United States Patent

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[54] **FLUID PRESSURE OPERATED FASTENER DRIVING DEVICE**
16 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **227/8,** 227/130
[51] **Int. Cl.** **B27f 7/06**
[50] **Field of Search** 227/7, 8, 130

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ABSTRACT: A fastener driving device having a fluid pressure operated system for moving a fastener driving element through repeated cycles each of which includes a drive stroke during which a fastener is driven and a return stroke, the main control valve for effecting the cycle of operation being moved by pilot pressure within a pilot chamber acting on a pilot piston forming part of the main control valve, the pilot chamber being communicated with reservoir pressure through a restricted orifice and the exhaust of the pilot chamber being under the control of an auto-fire valve operable to prevent exhaust of the pilot pressure in response to the establishment of a pressure signal in the return plenum chamber at the end of the drive stroke and operable to permit exhaust of the pilot pressure in response to a low pressure signal from the return plenum chamber toward the end of the return stroke. The device also includes an interlock lever pivoted intermediate its ends to the depending stem of the actuating valve and having its ends connected respectively to the trigger member and a motion transmitting member, which, in turn, is connected through a spring to the work contacting member so as to prevent undesired movement of the actuating valve into its closed position as a result of recoil movement of the device when the fastener driving element completes its drive stroke.

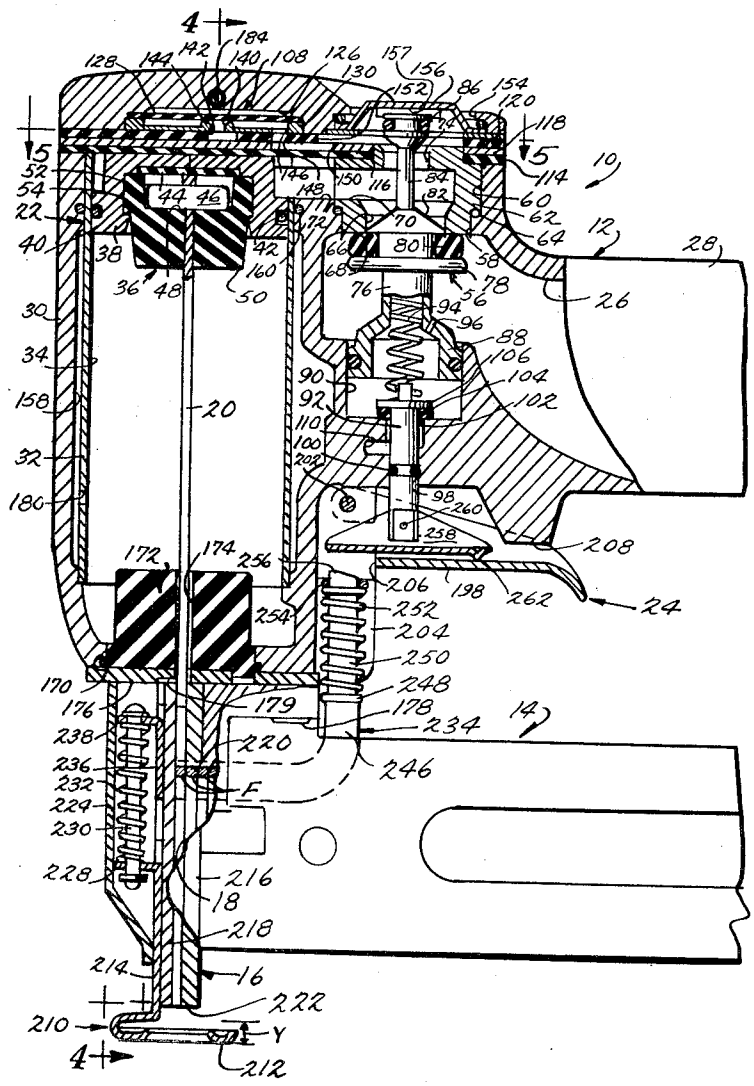

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Fig. 1.

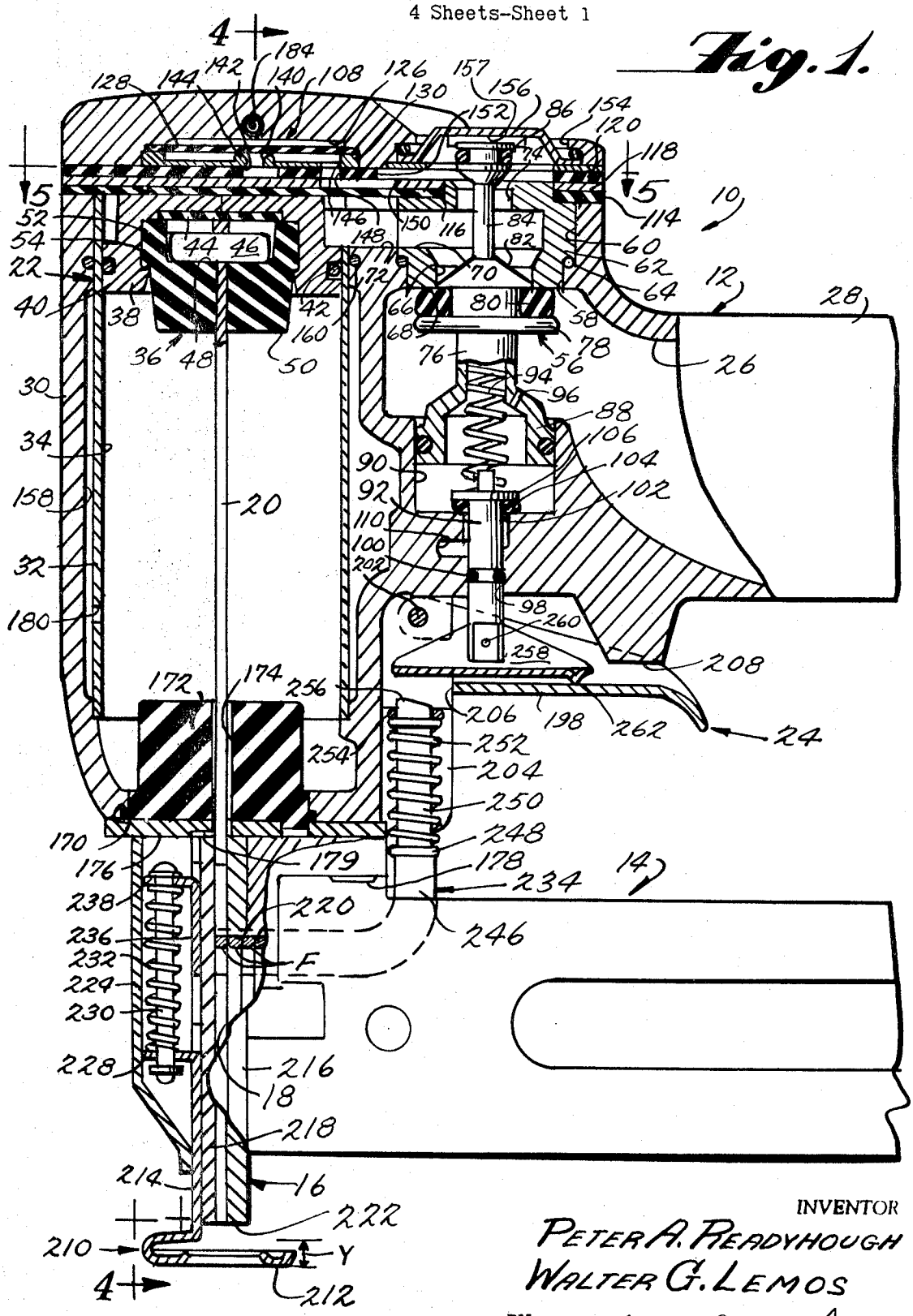

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Fig. 2.

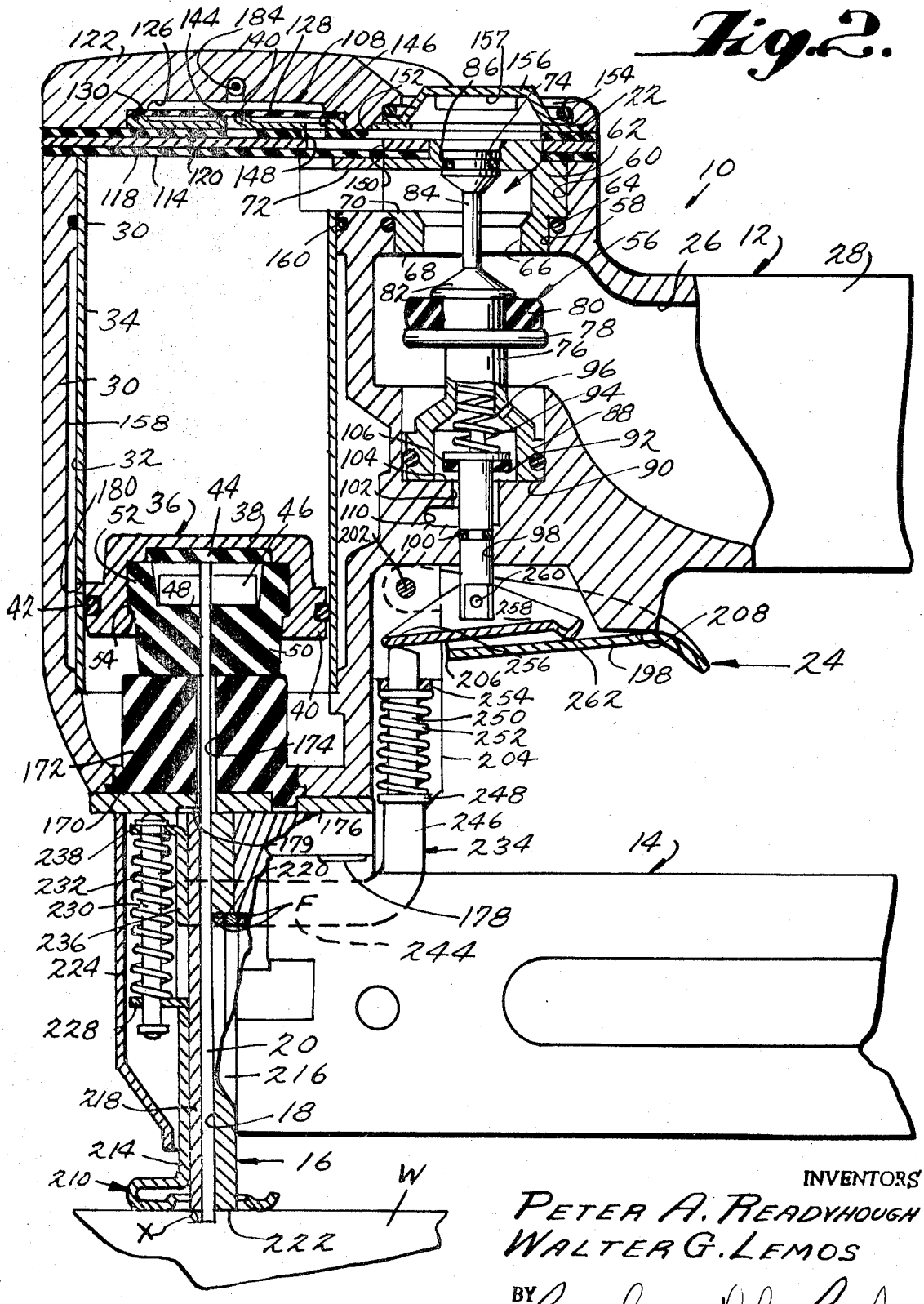

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Fig. 4.

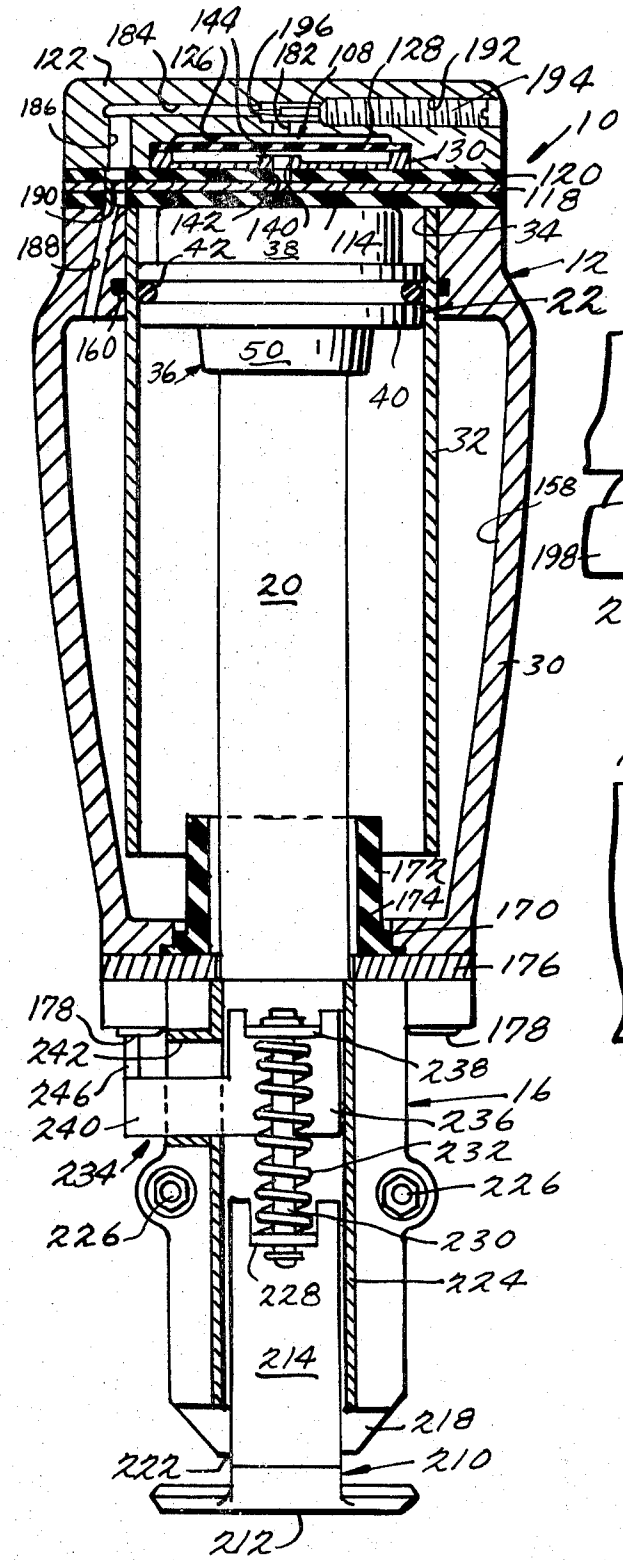

Fig. 3.

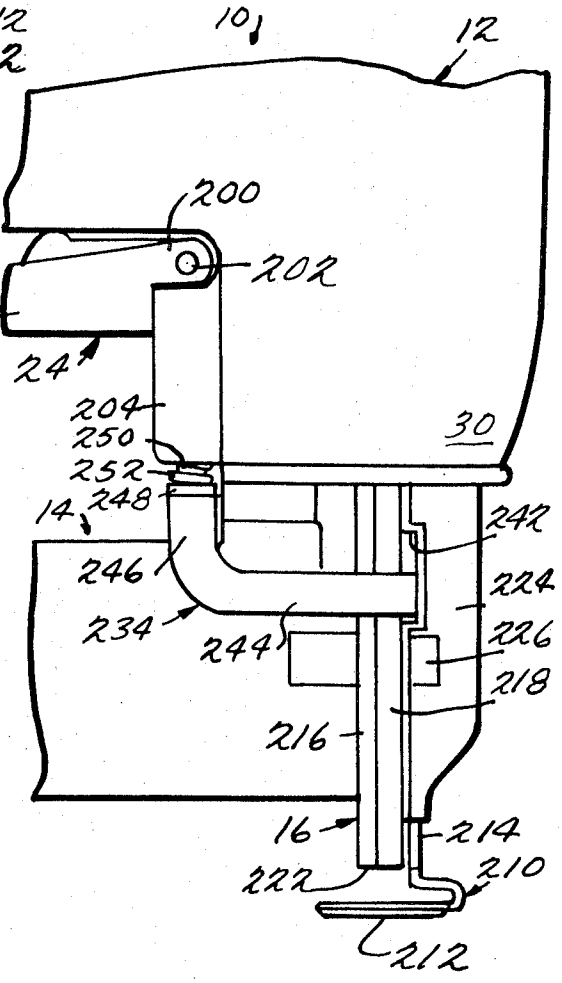

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Fig. 5.

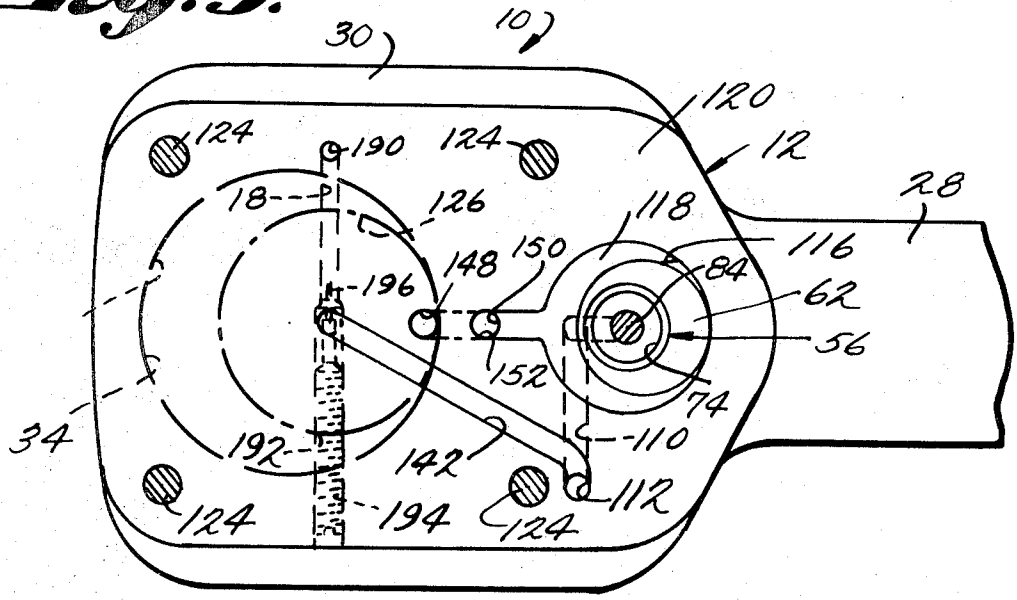


Fig. 6.

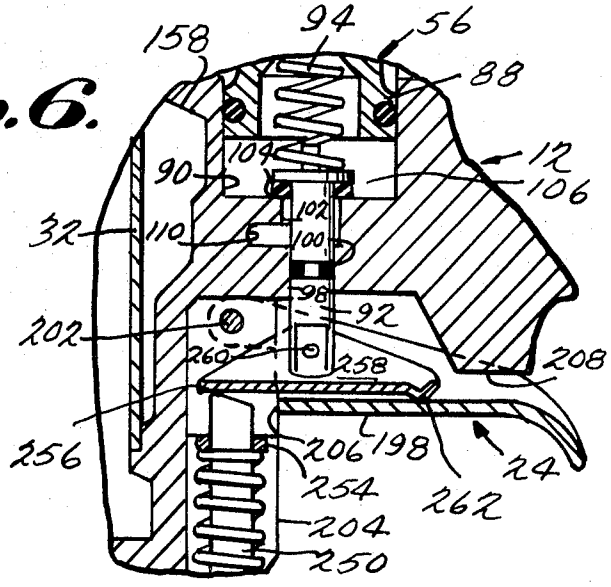
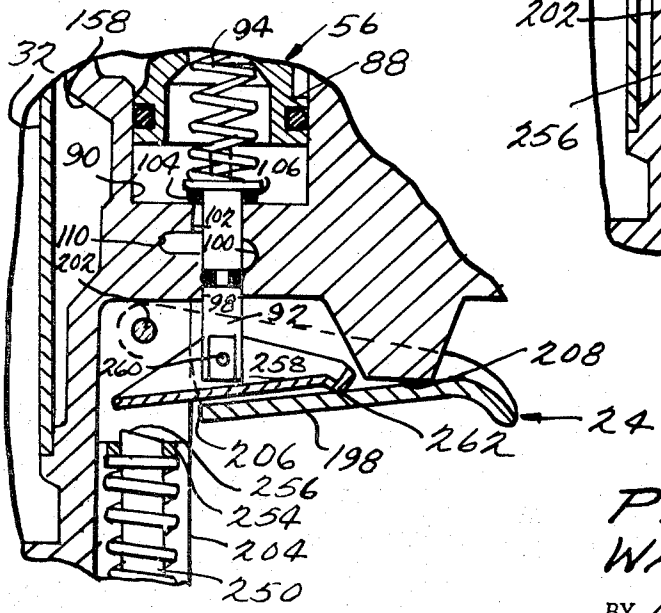


Fig. 7.



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FLUID PRESSURE OPERATED FASTENER DRIVING DEVICE

This invention relates to fastener driving devices and more particularly to fastener driving devices of the type which are operated by air under pressure.

Fluid pressure operated fastener driving devices are well known in the art. The simplest form of a device of this type is provided with a trigger which, when depressed by the finger of the operator, actuates the fluid pressure system to move the fastener driving element through its drive stroke during which a fastener fed from the fastener magazine is engaged and moved outwardly into the workpiece. When the trigger is released by the operator, the fluid pressure system is operated to move the fastener driving element through its return stroke.

A disadvantage of a simple trigger actuation is that the device is capable of being fired when out of operative relationship with the workpiece, thus presenting the possibility of a fastener becoming a projectile which can cause injury to personnel and the like. In order to overcome this disadvantage, it has been proposed to provide a work contacting member or contact trip which is interlocked with the trigger such that it is necessary for the operator to both depress the trigger with his finger and to move the entire device into engagement with the workpiece before actuation can occur.

Various interlocking arrangements have been provided which afford the operator essentially three different types or modes of actuation: first, single firing in which the operator simple moves the device into contact with the work and depresses the trigger and after the drive stroke has been completed, lifts the device away from the workpiece and releases the trigger; second, bump firing in which the operator continuously depresses the trigger and by successively moving the device into and out of engagement with the workpiece at specified locations effects firing solely by the movement of the work contacting member; and third, drag firing in which the operator moves the device into contact with the work to actuate the work contacting member and then moves the device along the work in continuous contact therewith while successively depressing and releasing the trigger to fire the device at spaced locations along the work.

In recent years it has been found that in certain applications where repeated firing is desired, the time required to operate pneumatic fastener driving devices even when bump or drag fired can be reduced by modifying the pneumatic system so that it will automatically recycle, so long as the trigger is depressed and the work contacting member (when provided) is in engagement with the workpiece. This mode of operation has been called "auto-fire."

In some instances it is desirable to provide the fastener driving element with a length sufficient to extend outwardly beyond the work contacting surface of the nose piece when the fastener driving element has reached the end of its drive stroke. A relationship of this type has, in the past, actually aided in the bump firing operation in that it has the effect of tending to move the entire device against the manual pressure of the operator away from the workpiece, thus insuring that the trigger valve will be moved to its inoperative position to commence the return stroke immediately after the drive stroke. However, where the pneumatic system of the device is modified to automatically recycle, the movement of the actuating valve into its inoperative position has the effect of stopping the automatic recycle. Consequently, under auto-fire actuation the provision of a work contacting member which may allow the actuating valve to move into its inoperative position as a result of recoil of the device following the completion of the drive stroke can have the effect of disrupting the automatic cycle of the device.

Accordingly, it is an object of the present invention to provide a fastener driving device of the type described capable of being operated in single fire, bump fire, drag fire and auto-fire fashion and which prevents disruption of the auto-fire cycle due to recoil while at the same time maintaining an overextended length of the fastener driving element sufficient to insure full penetration of the fasteners into the workpiece.

This result is achieved in accordance with the principles of the present invention by providing a motion transmitting mechanism between the work contacting member and trigger valve which includes a motion transmitting member and a spring means between the work transmitting member and the work contacting member. The work contacting member extends outwardly beyond the end of the fastener driving element when the latter is in its fastener driven position a predetermined distance and the spring means is arranged to transmit the inward movement of the work contacting member generally through the predetermined distance to the motion transmitting member, subsequent inward movement of the work contacting member resulting solely in the yielding movement of the spring without a corresponding movement to the motion transmitting member. The movement of the motion transmitting member is utilized, in conjunction with the movement of the trigger to effect movement of an interlock member which, in turn, serves to move the actuating valve into its operative position. In this way, when the fastener driving element moves through its drive stroke any tendency for the device to move away from the workpiece because of the extended length of the fastener driving element will simply result in a movement of the spring and work contacting member without an attendant movement of the motion transmitting member thus insuring that the trigger valve means will be maintained in its operative position for auto-fire operation by the pneumatic system.

A further object of the present invention is the provision of a fluid pressure operated fastener driving device of the type described having an improved pneumatic system for effecting autofire.

Another object of the present invention is the provision of a fluid pressure operated fastener driving device of the type described having an improved mechanical interlock linkage for effecting movement of the actuating valve into its operative position in response (1) to the simultaneous actuation of the work contacting member and trigger, (2) to the actuating of the work contacting member when the trigger is actuated, or (3) to the actuation of the trigger when the work contacting member is actuated.

A further object of the present invention is the provision of a fluid pressure operated fastener driving device of the type described which is simple in construction, efficient in operation and economical to manufacture and maintain.

These and other objects of the present invention will be come more apparent during the course of the following detailed description and appended claims. The invention may best be understood with reference to the accompanying drawings wherein an illustrative embodiment is shown.

In the drawings:

FIG. 1 is a side elevational view of a fluid pressure operated fastener driving device embodying the principles of the present invention with certain parts shown in vertical section, the trigger and work contacting member being illustrated in their normal inoperative position;

FIG. 2 is a view similar to FIG. 1 showing the trigger and work contacting member in their operative position and the fastener driving means in its fastener driven position at the end of the work stroke;

FIG. 3 is a fragmentary side elevational view of the device illustrating the side thereof opposite to that shown in FIGS. 1 and 2;

FIG. 4 is a sectional view taken along the line 4–4 of FIG. 1;

FIG. 5 is a sectional view taken along the line 5–5 of FIG. 1;

FIG. 6 is a fragmentary sectional view of the manually controlled actuating mechanism showing the position of the parts when the work contacting member is disposed in its operative position and the trigger member is disposed in its inoperative position; and

FIG. 7 is a fragmentary sectional view of the manually controlled actuating mechanism showing the position of the parts when the work contacting member is disposed in its inoperative position and the trigger member is disposed in its operative position.

Referring now more particularly to the drawings, there is shown therein a fluid pressure operated fastener driving device, generally indicated at **10**, embodying the principles of the present invention.

As a convenience, the device **10** will be described in an orientation operable to drive fasteners downwardly into a horizontal workpiece, although it will be understood that the device is not limited to such application but can be used to drive fasteners into vertical workpieces or beneath horizontal workpieces, as well as workpieces of any other orientation. Consequently, it will be understood that terms such as "vertical," "horizontal," "above," "below," "forward," "rearward," etc. as used herein are to be construed in their relative sense.

The device **10** includes a housing **12** to which is connected by suitable conventional means a magazine assembly, generally indicated at **14**, having a nose piece assembly, generally indicated at **16**, fixedly connected at its forward end to the magazine assembly and defining a vertically extending drive track into which successive fasteners are fed horizontally from the magazine assembly in accordance with conventional practice. It will be understood that the magazine assembly **14** may be of any known construction for feeding successive fasteners of any known construction as, for example, staples, T-head nails, pins, headed nails and the like.

Mounted for movement through the drive track **18** is an elongated fastener driving element **20** having a cross-sectional configuration compatible with the cross-sectional configuration of the drive track and the particular fastener which is fed thereto from the magazine assembly **14**. The housing **12** contains a fluid pressure operated system, generally indicated at **22**, for effecting movement of the fastener driving element between fastener receiving and fastener driven positions, through an operative cycle or cycles under the manual control of an operator by an actuating mechanism, generally indicated at **24**.

The operating cycle of the fastener driving element **20** includes a vertically downward drive stroke from the fastener receiving position to the fastener driven position and a vertically upward return stroke from the fastener driven position to the fastener receiving position. During the drive stroke, a fastener, such as designated by the reference character F in FIGS. **1** and **2**, which has been fed into the drive track **18** from the magazine assembly **14** prior to the commencement of the drive stroke is engaged by the lower end of the fastener driving element and moved downwardly through the drive track and outwardly therefrom into a workpiece such as the workpiece designated by the reference character W in FIG. **2**. Thus, during each operating cycle of the fastener driving element **20** a fastener F is fed to the drive track and driven outwardly thereof by the fastener driving element into the workpiece W.

The fluid pressure operated system **22** includes a fluid pressure reservoir **26** defined by a generally horizontally extending hollow handle portion **28** forming an integral part of a main casting of the housing **12**. In accordance with conventional practice, the rearward end of the reservoir is provided with a fitting (not shown) adapted to be connected with one end of a pressure line, the opposite end of which is connected with a suitable source of fluid under pressure as, for example, a compressor or the like (also not shown).

The main casting of the housing **12** also includes a generally vertically extending forward portion **30** within which a vertically extending cylinder **32** is mounted. The cylinder **32** defines a vertically extending cylindrical drive chamber **34** within which a drive piston assembly **36** is slidably mounted. As best shown in FIGS. **1** and **2**, the drive piston assembly **36** is in the form of a generally inverted cup-shaped piston member **38**, having an annular flange **40** extending radially outwardly from the lower end thereof. The periphery of the annular flange is suitably grooved to receive an O-ring seal **42** which slidably sealingly engages the interior periphery of the cylinder **32**. The interior central portion of the piston member **38** has a downwardly facing annular recess formed therein for receiving a disc-shaped pad **44**, the central lower portion of which is adapted to engage the upper end of the fastener driving element **20**. At a position spaced below the upper end of the fastener driving element **20**, the latter is apertured to receive therethrough a pin **46** which, in turn, seats within an upwardly facing recess **48** formed in a generally cylindrical pad **50**. The upper periphery of the pad includes a radially extending flange portion **52** which is adapted to engage within a correspondingly shaped annular recess **54** formed in the interior periphery of the piston member **38**.

The upper end of the drive chamber **34** is arranged to be alternately communicated with the fluid under pressure within the reservoir **26** and with the atmosphere by the action of a main control valve, generally indicated at **56**. To this end, the main casting of the housing **12** has a vertical bore **58** extending downwardly into communication with the reservoir **26** in parallel relation to the cylinder **32**. A counterbore **60** is formed in the upper end of the bore **58** and an annular valve insert **62** is engaged within both the bore **58** and counterbore **60**. The exterior periphery of the insert is sealed with respect to the bore and counterbore by any suitable means, such as an O-ring **64**, as shown in FIGS. **1** and **2**. The valve insert **62** provides a lower relatively large inlet opening **66**, the lower end of which communicates with the reservoir **26** and provides an annular valve seat **68** surrounding the inlet opening.

The upper end of the inlet opening **66** communicates with the central interior of the valve insert **62** which has a lateral passage **70** extending horizontally therefrom which communicates with the upper end of the drive chamber **34** through a correspondingly shaped lateral passage **72** formed in the main casting of the housing **12**. The upper end of the valve insert **62** is formed with a relatively small exhaust or outlet opening **74** concentric with the inlet opening **66** which communicates at its lower end with the central interior of the valve insert **62**.

The main control valve **56** includes a main valve member **76** having an annular flange **78** extending radially outwardly therefrom for receiving an annular inlet valve element **80**. The valve element **80** is retained in engagement with the flange **78** by a frustoconical portion **82** having a valve stem portion **84** extending upwardly therefrom. Formed on the upper end of the valve stem portion **84** is an enlarged portion of a size to engage within the exhaust opening **84** having its exterior periphery formed with an annular groove to receive an annular exhaust valve element **86** in the form of an O-ring or the like.

The main control valve member **76** is mounted within the housing **12** for vertical reciprocatory movement between two limiting positions. As shown in FIG. **1** in its upper limiting position, the inlet valve element **80** engages the valve seat **68** closing off communication of the fluid under pressure within the reservoir **26** from the drive chamber **34**, the exhaust valve element **86** extending above the exhaust outlet **74** thus communicating the driving chamber with the atmosphere in a manner hereinafter more fully described. As shown in FIG. **2**, when the main valve member **76** is in its lower limiting position, the inlet valve element **80** is disposed away from the valve seat **68** thus communicating the fluid under pressure within the reservoir **26** with the drive chamber **34**, the exhaust valve element **86** being in sealing relation with the exhaust outlet **74**.

The main valve member **76** is moved between those limiting positions by a pilot piston **88** formed integrally on the lower end of the valve member **76** and mounted within a cylindrical pilot pressure chamber **90** formed in the adjacent portion of the main casting of the housing **12**. The pilot pressure within the pilot chamber **90** is controlled by a manually actuated or trigger valve member **92** which is normally biased, as by a coil spring **94** into a position preventing the exhaust of pilot pressure from the chamber. Pilot pressure for the pilot chamber **90** is obtained directly from the reservoir **26** as by a restricted orifice **96** extending through the periphery of the valve member **76**.

Since the pilot piston **88** is of a diameter greater than the effective diameter of the valve element **80** (the greatest diameter dimension which contacts valve seat **68**) and reservoir pressure acts in opposite directions upon both of these diameters at all times, pilot pressure acting on the piston **88** normally will effect movement of the main valve into its uppermost limiting position, closing off communication of the reservoir with the drive chamber.

The trigger valve member **92** forms a part of the manually controlled actuating mechanism **24** and is adapted to be moved from its normal position closing off the exhaust of the pilot pressure within the pilot chamber to an operative position communicating the pilot chamber with the atmosphere by the operation of the manually controlled actuating mechanism **24** in a manner to be hereinafter more fully described.

As best shown in FIGS. **1** and **2**, the actuating valve **92** is preferably in the form of a cylindrical actuating member disposed within a bore **98** formed in the main casting of the housing **12** concentric with the main control valve **56**. An O-ring seal **100** is mounted in an appropriate annular groove formed in the exterior periphery of the cylindrical valve member for sealing engagement with the bore **98**. Formed in the upper end of the bore **98** is a counterbore **102** surrounding the upper end of which is an upwardly facing valve seat **104**. The actuating valve **92** includes an exhaust valve element **106** which is preferably in the form of an annular seal of a size to engage the valve seat **104**.

The counterbore **102** forms a part of an exhaust passageway for the pilot chamber **90** which is controlled by an auto-fire valve, generally indicated at **108**, for alternatively opening and closing the exhaust passageway to alternatively pressurize and exhaust the pilot pressure to effect repeated movements of the main control valve **56** between its limiting positions so long as the actuating valve **92** is disposed in its operative position. To this end, the exhaust passageway includes a lateral bore **110**, which communicates at one end with the lower end of the counterbore **102** and at its other end with a vertical bore **112** formed in the main casting of the housing **12**. The upper end of the bore **112** communicates with a registering opening formed in a lower gasket **114** which is preferably of resilient material such as rubber, plastic or the like. As best shown in FIGS. **1** and **2**, the gasket **114** is mounted on the upper end of the main casting of the housing **12**, throughout the periphery thereof, and in engagement with a shoulder **116** formed on the upper, outer periphery of the valve insert **62**.

Mounted above the lower gasket **114**, in abutting relation thereto, is a plate **118** having an opening, similar to the opening in the gasket **114** which registers with the upper end of the vertical bore **112**. Mounted in abutting relation to the upper surface of the plate **118** is an upper gasket **120**, the entire sandwich including the upper and lower gaskets **114** and **120** and the intermediate plate **118** being detachably secured to the main casting by a cap member **122**, as by a plurality of bolts **124** or the like, extending through all of the structure and threadedly engaged within the main casting of the housing **12**.

The auto-fire valve **108** is carried within the cap member **122** and includes a downwardly facing counterbored recess defining a chamber **126** disposed inwardly of the counterbore of the recess. A circular diaphragm **128** is disposed within the counterbored portion of the recess and is retained therein by an annular exhaust valve member **130**. The valve member **130** is formed with a central opening **140** which forms a part of the pilot pressure chamber exhaust passageway having its lower end communicated with the vertical bore **112**, as by an elongated slot **142** formed in the upper gasket **120** with its ends communicating respectively with the central opening **140** and the vertical bore **112** through the registering openings in the plate **118** and lower gasket **114**. The upper end of the opening **140** is defined by an annular portion defining an upwardly facing annular valve seat **144** adapted to be engaged by the central portion of the diaphragm **128**.

It can be seen that when chamber **126** is pressurized, diaphragm **128** will move into pressure engagement with the valve seat **144** closing the pilot pressure exhaust passageway. When the chamber **126** is exhausted to atmosphere, pilot pressure within the exhaust passageway including the central opening **140** will move the diaphragm **128** upwardly, thus communicating the pilot pressure with the annular space between the valve member **130** and the diaphragm **128**. This space is communicated with the atmosphere through a port **146** formed in the valve member **130** adjacent its periphery. The upper gasket **120** includes an opening **148** which communicates with the port **146** and with one end of an elongated slot **150** formed in the plate **118** therebelow. The opposite end of the slot **150** communicates with a radial extension of an annular opening **152** formed in the upper gasket **120** concentric with the valve insert **62**. Preferably, the cap member **122** is apertured, as indicated at **154**, concentric with the valve insert **62** and an exhaust cap assembly **156** is mounted within the aperture **154** to deflect the air under pressure exhausting to the atmosphere laterally away from the hand of the operator through a discharge opening **157**. The exhaust cap assembly **156** also serves to protect the exhaust valve element **86** of the main control valve **56** from damage.

As shown in FIGS. **1** and **2**, the fluid pressure operated system **22** includes a conventional plenum chamber system for effecting the return stroke of the fastener driving element **20**. To this end, the drive portion **30** of the housing **12** is formed with a plenum chamber **158** in surrounding relation to the exterior periphery of the cylinder **32**. The upper end of the plenum chamber is sealed with respect to the cylinder by any suitable means, such as an O-ring seal **160** mounted within an appropriate annular groove in the upper interior periphery of the main casting of the housing **12** and disposed in engagement with the exterior periphery of the cylinder **32**.

As best shown in FIG. **4**, the opposite lateral sides of the lower end of the cylinder **32** are communicated directly with the lower end of the plenum chamber **158**. In this regard, it should be noted that the main casting has a counterbored opening **170** formed in the lower end portion thereof, concentric with the cylinder **32** within which is engaged the lower end of a bumper pad **172**. The bumper pad **172** is formed with a central opening **174** of a size somewhat greater than the size of the fastener driving element **20** so as to provide part of an exhaust passageway for the bottom of the cylinder when the fastener driving element **20** is disposed in its uppermost fastener receiving position. Preferably, a plate **176** is secured to the main casting below the bumper pad **172**, the latter being detachably secured to the main casting by a series of bolts **178** or the like which also extend through the adjacent portion of the magazine assembly to detachably secure the forward end of the latter to the main casting of the housing **12**. As best shown in FIGS. **1** and **2**, the plate **176** has a restricted passage **179** therein which forms the remaining part of the exhaust passageway provided by the opening **174**.

In accordance with conventional practice, the cylinder **32** is formed with an opening **180** which is disposed in a position slightly above the O-ring **42** of the piston assembly **36** when the latter is disposed in its lowermost fastener driven position, as best shown in FIG. **2**. It will be understood that the plenum return system operates in conventional fashion. Thus, during the drive stroke of the drive piston assembly **36**, the air within the cylinder below the piston is initially, at least partially, discharged through the exhaust passageway provided by the opening **174** and passage **179**.

During the latter portion of the drive stroke, the air within the cylinder **32** below the piston assembly **36** may be somewhat compressed into the plenum chamber **158**. When the piston assembly reaches the end of its drive stroke, the engagement of the piston pad with the pad **172** seals off any exhaust through the aforesaid exhaust passageway while at the same time the air under pressure acting on the upper surface of the piston enters opening **180** to immediately pressurize the plenum chamber **158** to substantially full reservoir pressure.

The charging of the plenum chamber **158** with fluid under pressure in the manner indicated above, is used as a pressure signal to operate the auto-fire valve **108**. To this end, the diaphragm chamber **126** thereof is communicated with the plenum chamber **158** through a series of passages including a vertical port **182**, communicating with the central portion of the chamber **126**, a transverse port **184** communicating at one end with the port **182** and at its other end with a vertical bore **186**, the port **182** and bores **184** and **186** being formed in the cap member **122**. The lower end of the bore **186** communicates with the upper end of a vertical bore **188** formed in the main casting through a series of registering openings **190** formed in the upper gasket **120**, plate **118** and lower gasket **114**. The lower end of the bore **188** communicates with the upper end of the plenum chamber **158**.

Preferably, the bore **184** is counterbored as indicated at **192** to threadedly receive an adjusting member **194** having a frustoconical inner end portion **196** which is adapted to be positioned within the adjacent end of the bore **184** to provide an adjustable restriction to the flow of fluid from the plenum chamber **158** to the diaphragm chamber **126** and vice versa.

Referring now more particularly to FIGS. **3** and **4**, the manually controlled actuating mechanism **24** preferably includes a trigger member **198** which, as shown, is of generally U-shaped construction, having a pair of forwardly extending tabs **200** which are apertured to receive a pivot pin **202** extending through the upper end portion of a pair of transversely spaced vertically extending ribs **204** forming an integral part of the main casting of the housing **12**. The trigger member **198** is biased by its own weight into a normally inoperative limiting position wherein the bight portion of the trigger engages the adjacent outer surface of the ribs **204**, as indicated at **206** in FIG. **1**. The trigger member **198** is adapted to be engaged by the finger of an operator whose hand is in engagement with handle portion **28** and is mounted for pivotal movement about the pivot pin **202** in a counterclockwise direction as viewed in FIG. **1** into an operative position wherein the bight portion of the trigger engages a depending abutment **208** formed integrally on the main casting of the housing **12** as best shown in FIG. **2**.

The manually controlled actuating mechanism **24** also preferably includes a work contacting member or contact trip element **210** which, as shown, is generally of L-shaped configuration including an annular horizontally extending portion and having a lower work engaging horizontal surface **212** and a vertical portion **214** extending upwardly therefrom.

The vertical portion **214** of the work contacting member **210** is mounted for vertical reciprocating movement with respect to the nose piece **16** between a lower normally inoperable limiting position and an upper operative limiting position. To this end, it will be noted that the nose piece includes a pair of cooperating vertically extending plates **216** and **218**, the plate **216** having a transverse opening **220** formed therein through which the fasteners F from the magazine assembly **14** are fed to the drive track **18**, the latter being defined by a slot formed in the plate **218** and the encompassed surfaces of the plate **216**. The lower ends of the plates **216** and **218** define horizontal surface means **222** adapted to engage the surface of the workpiece W when the device **10** is disposed in operative engagement therewith, as shown in FIG. **2**.

The vertical portion **214** of the work contacting member **210** has one surface thereof disposed in sliding engagement with the lower central exterior surface of the plate **218**. The vertical portion **214** of the work contacting member **210** is guided for vertical sliding movement along the peripheral outer surface of the plate **218** by the lower end portion of a housing plate **224**, the housing plate **224** together with the plates **216** and **218** being detachably secured to the magazine assembly **14** as by a pair of bolts **226**.

The upper end of the vertical portion **214** has a tab **228** struck therefrom and bent downwardly and outwardly. The tab **228** is apertured to receive one end of a guide pin **230**. Mounted in surrounding relation to the guide pin **230**, is a compression coil spring **232** which is adapted to transmit the vertical movement of the work contacting member **210** to a motion transmitting member, generally indicated at **234**. The motion transmitting member **234** includes a front vertically extending portion **236** mounted in alignment with a vertical portion **214** of the work contacting member **210** in vertically spaced relation thereto. The upper end of the front vertical portion **236** has a tab **238** struck therefrom and bent downwardly and outwardly to engage the upper end of the coil spring **232** the lower end of which engages the tab **228**. The tab **228** is apertured to receive the upper end of the guide pin **230**.

The motion transmitting member **234** also includes an elongated bent section including a front portion **240** which extends laterally outwardly from the one side of the vertical portion **236** adjacent the lower end thereof, through an opening **242** in the housing plate **224**, a rearwardly extending horizontal portion **244** and upwardly bent vertical portion **246** and a horizontally extending portion **248**. Fixedly secured to the upper surface of the horizontal portion **248**, as by welding or the like, is a guide rod **250** having a coil spring **252** disposed in surrounding relation thereto. The upper end of the guide rod **250** extends through an opening in a plate **254** mounted between the ribs **204**, the upper end of the spring **252** engaging the plate **254** and the lower end of the spring engaging the portion **248** so as to resiliently urge the motion transmitting member **234** downwardly into a lower limiting position wherein the lower surface of the horizontal portion **240** engages the adjacent surface of the opening **242** formed in the housing plate **224**.

The upper end of the guide rod **250** includes a cam surface **256**, which, when the member **234** is disposed in its normally biased limiting position, is disposed in spaced relation below one end of an interlock lever member **258**. As best shown in FIGS. **1** and **2** the interlock member **258** is generally of U-shaped cross-sectional configuration having the central portion of its legs pivotally connected with the lower end of the actuating member **92**, as by a pivot pin **260**. The opposite end of the interlock member **258** has a depressed portion **262** formed in the bight portion thereof which is adapted to engage the adjacent surface of the trigger member **198**.

OPERATION

It will be noted that when the device **10** is in an inoperative condition as shown in FIG. **1**, spring **94** acts to resiliently bias the main valve **56** into its closed upper limiting position. The spring **94** also serves to bias the actuating valve **92** into its closed position. Trigger member **198** is biased by its own weight into its inoperative position and spring **252** serves to bias the motion transmitting member **234** into its lowermost limiting position, spring **232** serving to likewise maintain the work contacting member **210** in its lowermost limiting position.

When the device **10** is connected with a source of fluid under pressure, reservoir **26** is immediately charged and this fluid pressure is free to pass into the pilot chamber **90** through the restricted orifice **96**. Thus, the pressure within the pilot chamber **90** serves to maintain the main control valve **56** in its closed position wherein the upper end of the drive chamber **34** is communicated with the atmosphere through the open exhaust valve element **86**. It will also be understood that the drive piston assembly **36** will normally be disposed in its uppermost limiting position all as shown in FIG. **1**.

The fluid pressure operated system **22** is actuated by moving the actuating valve **92** from its normal inoperative closed position into its operative open position. This actuation requires a manual movement of the trigger member **198** and of the work contacting member **210** into their operative positions. The operation of the interlock lever **258** is such that the actuating valve will be moved into its operative position in response to any one of the three following conditions: (1) a

simultaneous or concomitant movement of the trigger member and contacting member **210** into their operative positions; (2) a movement of the work contacting member **210** into its operative position when the trigger member **198** is disposed in its operative position; and (3) a movement of the trigger member **198** into its operative position when the work contacting member **210** is disposed in its operative position.

With reference to FIG. **6**, it will be noted that a movement of the work contacting member **210** into its operative position, while the trigger member **198** is in its inoperative position, will merely result in moving the cam surface **256** into engagement with or into slightly spaced relation to the associated end of the interlock member **258**. Under these circumstances, a pivotal movement of the trigger member **198** into its operative position will effect a counterclockwise pivotal movement of the interlock member about the cam surface **256** as a fulcrum, which movement will effect movement of the trigger valve into its operative position, as shown in FIG. **2**. Likewise, with reference to FIG. **7**, it will be noted that a movement of the trigger member **198**, while the work contacting member **210** is disposed in its inoperative position will result in a counterclockwise pivotal movement of the interlock member **258** about the pivot pin **260** without any corresponding movement of the actuating valve **92**. This pivotal movement of the interlock member **258** merely serves to move the end thereof which is normally spaced from the cam surface **256** when the work contacting member **210** is disposed in its normal inoperative position into engagement with or into slightly spaced relation to the cam surface **256**. Under these conditions, movement of the work contacting member **210** into its operative position will effect a pivotal movement of the interlock member **258** about the projection **262** as a fulcrum, which movement will effect the movement of the trigger valve into its operative position as shown in FIG. **2**.

The movement of the actuating valve **92** into its operative position opens the pilot exhaust passageway. Pilot pressure enters the counterbore **102**, transverse bore **110**, vertical bore **112**, slot **142** and auto-fire valve opening **140**. Since the diaphragm chamber **126** is receiving an atmospheric pressure signal from the plenum chamber **158**, the pilot pressure in opening **140** moves the diaphragm **128** upwardly permitting the pilot pressure to exhaust to atmosphere through port **146**, opening **148**, slot **150**, opening **152** and laterally outwardly of the exhaust cap assembly **156** through opening **157**.

It will be noted that the exhaust passageway provides a cross-sectional area which is greater than the cross-sectional area of the restricted orifice **96** and, consequently, the pilot pressure within the pilot chamber **90** will exhaust substantially to atmospheric conditions notwithstanding its continuous communication with the reservoir **26** through the restricted orifice **96**. As soon as the pilot pressure drops, pressure within the reservoir **26** acting on the upper surface of the pilot piston **88** will move the main valve **76** downwardly into its lowermost position wherein the inlet valve element **80** communicates the inlet **66** with the reservoir and exhaust valve element **86** closes the outlet **74**. Reservoir pressure is then communicated to the upper end of the drive chamber **34** through openings **70** and **72** to effect the drive stroke of the piston assembly **36** and fastener driving element **20** connected thereto.

As previously noted, when the drive stroke is completed and the drive piston assembly **36** reaches its fastener driven position, plenum chamber **158** is charged with reservoir pressure from the drive chamber **34** through the opening **180**. This pressure is communicated as a signal past the metering element **196** to the auto-fire valve diaphragm chamber **126**. This pressure signal which acts on the entire surface of the diaphragm urges the central portion thereof into pressure-tight engagement with the annular valve surface **144**, thus closing the opening **140** of the pilot exhaust passageway. The reservoir pressure entering the pilot chamber **90** through the restricted orifice **96** can now build up in the pilot chamber until it reaches a value sufficient to effect the upward movement of the main valve **76** into its closed position as shown in FIG. **1**.

When the main control valve is in this position, the inlet valve element **80** is disposed in engagement with the valve seat **68** closing off communication between the reservoir and the drive chamber **34** while the outlet opening **74** is communicated past the open exhaust valve element **86** to the atmosphere through the cap assembly **156** through opening **157**. The exhaust of the fluid pressure above the drive piston **36** permits the fluid pressure charge within plenum chamber **158** to effect the rapid return stroke of the piston and fastener driving element **20** connected thereto into its uppermost position. During the latter portion of this movement the pressure within the plenum chamber **158** is allowed to restrictively exhaust to atmosphere through opening **174** and passage **179**. The arrangement of the exhaust passageway provided by the opening **174** and passage **179** provides a constant restriction to exhaust except when the pad **50** is actually in engagement with the bumper pad **172**. It will be understood that a variable restriction may be provided in accordance with conventional practice, wherein a lesser restriction taken place when the piston is adjacent its uppermost position.

The exhaust of the plenum chamber **158** serves as a pressure signal to condition the auto-fire valve **108** to unblock the pilot chamber exhaust passageway and thereby commence the drive stroke of the next cycle. In this regard, it will be noted that as soon as the pressure within the auto-fire valve diaphragm chamber **126** reduces to a value sufficient to permit the pressure in the opening **140** to move the diaphragm out of engagement with the seat **144**, the pilot chamber **90** will begin to exhaust which, when it reaches a predetermined lower pressure condition, will permit the main valve **76** to be moved downwardly into its open position to commence the drive stroke of the next cycle. Since the change in pressure within the auto-fire valve diaphragm chamber **126** serves to initiate the operations which effect automatic recycling and since the rate of change of the pressure within the chamber **126** can be controlled by adjusting the setting of member **194**, the latter serves as a means for controlling the rate of the cycle of operation. By adjusting the member **194** to provide a greater restriction to air flow thereby, the speed with which a cycle of operation is completed is reduced. Conversely, by adjusting the member **194** so as to provide less restriction to air flow thereby, the speed with which a cycle of operation is completed is increased.

It will be understood that the device will continue to recycle automatically so long as the actuating valve **92** is maintained in its operating position by the actuating mechanism **24**. In normal auto-fire operation, the operator moves the device along the surface of a workpiece W while continuously depressing the trigger member **198** and maintaining the surface **222** of the nose piece **16** in engagement with the surface of the workpiece W.

In accordance with conventional practice, it is sometimes desirable to provide the fastener driving element with a length such that when it is disposed in its fastener driven position, the lower fastener engaging surface thereof extends outwardly beyond the surface **222** of the nose piece **16** a predetermined distance, as, for example, the distance designated by the reference character X in FIG. **2**. The work contacting surface **212** of the work contacting member **210** when the latter is disposed in its normally biased inoperative position, is disposed outwardly of the nose piece surface **222**, a distance which is generally equal to the distance X plus the distance designated by the letter Y equal to the movement of the motion transmitting member **234** necessary to effect the movement of the trigger valve **92** into its operative limiting position. It will be noted, however, that since the movement of the work contacting member **210** is transmitted to the motion transmitting member **234** by the spring **232**, the total movement of the motion transmitting member **234** can be less than that of the work contacting member **210**. Preferably, the total movement of the motion transmitting member is generally equal to the distance Y and it will be noted that the upper surface of the vertical portion **236** thereof will engage the adjacent lower surface of the plate **176** when the motion transmitting member

240 has moved with the work contacting member through the distance Y. Subsequent movement of the work contacting member through the distance X will result in a yielding movement of the spring 232 without a corresponding movement of the member 234.

With this arrangement, it will be noted that in the event that the movement of the fastener driving element into its fastener driving position should result in a recoil movement of the entire device away from the work contacting surface in a range which is generally equal to the distance X, the work contacting member 210 alone will move under the action of spring 232 relative to the housing with substantially no movement of member 234 thereby preventing any undesired closing movement of the actuating valve 92 which would have the effect of disrupting the automatic cycling of the fluid pressure operating system 22.

It will be understood the operation of the spring 232 would have the same advantages in a device, without fastener driving element overtravel, which had sufficient recoil to cause the device to move off of the workpiece. Moreover, such operation would have advantages where the contact trip constitutes the only manual means for actuating the device.

It will be understood that the time required to automatically cycle the device is dependent upon the setting of the frustoconical needle valve 196 within the bore 184. Moreover, by adjusting the threaded member so as to provide the slowest speed of automatic cycle, the operator is enabled to effect manual operation either in single fire, bump fire or drag fire fashion before automatic recycling will take place.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

We claim:

1. A fastener driving device comprising:

a housing having means defining a pressure reservoir for receiving and containing fluid under pressure supplied thereto from a source of fluid under pressure;

means defining a drive track for receiving successive fasteners to be driven from a supply of such fasteners fed thereto;

fastener driving means carried by said housing for movement from a fastener receiving position through said drive track in a drive stroke into a fastener driven position and from said fastener driven position through a return stroke into said fastener receiving position;

means within said housing defining a driving pressure chamber disposed in fluid communicating relation to said fastener driving means;

main control valve means movable between a first position communicating said driving chamber with the atmosphere and closing communication between said driving chamber and said reservoir and a second position communicating said driving chamber with said reservoir and closing off communication of said driving chamber with the atmosphere so that said fastener driving means will be moved through said drive stroke in response to the movement of said main valve means into said second position and through said return stroke in response to the movement of said main valve means into said first position;

means defining a pilot pressure chamber;

a pilot pressure actuated member disposed in pressure communicating relation with said pilot chamber for movement from a first position into a first position in response to the communication of pilot pressure within said pilot chamber and from said second position into said first position in response to the exhaust of said pilot chamber to atmosphere;

means operable in response to the movement of said pilot pressure actuated member into said first position for effecting movement of said main valve means into said second position and operable in response to the movement of said pilot pressure actuated member into said second position for effecting movement of said main valve means into said first position;

means defining a restricted orifice continuously communicating said reservoir with said pilot chamber;

means defining an exhaust outlet for said pilot chamber of a size greater than said restricted orifice;

manually operable valve means mounted for movement between a normally closed position preventing communication of said pilot pressure chamber with said exhaust outlet and a manually actuated opened position communicating said pilot chamber with said exhaust outlet;

auto-fire valve means arranged in series with said manually operable valve means between said pilot chamber and said exhaust outlet for controlling communication of said pilot chamber and said exhaust outlet when said manually operable valve means is disposed in said manually actuated opened position;

said auto-fire valve means including a valve member mounted for movement between an opened position communicating said pilot pressure chamber with said exhaust outlet when said manually operated valve means is disposed in said manually actuated opened position and a closed position preventing communication of said pilot chamber with said exhaust outlet when said manually operated valve means is disposed in said manually actuated opened position;

first pressure surface means operatively associated with said valve member and disposed in pressure communicating relation with said pilot chamber operable to bias said valve member into said opened position in response to the communication of pressure in said pilot chamber therewith;

second pressure surface means operatively associated with said valve member of an effective area sufficiently greater than the effective area of said first pressure surface means to bias said valve member into said closed position in response to the communication of signal pressure therewith with a force greater than the force acting on said first pressure surface means biasing said valve member into said opened position; and

means for communicating with said second pressure surface means a signal pressure, separate from said pilot pressure, established as a result of the movement of said pilot pressure actuated member into said second position, which signal pressure is dissipated as a result of the movement of said pilot pressure actuated member into said first position so that when said manually operable valve means is disposed in said manually actuated opened position said autofire valve means is operable to effect movement of said fastener driving means through continuous drive stroke and return stroke cycles until said manually operable valve means is moved into said closed position.

2. A fastener driving device as defined in claim 1 including:

means defining a return plenum chamber;

means for charging said return plenum chamber with fluid under pressure when said fastener driving means has moved through its drive stroke;

means for communicating the fluid pressure charge of said plenum chamber with said fastener driving means to effect the return stroke thereof in response to the movement of said main valve means into its first position;

means for exhausting the fluid pressure charge of said plenum chamber when said fastener driving means has completed its return stroke; and

wherein said signal pressure communicating means include means defining a passageway communicating said plenum chamber with said second pressure surface means so that the fluid pressure charge of said plenum chamber constitutes said signal pressure.

3. A fastener driving device as defined in claim 2 including a flow restricting member adjustably mounted within said passageway for determining the rate at which said signal pressure is communicated with and dissipated from said second pressure surface means to thereby determine the rate of the continuous drive stroke and return stroke cycles.

4. A fastener driving device as defined in claim 3 wherein said valve member comprises a flexible annular diaphragm mounted with its periphery in confined relation, one surface of said diaphragm defined by the peripheral confinement thereof constituting said second pressure surface means, a central portion of the opposite surface of said diaphragm being engageable with an annular valve seat and constituting said first pressure surface means.

5. A fastener driving device as defined in claim 1 wherein said driving chamber defining means comprises a cylinder, said housing including a main casting having a bore extending downwardly from the upper end portion thereof receiving said cylinder, and a cap assembly fixedly secured to said main casting above said cylinder, said auto-fire valve means being carried by said cap assembly.

6. A fastener driving device as defined in claim 5 wherein said means for effecting movement of said main valve means in response to the movement of said pilot pressure actuated member comprises an elongated member mounted within said housing with its longitudinal axis parallel with the axis of said cylinder, said elongated member having a piston portion formed integrally on the lower end thereof which constitutes said pilot pressure actuated member, the lower surface of said piston portion being in communication with said pilot chamber and the upper surface thereof being in communication with said reservoir, said main valve means including an annular inlet valve element of an effective diameter less than said piston portion carried by said elongated member in upwardly spaced concentric relation to said piston portion and having an upwardly facing annular surface for engaging an annular valve seat fixed with respect to said housing in a position between said reservoir and the upper end of said cylinder and an annular exhaust valve element of a diameter less than said inlet valve element carried by said elongated member in upwardly spaced concentric relation to said inlet valve element for engaging an annular valve seat fixed with respect to said housing in a position between the upper end of said cylinder and a portion of said cap assembly having an exhaust opening therein.

7. A fastener driving device as defined in claim 1 wherein said housing includes a handle portion arranged to be gripped by the hand of an operator and a nose piece defining operatively fixed surface means engageable with a workpiece when said housing is manually moved by the operator into operative relation with a workpiece;

said fluid pressure operated fastener driving means includes a fastener driving element having a fastener engaging end spaced outwardly beyond said work engaging surface means when said fastener driving means is disposed in said fastener driven position;

a work contacting member carried by said housing for limited movement between a normal inoperative position and an operative position, said work contacting member including work engaging surface means disposed outwardly of said fixed surface means when said work contacting member is disposed in said inoperative position a predetermined distance beyond the position of said fastener driving element when the latter is disposed in said fastener driven position and in alignment with said fixed surface means when said work contacting member is in said operative position;

a motion transmitting member carried by said housing for limited movement between a normally inoperative position and an operative position;

spring means operatively connected between said members for transmitting the movement of said work contacting member from said inoperative position generally through said predetermined distance to said motion transmitting member to move the latter from said inoperative position to said operative position and for yielding during the remainder of the movement of said work contacting member into said operative position while said motion transmitting member remains immobile;

a trigger carried by said housing in a normal limited inoperative position operable to be engaged by a finger of the operator when said handle portion is manually gripped for manual movement into a limited operative position; and

interlock means operatively connected between said trigger and said motion transmitting member for effecting movement of said manually operable valve means into the opened position thereof in response (1) to the simultaneous movement of said motion transmitting member and said trigger into their operative position, (2) to the movement of said motion transmitting member into its operative position when said trigger is in its operative position or (3) to the movement of said trigger into its operative position when said motion transmitting member is in its operative position, the yielding movement of said spring means preventing undesired movement of said manually operable valve means into said closed position by a relative movement of said work contacting member away from its operative position as a result of a movement of the housing away from the work piece against the manual pressure of the operator on the handle portion by the action of the fastener driving element moving into said fastener driven position.

8. A fastener driving device as defined in claim 7 wherein said manually operable valve means includes an actuating member having a depending end portion and wherein said interlock means includes an elongated interlock member, means pivotally interconnecting said interlock member intermediate its ends with the depending end portion of said actuating member, means connecting one end of said interlock member with said motion transmitting member for movement thereby in response to the movement of said work contacting member from said inoperative position to said operative position, and means for connecting the other end of said interlock member with said trigger for movement in response to the movement of said trigger from said inoperative position to said operative position.

9. A fastener driving device comprising a housing defining a handle portion arranged to be gripped by the hand of an operator and a nose piece defining operatively fixed surface means engageable with a workpiece when said housing is manually moved by the operator into operative relation with a workpiece;

fluid pressure operated fastener driving means including a fastener driving element carried by said housing for movement from a fastener receiving position through a drive stroke into a fastener driven position and from said fastener driven position through a return stroke into said fastener receiving position;

manually operable valve means normally disposed in an inoperative position movable into an operative position to actuate said fluid pressure operated means;

a work contacting member carried by said housing for a limited movement between a normal inoperative position and an operative position, said work contacting member including work engaging surface means disposed outwardly of said fixed surface means when said work contacting member is disposed in said inoperative position a predetermined distance beyond the position of said fastener driving element when the latter is disposed in said fastener driven position and in alignment with said fixed surface means when said work contacting member is in said operative position;

a motion transmitting member carried by said housing for limited movement between a normally inoperative position and an operative position;

spring means operatively connected between said members for transmitting the movement of said work contacting member from said inoperative position generally through said predetermined distance to said motion transmitting member to move the latter from said inoperative position to said operative position and for yielding during the remainder of the movement of said work contacting member into said inoperative position while said motion transmitting member remains immobile;

a trigger carried by said housing in a normal limited inoperative position operable to be engaged by a finger of the operator when said handle portion is manually gripped for manual movement into a limited operative position; and

interlock means operatively connected between said trigger and said motion transmitting member for effecting movement of said valve means into the operative position thereof in response (1) to the simultaneous movement of said motion transmitting member and said trigger into their operative positions, (2) to the movement of said motion transmitting member into its operative position when said trigger is in its operative position or (3) to the movement of said trigger into its operative position when said motion transmitting member is in its operative position, the yielding movement of said spring means preventing undesired movement of said valve means into said inoperative position by a relative movement of said work contacting member away from its operative position as a result of a movement of the housing away from the work piece against the manual pressure of the operator on the handle portion.

10. A fastener driving device as defined in claim **9** wherein said work contacting member includes a vertically extending portion mounted adjacent said nose piece, said motion transmitting member includes a vertically extending portion disposed above said work contacting member portion and said spring means comprises a coil spring and means for mounting said coil spring between the vertically extending portions of said members.

11. A fastener driving device as defined in claim **10** wherein said coil spring mounting means includes a tab bent outwardly from each vertically extending portion engaging an end of said coil spring and a guide rod extending through said tabs and said coil spring.

12. A fastener driving device as defined in claim **11** including a housing plate secured to said nose piece generally enclosing said vertically extending portions, said tabs, said guide rod and said coil spring.

13. A fastener driving device as defined in claim **12** wherein said motion transmitting member further includes a second portion extending laterally outwardly through said housing place, a third portion extending horizontally rearwardly from said second portion, a fourth portion extending upwardly from said second portion, a fifth portion extending laterally from said fourth portion and a sixth portion extending upwardly from said fifth portion, a second coil spring disposed in surrounding relation to said sixth portion having its ends operatively engaged with said fifth portion and said housing respectively so as to bias said motion transmitting member into its inoperative position.

14. A fastener driving device as defined in claim **13** wherein said manually operable valve means includes an actuating member having a depending end portion and wherein said interlock means includes an elongated interlock member, means pivotally interconnecting said interlock member intermediate its ends with the depending end portion of said actuating member, a lost motion connection between one end of said interlock member and the upper end of the fifth portion of said motion transmitting member and a lost motion connection between the other end of said interlock member and said trigger.

15. In a fastener driving device of the type including a housing, fluid pressure operated fastener driving means carried by said housing for movement through a fastener driving stroke and a return stroke, valve means including a depending actuating member carried by said housing for movement from a normally inoperative position into an operative position for effecting the operation of said fluid pressure operated means through said fastener driving stroke, a work contacting member carried by said housing for movement from an inoperative position to an operative position in response to the movement of said apparatus into cooperating engagement with a work piece, a trigger member carried by said housing for manual movement from an inoperative position to an operative position, and interlock means for effecting movement of said valve means into the operative position thereof in response (1) to the simultaneous movement of said work contacting and said trigger members into their operative positions, (2) to the movement of said work contacting member into its operative position when said trigger member is in its operative position or (3) to the movement of said trigger member into its operative position when said work contacting member is in its operative position, the improvement which comprises said interlock means including an elongated interlock member, means pivotally interconnecting said interlock member intermediate its ends with the depending end portion of said valve means actuating member, means connecting one end of said interlock member with said work contacting member for movement thereby in response to the movement of said work contacting member from said inoperative position to said operative position, and means for connecting the other end of said interlock member with said trigger member for movement in response to the movement of said trigger member from said inoperative position to said operative position.

16. A fastener driving device comprising a housing defining a handle portion arranged to be gripped by the hand of an operator and a nose piece defining operatively fixed surface means engageable with a workpiece when said housing is manually moved by the operator into operative relation with a workpiece;

fluid pressure operated fastener driving means including a fastener driving element carried by said housing for movement from a fastener receiving position through a drive stroke into a fastener driven position and from said fastener driven position through a return stroke into said fastener receiving position;

manually operable valve means normally disposed in an inoperative position movable into an operative position to actuate said fluid pressure operated means;

a work contacting member carried by said housing for limited movement between a normal inoperative position and an operative position, said work contacting member including work engaging surface means disposed outwardly of said fixed surface means when said work contacting member is disposed in said inoperative position a predetermined distance beyond the position of said fastener driving element when the latter is disposed in said fastener driven position and in alignment with said fixed surface means when said work contacting member is in said operative position;

a motion transmitting member carried by said housing for limited movement between a normally inoperative position and an operative position;

spring means operatively connected between said members for transmitting the movement of said work contacting member from said inoperative position generally through said predetermined distance to said motion transmitting member to move the latter from said inoperative position to said operative position and for yielding during the remainder of the movement of said work contacting member into said inoperative position while said motion transmitting member remains immobile; and

means operatively connected with said motion transmitting member for effecting movement of said valve means into the operative position thereof when said motion transmitting member is disposed in its operative position.