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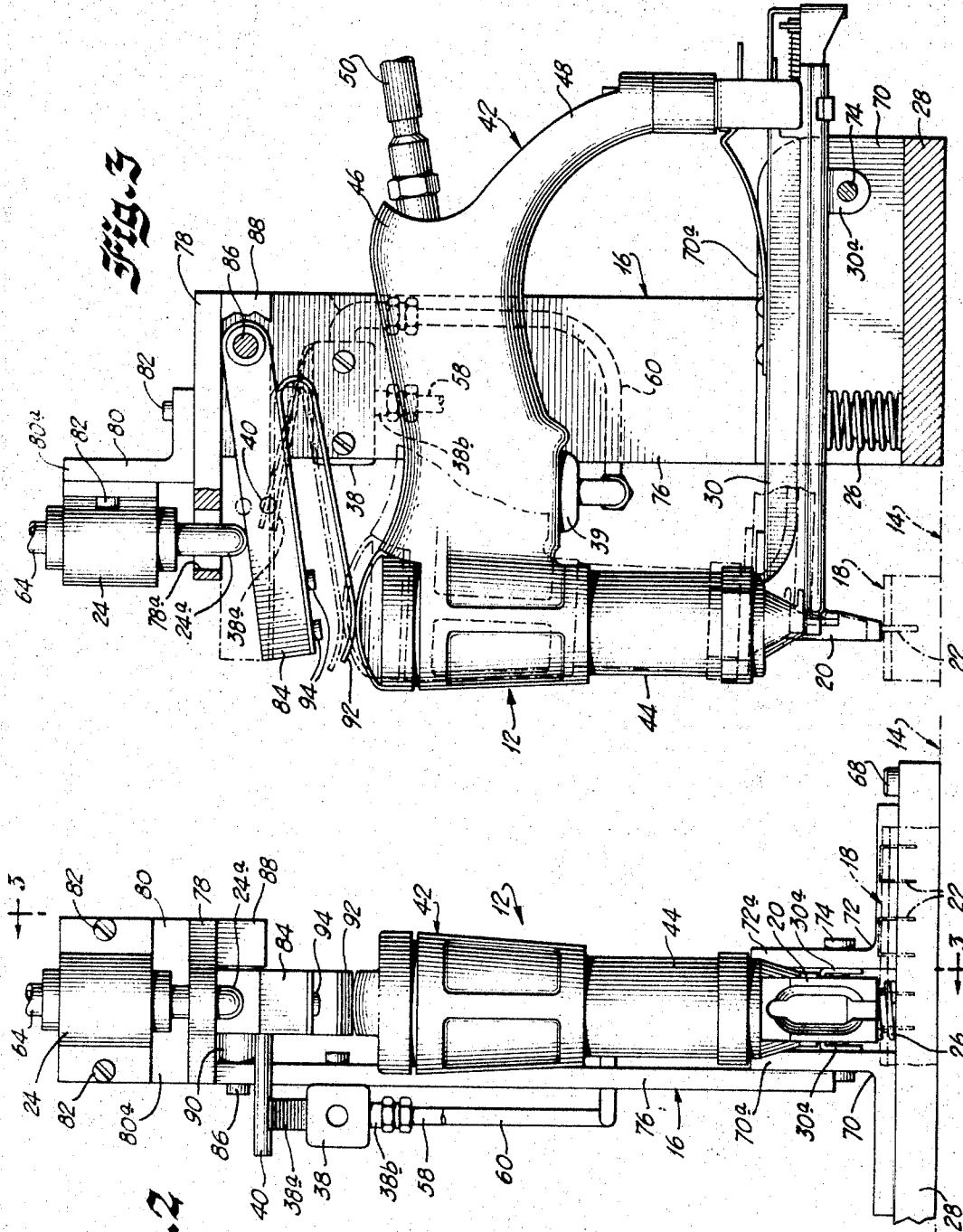
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AUTOMATIC FASTENER DRIVING APPARATUS

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Sheet 2 of 2



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1

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AUTOMATIC FASTENER DRIVING APPARATUS
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13 Claims

ABSTRACT OF THE DISCLOSURE

Automatic fastener driving apparatus comprising a power driven fastener driving tool, a workpiece support means adapted to support a workpiece adjacent the tool and motor means operable for producing relative movement between the tool and the support means to place the tool in contact with a workpiece. Manual control means movable between a normally inoperative position and an operative position is provided and timing means is operatively interconnected with the motor means and the control means for operating the motor means in response to movement of the control means to an operative position. The timing means includes means for operating the motor means at successive time intervals when the control means is maintained in the operative position, and tool control means is provided for operating the tool to drive a fastener into the workpiece in response to relative movement between the tool and the support means.

The present invention relates to automatic fastener driving apparatus and, more particularly, to a new and improved automatic fastener driving apparatus for driving fasteners in rapid succession into a workpiece at selectively timed intervals.

In many fasteners applying operations it is desirable to drive the fasteners in rapid succession into a moving workpiece so that the fasteners are spaced apart in the workpiece at a desired distance from each other. Because of this requirement, it is necessary that the time interval between successive driving strokes be accurately controlled and the time interval be selectively adjustable to effect the desired rate at which the fasteners are driven. It is generally impossible for even the most skilled operators to manually initiate the driving strokes at the speed rates required and, accordingly, it is an object of the present invention to provide a new and improved fastener driving apparatus which is capable of driving fasteners automatically in rapid succession at controlled rates, yet permit an operator to manually initiate a single driving stroke or a series of driving strokes in rapid succession.

Another object of the invention is the provision of a new and improved automatic fastener driving apparatus which is capable of driving a single fastener or a plurality of fasteners in a series of rapid, successive, timed driving strokes in response to the manual operation of a single control.

Yet another object of the invention is the provision of a new and improved automatic fastener driving apparatus of the type described, including timing means for selectively adjusting and controlling the time interval between successive driving strokes.

Still another object of the present invention is the provision of a new and improved automatic fastener driving apparatus including timing means for initiating a series of rapid successive timed driving strokes in response to a manual control actuated by an operator.

Yet another object of the invention is the provision of a new and improved automatic fastener driving apparatus employing electronic timing means for initiating a series of driving strokes in rapid succession.

2

Still another object of the invention is the provision of a new and improved automatic fastener driving apparatus of the type described which employs a minimum number of mechanical valves and control mechanisms therefor.

These and other objects and advantages of the present invention are achieved by providing a new and improved automatic fastener driving apparatus comprising a power driven tool having fastener driving means therein, a workpiece support means, and motor means operable for producing relative movement between the driving tool and support means between an inoperative and an operative position. Driving strokes of the fastener driving means are initiated by movement of a manual switch means into an operative position. Automatic timing means interconnected with the manual switch means is connected with the motor means to move the tool toward the workpiece support means and into an operative position wherein a fastener driving stroke is initiated. The timing means includes means for activating said motor means at rapid, successive, accurately timed intervals when an operator maintains the switch means in the operative position. Accordingly, an operator can effect a single power stroke of the driving means or a series of power strokes in rapid succession at timed intervals wherein the fasteners are driven into the workpiece with the desired spacing therebetween.

For a better understanding of the invention, reference should be had to the following detailed description taken in conjunction with the drawings, in which:

FIG. 1 is a perspective view of a new and improved automatic fastener driving apparatus constructed in accordance with the present invention;

FIG. 2 is a front elevational view of the apparatus of FIG. 1;

FIG. 3 is a side elevational view looking in the direction of the arrows 3—3 of FIG. 2; and

FIG. 4 is a schematic circuit diagram of a new and improved timing means constructed in accordance with the present invention.

Referring now, more specifically, to the drawings, therein is illustrated a new and improved automatic fastener driving apparatus constructed in accordance with the present invention and indicated generally in FIG. 1 by the numeral 10. The apparatus 10 includes a power driven fastener driving tool 12, a workpiece supporting table or platform 14, and an upstanding mounting bracket or tool-holding structure 16 for supporting the tool in working relation with the table 14. The tool 12 is pivotally supported on the structure 16 for movement toward and away from a workpiece 18 (FIGS. 2 and 3) placed on the table 14, and when the tool is moved downward into an operating position (solid lines, FIG. 3) the lower end of the drive track defining structure or nosepiece 20 of the tool is pressed firmly against the workpiece so that a staple or other fastener 22 can be driven downwardly into the workpiece.

Movement of the tool 12 on a downward stroke into an operative position in relation to the table 14 and workpiece 18 supported thereon, as shown in FIGS. 2 and 3, is accomplished by a motor or actuator 24, which, in the illustrative embodiment, comprises a pneumatic cylinder. However, the operator 24 could also comprise a power solenoid, or the like, actuated by electric current. Movement of the tool on an upward or return stroke to a normally inoperative position (dotted lines, FIG. 3) out of engagement with the workpiece is accomplished by a compression spring 26 (FIG. 3) interposed between a base 28 of the support structure and a fastener containing magazine assembly 30 extending rearwardly from the nosepiece 20 of the tool.

Actuation of the cylinder 24 to move the tool 12 into an operative position is controlled by a solenoid valve 32

which, in turn, is controlled by the output of an electronic timing device 34 (FIG. 1) shown schematically in FIG. 4. The timing device 34 is controlled by a manual switch 36 connected with the input circuitry thereof, and manual depression of the switch by an operator causes the timing device to activate the solenoid valve 32, thereby activating the cylinder 24 to move the tool 12 into operative position, as will be discussed more fully hereinafter.

A power or driving stroke of the tool 12 is initiated automatically when the motor 24 moves the tool from the inoperative position (dotted lines, FIG. 3) into the operative position (solid lines, FIG. 3). To this end, a mechanically actuated control valve 38 is mounted on the support structure 26 and is connected to a supply of compressed fluid. The tool itself includes a trigger valve 39 which is pneumatically connected through a line 60 with the valve 38. The valve 38 in turn is normally in an open condition for supplying fluid to the underside of a piston in the trigger valve 39 to normally maintain the trigger valve in a closed position. The valve 38 includes an operating arm or lever 38a which is mechanically depressed by a pin 40 upon movement of the tool 12 into the operating position, and depression of the arm 38a closes the valve 38, causing the line 60 to be vented to the atmosphere and thereby evacuating the underside of the piston in the trigger valve 39. When the underside of the trigger valve piston is evacuated, the trigger valve opens and a power stroke of the tool is thereby initiated.

The tool 12 can be of a known type, such as that shown and described in United States Patent No. 3,040,709, but modified, whereby fluid rather than manual means is used to control the air flow from the reservoir to cause a power stroke of the driver. A trigger valve assembly, such as that shown in the copending United States patent application Ser. No. 457,767, filed May 21, 1965, now Patent No. 3,353,453 employing a fluid actuated, piston operated valve, but without the manually operated button-like valve member, has been used in the present invention with excellent results.

The tool 12 includes a main body or housing 42 having a downwardly extending head end portion 44 and an integrally formed rearwardly extending hollow handle 46 which serves as a reservoir for containing a supply of compressed fluid. The depending head end portion 44 encloses a pneumatically powered motor mechanism (not shown) which includes a reciprocating driving element or driver movable rapidly downwardly on power or driving strokes into the drive track of the nosepiece 20 for driving fasteners 22. A supply of fasteners is contained in a magazine assembly 30 extending rearwardly from the nosepiece 20, which depends downwardly from the lower end of the head end portion 44. Fasteners are fed toward the forward end of the magazine 30 into a drive track in the nosepiece 20 and are driven downwardly into the workpiece 18 as the driver is moved rapidly downwardly by the motor mechanism of the tool. The rear portion of the magazine 30 is supported by a downwardly extending, integrally formed leg 48 projecting from the rear end of the hollow handle 46, and the fluid operated trigger valve 39 is mounted on the underside of the handle near the forward end thereof.

Fluid for operating the motor mechanism of the tool 12 is supplied directly to the rear end of the handle or reservoir 46 through a large fluid line 50 connected to a manifold 52 mounted on the underside of the table 14. In turn, pressurized fluid is supplied to the manifold 52 for distribution thereby by means of a fluid line 54 connected to a convenient source of compressed fluid (not shown).

Fluid for operating the trigger valve 39 of the tool is supplied through a fluid line 58 connected at one end to the supply manifold 52 and at the other end to an inlet fitting 38b on the mechanical actuated valve 38. When the valve 38 is closed by depression of the lever 38a, upon downward movement of the tool, pressurized fluid

is no longer supplied to the underside of the trigger valve piston and the line 60 is opened to exhaust through a port 38c in the valve housing. Accordingly, when the tool 12 is moved downwardly toward the table 14 far enough to depress the lever 38a, trigger valve 39 is opened to initiate a power or driving stroke of the tool.

Fluid for activating the motor cylinder 24 to move the tool 12 into the operating position is supplied through a line 62 connected between the manifold 52 and an input fitting 32a of the solenoid valve 32, and a line 64 is connected between an output fitting 32b of the solenoid valve and the top end of the cylinder.

When the valve 32 is opened by the operation of the timing device 34 and the manual switch 36, fluid is directed from an outlet fitting 32b through the line 64 connected to the upper end or downside chamber of the cylinder 24, causing the connected piston means in the cylinder, having a depending rod 24a, to move downwardly and force the tool 12 into the operative position with respect to the table 14. The solenoid valve 32 is only opened momentarily by the timing device 34 and the valve normally returns to a closed position after each operation. When this occurs, the line 64 is vented to the atmosphere and the spring 26 biases the tool upwardly into the inoperative position. Upward movement of the tool forces the operator 24a and piston means toward the upper end of the cylinder 24, thereby expelling the fluid in the upper end of the cylinder and the line 64 to the atmosphere through an exhaust port of the solenoid valve 32.

Referring now, more in detail, to the tool supporting structure 16, this structure includes a large baseplate 28 which is secured to the workpiece supporting table 14 by a plurality of cap screws 68 (FIG. 1). A pair of angle brackets 70 and 72 are attached to the baseplate 66 and are mounted so that their respective upstanding flanges 70a and 72a are in spaced apart, parallel relation, parallel to the longitudinal center plane of the tool 12. A pivot pin 74 extends between the flanges 70a and 72a for pivotally supporting the tool 12 and the magazine 30 is formed with a pair of downwardly depending lugs 30a adjacent the rear portion thereof and having apertures therein to receive the pivot pin 74. As viewed in FIG. 3, when the tool 12 is moved downwardly into the operating position, as previously described, the tool pivots about the axis of the pin 74 in a counterclockwise direction, and when the tool moves upwardly on a return stroke to the normally inoperative position, as shown in dotted lines, the tool pivots in a clockwise direction around the pin 74. The structure 16 includes an upstanding leg 76 which is secured to the upstanding flange 70a of the angle bracket 70, and a horizontally extending top plate 78 is attached to the upper end of the leg 76 for supporting the cylinder 24. An angle bracket 80 is mounted on the upper surface of the top plate 78 by a pair of cap screws 82, and the bracket 80 includes an upstanding flange 80a which forms a mounting base for the cylinder 24 secured thereto by a pair of cap screws 82, which project through suitable flanges on the cylinder and are threaded into openings in the flange 80a. The top plate 78 is formed with an aperture 78a therein aligned coaxially with the axis of the cylinder 24 so that the operator 24a can extend downwardly through the top plate.

In order to connect the operator 24a with the tool 12 to move the latter downwardly into the operative or firing position, lever 84 is pivotally mounted on the tool support structure 16 by a pin 86 projecting outwardly from the leg 76. The outer end of the pin 86 is secured in a block 88, FIG. 2, and the operating lever 84 thus pivots between the block 88 and the side leg 76, as best shown in FIG. 2. A bushing 90 is mounted on the pin 86 to space the lever 84 from the side leg 76 and maintain centered alignment between the lever and the tool 12. A U-shaped spring member 92 is mounted on the underside of the

lever 84 and the upper leg of a U-shaped spring member 92 is attached to the lever by a pair of screws 94.

The U-shaped spring 92 permits the apparatus 10 to be used on workpieces 18 of various thickness without requiring readjustment of the tool-supporting apparatus. The spring 92 insures that the nosepiece 20 is always forced against the workpiece when the valve lever 38a is actuated because the spring continually biases the lever 84 and tool body away from each other or to pivot about their respective mounting pins 86 and 74 in opposite directions. Thus, the spring 92 will force the nosepiece 20 against a workpiece 18 underneath with a minimum selected force before allowing the lever 84 and rod 40 to pivot downwardly far enough to trip the valve lever 38a and thereby initiate a fastener driving power stroke of the tool.

When fluid under pressure is introduced into the upper end of the cylinder 24, the operator 24a moves downwardly against the upper surface of the lever 84 causing it to pivot about the pin 86 in a counterclockwise direction. The lower leg of the spring 92 bears directly against the upper end of the head end portion 44 of the tool and forces the nosepiece 20 downwardly against the workpiece 18. The spring 92 is constructed of heavy spring material and provides the needed resilient action between the lever 84, tool 12, and operator 24a to reduce shock on these parts during actuation. After a driving stroke of the tool has been completed, and the line 64 is vented to the atmosphere through the solenoid valve 32, the bias spring 26 urges the tool upward and the spring 92 and lever 84 move the operator 24a of the cylinder upwardly toward the top end of the cylinder in readiness for the next downward stroke of the piston. The actuating pin 40, which operates the manual valve 38, is mounted to extend outwardly from the lever 84, and as the lever 84 is pivoted in a counterclockwise direction, the pin 40 engages the actuating lever 38a of the valve 38, causing it to close and thereby initiate a driving stroke of the tool, as previously described. The actuator 38a is adjusted so that it will not act to open the valve until the tool is in a selected downward position and, accordingly, a fastener driving power stroke is not initiated until the nosepiece 20 of the tool is resting against the workpiece 18 with the desired pressure. Accordingly, it is not necessary to adjust the apparatus each time workpieces of different thicknesses are used.

Referring now, more specifically, to FIG. 4 of the drawings, therein is illustrated the timing circuit 34 which is controlled by the switch or control means 36 to control the operation of the solenoid actuated valve assembly 32 between its normal position connecting the line 64 to the atmosphere and its operated position in which compressed air from the line 62 is supplied to the line 64 to start a cycle of operation of the machine 10. The timing circuit or control assembly 34 is energized from a conventional alternating current potential source over a line 100 and includes a combined on-off and time delay control actuated by a knob 102 which includes both a normally open on-off switch 104 and a variable resistor or potentiometer 106 whose controls are mechanically linked for common actuation by the knob 102.

When the control assembly or timing circuit 34 is placed in operation, the knob 102 is turned to close the switch 104. This connects a full-wave rectifier bridge 108 across the alternating current potential source through a voltage dividing capacitor 110. The output of the bridge 108 is applied to a filter network including a parallel network consisting of a resistance element 112 and a capacitor 114. When the knob 102 is actuated to close the switch 104, it is also turned to adjust the effective resistance of the potentiometer 106. If the machine 10 is to be used primarily for single cycle operation, each actuated by manual operation of the switch 36, the potentiometer 106 is adjusted so that substantially the full value of the resistance of this potentiometer is rendered effective in the

circuit. Alternatively, if the machine 10 is to be used for automatic cyclic operation of the machine 10, a lesser resistance value of the potentiometer 106 is placed in the circuit. The time between successive operations of the tool 10 can be reduced by reducing the amount of resistance of the potentiometer 106 in the circuit.

When the apparatus 10 is to be operated, the switch 36 is operated to a closed circuit condition so that the output potential from the bridge 108 is connected across a voltage divider including a pair of series connected resistance elements 116 and 118. The point of common connection of these two resistance elements is connected through a series resistor 120 to the base of a transistor 122. The emitter of the transistor 122 is connected to the negative side of the bridge output through the closed switch 36, and the collector of the transistor 122 is connected to the base of a transistor 124 through a series resistor 126 and to the positive output terminal of the bridge network 108 through a resistance element 128.

The potential supplied to the base of the transistor 122 by the voltage divider including the resistance elements 116 and 118 biases the base positive with respect to its emitter electrode, and the transistor 122 is placed in a conductive condition to apply a negative potential to the base of the transistor 124. The emitter of the transistor 124 is returned to the positive terminal of the potential source, and the collector electrode of the transistor is connected to the switch 36 through a winding 130 of a control relay including a pair of normally open contacts 132, the winding 130 being shunted by a capacitor 134.

The negative potential provided at the base of the transistor 124 by the conductive transistor 122 biases this base negative with respect to its emitter so that the transistor 124 is placed in a conductive condition to energize the winding 130. The energization of the winding 130 closes the contacts 132 which operate the control valve 32.

More specifically, the control valve assembly 32 includes a solenoid 135, one terminal of which is connected to one side of the input line 100 and the other terminal of which is connected through a diode 136 to the normally open contacts 132, the series circuit of the solenoid 135 and the diode 136 being shunted by a capacitor 138. When the contacts 132 are closed by the energization of the winding 130, the solenoid 135 and the diode 136 are connected in series across the input line and the solenoid is energized on alternate half cycles to operate the control valve assembly from the normal condition in which the line 64 is connected to the atmosphere to its actuated state in which this line is supplied with compressed air from the line 62. The capacitor 138 tends to hold the solenoid 135 energized during the alternate half cycles. The actuation of the control valve assembly 32 to its operated state initiates a driving cycle of the apparatus 10 in the manner described above.

With the transistors 122 and 124 in a conductive state, a timing network including a capacity 140 and the potentiometer 106 is rendered effective. More specifically, the capacitor 140 is charged over a circuit including the potentiometer 106 and a conductive path through the transistors 122 and 124. When the capacitor 140 has been sufficiently charged, the base of the transistor 122 is no longer sufficiently positive with respect to its emitter, and this transistor is placed in a nonconductive condition to remove the negative enabling signal from the base of the transistor 124. This, in turn, places the transistor 124 in a nonconductive state. The termination of conduction through the transistor 124 releases the relay including the winding 130 and the contacts 132 so that the contacts 132 are opened to terminate the energization of the solenoid 135. This releases the control valve assembly 32 so that it returns to its normal state in which the line 64 is connected to the atmosphere. This restores the fastener driving apparatus 10 to a normal condition in the manner described above.

During the interval in which the transistors 122 and

124 are in a nonconductive state, the charged capacitor 140 discharges over a circuit including the potentiometer 106, the winding 130, and the resistance elements 118 and 120. When the capacitor 140 has been sufficiently discharged, the voltage divider including the resistance elements 116 and 118 is again effective to bias the base of the transistor 122 positive with respect to its emitter, and an additional cycle of operation of the apparatus 10 is performed in the manner described above. The length of time that the switch 36 is held in an actuated condition relative to the time required to discharge the capacitor 140 to the point at which a transistor 122 can again be placed in a conductive state determines whether the apparatus 10 provides single or multiple stroke operation.

More specifically, if it is desired to operate the apparatus 10 in a manual mode in which it is necessary to actuate the switch 36 for each fastener to be driven, the potentiometer 106 is adjusted to a position placing substantially its full resistance in series with the capacitor 140 so as to increase the time required to discharge this capacitor to the point at which the transistor 122 can be returned to a conductive state. This time interval is long enough to permit the operator to release the switch 36 so that when the capacitor 140 has been completely discharged, the switch 36 is in an open condition, and the direct current potential source provided by the bridge 108 is disconnected from the transistors 122 and 124.

On the other hand, if it is desired to provide automatic repeated operation of the machine 10 to drive a series of staples at predetermined spaced time intervals, the operator maintains the switch 36 in an actuated condition, and the potentiometer 106 is adjusted to select a time interval for discharging the capacitor 140 which is equal to the desired time between successive operations of the apparatus 10. This is done by progressively reducing the resistance of the capacitor 106 to produce a corresponding decrease in the discharge time of the capacitor 140. Thus, by maintaining the switch 36 in a closed condition, the discharge of the capacitor 140 to the level at which the base of the transistor 122 is placed in a positive potential relative to its emitter by the voltage dividing network permits the initiation of an additional cycle of operation. This cyclic operation of the apparatus 10 continues for as long as the switch 36 is maintained in an operated condition.

Thus, an operator can initiate a single power stroke of the tool 12 by a momentary depression of the manual switch 36 or can initiate a series of power strokes in rapid succession by maintaining the switch in the depressed position for a period of time. In addition, the interval between successive strokes is accurately timed and, by adjusting the potentiometer 106, the interval can be selectively adjusted to provide the desired spacing between the fasteners being driven into a moving workpiece. The timing device of the invention is relatively inexpensive and eliminates the need for complicated mechanical structure, valves, and piping required to produce the same result.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An apparatus for driving fasteners into a workpiece comprising a power driven fastener driving tool; a workpiece support means adapted to support a workpiece adjacent said tool; motor means operable for producing relative movement between said tool and support means to place the tool in contact with a workpiece on said support means; manual control means movable between a normally inoperative position to an operative position; timing means operatively interconnecting said motor means

and control means for operating said motor means in response to movement of said control means to an operative position, said timing means including means for operating said motor means at successive, timed intervals when said control means is maintained in an operative position, and tool control means for operating said tool to drive a fastener into a workpiece in response to relative movement between said tool and said support means.

2. The apparatus of claim 1 wherein said timing means includes means for selectively adjusting the time intervals between successive operations of said motor means.

3. The apparatus of claim 1 wherein said timing means includes solenoid valve means for selectively interconnecting said motor means with a source of compressed fluid, said timing means further including electronic circuit means for selectively interconnecting said solenoid valve means and said control means.

4. The apparatus of claim 3 wherein said electronic circuit means includes means for actuating said solenoid valve means at timed successive intervals in response to holding of said control means in said operative position.

5. The apparatus of claim 3 wherein said motor means comprises fluid cylinder means interconnected with said solenoid valve means.

6. The apparatus of claim 1 wherein said fastener driving tool includes a trigger valve means for initiating a fastener driving power stroke, and said tool control means includes operator means for operating said trigger valve means to initiate a power stroke in response to the relative movement between said tool and said support means.

7. The apparatus of claim 6 including tool support means for pivotally mounting said tool adjacent said workpiece support means, said motor means including a fluid cylinder connected to move an operating lever pivotally mounted on said tool support means, and resilient means for biasing said operating lever and tool in opposite directions about their respective pivots.

8. An apparatus for driving fasteners into a workpiece comprising a fastener driving tool including a control unit for operating the tool to drive a fastener, a workpiece support adapted to support a workpiece adjacent the tool, motor means connected between the support and the tool and operable to produce relative movement between the support and the tool to place the tool in contact with the workpiece on the support, a control assembly connected to the motor means for operating the motor means to place the tool and workpiece in contact and to move the tool and workpiece out of contact in an automatic cycle, a timing circuit included in said control assembly for operating said motor means through an additional automatic cycle a predetermined time interval following the preceding automatic cycle, a control means connected to the control assembly and operable from a normal state to an actuated state to operate the control assembly to cause the motor means to operate through the automatic cycle, the control means effecting a single automatic cycle of the motor means when the control means is returned to its normal state before the expiration of the predetermined interval and effecting a series of automatic cycles of the motor means when the control means is retained in an actuated state for a period of time longer than the predetermined interval, and means for operating the control unit to operate the tool in response to relative movement between the tool and said workpiece support.

9. The apparatus of claim 8 including means for normally biasing said tool away from contact with a workpiece on said support, and resilient means interconnecting said motor means and tool for biasing the tool in contact against a workpiece upon operation of said motor means.

10. The apparatus of claim 8 wherein said means for operating said control unit includes lever means movable by said motor means when moving said tool into contact with a workpiece on said support.

11. The apparatus of claim 10 including tool support

9

means connected to said workpiece support for mounting said tool, said lever means, and said motor means, and biasing means interposed between said tool and lever means for accommodating workpieces of different dimensions.

12. In an apparatus for driving fasteners into a workpiece, the combination comprising a fastener driving tool, workpiece support means, tool support means for movably supporting said tool in relation to said workpiece support means, motor means for moving said tool between a workpiece engaging first position for driving fasteners and a second position away from said workpiece, said motor means including biasing means for resiliently urging said tool against said workpiece in said first position.

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13. The apparatus of claim 12 wherein said motor means includes a movable operator mounted on said tool support means and said biasing means is interposed between said operator and said tool.

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