March 7, 1950 W. SWIFT ET AL 2,499,539

MACHINE FOR USE IN THE CONSTRUCTION OF COMMUTATORS

Filed May 28, 1946 4 Sheets-Sheet 1

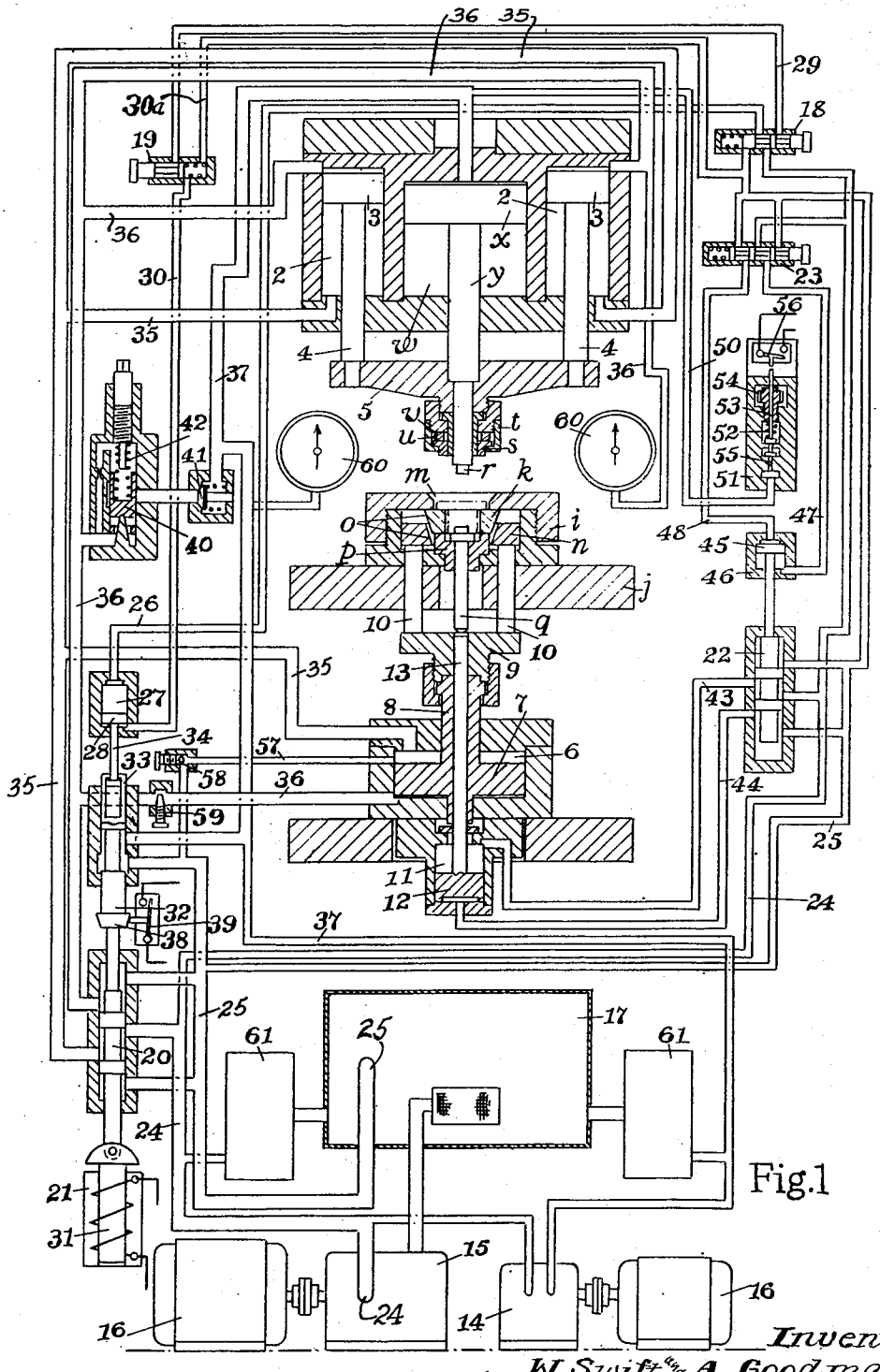


Fig.1

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MACHINE FOR USE IN THE CONSTRUCTION OF COMMUTATORS

Filed May 28, 1946 4 Sheets-Sheet 2

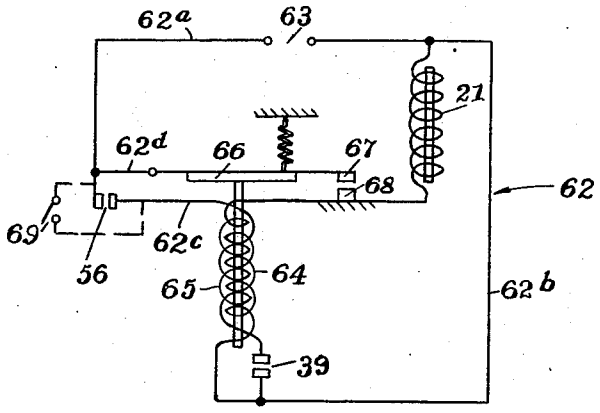


Fig.2

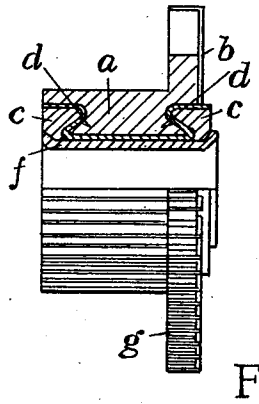


Fig.5

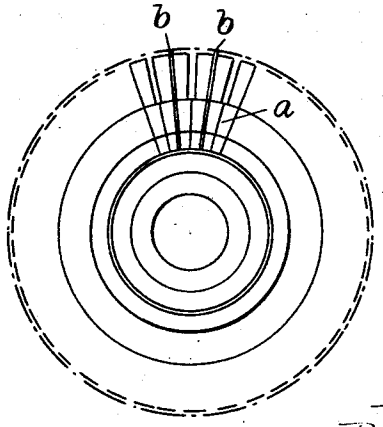


Fig.6

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March 7, 1950 W. SWIFT ET AL 2,499,539

MACHINE FOR USE IN THE CONSTRUCTION OF COMMUTATORS

Filed May 28, 1946 4 Sheets-Sheet 3

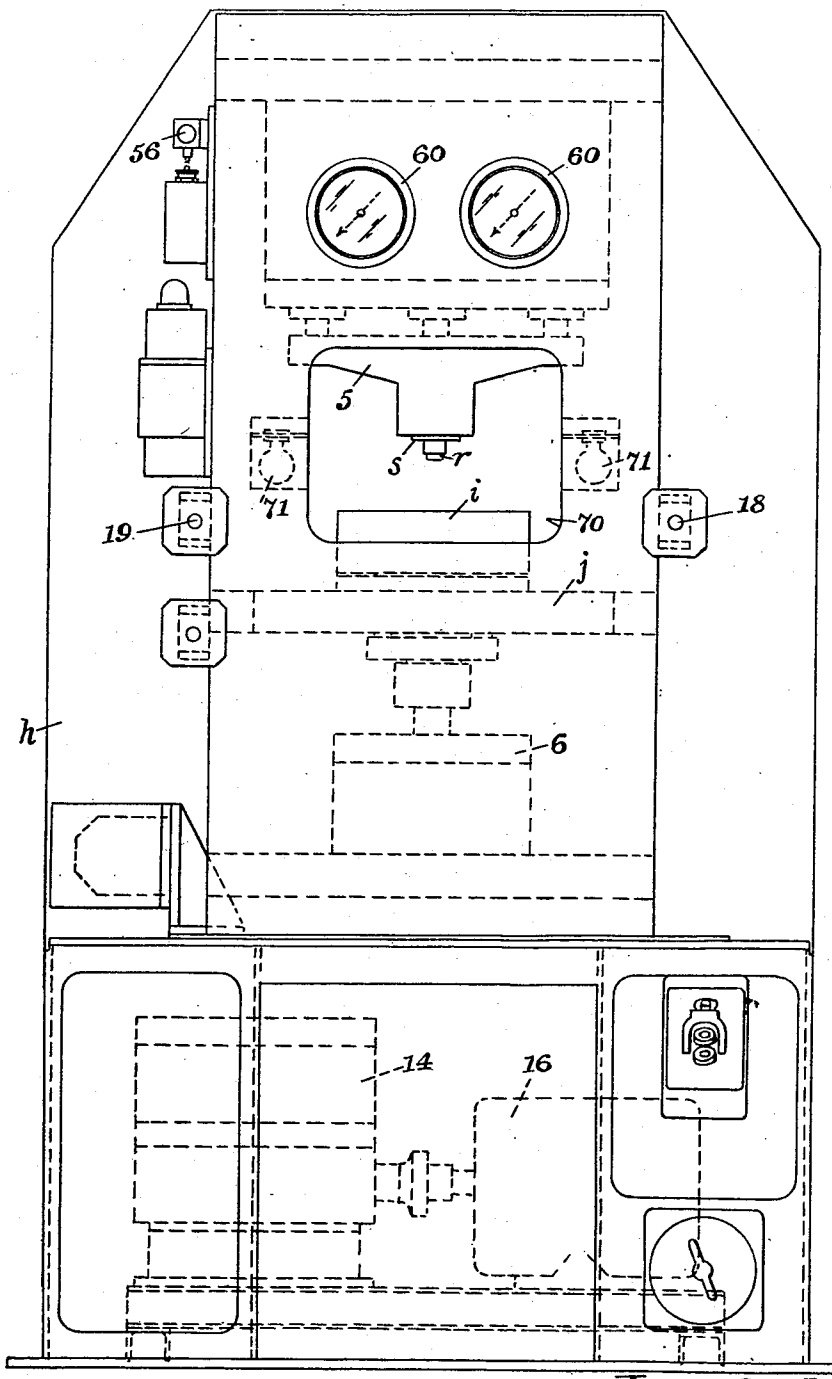


Fig. 3

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March 7, 1950 W. SWIFT ET AL 2,499,539

MACHINE FOR USE IN THE CONSTRUCTION OF COMMUTATORS

Filed May 28, 1946 4 Sheets-Sheet 4

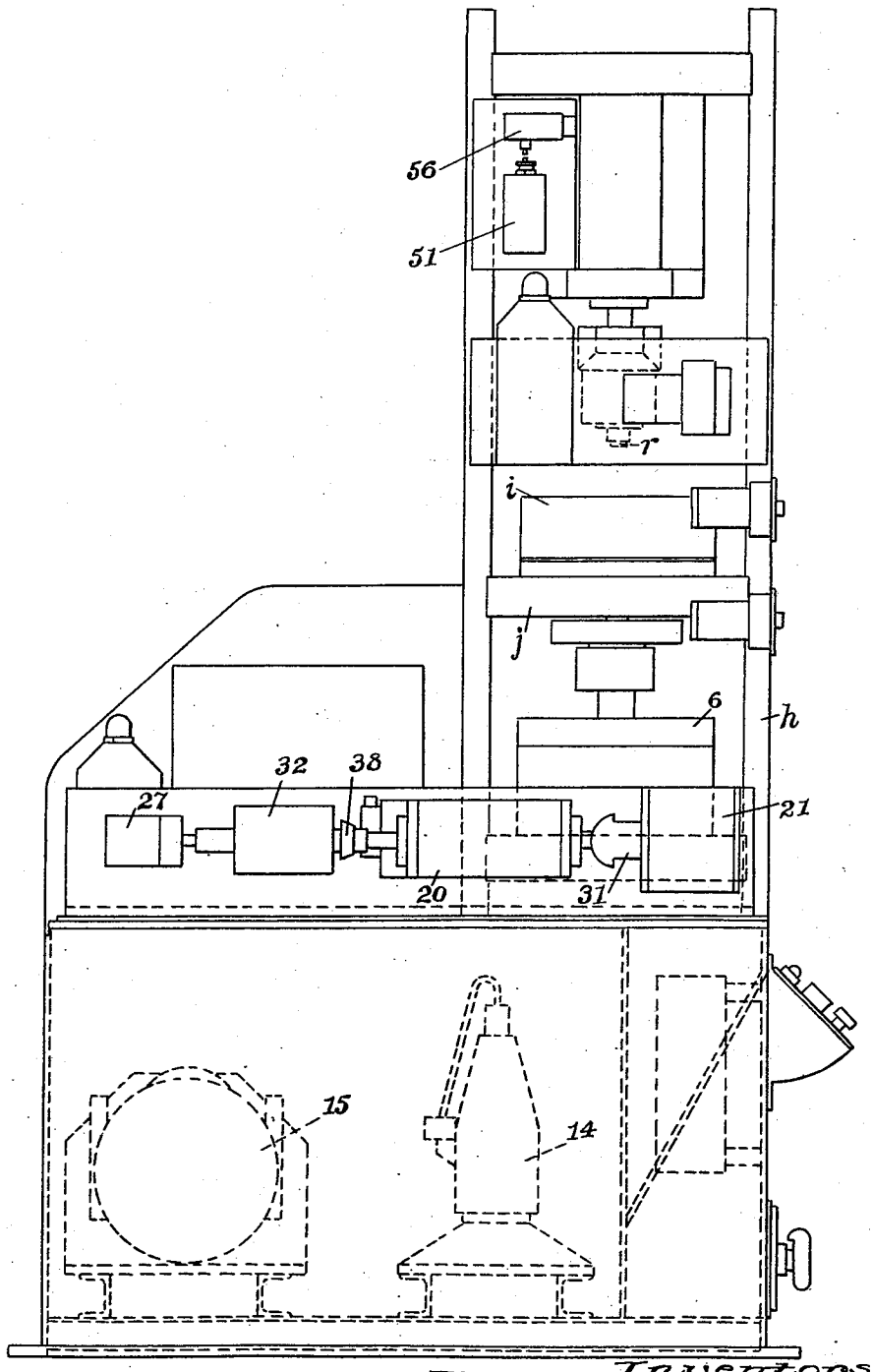


Fig. 4

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UNITED STATES PATENT OFFICE

2,499,539

MACHINE FOR USE IN THE CONSTRUCTION OF COMMUTATORS

William Swift and Arthur Goodman, Birmingham, England, assignors to Joseph Lucas Limited, Birmingham, England

Application May 28, 1946, Serial No. 672,794
In Great Britain June 5, 1945

7 Claims. (Cl. 218—1)

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This invention has for its object to provide a machine whereby the components of the commutators used in dynamoelectric machines and the like can be secured together in an expeditious manner.

The invention comprises the combination of an annular and contractible work holder, a tool for pressing a work piece formed by the components of a commutator into the holder, an annulus embracing the work holder and adapted by relative sliding movement to contract the work holder, a pair of coaxial and relatively slidable tools (one of which is adapted to occupy a position at the lower part of the work holder and to serve also as an ejector) for expanding the ends of a central bush of the work piece to secure together the other components of the work piece which are supported by the bush, and fluid operated means adapted to actuate the tools and annulus.

In the accompanying sheets of explanatory drawings—

Figure 1 is a diagrammatic sectional view illustrating a machine in accordance with the invention, and Figure 2 is a diagram illustrating electrical components of the machine.

Figure 3 is a front view, and Figure 4 a side view, of a preferred form of the machine illustrated by Figures 1 and 2.

Figure 5 is a sectional side view, and Figure 6 an end view, of a dynamo commutator.

The machine shown in Figures 1 to 4 is intended to secure together the components of dynamo commutators, such as that shown in Figures 5 and 6, after the components have been loosely assembled in the required relationship, the assembled components being hereinafter termed the work piece. The commutator shown in Figures 5 and 6 comprises an annular assembly of metal segments *a*, insulating strips *b* arranged between the segments, locking rings *c* engaging dovetail or like recesses *d* in the ends of the segments, and a central supporting bush *f* which when its ends are expanded or riveted over the locking rings as shown serves to secure all of the parts together, the segments being shaped at one end to form the usual external flange *g* to which wiring connections can subsequently be made.

In constructing the machine shown in Figures 1 to 4, we employ any convenient hollow body part *h* for carrying the various elements of the machine. At a suitable position in the body part we arrange a housing *i* which is supported on a stationary bed *j*, and which contains a horizontal

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annular and contractible work holder *k*, the upper side of the housing having an opening *m* through which the work piece can be inserted into the work holder. Also we arrange around the work holder *k* an annulus *n* which embraces the work holder, these two parts having contiguous inclined peripheral surfaces *o* arranged so that upward movement of the annulus can exert a contracting force on the work holder which is split radially in one or more positions. The work holder *k* rests on a base piece *p* through which extends the stem of a vertically slidable tool *q* having its upper operative end surrounded by the work holder. The tool *q* serves not only as the complement of another tool *r* whereby expanding or riveting action can be exerted on the opposite ends of the central bush *f* of the work piece, but also as an ejector whereby the work piece can be ejected from the work holder after the said expanding or riveting action.

The tool *r* is arranged above the work holder *k* and is surrounded by a third coaxially arranged tool *s* of annular form, the latter tool (which is herein termed the pressure tool) being adapted to press the work piece into the work holder, and consisting of a ring which is supported in a sleeve *t*, a compressible rubber ring *u* being arranged between the inner face of the ring and a shoulder *v* in the sleeve.

The annulus *n*, the two complementary expanding or riveting tools *q*, *r*, and the pressure tool *s* are adapted to be actuated by any convenient fluid operated mechanism, a preferred form of which will now be described.

In the upper end of the body part *h* is arranged a cylinder *w* containing a piston *x*, the latter being provided with a rod *y* which extends through the lower end of the cylinder and has the upper riveting tool *r* secured to its lower end. At opposite sides of the cylinder *w* are disposed two smaller and similar cylinders **2** each of which contains a piston **3** having a rod **4** extending through the lower end of the corresponding cylinder, the two rods being connected to a cross head **5** which carries the above mentioned sleeve *t* of the pressure tool *s*. In the lower portion of the body part *h* is arranged another cylinder **6** containing a hollow piston **7** from which a hollow piston rod **8** extends through the upper end of the cylinder, the upper end of the hollow piston rod being adapted to act through an intermediate piece **9** on a pair of thrust rods **10** which can actuate the above mentioned annulus *n* around the work holder *k*. Further, beneath the cylinder **6** is arranged an additional and

smaller cylinder 11 containing a piston 12, the latter having a rod 13 which extends through the hollow piston rod 8 and supports at its upper end the stem of the lower riveting tool *q*.

After the components of the work piece above described have been assembled loosely in the work holder as shown in broken lines in Figure 1, the machine is set in motion. In the first phase of the action of the machine the pressure tool *s* forces the work piece into the work holder *k* and in this operation the rubber ring *u* is compressed. Then the annulus *n* comes into action and contracts the work holder *k*, so causing the components of the work piece to be tightly squeezed together. Later the riveting tools *q*, *r* expand or rivet over the ends of the central bush *f* of the work piece and so secure the components together. During the withdrawal of the upper tools *r*, *s* the pressure exerted by the annulus *n* is released, and the lower riveting tool *q* ejects the completed work piece from the work holder *k*. Finally all parts of the machine resume their initial positions in readiness for action on the next work piece.

In association with the machine above described we provide a pair of pumps 14, 15 which are adapted to be driven by an electric motor or motors 16, the pump 14 being of high pressure and small volumetric capacity, and the pump 15 being of low pressure and large volumetric capacity. The high pressure pump 14 is supplied with liquid by the low pressure pump 15, and the latter is supplied with liquid from a tank 17 to which the liquid delivered by both pumps returns after passing through the various cylinders of the machine. For enabling the sequence of operations of the machine to be performed automatically under manual control, we arrange between the pumps 14, 15 and cylinders *w*, 2, 6, 11 an appropriate system of valves. Thus, we employ a pair of manually operable and spring loaded valves 18, 19 which require to be actuated simultaneously, and which are situated at such a distance apart on the body part *h* that they necessitate the use of both of the operative's hands, thereby ensuring that the latter are clear of the tools *q*, *r*, *s* before the machine can be set in motion. Also we employ a main valve 20 which is movable in one direction by fluid pressure under the control of the manually operable valve 18, and in the opposite direction by a solenoid 21. Moreover, we employ another valve 22 which is movable in opposite directions by fluid pressure under the control of another manually operable and spring loaded valve 23. The valves 18, 20, 22 and 23 are connected to the delivery side of the low pressure pump 15 by piping 24 (herein termed pressure piping), and to the tank 17 by piping 25 (herein termed exhaust piping), the pressure piping being also connected to the inlet side of the high pressure pump 14, and the exhaust piping being also connected to the valve 19.

The manually operable valve 18 serves when in its normal position (Figure 1) to connect the pressure piping 24 to piping 26 leading to the upper end of a cylinder 27 containing a piston 28, and is movable by the operative to a position in which it serves both to connect the pressure piping 24 to piping 29 leading to the valve 19, and to connect the exhaust piping 25 to the piping 26 leading to the cylinder 28.

The manually operable valve 19 serves when in its normal position to connect the exhaust piping 25 to piping 30 leading to the end of the cylinder 27 remote from the piping 26, and is movable by the operative to a position in which it serves both to interrupt communication of the exhaust piping 25 with the piping 30, and to connect the latter piping to the piping 29.

The main valve 20 is connected at one end to the movable core 31 of the solenoid 21, and at the other end to another valve 32 which has a lost-motion connection at 33 with a rod 34 extending from the piston 28, the arrangement being such that this piston after being actuated to move the valves 20 and 32 can subsequently be returned to its initial position without effecting these valves. In its initial extreme position the main valve 20 serves to connect the pressure piping 24 to piping 35 leading to the lower ends of the cylinders 2 and the upper end of the cylinder 6, and also to connect the exhaust piping 25 to piping 36 leading to the upper ends of the cylinders 2 and the lower end of the cylinder 6. In its other extreme position the main valve 20 serves to connect the pressure piping 24 to the piping 36 and the exhaust piping 25 to the piping 35. The valve 32 serves when in its initial position to connect the exhaust piping 25 to piping 37 interconnecting the delivery side of the high pressure pump 14 and the upper end of the cylinder *w*. When in its opposite extreme position the valve 32 serves to interrupt communication between the exhaust piping 25 and the piping 37. Also when the valves 20, 32 are moved from their initial positions to their opposite extreme positions a collar 38 on the end of the valve 32 adjacent to the valve 20 releases and allows closure of a normally open spring loaded switch 39 hereinafter referred to.

Between the piping 36 and the piping 37 are arranged a pair of valves 40, 41 of known form past which pressure fluid can flow to the piping 37 from the piping 36 only when the fluid pressure in the latter piping reaches a predetermined value. The valve 40 is movable to an open position against the action of an adjustable loading spring 42 by the action on its underside of pressure fluid in the piping 36. The valve 41 serves solely to prevent return flow of fluid from the piping 37 to the piping 36.

The valve 22 serves when in its initial extreme position to connect the pressure piping 24 to piping 43 leading to the upper end of the cylinder 11, and also to connect the exhaust piping 25 to piping 44 leading to the lower end of this cylinder. In its opposite extreme position the valve 22 serves to reverse the connections between the pipings 24, 25 and the pipings 43, 44. Movement of the valve 22 is effected by a piston 45 in a cylinder 46, the piston being connected to the valve, and being movable in opposite directions by fluid pressure.

The valve 23 serves when in its initial extreme position to connect the pressure piping 24 to piping 47 leading to the lower end of the cylinder 46, and to connect the exhaust piping 25 to piping 48 leading to the upper end of this cylinder. In its opposite extreme position the valve 23 serves to reverse the connections between the pipings 24, 25 and the pipings 47, 48.

The piping 37 through which pressure fluid can flow to the upper end of the cylinder *w* is connected by piping 50 to one end of a hollow body 51. Arranged within and extending through the opposite end of the body 51 is a slidable stem 53 which is supported by a bush 54 in adjustable screw thread engagement with the body. At the inner end of the stem 53 there is arranged within the body 51 a coaxial thrust piece 55 through

which the pressure fluid in the piping 50 can act on the stem to move the latter against the action of a loading spring 52, the latter being supported at one end by the adjustable bush 54. When the fluid pressure in the piping 50 reaches a predetermined value, it moves the stem 53 against the action of its loading spring 52, causing the stem to close a normally open switch 56 hereinafter referred to.

To enable a small amount of fluid to circulate between the pump 15 and the tank 17 when the machine is idle, a by-pass 57 having an adjustable restriction 58 may be provided between the exhaust piping 25 and the upper end of the cylinder 6.

Also an adjustable restriction 59 is provided in the part of the piping 36 leading to the lower end of the cylinder 6, the purpose of this restriction being to delay the action of pressure fluid on the underside of the piston 7 when the piping 36 is connected to the pressure piping 24.

Any convenient pressure gauges 60 may be connected to the piping 36 and the piping 37 respectively. Also any convenient pressure relief valves 61 may be provided between the pipings 24, 37 and the tank 17.

As illustrated in Figure 2, the normally open switch 56 associated with the pressure responsive stem 53 is contained in an electric circuit 62 which also contains a source of electric current 63 and a winding 64. The current source 63 is connected at one side to the switch 56 by a conductor 62^a, and at the other side to one end of the winding 64 by a conductor 62^b, the other end of the winding being connected to the switch by a conductor 62^c. The winding 64 forms a part of a relay having a second winding 65 and a spring loaded pivotal armature 66, the latter being connected to the conductor 62^a by another conductor 62^d. The second winding 65 is arranged in series with the other normally open switch 39 which is operable by movement of the valves 20, 32. The armature 66 carries a contact 67 which co-operates with a complementary fixed contact 68 to connect the above mentioned solenoid 21 across the current source 63 when the first mentioned winding 64 of the relay is energised, and at the same time to connect the second winding 65 and the switch 39 in parallel with the solenoid. If desired a manually operable switch 69 may be connected across the pressure-operable switch 56 for enabling the circuit 62 to be closed independently of the latter switch should the occasion arise, say, during testing or repair of the machine.

The operation of the machine above described is as follows:

It will be assumed that the machine is idle. In this condition the parts occupy the positions shown in Figure 1, and the low pressure pump 15 maintains piping 24, leading therefrom, and consequently the high pressure pump 14, constantly supplied with low pressure fluid. Also in this state the piping 24 communicates through the valve 20 with the piping 35 leading to the lower ends of the cylinders 2 and the upper end of the cylinder 6. Moreover, a small amount of low pressure fluid circulates between the low pressure pump 15 and the tank 17 through the piping 24, the valve 20, the piping 35, the upper end of the cylinder 6, the restricted by-pass 57, and the piping 25. To start the machine the operator simultaneously presses both of the manually operable valves 18, 19 inwardly from their normal extended positions shown in Figure 1. This permits low pressure fluid to flow past valve 18 into the pipe 29, and thence past valve 19 into pipe 30, and thence to the lower end of the cylinder 27. The actuation of valve 18 also simultaneously establishes communication between the upper end of the cylinder 27 and the supply and exhaust-receiving tank 17 through pipe 26, valve 18, and pipe 25. The low pressure fluid entering the lower end of the cylinder 27 causes the piston 28 in this cylinder to move upwardly and thereby move the valves 32, 20 from their lower extreme positions shown in Figure 1 to their upper extreme positions. Due to the lost-motion connection at 33 between the piston 28 and the valve 32, the manually operable valves 18, 19 can be released by the operator and allowed to return to their initial positions under their spring loading when the valves 32, 20 have been moved by the piston 28 to their upper extreme positions, and as this function of the piston is performed in a period of less than one second after the manually operable valves 18, 19 are pressed inwardly, it follows that the latter valves require only momentary manual operation.

However, to ensure that the valves 18, 19 are not released before the piston 28 has completed its upward movement, these valves may be held in their pressed-in condition by the operator until he sees the pressure tool *s* commencing to move as hereinafter described.

Return of the manually operable valves 18, 19 to their initial positions permits low pressure liquid to flow from the piping 24 past valve 18 and through pipe 26 to the upper end of the cylinder 27, and at the same time connects the lower end of this cylinder to the tank 17 through pipe 30, valve 19, pipe 30^a, and piping 25. Consequently the piston 28 is returned to its initial (lowered) position by low pressure liquid entering the upper end of the cylinder 27, but this movement has no effect on the valves 32, 20 owing to the lost-motion connection at 33.

During the upward movement of the valves 32, 20 with the piston 28, the collar 38 on the valve 32 releases the switch 39, allowing the latter to close under its spring loading. When the valves 32, 20 assume their upper extreme positions, low pressure fluid flows from the piping 24 past the valve 20 and through the piping 36 to the upper ends of the cylinders 2 for causing the pistons 3 therein to impart downward movement to the pressure tool *s* through the medium of the cross head 5. At the same time low pressure fluid flows from the piping 36 at a delayed rate past the adjustable restriction 59 to the lower end of the cylinder 6 for causing the piston 7 therein to impart upward movement to the annulus *n* through the medium of the thrust piece 9 and rods 10 at a slower rate than the downward movement of the pressure tool *s* so that the latter serves by contact with the upper end of the work piece to press the components thereof against the base piece *p* and hold them against relative axial movement when the work piece is contracted by the action of the annulus *n* on the work holder *k*. Also fluid from the lower ends of the cylinders 2 and the upper end of the cylinder 6 flows through the piping 35 and past the bottom piston of the valve 20 to the exhaust piping 25 leading to the tank 17. This exhausting of fluid permits the pistons 3, 7 to be actuated as above described. Moreover, the valve 32 in its elevated position interrupts communication between the piping 37, which is supplied with high pressure fluid by the pump 14, and the ex-

haust piping 25 leading to the tank 17. Consequently high pressure fluid flows from the piping 37 to the upper end of the cylinder *w* but has no effect on the piston *x* in this cylinder owing to the downward movement of this piston with the pistons 3, and the small volumetric capacity of the high pressure pump 14.

When the pressure of the fluid delivered by the low pressure pump 15 reaches a predetermined value in the piping 36 as a result of resistance opposing movement of the tools *r*, *s*, this fluid pressure serves, by acting on the underside of the valve 40, to move the latter against the action of its loading spring 42 to an open position in which it permits the fluid pressure to act on and open the valve 41. This enables a further supply of pressure fluid to flow under the action of the pressure pump 15 from the piping 36 through the valves 40, 41 to the piping 37, and thence to the upper end of the cylinder *w* for supplementing the high pressure fluid supplied to this end of the cylinder as above described. Upon the pressure in the upper end of the cylinder *w* and in the piping 37 reaching a predetermined value, the back pressure thereon will close valve 41 and isolate the low pressure pump 15 from this cylinder, the pressure in the upper end of the latter being then dependent on the high pressure pump 14 alone. The valve 40 remains open until the pipe 36, in a later operational stage, is connected by the valve 20 to the pipe 25 leading to the tank 17. When the pressure in the upper end of the cylinder *w* reaches that required for effecting the riveting operation, the stem 53 is moved against the action of its loading spring 52 by the fluid pressure in the piping 50 which communicates with the high pressure pump 14 through the piping 37, this movement of the stem serving to close the switch 56.

Closure of the switch 56, switch 39 having been closed earlier, establishes the electric circuit 62, and thereby causes the relay winding 64 (Figure 2) to be energised by current flowing from the source 63 through the conductor 62^b, winding 64, switch 56, and conductor 62^a, back to the source. Although the switch 39 has been previously closed in the manner above described, no current will flow through the solenoid 21 and winding 65 as these are short circuited by the conductor 62^b. The energisation of the winding 64 causes the armature 66 to close the contacts 67, 68, and thereby connect the windings 64, 65 and solenoid 21 in parallel with each other so that they are all energised by current from the source 63. Thus, the winding 64 is energised by current flowing through the circuit 62. Also, the winding 65, once switch 67, 68 is closed, is energised by current flowing from the source 63 through conductor 62^b, switch 39, winding 65, contacts 68, 67, armature 66, conductor 62^d, and conductor 62^a, back to the source. Moreover, solenoid 21, once switch 67, 68 is closed, is energised by current flowing from the source 63 through winding 21, contacts 68, 67, armature 66, conductor 62^d, and conductor 62^a, back to the source. The energised winding 65 serves by its action on the armature to retain the contacts 67, 68 closed when the switch 56 opens. The solenoid 21 effects return movement of the valves 20, 32 to their lower extreme positions, and in so doing causes the collar 38 on the valve 32 to re-open the switch 39 for releasing the armature 66 and de-energising the solenoid.

Fluid now flows under the action of the low pressure pump 15 from the piping 24 between the two pistons of valve 20 and through piping 35 to the lower ends of the pressure tool cylinders 2 and the upper end of the annulus cylinder 6. Also fluid from the upper ends of the pressure tool cylinders 2 and the lower end of the annulus cylinder 6 flows through piping 36, past the upper piston of valve 20, and through piping 25 to the tank 17. Consequently the pistons 3, 7 in the cylinders 2, 6 return to their initial positions (shown in Figure 1) under said fluid pressure. Also the piston *x* in the upper riveting tool cylinder *w* is returned to its initial position by the action of the cross head 5 attached to the rods 4 of the pistons 3.

After the operations above described have been effected for securing together the components of a work piece in the work holder *k*, and for subsequently releasing the work piece, the third manually operable valve 23 is pressed inwardly by the operator. This permits low pressure fluid to flow from piping 24, past valve 23, into piping 48, and thence to the upper end of the cylinder 46, and also establishes communication between the lower end of the cylinder 46 and the tank 17 through pipes 47, 25. Consequently pressure fluid entering the upper end of the cylinder 46 moves the piston 45 and the valve 22 from the extreme positions shown in Figure 1 to their other extreme positions.

Pressure fluid now flows from the piping 24, past valve 22, and through piping 44, into the lower end of the cylinder 11, and exhaust fluid flows from the upper end of this cylinder through piping 43, past valve 22, and through piping 25, to the tank 17, causing the piston 12 to impart upward movement to the rod 13 for ejecting the work piece from the work holder *k* through the medium of the tool *q*.

When this ejection has been effected the operator releases the third manually operable valve 23 which returns to its initial position under its spring loading. This permits pressure fluid to flow from piping 24, past valve 23, and through piping 47 to the lower end of the cylinder 46, and also establishes communication between the upper end of the cylinder 46 and the tank 17 through pipes 48, 25. Consequently the piston 45 and the valve 22 attached thereto are returned to their initial positions under fluid pressure. Pressure fluid now flows from the piping 24, past valve 22, and through piping 43, to the upper end of the cylinder 11, and from the lower end of this cylinder, through the piping 44, past valve 22, and through piping 25, to the tank 17. Consequently the piston 12 and rod 13 are returned to their initial positions by fluid pressure, and allow return movement of the tool *q* under gravity.

Access to the tools *q*, *r*, *s* is afforded by an aperture 70 in the front of the body part *h*, and a lamp 71 may be provided in the body part at each side of this aperture to illuminate the tools.

By this invention we are able to effect the securing together of commutator components as above described in a very satisfactory and expeditious manner. The invention is not, however, limited to the example described as subordinate details may be varied to suit requirements.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:

1. A machine for securing together the components of commutators, having in combination an annular and contractible work holder, a tool

for pressing a work piece formed by the components of a commutator into the holder, an annulus embracing the work holder and adapted by relative sliding movement to contract the work holder, a pair of coaxial and relatively slidable tools situated respectively in positions at the upper and lower sides of the work holder, and having their adjacent ends shaped for expanding the ends of a central bush of the work piece thereby securing the work piece components together in response to movement of the upper tool, the lower tool being movable to serve for ejecting the work piece from the holder, and fluid operated means for actuating the tools and annulus.

2. A machine for securing together the components of commutators, having in combination an annular and contractible work holder, a tool for pressing a work piece formed by the components of a commutator into the holder, an annulus embracing the work holder and adapted by relative sliding movement to contract the work holder, a pair of coaxial and relatively slidable tools situated respectively in positions at the upper and lower sides of the work holder, and having their adjacent ends shaped for expanding the ends of a central bush of the work piece thereby securing the work piece components together in response to movement of the upper tool, the lower tool being movable to serve for ejecting the work piece from the holder, pistons for imparting movements to the tools and annulus, cylinders in which the pistons are slidable under fluid pressure, and fluid-controlling means associated with the cylinders for enabling the operations of the machine to be performed automatically under manual control.

3. A machine as claimed in claim 2 and having in combination a low pressure pump for supplying fluid to the cylinders, a high pressure pump for supplying fluid to the cylinder associated with one of the coaxial tools, and means responsive to fluid pressure for isolating the said cylinder from the low pressure pump.

4. A machine for securing together the components of commutators, having in combination an annular and contractible work holder, a tool for pressing a work piece formed by the components of a commutator into the holder, an annulus embracing the work holder and adapted by relative sliding movement to contract the work holder, a pair of coaxial and relatively slidable tools situated respectively in positions at the upper and lower sides of the work holder, and having their adjacent ends shaped for expanding the ends of a central bush of the work piece thereby securing the work piece components together in response to movement of the upper tool, the lower tool being movable to serve for ejecting the work piece from the holder, pistons for imparting movements to the tools and annulus, cylinders in which the pistons are slidable under fluid pressure, and fluid-controlling means associated with the cylinders for enabling the operations of the machine to be performed automatically under manual control, the said means comprising in combination a pair of manually operable valves which require to be actuated simultaneously for starting the machine, another manually operable valve for initiating movement of the tool adapted to serve as an ejector, and valves operable by fluid pressure in response to movements of the manually operable valves for controlling the flow of fluid into and out of the cylinders.

5. A machine as claimed in claim 4, in which the manually operable valves for starting the machine are situated at a sufficient distance apart to necessitate the use of both hands of the operative.

6. A machine as claimed in claim 4, in which the fluid controlling means includes a main valve movable in one direction by fluid pressure, a solenoid for moving the main valve in the opposite direction, and electrical switching means responsive to the fluid pressure in the said means and the movement of the main valve for controlling the solenoid.

7. A machine as claimed in claim 4, in which the fluid controlling means includes a main valve movable in one direction by fluid pressure, a solenoid for moving the main valve in the opposite direction, electrical switching means responsive to the fluid pressure in the said means and the movement of the main valve for controlling the solenoid, an additional valve connected to the main valve, an actuating piston having a lost-motion connection with the said additional valve, and a cylinder in which the piston is slidable under fluid pressure in response to actuation of the manually operable valves whereby the machine is started, the said switching means including a switch operable by movement of the interconnected valves for controlling the said solenoid.

WILLIAM SWIFT.
ARTHUR GOODMAN.

No references cited.