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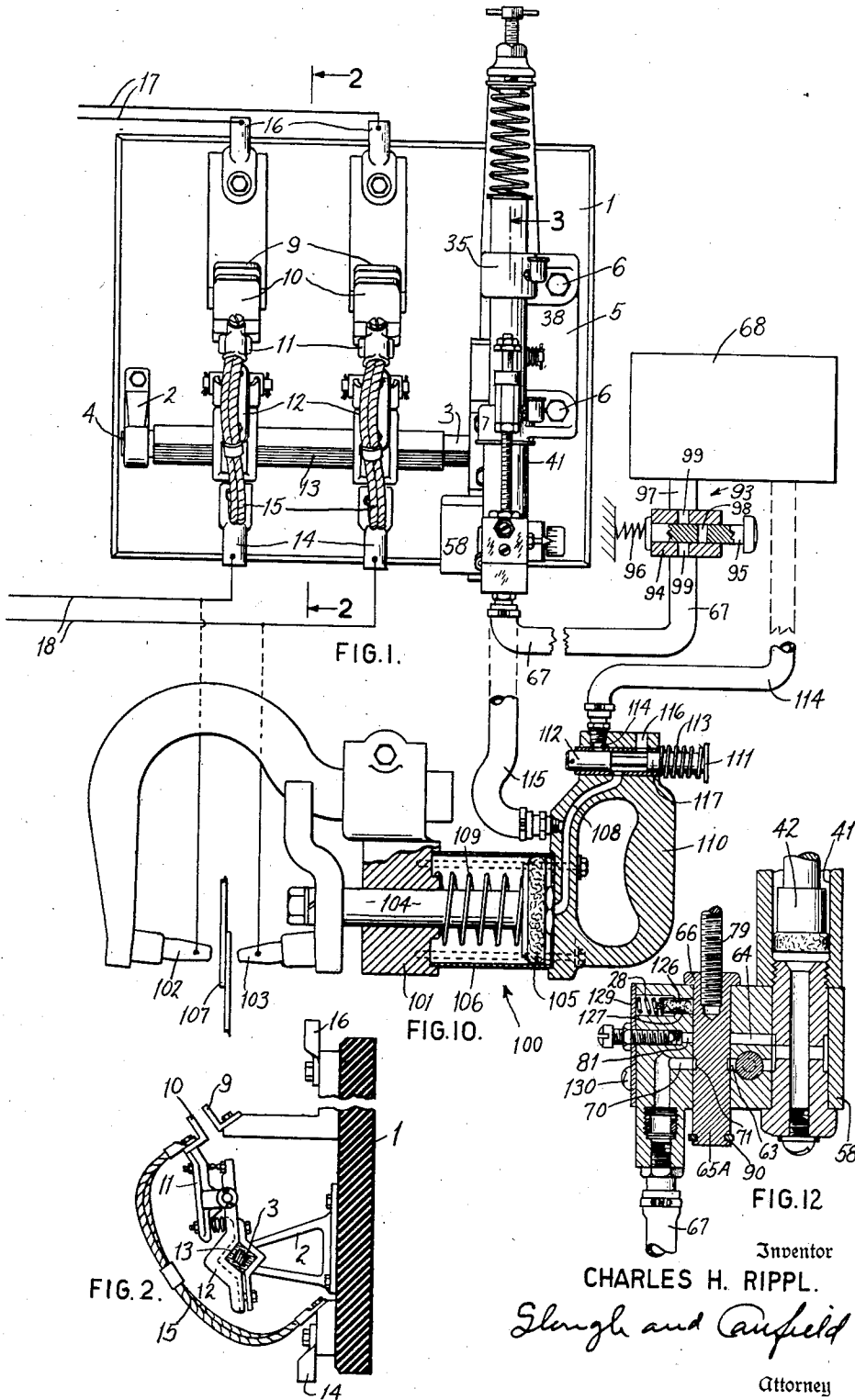
C. H. RIPPL

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PERIODIC PRESSURE CONTROL FOR ELECTRIC TIMING SWITCHES

Filed Jan. 18, 1937

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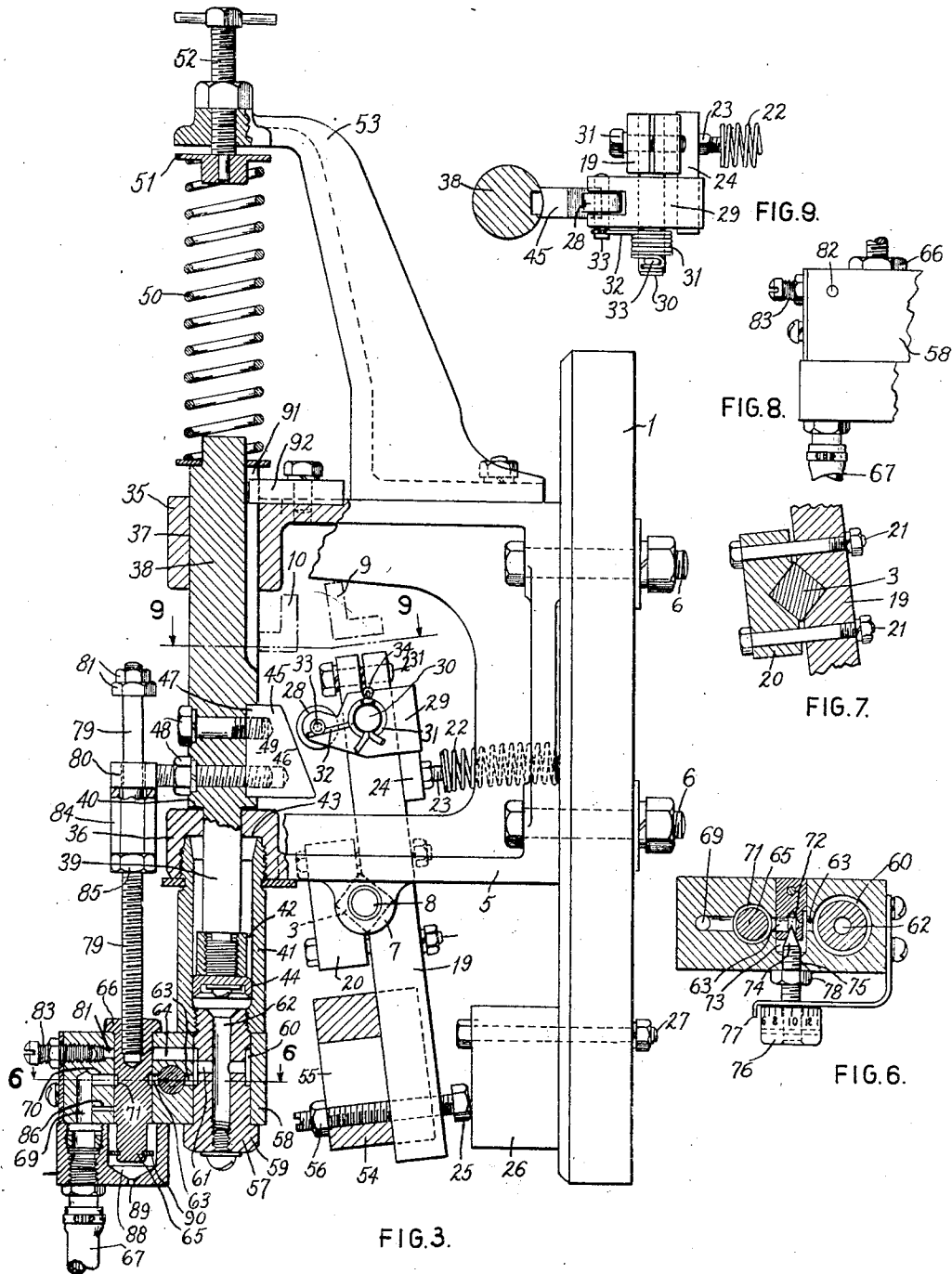
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

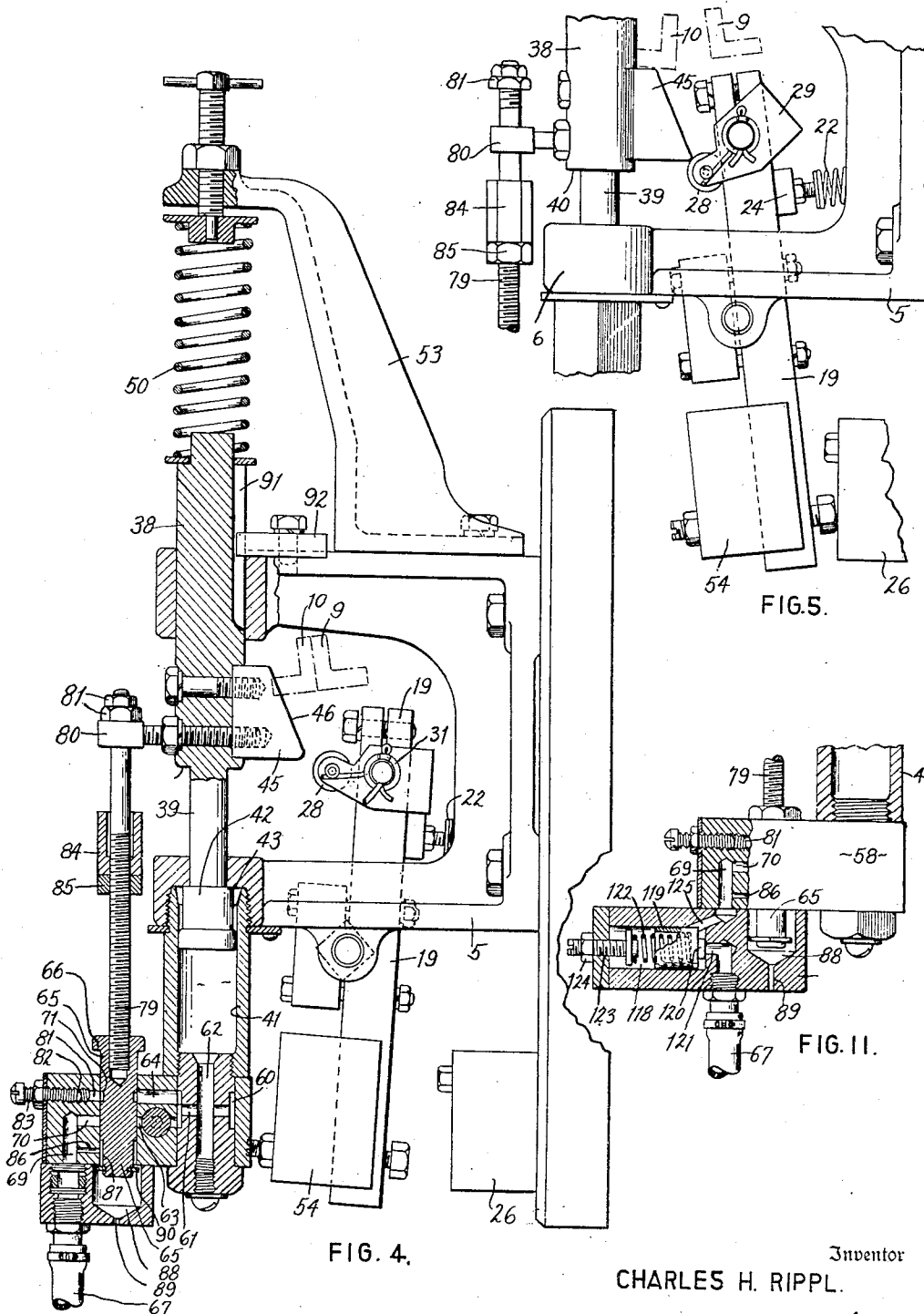


FIG. 4.

FIG. 5.

FIG. 11.

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UNITED STATES PATENT OFFICE

2,172,015

PERIODIC PRESSURE CONTROL FOR ELECTRIC TIMING SWITCHES

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Ohio, a corporation of Ohio

Application January 18, 1937, Serial No. 121,060

14 Claims. (Cl. 200—33)

This invention relates to timing electric switches for timing the duration of electric current impulses and relates particularly to the timing of current impulses when occurring in rapid sequence.

While my invention may be applied to numerous uses in the various arts, it is particularly applicable to the timing of a rapid succession of current impulses for electric welding, such for example, as spot welding, and its application to that use among others is described herein.

Among the objects of the invention are:

To provide an improved switch mechanism for periodically closing and opening an electric circuit.

To provide a switch mechanism for controlling in an improved manner the duration of a succession of the current impulses transmitted to a welding gun or other device.

To provide an improved switch mechanism for timing the duration of each of a rapid succession of current impulses.

To provide a fluid pressure operated electric switch mechanism having improved means for periodically communicating pressure to the mechanism and interrupting the application of the pressure to effect a periodic operation and restoration of the switch mechanism.

To provide an improved switch mechanism for effecting the periodic successive closing and opening of an electric circuit and for adjustably timing the period during which the circuit is closed.

To provide an improved fluid pressure operated switch mechanism arranged to close an electric circuit upon the communication of fluid pressure thereto and to open the circuit upon interrupting the application of the pressure, and provided with means to adjustably control the application of the pressure to adjustably vary the time during which the switch remains closed.

To provide a switch mechanism for periodically successively closing and opening an electric circuit to produce therein current impulses and having improved means to insure a like duration for all of the impulses.

To provide a fluid pressure operated electric switch mechanism having a fluid pressure controlling valve of improved mode of operation and improved construction.

To provide a fluid pressure operated switch mechanism having fluid pressure controlling means by which the time duration of an electric current impulse controlled by the switch and also the frequency of successive said impulses may be adjustably varied.

Other objects will be apparent to those skilled in the art to which my invention appertains.

My invention is fully disclosed in the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a front elevational view of a mechanism embodying my invention;

Fig. 2 is a cross sectional view taken from the plane 2—2 of Fig. 1;

Fig. 3 is a longitudinal sectional view taken from the plane 3 of Fig. 1 and drawn to an enlarged scale;

Fig. 4 is a view similar to Fig. 3 but with operative parts thereof in different positions;

Fig. 5 is a fragmentary view of a part of Figs. 3 and 4 illustrating fragmentarily another operative position of parts thereof;

Fig. 6 is a sectional view taken from the plane 6—6 of Fig. 3;

Fig. 7 is a fragmentary sectional view illustrating in section certain parts illustrated in elevation in Figs. 3, 4 and 5;

Fig. 8 is an elevational view showing fragmentarily parts which are shown in section in Figs. 3 and 4;

Fig. 9 is a fragmentary top plan view taken from the plane 9—9 of Fig. 3;

Fig. 10 is a partly sectional view of a welding device the parts thereof being arranged to show the association thereof with the parts of Fig. 1, the parts of Fig. 1 not being duplicated to avoid complication of the drawings;

Fig. 11 is a view similar to a part of Figs. 3 and 4 but illustrating a modification which may be employed.

Fig. 12 is another view similar to a part of Figs. 3 and 4 but illustrating another modification.

Referring to the drawings. Figs. 1 to 5 inclusive, I have shown generally at 1 a panel constructed from insulating material having mounted thereon a bracket 2 in which is oscillatably supported a rectangular shaft 3 having a rounded end 4 in the bracket 2. A frame 5, preferably of cast metal, is secured to the panel 1 by bolts 6—6 and has formed thereon a bracket 7 in which oscillates the opposite rounded end of the shaft 3.

A pair of stationary contacts 9—9 are mounted on the panel 1 in position to be engaged by a corresponding pair of movable contacts 10—10 mounted on switch arms 11—11 rigidly secured to the shaft 3 by clamp devices 12—12, the arms 11—11 being yieldable on the clamp devices 12—12, and the latter being insulated from the shaft 3 by a rectangular sleeve 13 of insulating

material telescoped on the shaft. The contacts 10—10 are connected to terminals 14—14 on the panel by flexible connectors 15—15 and the contacts 9—9 are connected to terminals 16—16, the terminals being mounted on the panel 1.

By this means when the shaft 3 is oscillated in one direction, the pairs of contacts will be engaged and close a circuit from supply mains 17—17 through the contacts to work circuit mains 18—18, and of course, when the contacts 9 and 10 are disengaged the current will be broken, the current having a duration determined by the rapidity with which the shaft 3 is oscillated first in one direction and then in the other.

A shaft operating arm 19 is rigidly secured thereto preferably by the arrangement shown in Fig. 7 wherein the rectangular part of the shaft 3 is gripped between a recess in the arm 19 and a corresponding recess in a clamp element 20, the locking engagement thus provided being maintained by bolts 21—21.

The arm 19 is normally maintained in the position to hold the contacts 9—10 disengaged by a spring 22 abutting at one end upon the panel 1 and at the other end abutting upon a stud 23 threadably adjustable in a cross arm 24 secured to the arm 19. The arm 19 is adjustably stopped in its contact disengaged position by a stud 25 thereon threaded thereto and engaging a block 26 secured to the panel 1 by a bolt 27.

A cam follower, the purpose of which is to be described, is mounted upon the upper end of the arm 19 and comprises a roller 28 pivoted in the forked end of a roller support 29 oscillatably supported on a pin 30 clamped in a slot in the upper end of the arm by a bolt 231. The roller support 29 is constrained in the clockwise direction of oscillation as viewed in Figs. 3 and 4 by a spring 31 wound around the pin 30 and having a free end 32 engaging the under side of the pin 33 on which the roller rotates, the other end of the spring being anchored to a cotter pin 34 projected through the outer end of the pin 30.

The roller support 29 is stopped in its clockwise direction by engagement of the rearward end thereof with the cross arm 24; and the roller support 29 being oscillatable in the other direction for a purpose to be described.

The frame 5 is provided with an upper and a lower boss 35 and 36, the upper boss being provided with a bore 37 in which is reciprocally mounted a plunger 38, the lower end of which is of reduced diameter and constitutes a piston rod 39, the shoulder 40 at the juncture of the rod with the plunger constituting a stop limiting downward movement of and supporting the plunger 38.

A cylinder 41 of tubular form is threaded upwardly into the boss 36 and a piston 42 on the rod 39 reciprocates in the cylinder engaging a shoulder 43 on the boss 36 to limit its upward movement, the piston 42 having an expansible sealing head 44.

A cam 45 having a cam face 46 is mounted on the plunger 38 intermediate the bosses 35 and 36 preferably being seated in a recess 47 in the plunger and secured by bolts 48—48, shims 49 preferably being provided behind the cam 45 to adjust its position toward and from the plunger.

Fluid pressure such, for example, as compressed air is supplied to the cylinder 41 on the under side of the piston 42 in a manner to be described, and the rate of admission thereof is controlled. The fluid pressure under the piston 42 moves the piston and therefore the plunger 38

upwardly at a rate controlled by the admission of the air to the cylinder. When this occurs, the cam face 46 moves into engagement with the cam follower roller 28 and the cam moving upwardly rocks the arm 19 clockwise, as viewed in Figs. 3 and 4 engaging the movable contacts 10—10 with the stationary contacts 9—9 and closing the electric circuit.

When the cam 45 has passed beyond the roller 28, the spring 22 will return the arm 19 to its normal position and break the engagement of the contacts, thus breaking the electric current. If the cam 45 moves upwardly slowly, the time duration of the contact engagement will be determined by the rate of movement of the plunger and by the length of the cam face 46. When the fluid pressure is relieved under the piston 42, the plunger 38 is returned downwardly by a spring 50 engaging at its lower end, the upper end of the plunger 38 and at its upper end engaging a head 51 on the end of a screw 52 threaded into the upper end of a bracket 53 mounted on the frame 5, the pressure of the spring 50 being adjustable by the screw 52. During the downward movement of the plunger 38, and with the arm 19 in its normal position, the cam engages the roller 28 and rocks it counter-clockwise as shown in Fig. 5 without moving the arm 19 and when the cam has passed beyond the roller 28, the spring 31 returns the roller to its normal position for another operation.

If the plunger 38 is timed to move upward rapidly, the force applied by the cam to the roller 28 will overthrow the arm 19 by the inertia thereof in the contact engaging direction, whereby the contacts 9 and 10 will be engaged and disengaged for a period of time determined by the inertia of the arm 19 and its associated parts and the pressure of the spring 22.

This mode of operation is preferred when the current duration is to be very short. The inertia of the arm 19 and its associated parts may be adjustably varied by means of a weight 54 on the lower end of the arm which may be adjusted toward and from the axis of oscillation by means of a slot 55 therein and by extending the stud 25 therethrough and providing a nut 56 outwardly of the weight to clamp it on the arm in any adjusted position.

When the inertia principle is utilized, as above described, the cam 45 and its face 46 may be so predetermined that a slow upward movement of the plunger 38 will not engage the contacts at all whereby for a rapid movement and an inertia throwing of the arm 19, the time duration of the engagement may be made very short.

Various means may be provided to supply air to the cylinder 41. In the means illustrated, a head element 57 is threaded into the lower end of the cylinder and clamps a valve housing 58 between a head 59 on the element 57 and the lower end of the cylinder 41. The head element 57 has an annular chamber 60 therein communicating by ducts 61 with a longitudinal duct 62 in the head element opening at its upper end into the cylinder 41. A pressure admission duct 63 and a pressure exhaust duct 64 communicate with the chamber 60. A vertically reciprocable valve 65 controls the admission and exhaust. The valve 65 has a normal downward position in which a head 66 thereon engages the upper side of the valve housing 58. In this position, fluid pressure such as compressed air is supplied from a conduit 67, communicating with a fluid pressure source 68 as shown in Fig. 1, by way of ducts 75

69 and 70 leading to an annular chamber 71 in the valve 65 and thence to the admission duct 63 whence it flows to the cylinder, as described, to operate the plunger 38.

To control the rate of airflow, the arrangement illustrated best in Fig. 6 may be provided. The approach side of the duct 63 has a valve seat 72 therein, the air flowing through the valve seat into a chamber 73 which communicates with the other side of the duct 63, the flow through the valve seat being controlled by a needle valve 74 on a screw 75 provided with a calibrated head 76 cooperating with a pointer 77 and locked in any adjusted position by a nut 78.

By the following means, when the plunger 38 moves upwardly it cuts off the supply of pressure and opens an exhaust to the cylinder 41. A rod 79 threaded into the upper end of the valve 65 passes upwardly through an eye 80 secured to the plunger and has a shoulder on the upper end provided with a pair of locked nuts 81. When the plunger moves upwardly, the eye 80 engages the nut 81 and lifts the valve 65 from the position shown in Fig. 3 to the position shown in Fig. 4, this upper position of the valve aligning the annular chamber 71 of the valve with the exhaust duct 64 whereupon pressure in the cylinder 41 is exhausted outwardly through the duct 64, the annular chamber 71 and a duct 81 communicating with an outlet 82 open to atmosphere, the flow through the duct 81 being adjustable by a screw 83 overlapping more or less of the outlet 82. In its upper position, the supply duct 70 is closed off by the body of the valve, as shown in Fig. 4.

Pressure being relieved under the piston 42, it and the plunger 38 return downwardly and at or near the bottom of its downward movement, the eye 80 engages a nut 84 adjustably positioned on the rod 79 and secured by a lock nut 85 and pushes the valve 65 downwardly to its lower position.

This again admits air to the cylinder and the cycle of operation repeats, the plunger 38 rapidly reciprocating and successively closing the contacts 9 and 10 for the predetermined timed current duration. If desired, although not always necessary, the valve 65 may be held in its upper exhausting position to insure that it will not reseat prematurely. To this end, when the valve is moved to its upper position, air under pressure is admitted from the duct 69 through a duct 86 into an annular chamber at the lower end of the valve and thence into a compression chamber 88 under the valve having a slow exhaust restricted outlet 89 to atmosphere; and the upward movement of the valve may be stopped by a ring 90 on the lower end of the valve engaging a shoulder on the valve housing 53 above it. When the stop ring 90 is employed, there will be no liability that the rapid upward movement of the rod 69 will throw the valve 65 beyond its exhausting position. The pressure admitted to the chamber 88 is a reduced pressure determined by the size of the outlet 89 and while it is sufficient to hold the valve and the rod 79 in their upper positions, it is not sufficient to prevent downward movement of the valve, as above described by the force of the downwardly returning plunger 38.

To prevent rotation of the plunger 38, it may be provided with a groove 91 into which extends a key 92 bolted to the upper side of the frame 5.

To admit air to the conduit 67, from the source 68, a valve such as that shown generally at 93 may be employed comprising a cylinder 94 in

which reciprocates a valve stem 95 normally held in an upper position by a spring 96 and arranged to be manually depressed whereby pressure from the source 68 may be communicated from a conduit 97 to the conduit 67 through a valve duct 98 in the plunger and valve ducts 99—99 in the cylinder 94; and as will now be understood, when the plunger 95 is depressed to its lower position, the pneumatically operated switch above described will repeatedly close and open and supply current impulses of timed duration to the work circuit 18.

The upward movement of the plunger 38 may be timed by the valve arrangement shown in Fig. 6 and when at or near the top of its stroke the plunger opens the valve to the exhaust, the downward movement of the plunger likewise may be timed by the adjustment of the screw 83 prior to resetting of the valve 65.

In Fig. 10, taken in connection with Fig. 1, is illustrated the use of the pneumatically operated switch construction to control the welding current impulses supplied to a welding gun or device shown generally at 100. The gun comprises a head 101 to which is secured an electrode 102. Another electrode 103 is connected to the piston rod 104 of a piston 105 reciprocable in a cylinder 106, in the direction to engage the electrodes 102 and 103 with work to be welded 107 when fluid pressure such as air under compression is supplied to the cylinder 106 through a duct 108, a spring 109 returning the cylinder 105 to disengage the electrodes from the work when the pressure is released. The gun comprises a handle 110 convenient to which is an operator's button 111 operating a piston type valve 112. When the button 111 is depressed against the tension of a spring 113, the valve 112 effects communication from a conduit 114, which may be connected as shown in dotted lines to the pressure source 68, with the duct 108 supplying the fluid under pressure to move the piston 105. A back pressure conduit 115 communicates with the duct 108 at one end and at the other end may be connected to or may be continuous with the above described conduit 67 as indicated in dotted lines in Fig. 10. While the piston 105 is moving and therefore while the air from the conduit 108 is expanding therein, the pressure in the conduit 115—67 will be at less than the full pressure but as soon as the contacts 102—103 have been pressure engaged with the work 107, the pressure in the conduit 115—67 will quickly build up to the full pressure of the source 68 and then the pneumatically operated switch above described will be operated and send an impulse of current to the work circuit 18 to which the electrodes 102 and 103 may be connected as shown in dotted lines in Fig. 10. If the operator's button 111 will be held in its operative position, a succession of current impulses will be supplied to the electrodes 102 and 103 but in some cases in welding practice with a device such as the gun 100, this is not wanted so that after the switch has once operated, the operator will release the button 111 and the spring 113 will return the piston valve 112 and the cylinder 106 as well as the conduit 115—67 will be relieved outwardly by way of the duct 108 and an exhaust duct 116 on the gun, which during the operation thereof above described was closed by a portion 117 of the piston valve. When the pressure on the electrodes 102—103 is relieved, as just described, the operator moves them to another position on the work and again presses the button 111 and because the

plunger 38, above described, cuts off its own pressure supply and returns ready for another operation in a very short period of time which may be determined by adjustment above described independently of the duration of the current impulse, the switch is always ready for another current impulse even if the operator rapidly moves the gun from one position to another. In practice, there will be a normal rapidity for the successive operations of the gun by the operator in making a row of spot welds, for example, and the switch as above described may be adjusted to this frequency of operation of the gun so that each time the operator presses the button 111, the plunger 38 of the switch has returned and is ready for timing the corresponding current impulse.

In some cases, the pressure may build up in the conduit 115—67 relatively slowly and may reach a pressure in the switch cylinder 41 capable of moving the plunger upwardly but not at its predetermined velocity and therefore the current impulses will not be accurately timed, particularly if the supply pressure should vary.

In Fig. 11 is illustrated a modification whereby the plunger will not be moved until the pressure at the conduit 67 has attained a full operating pressure whereby each time the plunger is moved to operate the switch it will be moved at the same velocity.

In this form, instead of leading the pressure directly from the conduit 67 to the duct 69, it is led into a cylinder 118 in which reciprocates a piston 119 having a portion of reduced diameter 120 normally closing a duct 121 in direct communication with the conduit 67. The piston 119 is yieldably constrained in the said duct closing position by a spring 122 adjustable by a screw 123 and fixed by lock nut 124. When the pressure in the conduit 67 reaches the value for which the spring 122 is set, which is the value capable of operating the plunger 38 throughout its full stroke with the predetermined velocity, the pressure on the reduced portion 120 forces the piston 119 backwardly against the spring 122 and admits the fluid pressure to the cylinder 118 under the end of the piston 119 and thence it flows by a duct 125 to the duct 69 and so on as described above.

In Fig. 12 is illustrated another means for holding the valve 65 in its upper or exhaust position until it is positively moved downward to its air supply position by the rod 79. In Fig. 12 this valve is illustrated at 65A and has the annular chamber 71 effecting communication between the ducts 70 and 63 by which fluid pressure may be conducted from the conduit 67 to the cylinder 41 to operate the piston 42; and has a ring 90 on the lower end of the valve to engage the housing 58 when the valve moves upwardly to cause the annular chamber 71 to effect communication between ducts 31 and 64; and has the rod 79, which may be identical with the rod 79 of the first described form to raise the valve to this position when the piston 42 has moved upwardly; and has the flange 66 to position the valve when it is moved downwardly by the downward movement of the piston 42, as described in the first form; these parts being shown as identical with the parts bearing the same numbers in the first described form; and the mode of operation thereof is the same as that of the parts in the first described form.

The means for holding the valve 65A in its upper position however is different from that of

the first described form and this will now be described. At 126 is a short rod or body of felt or like friction material disposed in a bore 127, abutting at its inner end upon the cylindrical side of the valve 65A and at its outer end abutting upon one end of a compression spring 128, the other end of which abuts upon a plate 129 forming part of the housing 58. The spring thus holds the body 126 in frictional engagement with the side of the valve and while permitting it to be moved by the connection of the valve through the rod 79 with the piston 42, will prevent its premature movement downwardly by gravity. To give access to the bore 127 in which the body 126 and spring 128 are trapped, the plate 129 may be removed upon removing the screw 130. By this means the friction body 126 and the spring 128 may be replaced or adjusted.

In the first above described embodiment of my invention as well as in the two modifications thereof, it will be understood from the foregoing description that the velocity of the upward movement of the plunger 38 and therefore the duration of the current impulse flowing through the contacts 9 and 10 may be adjustably varied by adjustably turning the screw 75 having the needle valve 74 thereon to adjustably vary the rate at which air is admitted to the cylinder 41; and also that the frequency of successive said impulses may be adjustably varied by adjustably turning the screw 83 controlling the rate at which the air in the cylinder 41 exhausts outwardly to atmosphere through the port 82; and as will be apparent either adjustment may be made independently of the other.

In Fig. 10, the electrodes 102 and 103 are illustrated as receiving electric current directly from supply mains. It will be understood that whereas this arrangement may be utilized, the well known arrangement by which the electrodes 102 and 103 may be energized from the secondary of an electric transformer may, if desired, be utilized, it being deemed well understood without further illustration or description.

My invention is not limited to the exact details of construction illustrated and described. Changes and modifications may be made within the spirit of my invention without sacrificing its advantages and within the scope of the appended claims.

Subject matter illustrated and described in this application and not claimed herein is being claimed in my copending application, Serial Number 62,795, filed February 7, 1936, for improvements in Welding current control apparatus.

I claim:

1. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and chamber movable wall elements one of which is reciprocatory, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the chamber with the source, reciprocable valve means operated in one direction by each movement of the reciprocatory element in said one direction to exhaust fluid pressure from the chamber and cut off connection thereof with the source and operated in the return direction by each return movement of the reciprocable element in the other direction to cut off the exhaust and again effect connection between the

source and the chamber, and spring means to effect quick return of the reciprocable element and the valve means to effect rapid repeating of the mechanism.

2. A repeating electric switch mechanism comprising an electric switch, pneumatic cylinder and piston elements one of which is reciprocatory, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch and in the return reciprocatory direction being ineffective to operate the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the cylinder with the source, a reciprocable valve operated by each movement of the reciprocatory element in said one direction to exhaust the cylinder and cut off connection thereof with the source and operated in the return direction by each return movement of the reciprocable element in the other direction to cut off the exhaust and again effect connection between the source and the cylinder, and a spring to effect quick return movement of both the reciprocable element and the valve to effect rapid repeating of the mechanism.

3. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and chamber movable wall elements one of which is reciprocatory, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the chamber with the source, means to cut off pressure connection with the source and to exhaust pressure from the chamber after the said one direction of movement of the reciprocable element to effect return reciprocation of the reciprocable element, and means operated by each return movement of the movable element to again effect connection of the chamber with the source, and mutually independent means to adjustably vary the rate of admission of fluid pressure from the source to the chamber and the rate of exhaust of fluid pressure from the chamber to independently adjustably vary the rate of the reciprocatory movement of the reciprocable element in each direction.

4. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and movable wall elements one of which is reciprocatory, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the chamber with the source, and valve means operated by each movement of the reciprocatory element in said one direction adjacent the end of said movement to exhaust fluid pressure from the chamber and cut off connection thereof with the source and operated by each movement in the other direction adjacent the end of said movement to cut off the exhaust and again effect connection between the source and the chamber and mutually independent means to adjustably vary the rate of admission of fluid pressure from the source to the chamber and the rate of exhaust of fluid pressure from the chamber to independently adjustably vary the rate of the reciprocatory movement of the reciprocable element in each direction.

5. A repeating electric switch mechanism comprising an electric switch, pneumatic cylinder and piston elements one of which is reciprocatory, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the cylinder with the source, and valve means operated by each movement of the reciprocatory element in said one direction adjacent to the end of said movement to exhaust the cylinder and cut off connection thereof with the source and operated by each movement in the other direction adjacent to the end of said movement to cut off the exhaust and again effect connection between the source and the cylinder and mutually independent adjusting means to adjustably vary the rate at which fluid pressure is admitted to the cylinder and the rate at which fluid pressure is exhausted therefrom.

6. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and chamber movable wall elements one of which is reciprocatory, mechanism means operated by the reciprocation of the reciprocable element in one direction to both operate and restore the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means communicating fluid pressure from the source to the chamber, means to exhaust pressure from the chamber after the said one direction of movement of the reciprocable element to effect return reciprocation of the reciprocable element and means to cut off the exhaust upon each return movement of the movable element, and mutually independent means to adjustably vary the rate of admission of fluid pressure from the source to the chamber and the rate of exhaust of fluid pressure from the chamber to independently vary the rate of reciprocatory movement of the reciprocable element in each direction.

7. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and movable chamber wall elements one of which is reciprocatory, mechanism means operated by the reciprocation of the reciprocable element in one direction to both operate and restore the switch, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the chamber with the source, valve means operated by each movement of the reciprocatory element in said one direction adjacent to the end of said movement to exhaust fluid pressure from the chamber and operated by each return movement adjacent to the end of said movement to cut off the exhaust, and mutually independent means to adjustably vary the rate of admission of fluid pressure to the chamber and the rate of exhaust of fluid pressure from the chamber to independently vary the rate of reciprocatory movement of the reciprocable element in each direction.

8. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and movable chamber wall elements, one of which is reciprocatory, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch and to maintain the switch operated for a time duration commensurable with the velocity of movement of the reciprocable

element, actuating means to repeatedly reciprocate the reciprocable element comprising a source of fluid pressure, conduit means connecting the chamber with the source, means to exhaust pressure from the chamber after the said one direction of movement of the reciprocable element to effect return reciprocation of the reciprocable element with a velocity commensurable with the rate of exhaust from the chamber, and mutually independent means to adjustably vary the rate of admission of fluid pressure from the source to the chamber and the rate of exhaust of fluid pressure from the chamber to independently vary the rate of reciprocatory movement of the reciprocable element in each direction to correspondingly independently vary the said time duration and the frequency of repeating of the mechanism.

9. A repeating electric switch mechanism comprising an electric switch, pneumatic chamber and movable chamber wall elements one of which is reciproctary, mechanism means operated by a reciprocation of the reciprocable element in one direction to both operate and restore the switch and to maintain the switch operated for a time duration commensurable with the velocity of movement of the reciprocable element, actuating means to repeatedly reciprocate the reciprocable element, comprising a source of fluid pressure, conduit means connecting the chamber with the source, valve means operated by movement of the reciprocable element in said one direction adjacent to the end of said movement to exhaust fluid pressure from the chamber and operated by each movement in the return direction adjacent to the end of said movement to cut off the exhaust, and mutually independent adjusting means to adjustably vary the rate of admission of fluid pressure from the source to the chamber to independently vary the velocity of reciprocatory movement of the reciprocable element in each direction, to correspondingly vary the said time duration and frequency of repeating of the mechanism.

10. A repeating electric switch mechanism for timing the frequency and duration of a succession of electric current impulses comprising an electric switch, a movable element, power means for repeatedly moving the movable element, means operated by repeated movements of the movable element to repeatedly effect closure of the switch and opening thereof after a time interval, means to adjustably vary the time interval during which the switch remains closed, and means to vary the frequency of repeated closures of the switch independently of variations of the said time interval comprising means to adjustably vary the velocity of the movement of the movable element.

11. A repeating electric switch mechanism for timing the frequency and duration of a succession of electric current impulses, comprising an electric switch, a movable switch operating element, power means for repeatedly moving the movable element comprising a source of fluid pressure, a fluid pressure chamber and means to admit fluid pressure to the chamber and exhaust it therefrom, the movable member being mov-

able in response to changes of fluid pressure in the chamber, mechanism means operated by repeated movements of the movable element to repeatedly close the switch and then open it after a time interval, means to vary the time interval during which the switch remains closed and means to vary the frequency of repeated closures of the switch independently of variations of the time interval comprising means to adjustably vary the rate of fluid pressure admission to the chamber and means to adjustably vary independently thereof the rate of fluid pressure exhaust from the chamber.

12. A repeating electric switch mechanism for timing the frequency and duration of a succession of electric current impulses, comprising an electric switch, a source of fluid pressure, a fluid pressure chamber, means to admit fluid pressure from the source to the chamber and exhaust it therefrom, a movable member movable in response to changes of fluid pressure in the chamber, mechanism means operated by repeated movements of the movable element to repeatedly close the switch and then open it after a time interval, means to control the duration of the time interval and means to control the frequency of repeated closures of the switch comprising means controlling the rate of fluid pressure admission to the chamber independently of the rate of fluid pressure exhaust therefrom.

13. A repeating electric switch mechanism for timing the frequency and duration of a succession of electric current impulses for welding or the like, comprising an electric switch, a movable element, power means for repeatedly moving the movable element, means operated by repeated movements of the movable element to repeatedly effect closure of the switch and to effect opening of the switch after a time interval, means to adjustably vary the time interval during which the switch remains closed and means to vary the frequency of repeated closures of the switch independently of variations of the time interval comprising means to adjustably vary the velocity of the movement of the movable element.

14. A repeating electric switch mechanism for timing the frequency and duration of a succession of electric current impulses for welding or the like comprising an electric switch, a reciprocable mechanism element, power means for repeatedly effecting reciprocation of the reciprocable element, means operated by repeated reciprocations in one direction to effect closing of the switch and to effect opening of the switch after a time interval, means to adjustably vary the time interval during which the switch remains closed comprising means to adjustably vary the velocity of movement of the reciprocable element in said direction of reciprocation, and means to adjustably vary the frequency of repeated closures of the switch independently of variations of the time interval comprising means to adjustably vary the velocity of the reciprocable element in the return reciprocatory direction.

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