April 8, 1941. H. T. PLATZ 2,237,747

WELDING EQUIPMENT

Filed Jan. 8, 1940 2 Sheets-Sheet 1

Fig. 1.

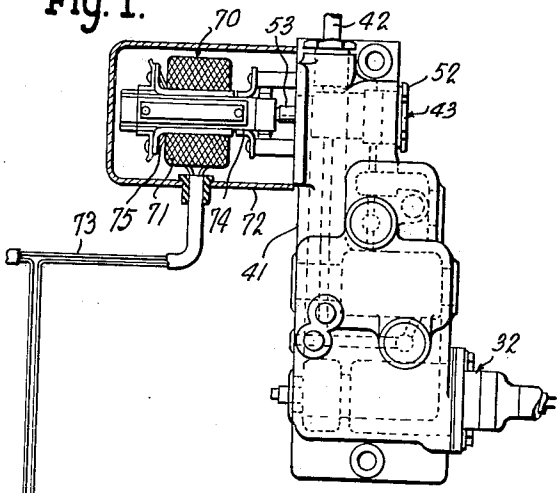


Fig. 3.

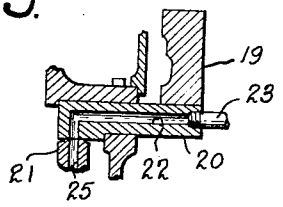
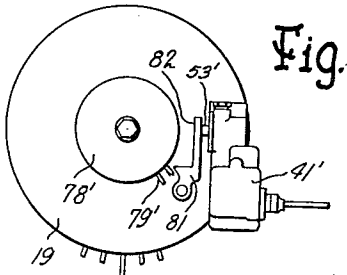


Fig. 7.



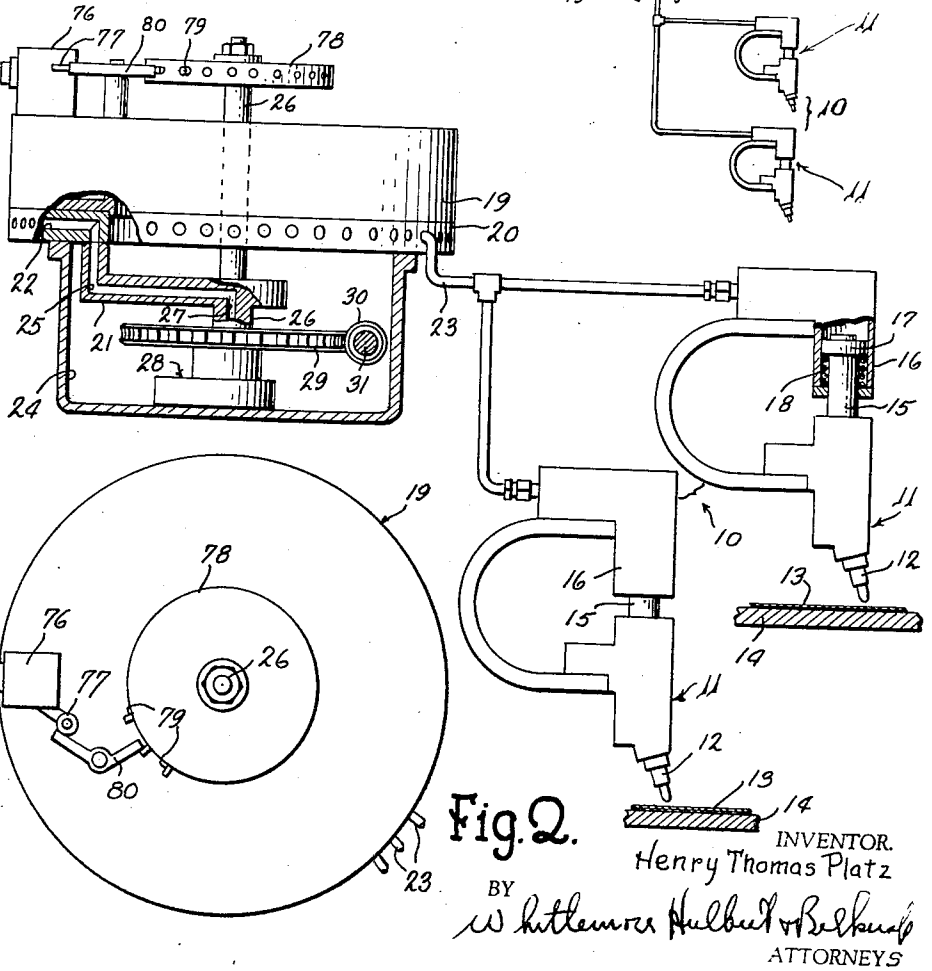


Fig. 2.

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WELDING EQUIPMENT

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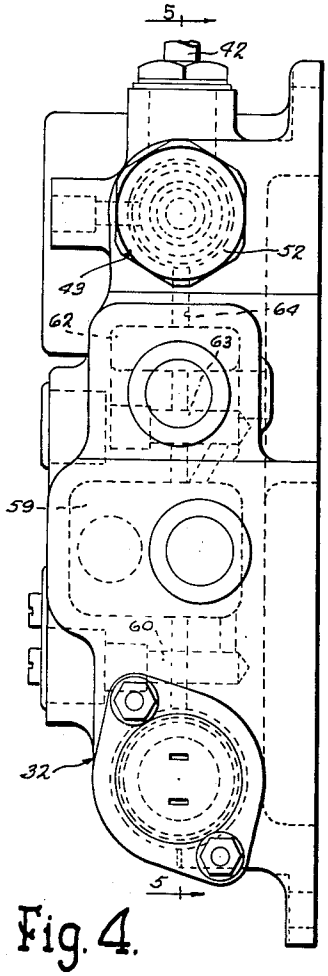


Fig. 4.

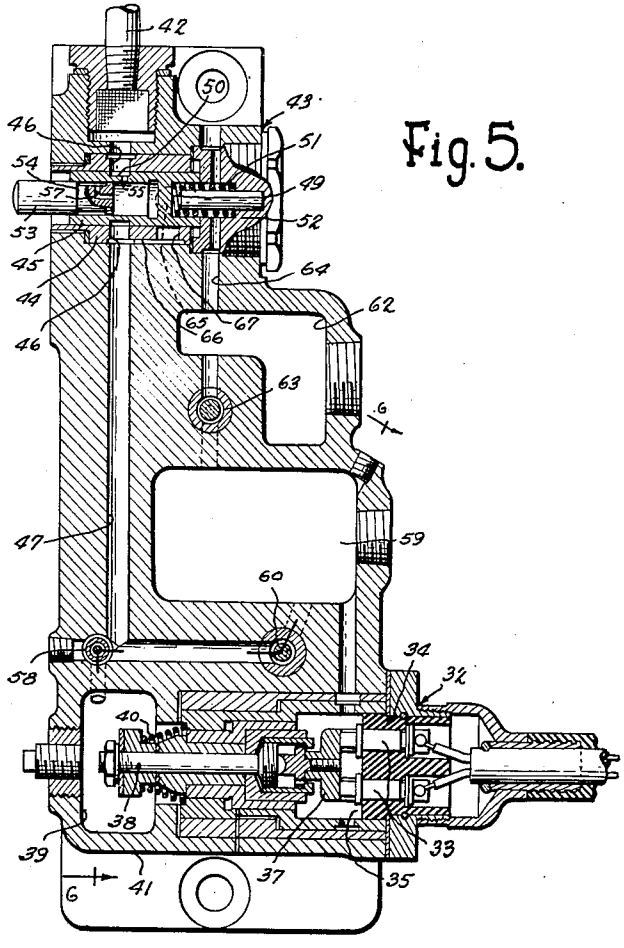


Fig. 5.

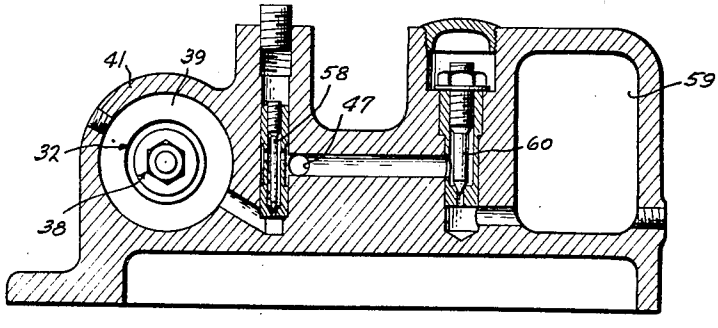


Fig. 6.

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UNITED STATES PATENT OFFICE

2,237,747

WELDING EQUIPMENT

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Application January 8, 1940, Serial No. 312,973

18 Claims. (Cl. 219—4)

This invention relates generally to welding apparatus and refers more particularly to improvements in the control mechanism for electrical welding equipment.

It has been proposed to operate a series of fluid pressure actuated welders sequentially by control mechanism having means for successively connecting the welders to a source of fluid under pressure and having a single fluid pressure operated switch for controlling the circuit to a plurality of welders in timed relation to relative movement of the electrodes into and out of engagement with the work. One method of accomplishing the above result consists in locating a rotary distributing valve between the source of fluid pressure and the welders so that rotation of the valve sequentially connects the welders to the source of fluid pressure.

In this method of procedure, a plurality of valves are associated with the distributor and each valve establishes communication between a source of fluid under pressure and the switch. The valves are opened by the fluid pressure flowing through the distributor valve to the welders and the arrangement is such that one valve is opened each time fluid pressure is admitted to one welder by the distributor valve. The operation of the switch is timed to close the circuit to the welders after the electrodes are relatively moved into engagement with the work and to open the circuit before the electrodes are relatively moved out of engagement with the work.

The above arrangement operates satisfactorily to perform the desired results and, in some instances, may actually be preferred. However, the present invention contemplates simplifying the apparatus by eliminating the necessity of providing individual switch operating valves for each welder. According to this invention, a single valve controls communication from a source of fluid pressure supply to the switch and this valve is sequentially operated in timed relation to the rotation of the distributing valve to supply fluid pressure to the welders.

Another object of this invention consists in operating the switch control valve by a solenoid arranged in an electric circuit with a limit switch which, in turn, is operated by a contact member rotatable in timed relation with the distributing valve.

A further object of this invention consists in operating the switch control valve directly from the contact member by suitable cam means carried by the contact member and engageable with the valve.

In addition to the foregoing, the present invention contemplates relatively simple control mechanism of the type set forth above wherein a hydraulic fluid medium is supplied to the welders for operating the latter and wherein a pneumatic fluid pressure is supplied to the circuit control switch for actuating the latter. With this arrangement, relatively high pressures may be attained in the welders with the minimum dimension of parts to secure the desired forging pressures at the work and rapid operation of the switch control means is insured. In other words, by operating the switch by pneumatic pressure, the switch not only responds more quickly to close and open the circuit to the welders, but the fluid under pressure may be exhausted directly into the atmosphere, with the result that the switch is immediately conditioned for the next cycle of operation. This latter feature is particularly advantageous where a single switch is employed to control the circuit to a plurality of sequentially operated welding devices since it provides for reducing the time interval between successive operations of the welders to a minimum.

The foregoing, as well as other objects, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein—

Figure 1 is a semi-diagrammatic view of welding equipment embodying my improved control mechanism;

Figure 2 is a plan view of the control mechanism shown in Figure 1;

Figure 3 is a fragmentary sectional view through a part of the control mechanism shown in Figure 2;

Figure 4 is an elevational view of a part of the control mechanism;

Figure 5 is a sectional view taken substantially on the plane indicated by the line 5—5 of Figure 4;

Figure 6 is a sectional view taken substantially on the plane indicated by the line 6—6 of Figure 5;

Figure 7 is a semi-diagrammatic view of a modified form of construction.

Referring first to the embodiment of the invention illustrated in Figures 1 to 6, inclusive, it will be noted that I have shown in Figure 1 welding equipment comprising a plurality of groups 10 of welding devices. The number of welding devices in each group may, of course, be varied from one welder to any number required to accomplish the desired operation and the welding

devices in each group may be identical in construction.

Referring again to Figure 1 of the drawings, it will be observed that each welding device comprises an electrode 12 electrically included in a secondary circuit (not shown) and movable into engagement with the work 13 by fluid under pressure. In the present instance, the work is supported on a cooperating electrode 14 also included in the secondary circuit to cooperate with the electrode 12 to weld the work in accordance with the resistance principle when the electrode 12 is moved into engagement with the work and when the secondary circuit is closed. Each of the electrodes 12 is shown in Figure 1 as connected to the lower end of a plunger 15 having the upper end extending into a cylinder 16 and connected to a piston 17 reciprocably mounted in the cylinder. The plunger 15, together with the electrode 12, are normally urged in a direction to move the electrode out of engagement with the work by means of a spring 18 surrounding the plunger 15 within the cylinder and having the opposite ends respectively abutting the bottom wall of the cylinder and the underside of the piston.

The cylinders 16 of the welding devices in each group 10 are sequentially connected to a source of hydraulic fluid medium by means of a distributor 19 comprising a plate 20 and a rotatable distributing arm 21. The plate 20 is fashioned with a plurality of radially extending passages 22 therein spaced from each other around the axis of rotation of the arm 21 and having the outer ends respectively communicating with flexible conduits 23. Each flexible conduit 23 communicates with the cylinders 16 of the welding devices in each group 10 and operates in a manner to be presently described to admit fluid under pressure to the cylinders 16 above the pistons 17. The radially inner ends of the passages 22 extend downwardly through the bottom of the plate 20 in communication with the interior of a reservoir in the form of a tank 24 adapted to contain a suitable liquid, such as oil. In addition, it will be noted that the inner ends of the passages 22 are concentrically arranged with respect to the axis of rotation of the arm 21 and the latter is formed with a supply passage 25 therethrough having the upper end successively registrable with the passages 22 upon rotation of the arm relative to the plate 20.

The arm 21 is secured to a vertically extending revoluble shaft 26 having an axial passage 27 therein communicating with the passage 25 through the arm and communicating with the discharge side of a suitable pump 28. The pump 28 is housed in the bottom of the tank 24 so as to receive liquid therefrom and may be operatively connected to the shaft 26 through the medium of step-up gearing (not shown). The shaft 26 is rotated at the required speed by means of a worm gear 29 secured to the shaft and meshing with a worm 30 which, in turn, is secured to a drive shaft 31. The drive shaft 31 is preferably driven by a suitable electric motor (not shown) and the ratio of the worm gearing is such as to effect rotation of the arm 21 relative to the plate 20 at the desired speed.

Thus, from the foregoing, it will be observed that the passage 25 in the arm 21 is constantly charged with fluid under pressure and since rotation of the arm 21 successively registers the passage 25 with the passages 22 in the plate 20, it follows that the groups of welders 10 are sequentially operated to engage their respective electrodes with the work. It may be pointed out at this time that when the passage 25 in the arm 21 moves out of registration with any one of the passages 22, the hydraulic fluid medium under pressure in the latter pasage is permitted to exhaust directly into the tank 24 and thereby permits the electrodes of the welders communicating with this passage to be moved out of engagement with the work by the springs 18.

In accordance with the present invention, the electrodes of each group of welders are arranged in an electric circuit which is closed after the electrodes are moved into engagement with the work and is opened prior to movement of the electrodes out of engagement with the work. In the present instance, a single switch 32 is provided for controlling the circuit to the electrodes of each group of welders and this switch is operated by air under pressure. Upon reference to Figure 5, it will be noted that the switch comprises a pair of stationary contacts 33 supported by a block of insulating material 34 in a chamber 35 and electrically connected to a suitable relay (not shown) for controlling the circuit to the welders.

Cooperating with the stationary contacts 33 is a movable bridge member 37 which, in turn, is supported in the chamber 35 on the forward end of the plunger 38. The rear end of the plunger 38 extends into a second chamber 39 and is normally urged in a direction to maintain the bridge member 37 out of engagement with the cooperating stationary contacts 33 by means of a relatively weak spring 40. The chamber 39 is separated from the chamber 35 and the area of the plunger exposed to the interior of the chamber 39 is smaller than the area of the plunger exposed to the interior of the chamber 35.

Both of the switch chambers are formed in a suitable casting 41 and the chamber 39 communicates with an air pressure supply line 42 through the medium of a valve assembly 43. The valve assembly 43 comprises a bushing 44 sleeved within a bore formed in the casting 41 and forming a cylinder within which a piston 45 reciprocates. The bushing 44 is provided with diametrically opposed ports 46 therethrough respectively communicating with the air supply line 42 and with the switch supply passage 47. Communication between the supply line 42 and passage 47 is normally prevented by means of the piston 45. This piston is in the form of a sleeve having a transverse partition 49 therein intermediate the ends thereof and having an annular recess 50 in the periphery adapted to register with the radially inner ends of the ports 46 to establish communication from the supply line 42 to the passage 47.

As indicated above, the piston is normally urged to a position wherein the recess 50 is out of registration with the ports 46 and this is accomplished herein by means of a coil spring 51 located in the bore with the forward end projecting into the piston in engagement with the adjacent side of the partition 49 and with the rear end abutting a plug 52 threaded in the bore to close the same. The piston is moved against the action of the spring 51 to register the recess 50 with the ports 46 by means of a plunger 53 slidably mounted within the piston at the front side of the partition 49 and adapted to abut the partition 49 to effect the rearward movement of the piston required to establish communication from the supply line 42 to the passage 47. In this connection, it may be pointed out that the plunger 53 is im-

mediately returned to its outermost position with respect to the piston after the latter has been operated to register the recess 50 with the ports 46. As shown in Figure 5, the plunger 53 is fashioned with an annular recess 54 adapted to communicate with a restricted aperture 55 which, in turn, directly communicates with the annular recess 50 in the cylinder. In addition, the recess 54 in the plunger communicates with the space at the rear of the plunger by means of a passage 57 formed in the plunger and opening through the rear end of the plunger. The arrangement is such that when the plunger 53 is actuated to move the piston to a position wherein the annular recess 50 communicates with the ports 46, the passage 57 in the plunger also communicates with the air under pressure. The air under pressure builds up in rear of the plunger 53 and returns the latter to its outermost position.

The air under pressure admitted to the passage 47 flows through a metering valve 58 into the chamber 39 and acts upon the relatively small area of the switch plunger 38 to move the latter against the action of the spring 40 in a direction to engage the bridge member 37 with the stationary contacts 33. Also, the air under pressure flows into an accumulating chamber 59 formed in the casting 41 and the rate of pressure rise in this accumulating chamber is regulated by means of a second metering valve 60. The accumulating chamber 59 communicates with the switch chamber 35 and acts upon the relatively larger area of the switch plunger tending to move the latter in a direction to disengage the bridge member 37 from the stationary contacts 33. When the pressure in the chamber 35, plus the force of the spring 40, exceeds the pressure in the chamber 39, the switch 32 is, of course, opened and the primary circuit is also opened. The period of the weld will, of course, depend upon the interval between closing and opening of the switch 32. This period may be varied by regulating the metering valve 60 to control the rate of pressure rise in the switch chamber 35.

Attention is also called to the fact at this time that the accumulating chamber 59 also communicates with a second accumulating chamber 62 through the medium of a metering valve 63. The second accumulating chamber 62 in turn communicates with the valve cylinder in rear of the piston 45 by means of a passage 64 so that fluid under pressure is built up in rear of the valve piston 45 tending to assist the spring 51 in moving the piston to a position wherein communication from the supply line 42 to the passage 47 is closed. It will be noted upon reviewing Figure 5 that the area of the piston exposed to the action of the fluid pressure from the accumulating chamber 62 is greater than the area of the piston acted upon by the fluid under pressure flowing through the supply line 42 to the passage 47. Accordingly, when the pressure in rear of the piston reaches a predetermined value, the piston is automatically operated to close communication from the source of supply to the switch. Of course, it is necessary to maintain communication from the supply line 42 to the switch until the latter has been automatically opened and the proper timing between opening of the switch and operation of the valve 43 to close communication to the switch is insured by regulating the metering valve 63.

Movement of the valve piston 45 to its closed position also opens an exhaust port 65 and permits the switch, together with the associated passages and chambers, to exhaust directly into the atmosphere. As shown in Figure 5, when the piston 45 is in its forewardmost position, the exhaust port 65 is uncovered and communicates with a longitudinally extending recess 66 in the periphery of the cylinder 44 through the medium of a port 67. The recess 66 communicates with the passage 47 and thereby permits exhausting the switch 32.

There are several ways in which the plunger 53 may be operated to initiate operation of the switch 32 in timed relation to the rotation of the distributing arm 21 and one especially advantageous method for accomplishing this result is shown in Figure 1. Upon reference to Figure 1, it will be noted that the valve plunger 53 is operated to open the valve 43 by means of a solenoid 70 positioned on the casting 41 opposite the valve assembly 43. In detail, the solenoid 70 comprises a coil 71 suitably supported within a casing 72 and included in an electric circuit 73. In addition, the solenoid is provided with a reciprocable armature 74 extending through the coil and adapted to abut the free end of the plunger 53. The general arrangement is such that when the coil 71 is energized by closing the circuit 73, the armature 74 is moved toward the valve 43 and applies the necessary force against the free end of the plunger 53 to move the valve piston 45 to its open position. Of course, when the circuit 73 is opened, the spring 51 together with the fluid under pressure acting on the rear end of the plunger 53, returns the armature 74 to its inoperative position.

As stated above, the valve 43 is operated in timed relation to the rotation of a distributor arm 21 and, for accomplishing this result, I provide the circuit 73 with a switch 76 suitably supported on the distributor 19 and having a control element 77 normally urged to a position wherein the switch is opened. The detailed construction of the switch 76 is not shown herein since any one of a number of standard limit switches may be satisfactorily employed.

The control member 77 is automatically operated to close the switch 76 each time the passage 25 in the distributor arm 21 registers with one of the passages 22 in the plate 20. As shown in Figures 1 and 2, the switch is automatically operated by means of a disc 78 secured to the upper end of the drive shaft 26 above the distributor 19 and having a plurality of pins 79 projecting radially outwardly from the periphery thereof. The number of pins 79 corresponds to the number of passages 22 in the plate 20 and these pins cooperate with a suitable bell crank lever 80 to positively operate the control 77 to close the switch 76. It will, of course, be understood that the spacing of the pins 79 on the disc 78 is predetermined with reference to the spacing of the passages 22 in the distributor plate 20 to insure closing of the switch 76 as soon as the passage 25 in the revoluble arm 21 establishes communication with the passages 22.

Operation

Assuming that the parts of the control mechanism are in their relative positions shown in Figure 1 wherein the passage 25 in the distributor arm 21 registers with one of the passages 22 in the plate 20, it will be noted that oil under pressure from the pump 28 is supplied to the conduit 23 communicating with the aforesaid passage 22. As a result, each of the weld-

ing devices communicating with the conduit 23 is supplied with oil under pressure and the electrodes 12 of these devices are moved into engagement with the work 13 to be welded. At the same time that the distributor arm 25 is rotated to a position to register the passage 25 therethrough with one of the passages 22 in the plate 20, the switch control disc 78 is correspondingly rotated to engage one of the pins 79 with the bell crank 80 to close the switch 76. Immediately upon closing the switch 76, the coil 71 of the solenoid 70 is energized causing the armature 74 to move against the action of the spring 51 and force the valve plunger 53 in a rearward direction to open the valve 43. It may be pointed out at this time that the switch 76 is permitted to open as soon as the pin 79 disengages from the bell crank lever 80 and, accordingly, the coil 71 of the solenoid is de-energized immediately after actuating the plunger 53 to open the valve 43.

Movement of the plunger 53 in a rearward direction effects a corresponding movement of the valve piston 45 to register the annular recess in this piston with both the air pressure supply line 42 and the passage 47. In addition, the annular recess 54 in the periphery of the plunger 53 registers with the restricted aperture 55 formed through the base of the annular recess 50 and since the recess 54 also communicates with the space in rear of the plunger 53 of the passage 57, it follows that the plunger 53 is returned to its outermost position by fluid under pressure. As a result, there will be no opportunity for accidental holding of the valve piston in its open position and return movement of the valve piston to its closed position under the action of fluid pressure at the proper period is insured.

The air under pressure by-passed around the piston 45 into the passage 47 is metered into the switch actuating chamber 39 through the valve 58 and acts upon the rear end of the switch plunger 38 to move the bridge member 37 of the switch 32 into engagement with the stationary contacts 33. The metering valve 58 is, of course, adjusted to effect the delay in closing of the switch 32 required to insure engagement of the electrodes 12 with the work before the switch 32 is actually closed. As previously stated, closing of the switch 32 operates through a suitable relay (not shown) to close the circuit to the electrodes 12 and, accordingly, the welding period is initiated.

Fluid under pressure also flows from the passage 47 into an accumulating chamber 59 through a metering valve 60 and is discharged from the accumulating chamber into the switch opening chamber 35. The pressure in the switch opening chamber 35 acts upon a larger area of the switch plunger and serves to assist the spring 40 in moving the plunger in a direction away from the stationary contacts 33 to open the switch. The rate of pressure rise in the switch opening chamber 35 is controlled by the metering valve 60 which is adjusted to provide the desired welding period.

The fluid pressure in the accumulating chamber 59 is also admitted to the accumulating chamber 62 through the medium of the metering valve 63, and this latter accumulating chamber communicates with the space in rear of the valve piston 45. The fluid pressure supplied to the space in rear of the valve piston 45 acts upon a greater area of this piston than the opposing pressure and, accordingly, the valve piston is eventually moved to its forwardmost position wherein the supply line is closed. As soon as the valve 43 is closed, the exhaust port 65 is opened to the atmosphere and the switch, together with the associated passages, are exhausted. In this connection, it may be pointed out that closing of the valve 43 is, of course, delayed until after the switch 32 is opened and the interval of closing the valve 43 may be accurately controlled by adjusting the needle valve 63.

The above operation of the switch 32 takes place during the interval the passage 25 through the distributing arm 21 communicates with one of the passages 22 in the distributor plate 20 and as soon as these passages are moved out of registration with each other, the oil under pressure in the passage 22 is permitted to flow back into the tank 24. As a result, the springs 18 in the welders return the electrodes 12 to their inoperative positions. When the distributor plate registers its passage 25 with the next adjacent passage 22 in the distributor plate, the switch 76 is again closed and the above cycle of operation is repeated.

Referring now to the embodiment of the invention illustrated in Figure 7, it will be noted that the control mechanism illustrated in this figure is identical to the control means previously described, with the exception that the solenoid 70 is omitted and the casting 41' is mounted on the distributor 19 immediately adjacent the revoluble control disc 78' so as to permit direct operation of the valve plunger 53'. Upon reference to Figure 7, it will be noted that the pins 79', projecting radially outwardly from the periphery of the disc 78', successively engage a suitable trip or arm 81 pivotally mounted on the distributor 19 and having the end 82 extending to a position in abutting engagement with the free end of the valve plunger 53'. The arrangement is such that as the disc 78' is rotated, the arm 81 is successively rocked by the pins 79' to move the valve plunger 53' in a direction to open the valve 43'. In this connection, it may be pointed out that the arm 81 is returned into the path of travel of the pins 79' by return movement of the plunger 53' by the fluid under pressure supplied to the space in rear of this plunger. In other respects, the construction and operation of the embodiment shown in Figure 7 is the same as the modification previously described.

What I claim as my invention is:

1. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by fluid pressure to close the circuit, a valve controlling the flow of fluid under pressure to said switch, means operating independently of the fluid under pressure and each time fluid under pressure is admitted to one welder to move the valve to its open position and admit fluid under pressure to the switch to close the latter and means also operating during the interval the latter welder is connected to the source of fluid under pressure to open said switch in timed relation to closing of said switch.

2. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric

circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by fluid pressure to close and open the circuit during the interval fluid under pressure is admitted to one of the welders, a valve controlling the flow of fluid under pressure to said switch, means operating independently of the fluid under pressure to move the valve to its open position and admit fluid pressure to the switch, and means for regulating the flow of fluid pressure to the switch to provide for closing and opening the switch during the interval fluid under pressure is admitted to one of said welders.

3. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by fluid pressure to close the circuit, a valve controlling the flow of fluid under pressure to said switch, means operating independently of the fluid under pressure and each time fluid under pressure is admitted to one welder to move the valve to its open position and admit fluid under pressure to the switch to close the latter, means also operating during the interval the latter welder is connected to the source of fluid under pressure to open said switch in timed relation to closing of said switch, means for regulating the interval of closing of the switch with respect to movement of the electrodes into engagement with the work, and means for regulating the time interval between closing and opening said switch.

4. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by fluid pressure to close the circuit, a valve controlling the flow of fluid under pressure to said switch, means operating independently of the fluid under pressure and each time fluid under pressure is admitted to one welder to move the valve to its open position and supply fluid under pressure to the switch to close the latter, means also operating during the interval the latter welder is connected to the source of fluid under pressure to open said switch in timed relation to closing of said switch, and means operating in timed relation to opening of the switch to close the valve and exhaust said switch.

5. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by fluid pressure to close and open the circuit during the interval fluid under pressure is admitted to one of the welders, a valve controlling the flow of fluid under pressure to said switch, means operating independently of the fluid under pressure and each time fluid under pressure is admitted to one of the welders to move the valve to its open position and admit fluid under pressure to the switch, means for regulating the flow of fluid pressure to the switch to provide for closing and opening the switch during the interval fluid under pressure is admitted to one of said welders, means responsive to the fluid pressure admitted to said switch to close the valve and exhaust the switch, and means for regulating the time interval between opening of said switch and exhausting of the switch.

6. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the welders into engagement with the work, a switch in said circuit operated by fluid under pressure to close the circuit, a valve controlling the flow of fluid under pressure to said switch, a solenoid located in an electric circuit and positioned to operate the valve to open the same, a switch in the solenoid circuit, means operating in timed relation to the first named means for closing the second switch to open the valve by the solenoid and thereby effect closing of the first named switch, and means for opening the first mentioned switch in timed relation to closing of the latter.

7. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by fluid pressure to close and open the circuit during the interval fluid under pressure is admitted to one welder, a valve controlling the flow of fluid under pressure to said switch, a solenoid located in an electric circuit and positioned to operate the valve to open the same, a switch in the solenoid circuit, means operating each time one of the welders is connected to the source of fluid pressure by the first named means to close the second switch and operate the solenoid to open the valve and admit fluid pressure to the first named switch, and means for regulating the flow of fluid pressure to the first mentioned switch to effect closing and opening of the latter during the interval one of the welders is connected to the source of fluid under pressure.

8. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of hydraulic fluid medium under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by pneumatic fluid under pressure to close said circuit, a source of pneumatic fluid under pressure communicating with said switch, a valve controlling the flow of pneumatic fluid under pressure to said switch, means operating in timed relation to the first named means for actuating the valve to open the same and close the switch each time hydraulic fluid under pressure is admitted to one of the welders, and means for opening the switch in timed relation to closing of the latter and during the interval the welder is connected to the hydraulic fluid under pressure.

9. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric

circuit, means for sequentially connecting the welders to a source of hydraulic fluid medium under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by pneumatic fluid under pressure to close and open the circuit during the interval each welder is connected to the source of hydraulic fluid medium under pressure, a source of pneumatic fluid under pressure communicating with said switch, a valve controlling the flow of pneumatic fluid under pressure to the switch, means operating in timed relation to the first named means for actuating the valve to open the same and effect closing of the switch each time hydraulic fluid under pressure is admitted to one of the welders, means also responsive to the pneumatic fluid under pressure admitted to the switch to open the latter in timed relation to closing of the same and during the interval hydraulic fluid medium under pressure is admitted to the welder, and means also responsive to the pneumatic pressure admitted to the switch to close said valve and exhaust the switch.

10. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of hydraulic fluid medium under pressure to successively move the electrodes into engagement with the work, a switch in said circuit operated by pneumatic fluid under pressure to close and open the circuit during the interval each welder is connected to the source of hydraulic fluid medium under pressure, a source of pneumatic fluid under pressure communicating with said switch, a valve controlling the flow of pneumatic fluid under pressure to the switch, means operating in timed relation to the first named means for actuating the valve to open the same and effect closing of the switch each time hydraulic fluid under pressure is admitted to one of the welders, means also responsive to the pneumatic fluid under pressure admitted to the switch to open the latter in timed relation to closing of the same and during the interval hydraulic fluid medium under pressure is admitted to the welder, adjustable means for regulating the flow of pneumatic fluid under pressure to the switch to vary the interval of closing the circuit with respect to the interval of movement of the electrodes into engagement with the work, means for regulating the time interval between closing of the switch and opening of the latter, and means for closing said valve subsequent to the operation of the switch to open said circuit.

11. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the welders into engagement with the work, a fluid pressure operated switch in said circuit having a switch closing chamber and a switch opening chamber, said switch being responsive to a predetermined pressure in the switch closing chamber to close the circuit and also being responsive to a predetermined pressure in the switch opening chamber to open the circuit, a valve controlling the flow of fluid under pressure to said chambers, means operating independently of the fluid under pressure and each time fluid under pressure is admitted to one of the welders to move the valve to its open position and admit fluid under pressure to the switch to close the latter, means for regulating the flow of fluid under pressure to the switch closing chamber, and means for independently regulating the flow of fluid under pressure to the switch opening chamber to effect operation of the switch to open the circuit during the interval the welder aforesaid is connected to the source of fluid under pressure.

12. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of fluid under pressure to successively move the welders into engagement with the work, a fluid pressure operated switch in said circuit having a switch closing chamber and a switch opening chamber, said switch being responsive to a predetermined pressure in the switch closing chamber to close the circuit and also being responsive to a predetermined pressure in the switch opening chamber to open the circuit, a valve controlling the flow of fluid under pressure to said chambers, means operating independently of the fluid under pressure and each time fluid under pressure is admitted to one of the welders to move the valve to its open position and supply fluid under pressure to the switch to close the latter, means for retarding the flow of fluid under pressure to the switch opening chamber to insure closing of the switch prior to increasing the pressure in the switch opening chamber to said predetermined value, means for regulating the flow of fluid under pressure to the switch opening chamber to effect operation of the switch to open the circuit during the interval the welder aforesaid is connected to the source of fluid under pressure, and means responsive to the fluid under pressure admitted to the switch by said valve to close the latter and exhaust said chambers.

13. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, means for sequentially connecting the welders to a source of hydraulic fluid medium under pressure to successively move the welders into engagement with the work, a fluid pressure operated switch in said circuit having a switch closing chamber and a switch opening chamber, a source of pneumatic fluid under pressure communicating with said switch, said switch being responsive to a predetermined pneumatic pressure in the switch closing chamber to close the switch and also being responsive to a predetermined pneumatic pressure in the switch opening chamber to open the switch, a valve controlling the flow of pneumatic fluid pressure to said chambers, means operating in timed relation to the first named means for actuating the valve to open the same and close said switch each time hydraulic fluid pressure is admitted to one of the welders, means for regulating the flow of pneumatic fluid pressure to the switch opening chamber to effect operation of the switch to open the circuit during the interval the welder aforesaid is connected to the source of fluid under pressure, and means responsive to the pneumatic pressure admitted to the switch for closing the valve and exhausting said switch chambers.

14. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric

circuit, a distributor member having a series of passages therein each passage communicating with a welder, a second distributor member having a passage therein charged with fluid under pressure and successively registrable with the passages in the first distributor member upon relative rotation of said members to sequentially operate the welders, a switch operated by fluid under pressure to close the circuit to the electrodes each time one of the welders is connected to the passage in the second member, a valve controlling the flow of fluid pressure to the switch, a disc rotatable in timed relation to relative rotation of said distributor members and having means for operating the valve to open the same and close said switch, and means also operable during the interval the welders are connected to the fluid under pressure to operate said switch to open the circuit to the electrodes.

15. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, a distributor member having a series of passages therein each passage communicating with a welder, a second distributor member having a passage therein charged with fluid under pressure and successively registrable with the passages in the first distributor member upon relative rotation of said members to sequentially operate the welders, a switch operated by fluid under pressure to close the circuit to the electrodes each time one of the welders is connected to the passage in the second member, a valve controlling the flow of fluid pressure to the switch, a solenoid arranged in an electric circuit and positioned to operate the valve to supply fluid pressure to the switch when said circuit is closed, a disc rotatable in timed relation to relative rotation of the distributor members, a switch included in the solenoid circuit and operated by the disc to close the solenoid circuit each time one welder is connected to the fluid under pressure, and means operating during the interval fluid pressure is supplied to the welders to operate the first switch to open the circuit to the electrodes.

16. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, a distributor member having a series of passages therein each passage communicating with a welder, a rotatable distributing member having a passage therein charged with hydraulic fluid medium under pressure and successively registrable with the passages in said first distributing member to sequentially operate the welders, a switch in the circuit to the electrodes operated by a pneumatic fluid under pressure to close and open the circuit to the electrodes each time one of the welders is supplied with fluid under pressure, a valve controlling the flow of pneumatic fluid pressure to the switch, a disc rotatable with the second distributor member and having means for opening the valve and closing the switch each time the passage in the second distributor member registers with a passage in the first distributor member, and means also operating during the interval the passages are in registration to operate the switch to open the circuit to the electrodes.

17. In electric welding equipment, a plurality of welders each having an electrode movable by fluid under pressure into engagement with the work to be welded and arranged in an electric circuit, a distributor member having a series of passages therein each passage communicating with a welder, a rotatable distributing member having a passage therein charged with hydraulic fluid medium under pressure and successively registrable with the passages in said first distributing member to sequentially operate the welders, a switch in the circuit to the electrodes operated by a pneumatic fluid under pressure to close and open the circuit to the electrodes each time one of the welders is supplied with fluid under pressure, a valve controlling the flow of pneumatic fluid pressure to the switch, a disc rotatable with the second distributor member and having means for opening the valve and closing the switch each time the passage in the second distributor member registers with a passage in the first distributor member, means also operating during the interval the passages are in registration to operate the switch to open the circuit to the electrodes, means for regulating the interval of closing of the switch with reference to movement of the electrodes into engagement with the work, and means for regulating the time interval between closing of the switch and opening of the latter to vary the welding period.

18. In electric welding equipment, a pair of independent fluid pressure supply lines, a plurality of welders communicating with one of the supply lines and each welder having an electrode movable by the fluid pressure in said one supply line into engagement with the work to be welded, an electric circuit serving the welders, means in the said one supply line in advance of the welders for sequentially connecting the welders to said one supply line and thereby successively move the electrodes into engagement with the work, a fluid pressure operated switch in said circuit and communicating with the other supply line, a valve in the said other supply line for controlling the flow of fluid pressure to the switch, means operated in timed relation to the first named means for opening the valve to admit fluid pressure from the said other supply line to the switch to close the latter each time fluid pressure from the first supply line is admitted to one welder and to open the switch during the interval fluid pressure is supplied to the latter welder, and means for regulating the flow of fluid under pressure to the switch to insure closing the latter after the electrode of the welder receiving fluid under pressure is engaged with the work and to insure opening of the switch prior to disengagement of the latter electrode from the work.

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