motor means, power means to cause reciprocal axial movement of the motor means and wrench element, switch means to limit the extent of such axial movement in either direction, a fastener element receiving and positioning means, and means to coordinate operation of the receiving and positioning means with axial movement of the wrench element whereby a fastener element will be engaged and rotated by the wrench means.

In the drawings:

FIG. 1 is a plan view of a fastener driving machine illustrative of the invention;

FIG. 2 is a side elevation view of the same;

FIG. 3 is an enlarged partial sectional view as generally seen along line 3—3 in FIG. 1;

FIG. 4 is the same but showing another operational position;

FIG. 5 is a fragmentary partial sectional view generally as seen along line 5—5 in FIG. 2;

FIG. 6 is a partial sectional view generally as seen along line 6—6 in FIG. 3;

FIG. 7 is a fragmentary sectional view as generally seen along line 7—7 in FIG. 6;

FIG. 8 is an enlarged sectional view generally as seen along line 8—8 in FIG. 3;

FIG. 9 is a sectional view generally as seen along line 9—9 in FIG. 8;

FIG. 10 is an enlarged sectional view generally as seen along line 10—10 in FIG. 2;

FIG. 11 is a detail in section showing the escapement mechanism in one position of operation;

FIG. 12 shows the escapement mechanism of FIG. 11 in a reverse position;

FIGS. 13 and 14 are schematic illustrations in vertical projection of the fastener driving machine in FIG. 2, showing various operational positions; and

FIG. 15 is an electrical control circuit diagram utilized in the apparatus of the invention.

The fastener driving machine 42 (FIGS. 1 and 2) is adapted to set fasteners or screws 64 into workpieces 50 (FIG. 13) which are supported upon an indexing table (not shown). The fastener driving machine 42 includes a base 190 on which is fixedly mounted a rear pedestal 192, a front pedestal 193, and a pair of guide pieces 194. Extending between the pedestals and supported parallel with the base 190 are parallel spaced guide rods 196 which slidably support a carriage or crosspiece 198. The latter serves as a support for an air operated motor 200 which rotates a wrench element 202 having a socket screw engaging end extending forward to the front pedestal 193.

Means is provided for causing reciprocal movement of the crosspiece 198, comprising a cylinder 204 and a piston including a piston rod 206, the forward end of which has a grooved knob 208 affixed thereto. As best seen in FIG. 10, the knob 208 seats in a recess 210 formed in the crosspiece 198 and has a circumferential V-shaped groove 211 which is engaged by a detent 212 urged into engagement with the groove 211 by a helical spring 214. The compression of the spring 214 may be adjusted by means of a screw 216 threadedly received by the crosspiece 198. The detent allows disengagement between the piston rod 206 and the crosspiece 198 when the resistance to forward movement of the crosspiece, e.g. toward the front pedestal 193, exceeds the holding effort of the detent 212 upon the knob 208. The reason for such a breakaway connection will be explained in greater detail hereinafter.

A slide piece 218, guidingly maintained between the guide pieces 194 and slidable upon the base 190, is movable relative to the front pedestal 193 by means of a screw 220. Mounted upon the slide piece 218 is a normally open electrical switch LS-5 having a plunger 222 positioned in axial alignment with the piston rod 206. It will be seen that positional adjustment of the switch LS-5 relative to the end of the piston rod 206 is afforded by the screw 220.

The front pedestal 193 includes a forwardly projecting fastener receiving portion 224, the longitudinal axis of which is in substantial alignment with the axis of the wrench element 202. As best seen in FIGS. 3, 4, 6 and 7, a fastener element receiving and orienting means, which is in the form of a cylindrical piece 226, is rotatably supported in the portion 224 with the axis of rotation transverse to the axis of the wrench element 202 and parallel with the base 190. A diametrical hole 228 is formed in the cylindrical piece 226 which is of a size to

slidingly accommodate a fastener or screw 64. An indexing pin 230, positioned in the portion 224, is arranged to project into a slot 232 formed on a peripheral surface of the cylindrical piece 226. The end limits of the slot 232 are such as to allow rotary positioning of the cylindrical piece 226 so that the hole 228 is in alignment with the bore of a connecting piece 234 (FIG. 3), or is in alignment with the bore of a guide piece 235 (FIG. 4). The latter is arranged to slidingly receive the wrench element 202. Connecting piece 234 is connected with the lower end of a flexible hose 44. The opposite end of hose 44 is connected to an escapement mechanism (FIG. 11) adapted to intermittently feed one at a time a screw 64 through the hose 44 to the cylindrical piece 226. A piston 172 is adapted to intermittently rotate an escapement piece 166 from a position as in FIG. 12 relative to a feed tube 134 in which the escapement piece is adapted to receive a screw 64 into a bore 168, to a position as in FIG. 11 in which the screw is caused to be pneumatically propelled through hose 44 to the receiving piece 226 when a blast of air is admitted through the inlet 188 to bore 168.

An axial shaft 236 is formed integral with the cylindrical piece 226 and projects beyond one side of the portion 224. Affixed to this shaft is an arm or crank member 238 which is pivotally connected to a link member 240, the other end of the latter being pivotally secured to a yoke piece 242. The yoke piece 242 is affixed to one end of a rod 244 which is arranged for axial movement to effect rotation of the cylindrical piece 226 to either of the rotary limiting positions. The other end of the rod 244 is slidingly supported in the crosspiece 198. A flanged bushing 246 is slidingly mounted upon the rear end of the rod 244 which extends through the crosspiece 198, said bushing being adapted to abut a collar 247 secured to the rod in the forward direction, i.e. toward the front pedestal 193. A helical spring 248 is positioned between the bushing 246 and a collar 250 of a sleeve 252 secured to the rod 244, which rod is slidable in a passageway 256 formed in the rear pedestal 192. A helical spring 258 is compressively arranged between the collar 250 and the side of the rear pedestal 192. Spring 248 is of greater strength than spring 258 so that upon forward movement of the cross piece 198, the rod 244 will be moved with the crosspiece due to the expansive effort of the spring 258. The spring 248 will allow a certain amount of overtravel of the crosspiece in the rearward direction, i.e. toward the rear pedestal 192 (FIG. 3).

A fastener holding collet assemblage 260 is positioned in the front end of the fastener receiving portion 224, said machine functioning to receive a fastener being moved from the cylindrical piece 226 by movement of the wrench element 202, and holding the fastener until drivingly coupled to the wrench element. Toward this end, the collet machine includes a disc-like housing 261 in which is arranged a plurality of balls 262 disposed in two sets, each set consisting of three equi-angularly spaced balls positioned in the same plane, said planes being in parallel spaced relation (FIGS. 8 and 9). The angular orientation of each of the two sets of balls is symmetrical so that in end view projection the center lines of passageways 264, in which each ball is slidingly maintained, are sixty degrees apart. An axial hole 266 is formed in the housing 261, said hole being of slightly greater diameter than the major diameter of a fastener being handled. Each ball 262, which is arranged to project a slight amount into the passageway 266, is urged inwardly by a helical spring 268 compressively maintained between the ball and a snap ring 270 disposed within one of two peripheral grooves 272 formed on the housing 261.

The rear end of the cylinder 204 is mounted within an end head 274 secured to a block 276 which is slidingly supported between a pair of guide members 278 affixed to the base 190 (FIG. 5). Such an arrangement allows a limited amount of reciprocal axial movement of the cylinder 204. Longitudinal movement of the block 276 is

resisted by helical springs 280 and 282, the former of which is disposed between a pad means 284 and the block 276, the latter of which is disposed between a pad means 286 and the opposite side of the block 276. The pad means 284 and 286 are secured to the base 190.

As seen in FIGS. 1, 2 and 5, an electric switch LS-6, having a plunger 288 engageable by the block 276, is secured to the pad means 286, while an electric switch LS-4, having a plunger 290 engageable by the block 276, is secured to the pad means 284. An electric switch LS-1 having a plunger 292 engageable by the crosspiece 198 is mounted atop a block 294 affixed to the base 190. An electric switch LS-7, having a contact arm 296 engageable to the cross piece 198, is mounted atop a block 298 secured to the base 190. The contact arm 296 is arranged to activate the switch LS-7 only upon forward movement of the crosspiece, i.e., when moving toward the front pedestal 193.

The operation of the fastener driving machine 42, under certain conditions of operation, will now be described. Reference may be had to the circuit diagram of FIG. 15 for a full understanding of the operating description.

Assume that certain parts are in the relative position shown in FIG. 3, with the screw driver motor 200 operating and with pressure fluid directed to the cylinder 204 so that the piston rod 206 moves outwardly to cause movement of the crosspiece 198 toward the front pedestal 193.

Such movement will result in forward movement of the rod 244, due to expansive force of the spring 258, whereby the cylindrical piece 226 will be rotated so that the hole 228 will be in alignment with the bore in the guide piece 235 (FIG. 4). Simultaneously with such movement, the wrench element 202 will be moved into contact with the screw 64 within the hole 228, and cause positioning of the screw in the collet assembly 260. In such position of the screw, the socket engaging end of the wrench 202 will enter into the matching hole in the screw 64 and cause rotation of the screw. Continued forward movement of the wrench element 202 will move the screw out of the collet assembly 260 and drive it into the threaded opening of a workpiece 50. The reacting force developed by engagement of the screw with the workpiece will be transmitted to the cylinder head 274 to move the block 276 into engagement with the plunger 288 of switch LS-6 and cause opening of the circuit therethrough.

It will be seen that closing of switch LS-5 energizes the coil of relay R-4 to open the circuit to relay R-5 and holds on R-4 until LS-5 is opened. Such action insures proper sequence for LS-5 and LS-6, which is LS-6 open before LS-5 closes, and LS-5 open before LS-6 closes. Such sequence is necessary to avoid a false signal which could adversely affect subsequent automatic inspection function of the device, as will be more apparent hereinafter.

When the screw has been driven, or set, a predetermined distance in the workpiece, the knob 208 will engage the plunger 222 of switch LS-5 to close the circuit therethrough. Such action will energize a solenoid 302 causing a reversal of air pressure on the piston in the cylinder 204 to cause reverse movement of the piston rod 206. Simultaneously, solenoids 304 and 306 will be energized to cause operation of the piston 172, as in FIG. 11, and cause a brief blast of air to pass through the cylinder passageway 168, respectively. The flow of air through the passageway 168 propels the screw from the passageway 168 through the hose 44 and into contact with the peripheral surface of the cylindrical piece 226. Such action, i.e. propelling action on the screw 64, occurs very rapidly and slightly in advance of rotary movement of the cylinder 166. Rotation of the cylinder 226 from the FIG. 3 position to the FIG. 4 position does not take place until toward the end of rearward movement of the crosspiece 198.

As previously mentioned, the device will automatically operate to assure setting of a screw in each workpiece,

and in event such is not accomplished, the machine will stop and signal for attention. Consider the situation wherein a screw is missed, that is, there is no screw on the end of the screw driving element as the latter is advanced to the workpiece. Under such condition, there will be no reaction force to open LS-6. At the end of the forward stroke, LS-5 will be closed thus energizing the coils for reverse operation of the screw drive piston 206, the escapement piston 172 and the coil for relay R-5. Closing of the contacts on R-5 will complete circuits through the coil for relay R-3, the re-cycle light 308, the coil for relay R-2, and the timer 310. When contacts on R-3 close, one contact establishes a holding circuit through R-3, a second contact closes in parallel with LS-1, and a third contact closes in parallel with LS-2 and LS-3.

The piston 206 of the drive cylinder will start to retract, and LS-5 will be opened causing R-5 to drop out thereby opening the contacts of R-5. The coil of relay R-3 will continue to be energized thus holding R-3 in operative condition and maintaining the re-cycle light 308 in "on" condition. R-2 and the timer 310 will be maintained in operative condition by the closed contact of R-2. At the end of the retraction stroke of the piston rod 206, LS-1 will be closed. Since R-3 is closed, the circuit will be completed through the drive cylinder solenoid 302 and the escapement advance solenoid 304. Relays R-1, R-2 and R-3, and timer 310 will be maintained in operative condition because the contacts on R-2 and R-3 are still closed. As the piston 206 advances, LS-7 is opened, causing R-3 to drop out and the contact of R-3, in the re-cycle circuit, is opened. The relays R-1, R-2 and the timer 310 will be maintained in operative condition because LS-1 is open.

If no screw is driven, the steps set forth in the preceding paragraph are repeated until the timer, which may be pre-set for any time period, will operate to open LS-8 thus breaking the re-cycle circuit. The piston 206 will then stop in retracted position, and the circuit will be maintained through R-1, R-2 and R-3. The index-off light 312, the cycle-off light 320 and the re-cycle light 308 will now all be "on."

To restore the device to initial operative condition, the reset button PB-2 is actuated which causes interruption of the circuit through relay R-3. As a result, the circuit to R-1, R-2 and the timer 310 is broken, and the screwdriver motor 200 is again energized.

If a screw is missed but another screw is driven before the timer opens LS-8, the device will restore itself to normal, or initial operation in the following manner. The reactive force moves the block 276 so that LS-6 is opened. At the end of forward movement of the rod knob 208, LS-5 is closed, and retraction movement of the piston rod 206 occurs as in a normal driving cycle. At the end of such retraction movement, LS-1 is closed, disrupting the circuit through R-2, R-1 and the timer 310, whereupon the device is restored to initial operative condition.

In the event there is a failure to complete the forward stroke of the screwdriver element 202, because of an untapped hole in a workpiece 50, or in event of jamming of a screw in the collet assembly 260, the following action will take place. The detent knob 208 on the piston 206 will be forced from holding engagement with detent 212 and will move forward to make contact with the plunger 222 of LS-5. As a result, circuits will be established to cause retraction movement of the piston 206 in the manner as previously set forth, and a subsequent driving action will take place.

In the event the screwdriver element 202 becomes wedged in the screw being set so that the element 202 cannot be withdrawn from the set screw, the screwdriver motor 200 will be stalled. As in the foregoing paragraph, the detent knob 208 on the piston rod 206 will be forced from holding engagement with detent 212, and will move forward to make contact with the plunger 222 of LS-5.

As a result, circuits will be established to cause retraction movement of the piston 206. The reactive force transmitted to the cylinder head 276 will cause LS-4 to be closed, which in turn will disrupt the circuit through the solenoid 315 of a valve controlling flow of compressed air to the screw driver motor 200, and cut off motive power thereto. The screwdriver element 202 will then be withdrawn from the set screw by rearward movement of the motor 200.

Attention is directed to the fact that switch LS-1 must be open for switch LS-4 to complete a circuit, hence, LS-1 functions when the cross piece 198 moves away from abutment with plunger 292 of LS-1. Proper operational sequence for LS-1 and LS-4, when the cylinder 204 is retracted normally, is provided by spring loads. The sequence is: LS-1 closes before LS-4 closes, and LS-4 opens before LS-1 opens.

What is claimed is:

1. A fastener driving machine for receiving fasteners in sequential and intermittent manner and for driving them into workpieces, including a rotary power wrench, a carriage carrying the wrench, power means defined by a cylinder having a reciprocable piston rod connected with the carriage for reciprocating the carriage so as to carry the wrench toward and away from a workpiece, a fastener receiving and positioning means, linkage arranged to co-ordinate operation of the receiving and positioning means with axial movement of the carriage so that a fastener received in the receiving and positioning means will be engaged and driven by the wrench, a spring loaded slidable block supporting the cylinder having limited axial movement as a consequence of a reactionary force transmitted to it by the cylinder upon the wrench engaging a fastener and advancing it into engagement with a workpiece, a circuit controlling operation of the power means including a control switch operable by the block during such axial movement and including an advance limit switch operable by abutment means carried by the carriage after a predetermined degree of axial movement of the wrench toward a workpiece.

2. A fastener driving machine as in claim 1, wherein the abutment means is a slidable end of the piston rod projecting partly beyond the carriage in axial alignment with the advance limit switch, and detent means engaging the abutment means normally restrains the latter from being slidably advanced by the piston rod relative to the carriage, the detent means being adapted to release its engagement with the abutment means upon the carriage experiencing a predetermined degree of resistance to being advanced by the piston rod.

3. In a fastener driving machine according to claim 1, wherein said fastener and positioning means comprises a cylindrical piece having a diametrical hole of slightly greater diameter than that of a fastener, said cylindrical piece being rotatable by said linkage during axial movement of the carriage from a first position wherein a fastener is fed into said hole, to a second position wherein the axis of the hole is in alignment with the axis of the wrench.

4. In a fastener driving machine according to claim 1, including a fastener releasable holding means positioned adjacent the receiving and positioning means, said holding means being formed to provide a hole which is in axial alignment with said wrench, and resiliently mounted means projecting into the hole of the holding means for releasable engagement with a fastener.

5. A fastener driving machine for receiving fasteners in sequential and intermittent manner and for driving them into workpieces, including: a motor means; a wrench driven by the motor means; power means to cause reciprocal axial movement of the motor means and wrench including a carriage upon which the motor means and wrench is mounted and a pneumatic cylinder having a piston rod connected to reciprocate the carriage; a spring

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loaded slidable block supporting the cylinder; a fastener receiving and positioning means; linkage coordinating operation of the receiving and positioning means with axial movement of the carriage so that a fastener received and positioned in the receiving and positioning means will be engaged and driven by the wrench; the block having limited axial movement against its spring load in response to engagement of the wrench with a fastener; and circuit means controlling the operation of the power means, including control switch means operable as a consequence of said movement of the block, and other control switch means operable as a consequence of movement of the carriage.

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29—211, 240, 407; 81—57; 144—32