April 27, 1965

W. R. SIMMONS

LOCK BOLT GUN

3,180,017

Filed Feb. 12, 1962

5 Sheets-Sheet 1

Fig. 1.

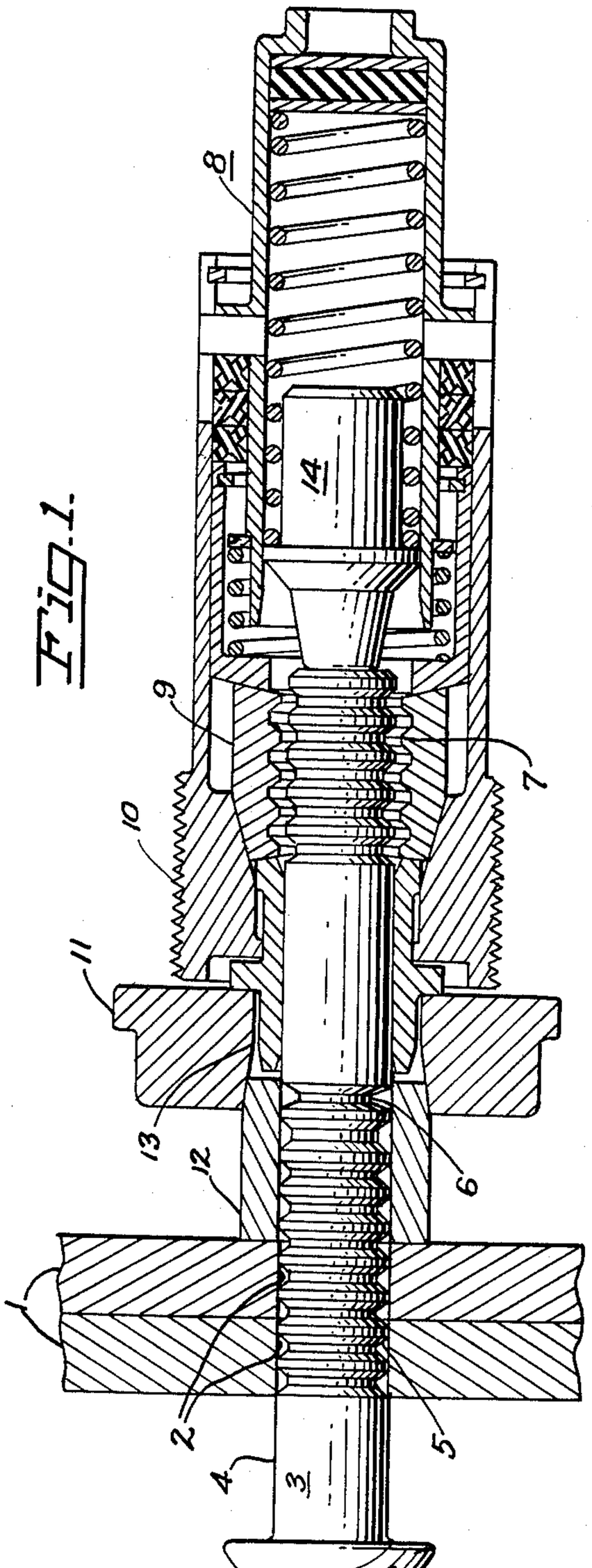
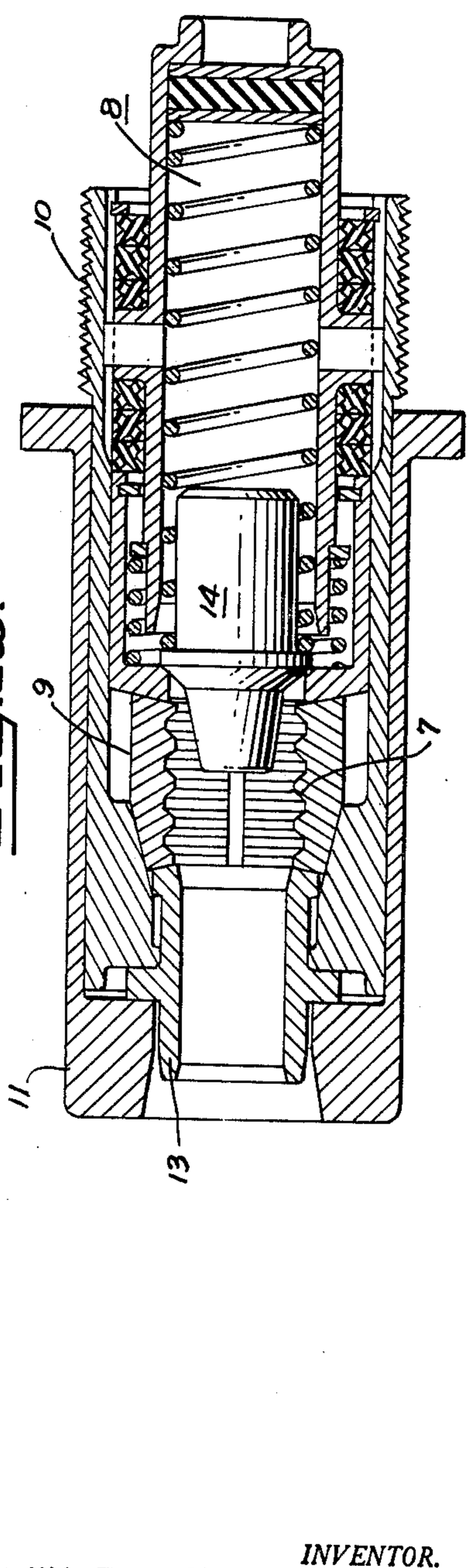


Fig. 1a.



INVENTOR.
WALTER RUSSELL SIMMONS
BY
George B White
ATTORNEY

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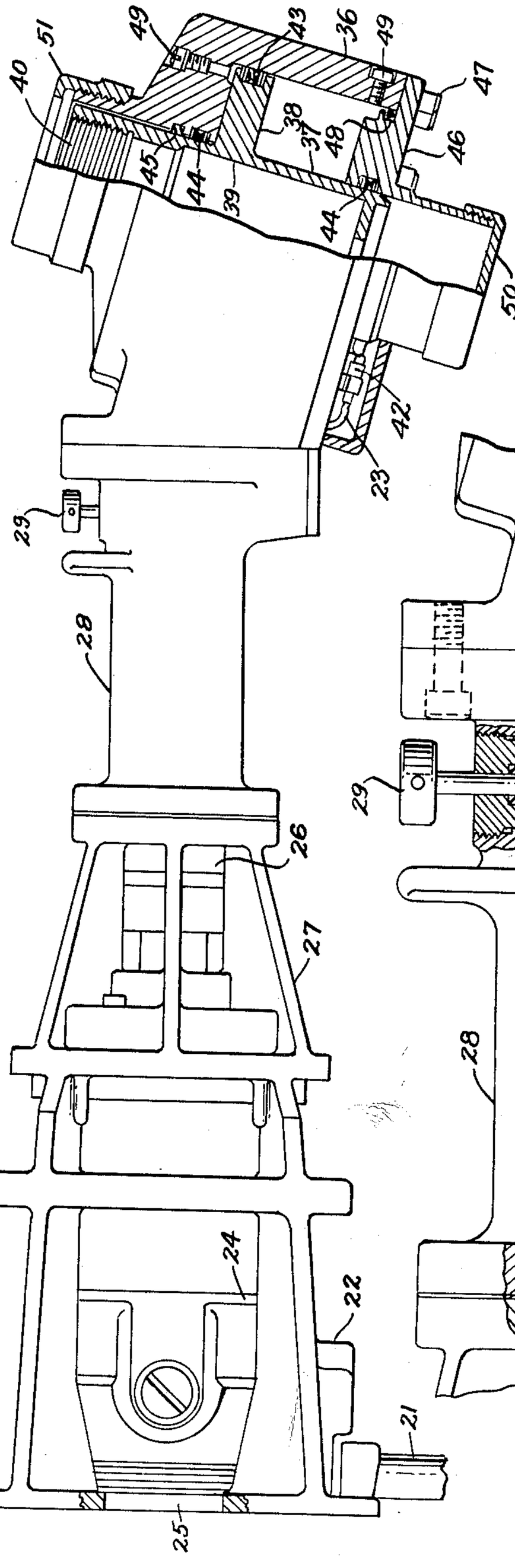

Fig. 2.

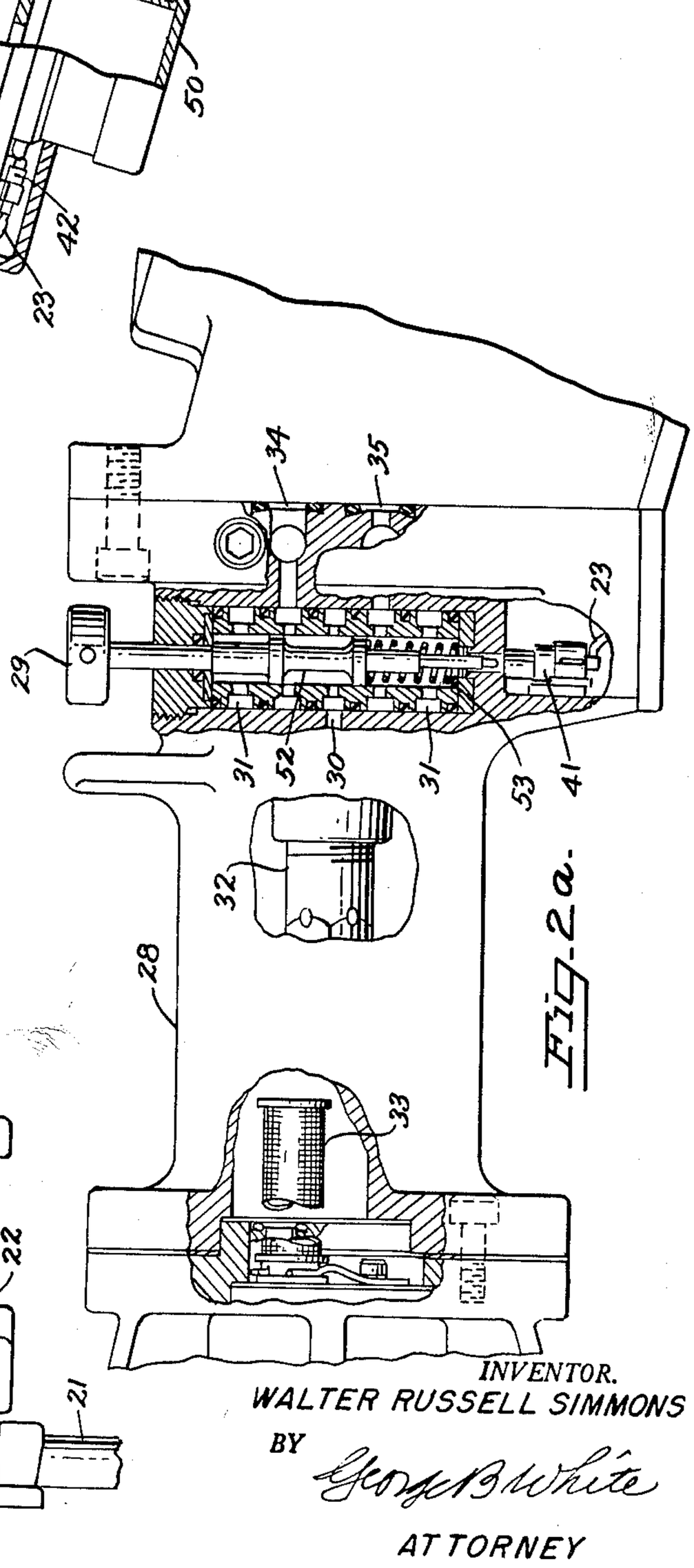

Fig. 2a.

INVENTOR.
WALTER RUSSELL SIMMONS
BY George B. White
ATTORNEY

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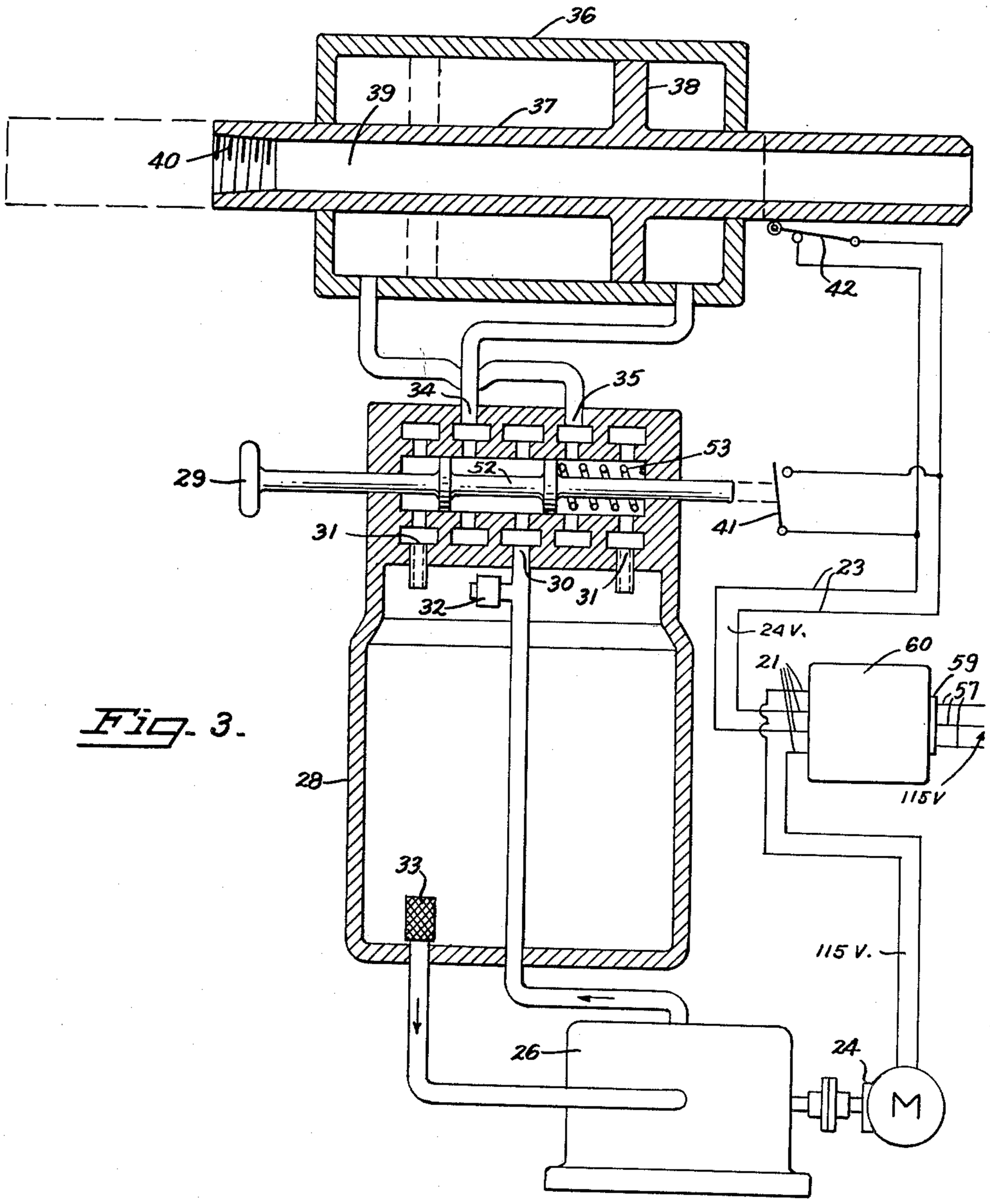

Fig. 3.

INVENTOR.
WALTER RUSSELL SIMMONS
BY
George B White
ATTORNEY

April 27, 1965 W. R. SIMMONS 3,180,017

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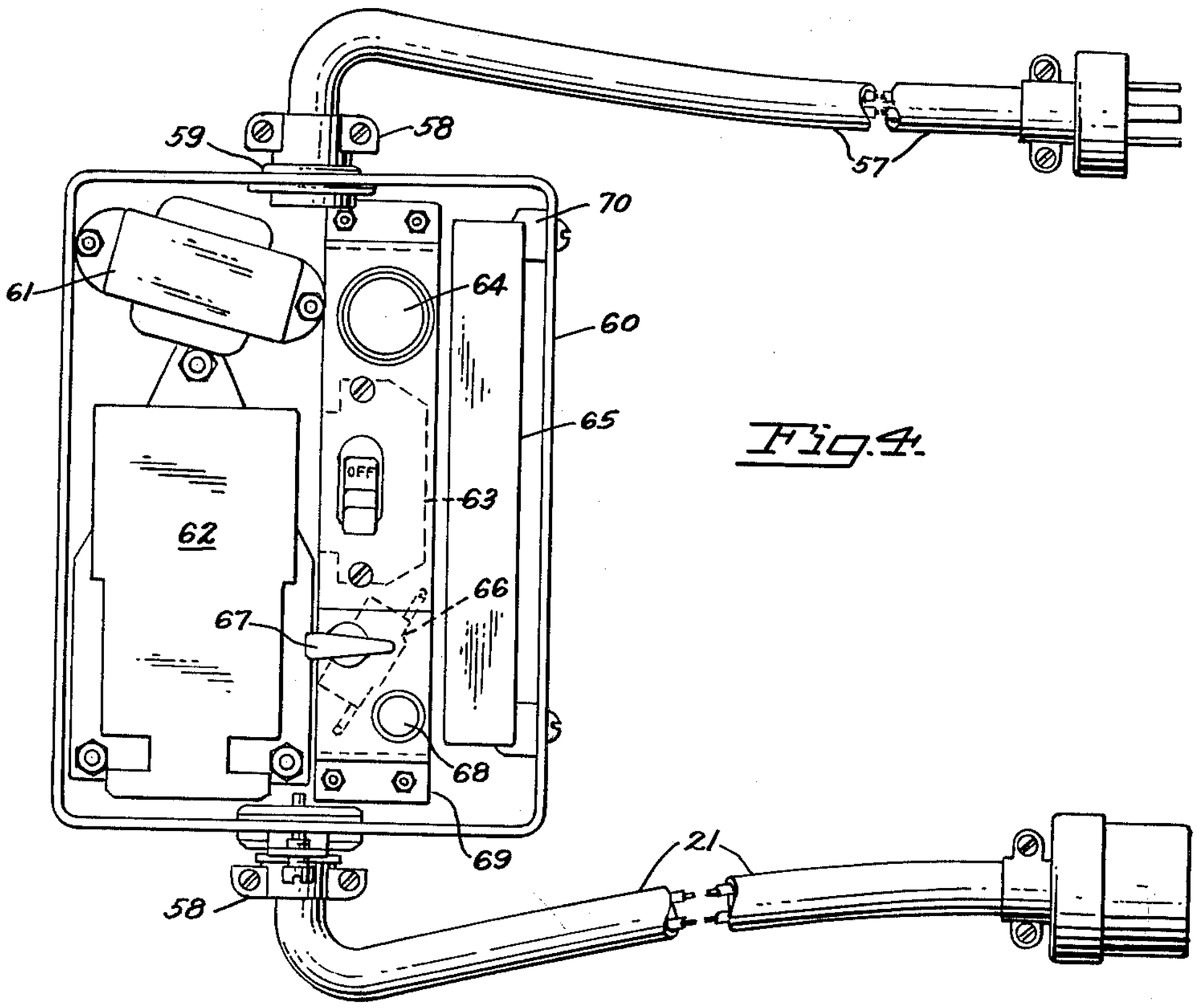

Fig. 4.

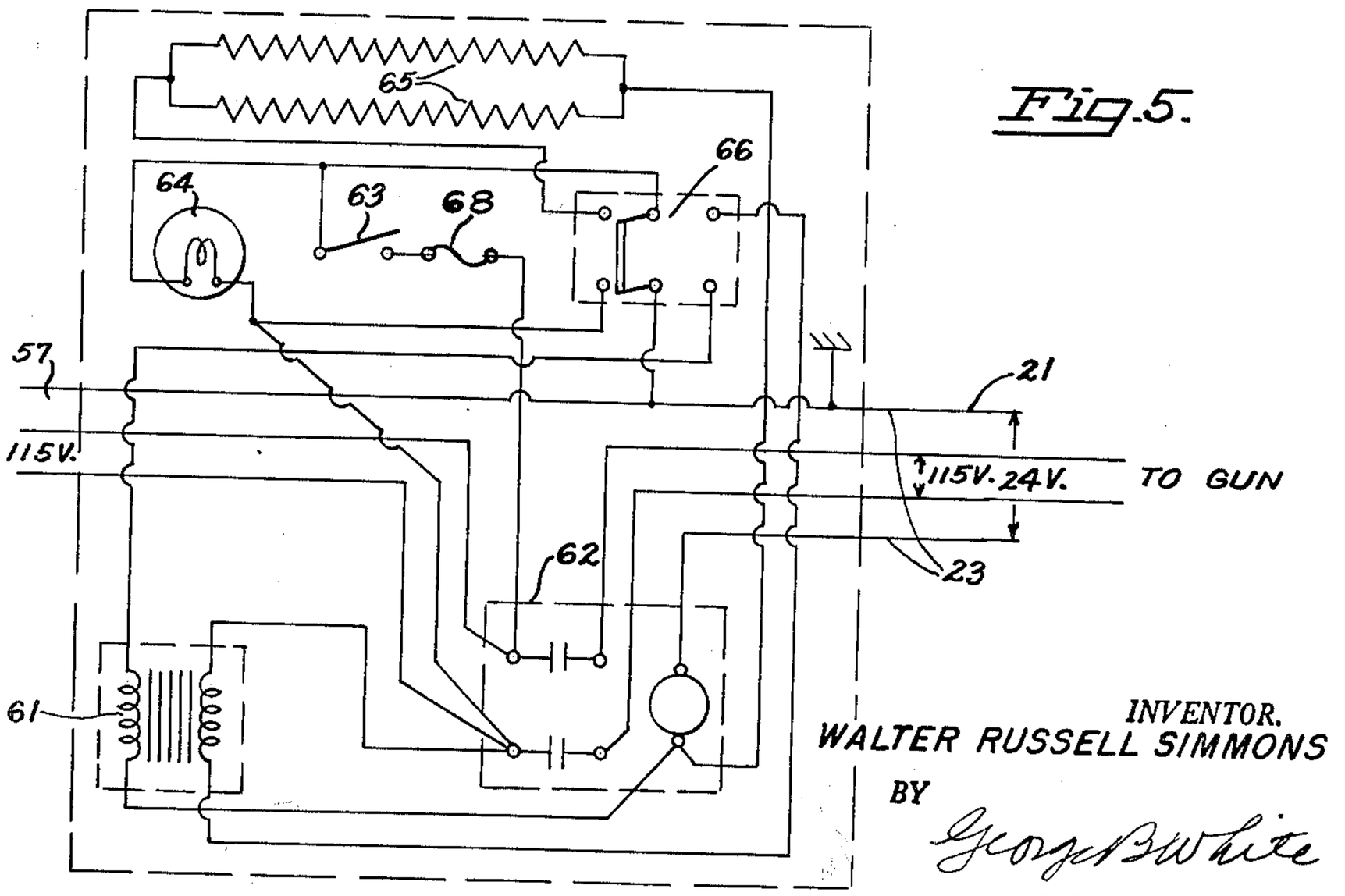

Fig. 5.

INVENTOR.
WALTER RUSSELL SIMMONS
BY
George B. White
ATTORNEY

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Fig. 6.

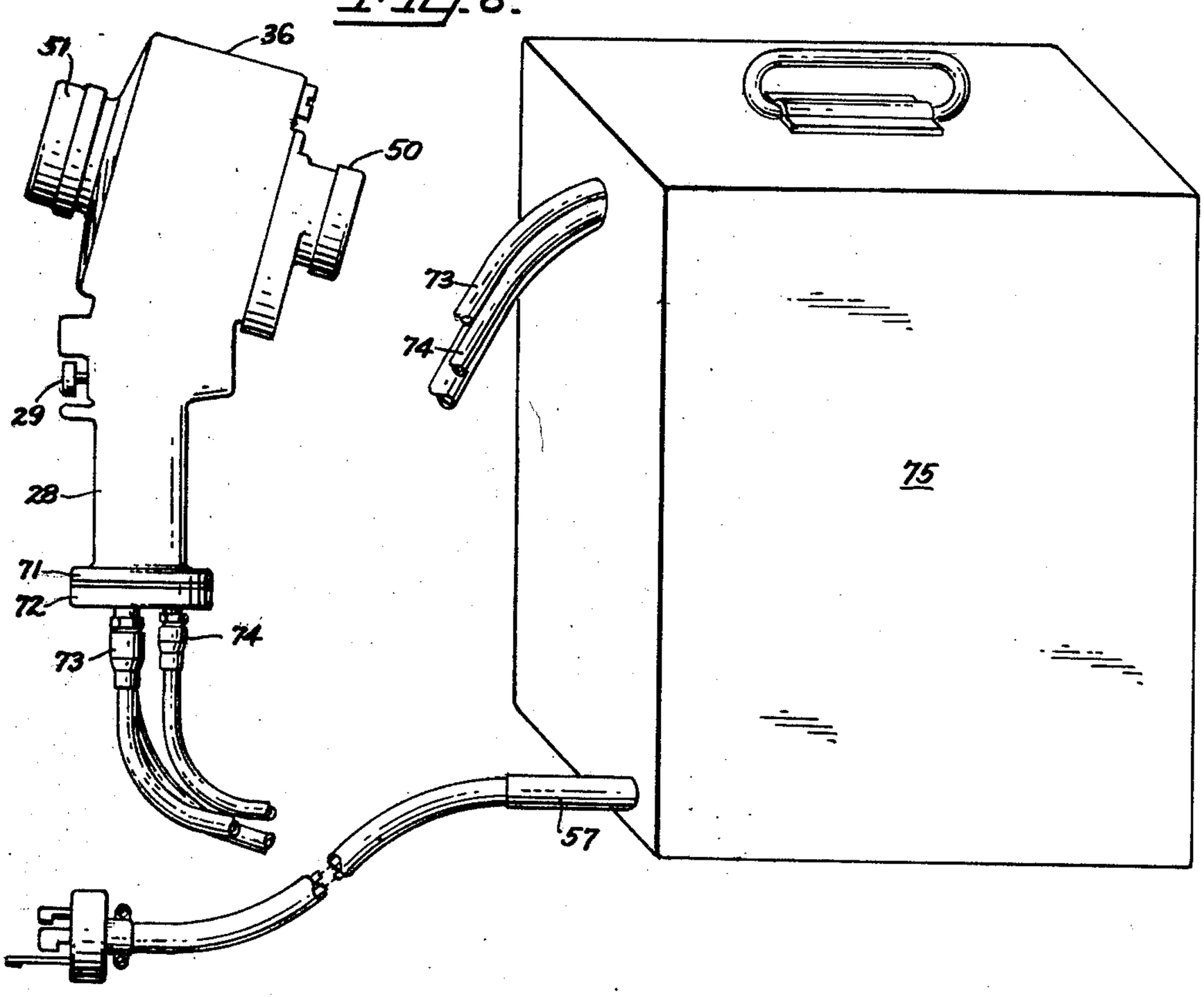
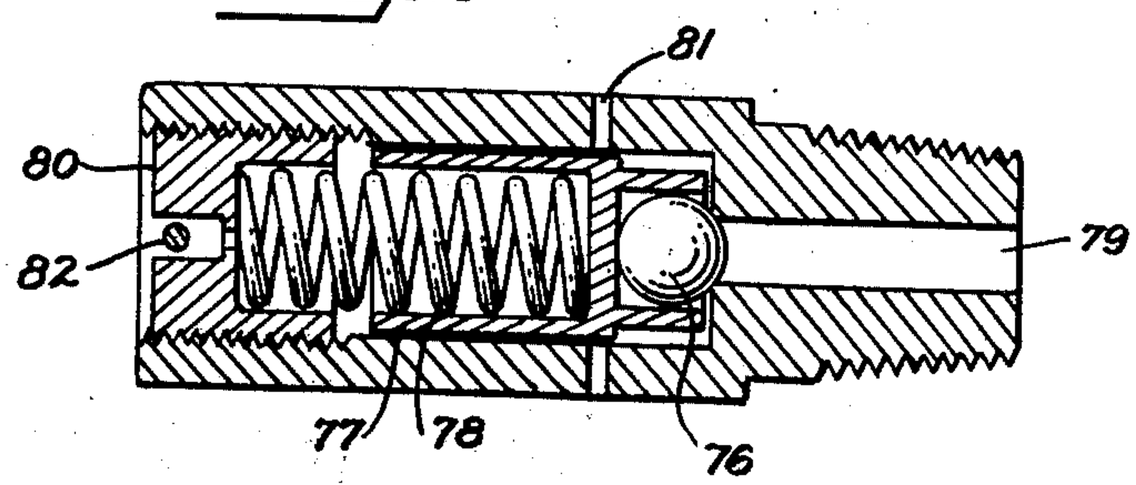


Fig. 7.



INVENTOR.
WALTER RUSSELL SIMMONS
BY
George H. White
ATTORNEY

United States Patent Office

3,180,017

Patented Apr. 27, 1965

3,180,017
LOCK BOLT GUN

Walter Russell Simmons, Buena Park, Calif., assignor to Townsend Company, a corporation of Delaware

Filed Feb. 12, 1962, Ser. No. 172,739
3 Claims. (Cl. 29—252)

This invention relates to an apparatus for fastening together plates, or similar objects, by means of bolts or rivets. It involves the method in which the fastening is accomplished from one side only of the articles being fastened and makes use of a lock bolt equipped with grooves into which a suitable lock nut is swaged after the articles have been pulled tightly together, after which the surplus portion of the rivet or bolt is broken off under tension.

In this method of fastening it is necessary to utilize relatively high pressures and forces which must be applied in a short interval of time to effect a proper and economical joint. This necessitates the use of heavy fastening apparatus and rather bulky and cumbersome auxiliary machinery. Previous devices have used elaborate hydraulic and combinations of hydraulic and pneumatic equipment to supply the pressures required. These have likewise entailed the use of complicated systems of control and operation involving difficulty in operation and high maintenance. The large size and heavy weight of existing devices for performing this operation have militated heavily against the use of this method of fastening heretofore.

It is therefore an object of this invention to provide an apparatus for fastening of the class described which would be simple and more efficient than those now in use.

It is another object of this invention to provide an apparatus of the class described which would be smaller and lighter and permit more rapid operation than those now in use.

It is yet another object of this invention to provide an apparatus for fastening articles from one side only which would be extremely flexible in its applications.

It is a more specific object of this invention to provide an apparatus or gun for fastening together articles from one side only which would be exceedingly simple in operation and yet entirely reliable.

I am aware that some changes may be made in the general arrangements and combinations of the several devices and parts, as well as in the details of the construction thereof without departing from the scope of the present invention as set forth in the following specification, and as defined in the following claims; hence I do not limit my invention to the exact arrangements and combinations of the said device and parts as described in the said specification, nor do I confine myself to the exact details of the construction of the said parts as illustrated in the accompanying drawings.

With the foregoing and other objects in view, which will be made manifest in the following detailed description, reference is had to the accompanying drawings for the illustrated embodiment of the invention, wherein:

FIG. 1 is a cross-section showing a typical type of fastener and fastening device which may be used with this invention.

FIG. 1*a* is another type of fastening device which is suitable for use with this invention.

FIG. 2 is an elevation, partly cut away, showing a preferred embodiment of the lock bolt gun of this invention.

FIG. 2*a* is an enlarged elevation, partly cut away, showing the trigger and associated parts of this invention.

FIG. 3 is a diagrammatical layout, partly in section, illustrating the operation of this invention.

FIG. 4 is a cut away view of the electrical control box of this invention.

FIG. 5 is a preferred wiring diagram for the electrical control for this invention.

FIG. 6 is an alternate embodiment of this invention in which the pulling head cylinder, handle, trigger and valve, comprise a separate unit from the motor and pump.

FIG. 7 is a cut away view of relief valve 32 of FIG. 2.

The method of fastening for which the apparatus is used may best be understood by reference now to FIG. 1. The articles to be joined are shown as two plates 1 with aligned holes 2. A rivet, bolt, or pin 3, of the special construction shown and having a preformed head is inserted in aligned holes 2 as shown. The bolt is equipped with a hole-filling section 4, a grooved section 5, and a break groove 6. At the other extremity of the bolt there is another grooved section which is known as the pulling section 7. A lock nut or collar 12 which is later to be swaged into grooves 5 is slipped over the bolt and up against the plates 1. A pulling device or pulling head assembly 8 is used to adapt the lock bolt and lock nut to the operation of the apparatus of this invention. This pulling head assembly 8 comprises a pair of pulling or gripping jaws 9 which engage the pulling section 7. The pulling collar 10 screws into head piston 37 of FIG. 2, as explained below. Positioned on one end of the pulling head assembly is anvil 11 which bears against lock nut 12. The ejector 13 serves to kick the gun loose from the bolt after completion of the fastening operation. A pin ejector 14 may be employed to eject the fractured end of the bolt from the pulling assembly if desired.

The method of fastening will now be evident to those skilled in the art and is briefly as follows. Initial movement of the pulling collar 10 FIG. 1 to the right by the action of pulling piston 37 of FIG. 2 as hereinafter set forth serves to clamp gripping jaws 9 upon grooves of pulling section 7. Further movement of collar 10 draws bolt 3 through holes 2, which movement is backed up by the reaction of lock nut 12, backed up by anvil 11, which is held by head nut 51 of the gun of FIG. 2. As the pulling action progresses, hole-filling section 4 fills the holes 2 and the action of anvil 11 swages the lock nut 12 into grooves 5. Still further pulling action fractures bolt 3 in tension at break groove 6. Reverse action of pulling collar 10 then kicks the gun loose from the joint and ejects the fractured portion of the rivet.

In FIG. 1*a* in which like parts bear like numbers, the pulling collar 10 is shown on the opposite end of pulling head assembly 8. This embodiment is advantageous in certain arrangements, as for example where a longer protrusion from the gun is required for side clearance. The operation of the device however, is identical in other respects.

It will now be obvious to those skilled in the art that the forces required to be exerted on lock bolt 3 and lock nut 12 in order to effect a sufficient joinder of plates 1 will be quite substantial. In fact, it has been discovered that in order to satisfactorily fasten a bolt having a diameter of ¾ inch a force of 35,000 pounds is required to be exerted in collar 10. It will be further evident that this force must be built up from zero to 35,000 pounds in as short a time as possible in order to result in economical operation. It is likewise evident that this force must be released and the action of collar 10 reversed promptly so that the entire cycle would be completed as rapidly as possible. It has been discovered that by the use of the apparatus of this invention these results may be accomplished in a manner heretofore not found possible. It has likewise been discovered that these results may be accomplished with an apparatus that is exceedingly simple, flexible, and light, as well as of small size, a detailed description of which follows.

Reference should now be had to FIG. 2 which repre-

sents a preferred embodiment of this invention and to FIG. 3 which shows diagrammatically its method of operation, like parts on both figures being represented by like numbers. A four conductor electrical cable **21** is connected to terminal box **22** from which control cable **23** leads to micro-switches **41** and **42**, the function of which is more fully described below, and two conductors furnish power supply to motor **24**. Motor base **25** supports motor **24** which is direct-connected to pump **26** which in turn is supported by pump frame **27**. The handle **28** has a hollow interior which functions also as a reservoir for the hydraulic fluid used to operate the gun. Trigger **29** is part of a control valve of the piston type, the operation of which may be better seen in FIG. 3. Pressure inlet port **30** connects with discharge of pump **26**, while outlet ports **31** connect with reservoir located inside of handle **28**. A relief valve **32** to protect against excess pressure is located on the discharge of pump **26**. This valve is unique as will be described below. Relief valve **32** discharges into the reservoir in pump handle **28**. A strainer **33** is positioned on the suction intake of pump **26** which connects with the bottom of the reservoir. Upper ports **34** and **35** connect to opposite ends of a hydraulic cylinder **36**, which is also known as a pulling head cylinder, as shown. A pulling head piston **37** is positioned within cylinder **36**. Piston **37** comprises an annular or pressure section **38** and a hollow central pulling section **39**. The pulling head piston is adapted to receive a pulling head similar to that described in FIG. **1** above by engaging its threaded section **40** with threaded section **10** of the pulling head. Micro-switch **41** is so located that it would be closed upon depressing of trigger valve **29**. Micro-switch **42** is so located that it would be closed by piston **37** soon after the latter starts its pulling stroke. Micro-switches **41** and **42** are connected in parallel and comprise an important part of the control circuit more fully described below.

Other features of the construction of the embodiment shown in FIG. **2** are as follows. Sealing rings **43** which may be of neoprene, or similar material, are positioned on the pressure part of the cylinder **38**, while outside packing rings **44** are positioned on the outside of the pulling part of the piston **39**. The latter may also be of neoprene. A felt washer **45** is likewise positioned on the outside of the piston as shown. Cylinder cover or head **46** is secured to cylinder **36** by means of socket head cap screws **47**. O-ring **48** completes the seal. Filling port and screws **49** are located as shown. A cap **50** serves to protect the open end of the pulling head piston **37**, while head nut **51** secures the anvil **11** of FIG. 1 to opposite end. Inner slide **52** of trigger valve **29** serves to provide communication between the ports, as explained below, while spring **53** tends to return the trigger valve to its normal position at the start of the cycle.

Reference should now be had to FIGS. 4 and 5 which show the assembly of the electrical components of the control system of the invention and their wiring diagram, respectively. A three conductor cable **57** provides a 115 volt A.C. or D.C. supply from an outside source, while four conductor cable **21** provides the feed and control to the gun mentioned above. These are secured by cable grips and lock nuts **58**. Knockout opening **59** is provided in control box housing **60**. Transformer **61** provides a 24 volt supply for the control circuit. Contactor **62** which is energized from the control circuit makes and breaks the 115 volt supply in order to start and stop the motor. Main disconnect switch **63** is of the single pole, single throw type and is connected to the power source through pilot lamp **64** which indicates that electrical power is on the gun. Where D.C. is used as a source of power supply the 24 volt source for the control circuit is provided through resistor **65** which may be of 100 watt, 50 ohm capacity. A double pole, double throw switch **66** having control knob **67** may be used

in switching from A.C. to D.C. and vice versa. The fuse **68** completes the electrical circuit in the control box. The components are mounted in an assembly on plate **69** as shown. Insulator **70** protects the resistor from the housing.

From the wiring diagram of FIG. 5 it will now be seen how a 115 volt two wire and ground A.C. or D.C. supply is converted to a two wire 115 volt supply to the motor and a 24 volt one wire and ground supply to the micro-switches. The principal operating components of FIG. 4 bear like numbers on the wiring diagram FIG. 5.

The power supply is indicated at **57**, and the various lines may be given color designations to facilitate tracing of the circuit. Thus the two power lines of the feed are run directly to the contactor **62**, while the ground line runs through to the motor directly and comprises a grounded leg of the entire electrical circuit. The pilot light **64** is connected across the main power supply and in series with single pole, single throw switch **63** and fuse **68**. One leg of the main power supply and a ground are connected to double pole, double throw switch **66** which may be used to energize transformer **61** when A.C. is used or resistor **65** when D.C. is employed. Consequently, either the secondary of transformer **61** or the output of resistor **65** will supply a two wire 24 volt circuit to the gun, as is seen at **21**. This circuit is completed through the micro-switches **41** and **42**, as above described and in turn energizes the solenoid of contactor **62** to throw the power on and off the motor in line with the operation as described below.

Operation

The operation of the invention with special reference to FIGS. 1, 2, and 3 will now be understood to be as follows. Pulling head **8** of FIG. 1 is first inserted in head piston **37** of FIG. 2, as previously described. Lock bolt **3** is inserted in the holes **2** of plate **1** and lock nut **12** placed in position for start of the operation. The gun is then gripped by handle **28** and placed in contact with lock bolt **3** and lock nut **12**. Trigger valve **29** is depressed against spring **53**, which closes micro-switch **41**. This energizes the contactor on the main power supply starting motor **24** and pump **26**, thus supplying a fluid under hydraulic pressure to port **30** of the trigger valve. This depressed position of the trigger valve permits the fluid under pressure to flow from port **30** to port **35** and into cylinder **36**. At the start of the cycle, piston **37** is in a position shown approximately by the dotted lines of FIG. 3. The piston will move under considerable pressure to the right approaching the position shown in solid lines of FIG. 3 and perform the pulling and swaging operation on the lock bolt and nut described above. After the piston moves approximately ⅛" it closes micro-switch **42** which being in parallel with micro-switch **41** has the effect of continuing operation of the motor and pump, even though trigger valve **29** is released. When the latter occurs, port **30** communicates with port **34**, thus applying pressure to the opposite side of the piston, while port **35** communicates with port **31**, thus permitting return of the fluid in cylinder **36** back to the reservoir in handle **28**. If the trigger valve **29** should not be released by the operator before or immediately after piston **37** reaches its extreme right position pump **26** will be pumping against a non-moving piston or non-expanding system and the pressure will tend to increase rapidly. Under such conditions the ball valve **76** of FIG. 7 is moved away from its seat and against cage **77** and spring **78** which has been preset to yield under a predetermined pressure in body opening **79**. Once the ball is off the seat, fluid from opening **79** exerts pressure not only on the ball but also on the much larger end area of cage **77** thus continuing its motion until its opposite end seats against adjustment nut **80** and opens fluid exit ports **81** which communicate directly into the reservoir inside handle **28**. It

will be apparent that cage **77** will be held in its open position with exit ports **81** open until the fluid pressure decreases to a much lower value than that required to lift the ball **76** from the seat initially. For example, if the cross-sectional area of the cage **77** is ten times the cross-sectional area of the ball seat the fluid pressure required to hold the valve open could be 300 p.s.i. as compared to 3,000 p.s.i. required to open the valve initially. This is a most important feature in preventing excessive heating in this type of pumping system. As soon as the trigger valve **29** is released, the fluid from pump **26** is directed against the opposite end of piston **37** which will start to move freely back to its initial position against practically no resistance. Pumping pressure is almost immediately lowered and ball **76** of relief valve FIG. 7 seats firmly. When the piston approaches its initial position micro-switch **42** opens, de-energizing the contactor coil and the motor is shut off. Locking pin **82** serves to hold adjustment nut **80** in any desired predetermined position as explained above.

From the above description of the construction and operation of this invention it will now be evident that this invention makes possible the application of high pulling forces and an efficient cycle involving rapid riveting and return in a simple and efficient manner and that the apparatus employed is very simple and extremely easy to operate, particularly by virtue of being much lighter and more compact than any others now in use. In addition to the rapid return features of the pulling piston, it will also be evident that this invention provides an automatic cushion or dash-pot effect on the piston by utilizing the interlocking electrical and hydraulic circuits in a manner to prevent excessive hammer, shock, excessive heating, and similar effects which would seriously hamper the operation of other types of equipment, without employing elaborate preventive devices.

Where it is desirable to physically separate the gun proper comprising the pulling cylinder and handle from the rest of the apparatus comprising the motor and hydraulic pump, the embodiment of FIG. 6 may be used. In this figure there is seen an outline of the gun proper showing handle **28**, trigger valve **29**, cylinder **36**, head nut **51**, and cap **50**. The bottom flange **71** of handle **28** connects with companion flange **72**. The latter is arranged to receive hydraulic fluid lines **73**, one of which is the suction of the pump connecting with the strainer **33** of FIG. 2 and the other the discharge of the pump connecting with port **30** of FIG. 2 and FIG. 3. Control cable **74** carries the 24 volt circuit to the microswitches as in other embodiments of the invention. The motor pump and control box are housed in portable container **75** to which a 115 volt power supply is introduced through three conductor cable **57**.

While I have shown an electric motor and controls for the operation of the hydraulic system of my invention, I may substitute air for electricity as a source of power without departing from the spirit of the invention. That this may be accomplished very readily is further apparent by reference again to FIG. 2 and FIG. 3. I may substitute an air motor for the electric motor **24** and a pilot operated air valve for the control box **60**. Micro-switches **41** and **42** are then replaced with pilot valves connected by suitable air lines to the main air supply valve. These pilot valves could be of bleed type, thereby permitting the air to be bled from the pilot circuit by the respective positions of trigger control valve **29** and pulling head piston **37** which in turn would open the main air supply valve supplying air motor **24**. The operation of my invention using an air supply would be in every other respect the same as when using alternating or direct current electrical supply as described above.

I claim:

1. A bolt fastening apparatus comprising:
a bolt fastening mechanism in combination with means for imparting reciprocating motion to said mechanism comprising:
a hydraulic circuit comprising:
a motor driven pump;
a fluid reservoir;
a piston reciprocally mounted in a cylinder and operatively engaging said bolt fastening mechanism;
manually operated means for starting said motor and simultaneously admitting fluid from said pump to the first end of said cylinder while admitting fluid from the second end of said cylinder to said reservoir;
means for admitting fluid from said pump to the second end of said cylinder while relieving fluid from said first end;
means for admitting fluid from said first end to said reservoir while continuously operating said motor driven pump;
independent means operatively connected to said piston for cutting power off said motor when said piston reaches a predetermined position in said cylinder.

2. A bolt fastening apparatus comprising:
a bolt fastening mechanism in combination with means for imparting reciprocating motion to said mechanism comprising:
a hydraulic circuit comprising:
an electric motor driven pump;
a fluid reservoir;
a piston reciprocally mounted in a cylinder and engaging said bolt fastening mechanism;
a manually operated slide valve arranged for alternately connecting each end of said cylinder to the discharge of said pump while simultaneously connecting the opposite end to a return to said reservoir thereby effecting a forward stroke and a return stroke and further arranged to connect said opposite end of said cylinder to the discharge of said pump before the end of said forward stroke;
a first micro-switch responsive to the position of said slide valve;
a second micro-switch responsive to the position of said piston;
said micro-switches being connected in parallel and controlling the power supply to said electric motor;
whereby said first micro-switch starts said motor when said valve is placed in position to start said forward stroke;
and whereby said second micro-switch causes said motor to continue running after said piston reaches a predetermined position on said forward stroke and after said valve is placed in position to start said return stroke, and stops said motor after said piston has returned to said predetermined position on said return stroke.

3. In a bolt fastening apparatus comprising:
a bolt fastening mechanism;
a reciprocating bolt pulling piston operatively connected to said bolt fastening mechanism;
a hydraulic circuit connected to both sides of said piston;
an electrically driven pump supplying hydraulic fluid under pressure to said circuit;
an electric circuit supplying power to said pump;
the improvement comprising:
a manually operated spring loaded slide valve controlling the flow of said hydraulic fluid to and

from said piston by alternately admitting said fluid to one side of said piston while relieving said fluid from the opposite side;

a first micro-switch positioned at one end of said slide valve to close said electric circuit when said slide valve is positioned to admit fluid to a first side of said piston thereby to initiate a pulling cycle;

a second micro-switch in operating relation with said piston to maintain said electrical circuit closed until said piston completes said cycle;

whereby the reciprocating action of said piston may be controlled, by admitting the flow of hydraulic fluid to both sides of said piston.

References Cited by the Examiner

UNITED STATES PATENTS

1,003,154	9/11	Scott	78—46
1,740,173	12/29	Hasting	137—539.5
2,323,519	7/43	Dean	60—60
2,342,659	2/44	Grove	137—543.19
2,529,777	11/50	McInnis.	
2,555,421	7/51	Ronan	78—42
2,651,832	9/53	Menard et al.	82—20
2,742,656	4/56	Fisher	10—162
3,029,665	4/62	Baugh	78—46

CHARLES W. LANHAM, *Primary Examiner.*

WILLIAM J. STEPHENSON, RICHARD H. EANES, *Examiners.*