United States Patent

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[54] **CONTROL APPARATUS**
12 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **307/38,** 317/141
[51] **Int. Cl.** **F15c 21/10**
[50] **Field of Search** 317/136; 318/285; 307/38, 39, 41; 62/158, 159, 160

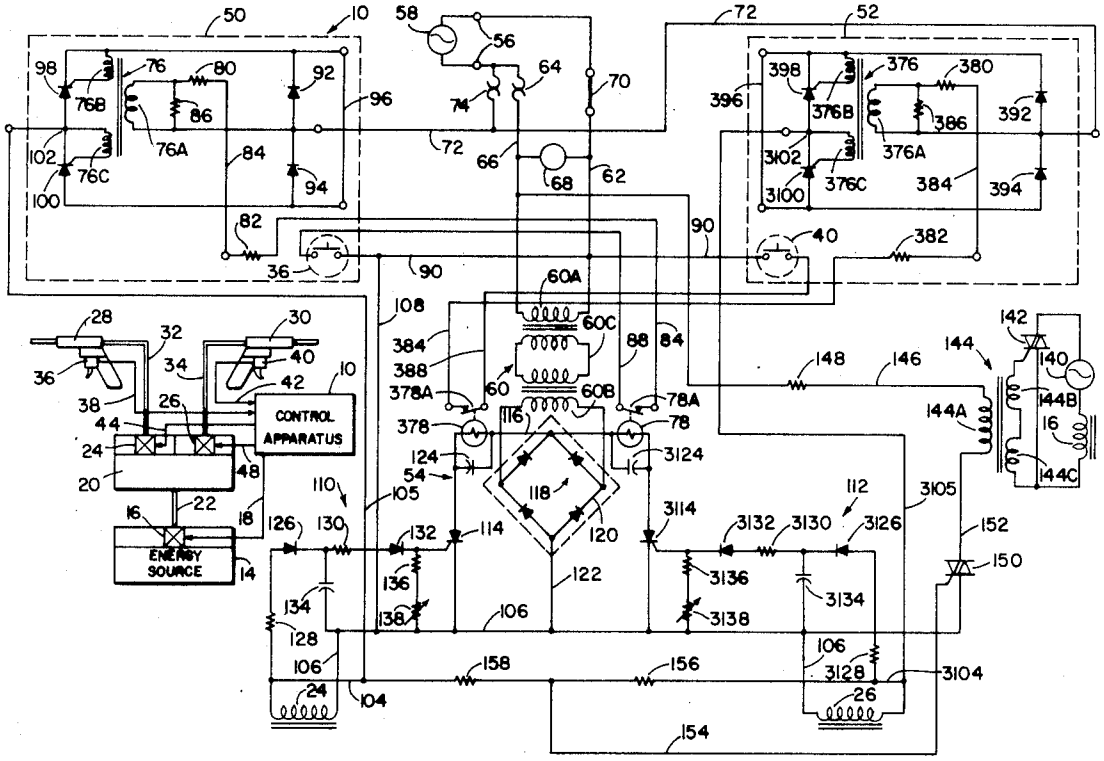
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ABSTRACT: Apparatus for controlling the selective and individual operation of at least a first and a second tool operable from a single energy source of the cyclical type comprising a first switch which is operable to connect the first tool to the energy source and a second switch which is operable to connect the second tool to the energy source. Disabling means responsive to the operation of the first or second switch is operable to disable the other switch for a predetermined interval of time after one of the switches has been operated to permit the energy source to recycle.



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SHEET 1 OF 2

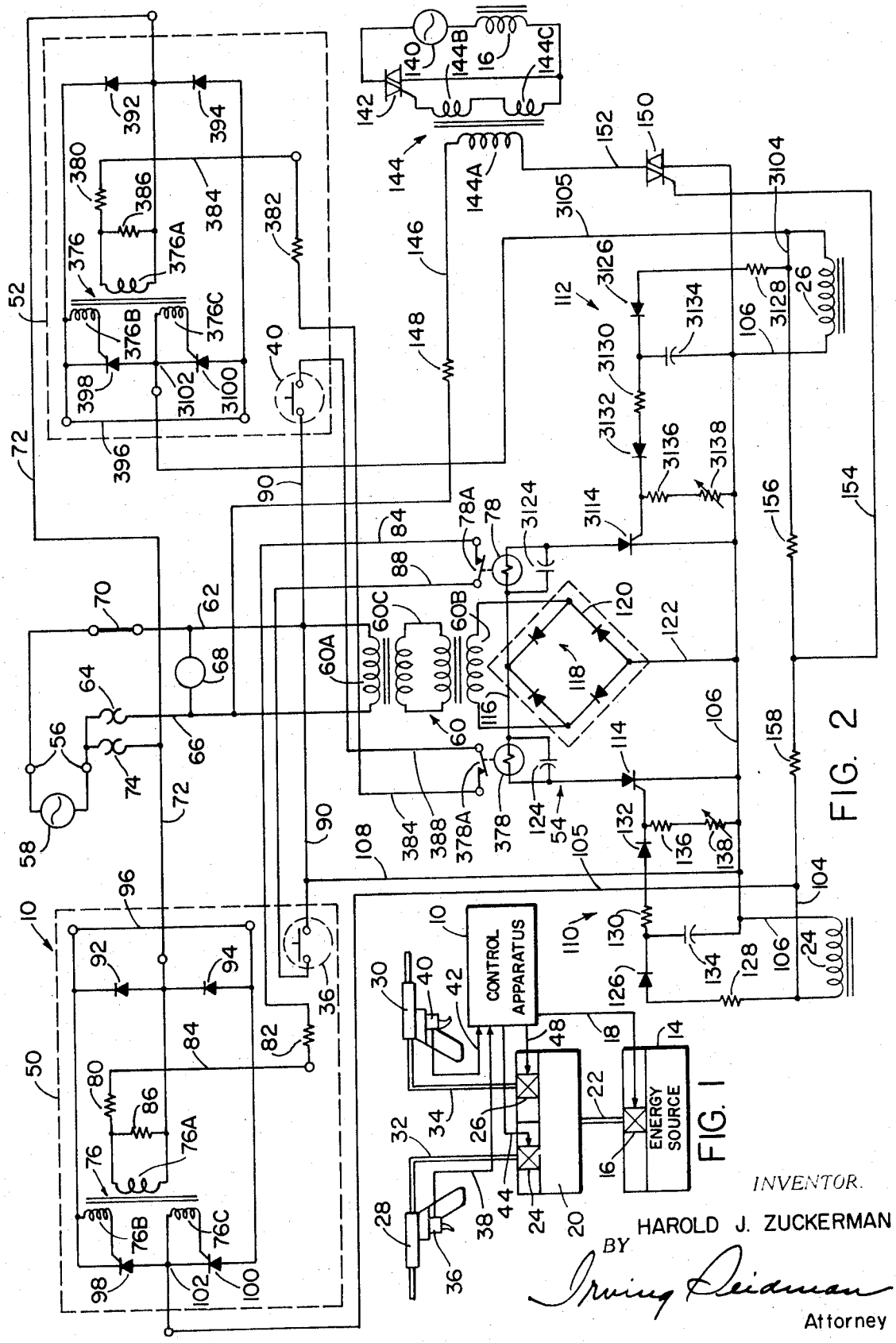


FIG. 2

FIG. 1

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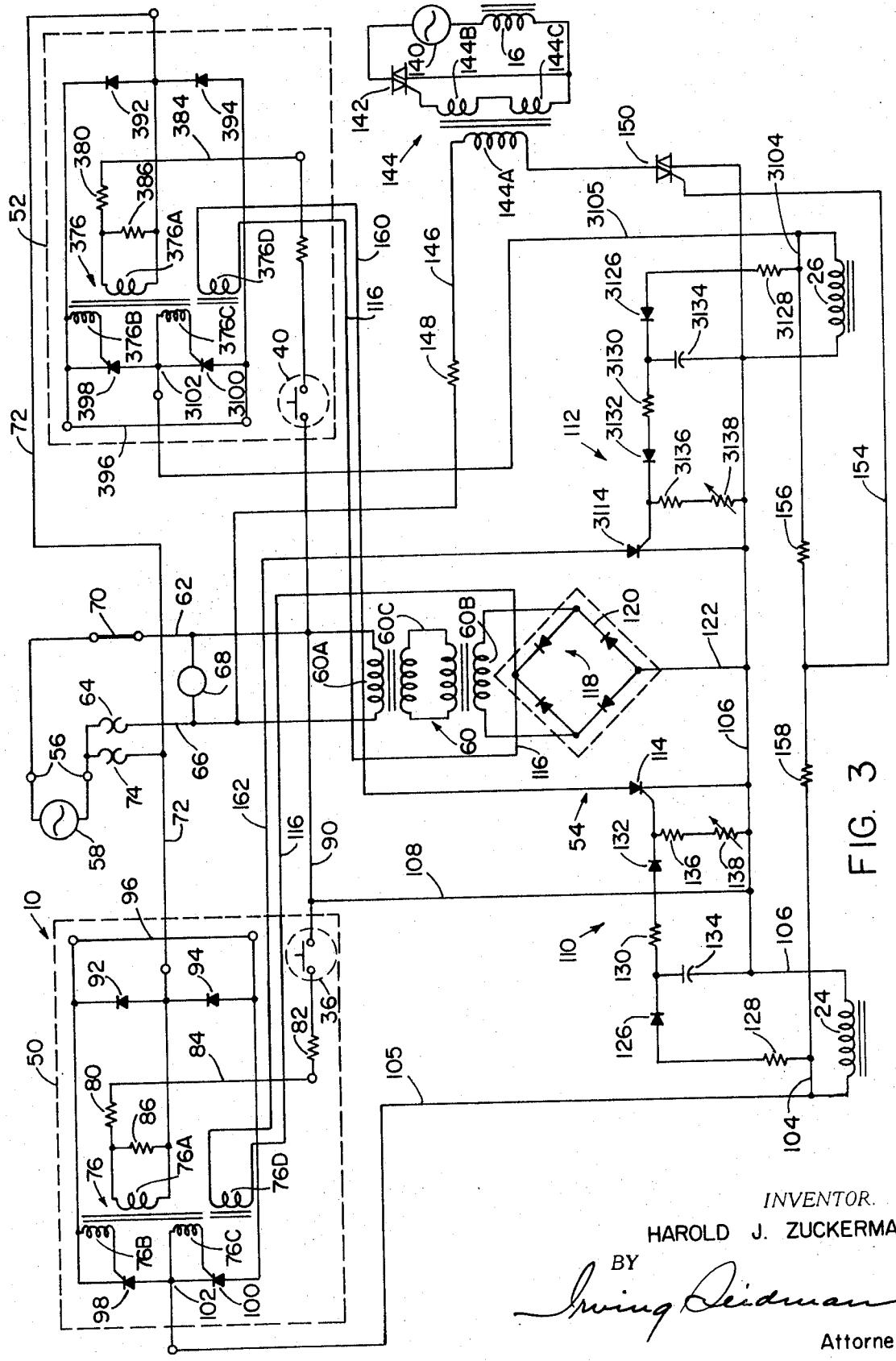


FIG. 3

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CONTROL APPARATUS

This invention relates generally to a control apparatus and, more particularly, pertains to an apparatus for controlling the operation of two devices from a single energy source.

Many systems employ energy sources which require a finite interval of time to regenerate sufficient energy to operate an associated device such as a steam energy source or a hydraulic energy source. For example, after expending some energy from a hydraulic energy source to operate an associated device such as a rivet gun, an interval of time must elapse which is sufficient to permit the source to recycle whereby it builds up to the operating pressure. If it is desired to operate more than one device such as the rivet gun from a single energy source, many problems are encountered.

More specifically, under normal conditions a hydraulic energy source can easily recycle in the time it requires to move a rivet gun from one rivet to the next rivet. However, if two guns are connected to the source, it is possible for both operators to actuate the guns simultaneously, in which case neither gun will receive sufficient energy to properly deform the rivet thereby producing a resultant structural deformity in the riveted construction. An associated problem arises where one gun is actuated before the energy source can recycle. In this latter case, insufficient energy is again delivered to the gun and the same result is obtained.

One solution to the above problem is to limit use of the energy source to a single gun or unit. However, this is an extremely inefficient method and costly, particularly in view of construction costs. An alternative solution is to increase the energy capacity of the energy source. However, this solution is likewise costly since the price of a source is directly related to its capacity.

Accordingly, an object of the resent invention is to provide an improved control apparatus which permits at least two devices to be connected to a single cyclical energy source.

A more specific objective of this invention is to provide a control apparatus which controls the operation of two devices which are connected to a cyclical energy source and which insures that full operating power will be delivered to each device.

Another object of this invention resides in the novel details of circuitry which provides a control apparatus of the type described which is simple in construction and efficient in operation.

Accordingly, a control apparatus constructed according to the present invention is adapted for use in controlling the selective and individual operation of at least a first and a second device operable from the same energy source and comprises first switch means operable to connect the first device to the energy source to energize the first device. Second switch means is operable to connect the second device to the energy source to energize the second device. First disabling means is provided which is responsive to the operation of the first switch means for disabling the second switch means for a preselected interval of time after the operation of the first switch means. And second disabling means is also provided which is responsive to the operation of the second switch means for disabling the first switch means for a predetermined interval of time after the operation of the second switch means.

Other features and advantages of the present invention will become more apparent from a consideration of the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic representation of a system utilizing the control apparatus constructed according to the present invention;

FIG. 2 is a schematic circuit wiring diagram of a control apparatus constructed in accordance with the present invention; and

FIG. 3 is a schematic circuit wiring diagram of a modified embodiment of a control apparatus of the type shown in FIG. 1.

In the discussion which follows, it will be assumed that the control apparatus of the present invention is utilized in connection with a riveting system to control the operation of the hydraulic energy source and the rivet guns. However, it is emphasized that this is by way of illustration only and is not to be interpreted as being a limitation of the present invention. That is, the control apparatus may be utilized to control the operation of any two or more devices which are actuated from an energy source.

Accordingly, as shown in FIG. 1, a control apparatus **10** constructed according to the present invention is adapted to be utilized in conjunction with a system which includes an energy source **14**. In the illustrative example, the energy source **14** is a hydraulic source which requires a finite time to recycle and build up to an operative pressure after it operates one of the rivet guns, as noted below. The energy source **14** includes a main valve **16** which is controlled by the control apparatus **10** via a lead **18**. The fluid from the energy source **16** is connected to a valve housing **20**, through the valve **16**, by means of a conduit **22**. The valve housing **20** houses a first auxiliary valve **24** and a second auxiliary valve **26** which respectively control flow of the hydraulic fluid to riveting guns **28** and **30**.

More specifically, the gun **28** is connected to the valve **24** by a hose **32**. Similarly, the gun **30** is connected to the valve **26** by a hose **34**. Provided on the gun **28** is a switch **36** the contacts of which are connected with the control apparatus **10** by a cable **38**. Similarly, a switch **40** is provided on the gun **30** and is connected to the control apparatus **10** by a cable **42**. The control apparatus **10** controls the operation of the valves **24** and **26** via the respective leads **44** and **48**.

In operation, assuming that the switch **36** on the gun **28** is operated, the control apparatus opens the main valve **16** to permit fluid to flow from the energy source to the valve housing **20**. Simultaneously therewith, the control apparatus, via the lead **44**, causes the valve **24** to open, thereby to permit the fluid from the energy source **14** to flow to and operate the rivet gun **28**. When the switch **36** is released, the control apparatus **10** permits the valves **24** and **16** to close thereby allowing the energy source **14** to recycle and build up to the required operating pressure. However, under normal circumstances if the operator of the gun **30** operated the switch **40** while the rivet gun **28** was being actuated, it is obvious that only partial pressure would be delivered to the guns **28** and **30** thereby rendering them ineffective for their intended use. However, in accordance with the present invention, the control apparatus **10** is operable to disable one of the rivet guns when the other rivet gun has been actuated for a preselected interval of time after said actuation thereby permitting the energy source to recycle and build up to the required operative pressure.

Thus, in the example under consideration, upon actuation of the switch **36** the gun **28** will be operated by the fluid from the energy source **14** in the manner noted above. Simultaneously with the operation of the gun **28**, the control apparatus disables the gun **30** so that even if the switch **40** is operated it will have no effect and the valve **26** will remain closed so that all hydraulic energy is delivered to the rivet gun **28** through the open valve **24**. Moreover, the control apparatus **10** is effective to render the gun **30** disabled for a preselected interval of time after the rivet gun **28** has been operated thereby permitting the energy source **14** to recycle. Similar comments apply when the rivet gun **30** is operated. That is, when the rivet gun **30** is operated, the rivet gun **28** is disabled for a sufficient interval of time to permit the energy source **14** to recycle after operation of the gun **30**.

The control apparatus **10** is illustrated in FIG. 2 and basically comprises a first switch means designated generally by the reference numeral **50** and a second switch means designated generally by the reference numeral **52**. Each one of the switch means **50** and **52** is associated with one of the rivet guns **28** and **30** so that the rivet gun is operated upon actuation of its associated switch means. Also provided is a dis-

abling means designated generally by the reference numeral 54. The disabling means is responsive to the operation of a switch means 50 or 52 to disable the unoperated switch means for a predetermined time after operation of the operated switch means thereby disabling the unoperated rivet gun until the energy source 14 has recycled.

More specifically, the apparatus 10 includes a pair of input terminals 56 which are adapted to be connected to a source of alternating current energy 58. One input terminal 56 is connected to one side of the primary winding 60A of a transformer 60 by a lead 62. The other side of the winding 60A is connected to the other input terminal 56 through the contacts of circuit breaker 64 by a lead 66. Connected across the leads 66 and 62 is a pilot light 68 which signifies that the unit is energized. A single-pole single-throw switch 70 is connected in the lead 62 to control the energization of the apparatus 10.

The switch means 50 includes a lead 72 which is connected, at one end, to the junction of the terminal 56 and the circuit breaker 64 through a circuit breaker 74 and, at the other end, to the primary winding 76A of a transformer 76. The other end of the primary winding 76A of the transformer 76 is connected to normally closed contacts 78A of a relay 78 through series connected resistors 80 and 82 by a lead 84. A resistor 86 is connected in parallel with the winding 76A. The other end of the contacts 78A is connected to one terminal of normally open rivet gun switch 36 by a lead 88. The other terminal of the switch 36 is connected to the lead 62 and, thereby, to the other input terminal 56, by a lead 90. As noted above, the switch 36 is mounted on the gun 28.

Also connected to the lead 72 is the anode electrode of a diode 92 and the cathode electrode of a diode 94. The cathode electrode of the diode 92 and the anode electrode of the diode 94 are connected together by a lead 96. Also connected to the cathode electrode of the diode 92 is the cathode electrode of a silicon controlled rectifier or SCR 98. Connected to the anode electrode of the diode 94 is the anode electrode of an SCR 100. The cathode electrode of the SCR 100 and the anode electrode of the SCR 98 are connected together at a junction 102. The gate electrode of the SCR 98 is connected to the cathode electrode thereof through the secondary winding 76B of the transformer 76. Similarly, the gate electrode of the SCR 100 is connected to the cathode electrode thereof through the secondary winding 76C of the transformer 76.

The second switch means 52 is substantially similar to the first switch means 50 and the elements in the switch means 52 identical to the elements in the switch means 50 are indicated by the same reference numeral as in switch 50 but preceded by the numeral 3. Thus, diode 392 in second switch means 52 corresponds to diode 92 in first switch means 50. It is to be noted that the relays 378 and 78 are operable to inhibit the associated switch means 52 and 50, respectively, as noted in greater detail hereinbelow.

The junction 102 of the first switch means 50 is connected to one end of the solenoid valve 24 at a junction 104 by a lead 105. The other end of the winding of the valve 24 is connected to the lead 90 through leads 106 and 108. When the first switch means 50 is operated, the solenoid valve 24 will be energized from the source 58 through the circuit including the leads 62, 90, 108, and 106, and via the leads 105, the first switch means 50 and the lead 72 back to the source 58.

The disabling means 54 includes a first disabling means designated generally by the reference numeral 110 and a second disabling means designated generally by the reference numeral 112 which is substantially similar in construction to the disabling means 110. More specifically, the disabling means 110 includes an SCR 114 the cathode electrode of which is connected to the lead 106 and the anode electrode of which is connected to one end of the relay winding or relay 378. The other end of the relay winding 378 is connected by a lead 116 to a biasing arrangement designated generally by the reference numeral 118. The biasing arrangement 118 includes a full-wave diode bridge rectifier 120 one diagonal of which is connected across a secondary winding 60B of the transformer 60. It is to be noted that the transformer windings 60A and 60B are separated by an intermediate winding 60C to provide a degree of isolation between the primary winding 60A and the secondary winding 60B. One terminal of the other diagonal of the bridge is connected to the lead 106 by a lead 122; the other terminal of this diagonal of the bridge is connected to the lead 116. A capacitor 124 is connected in parallel with the winding of the relay 378.

A time delay circuit is connected between the gate and cathode electrodes of the SCR 114. To be more specific, the anode electrode of a diode 126 is connected to the junction 104 through a resistor 128. The cathode electrode of the diode 126 is connected to the gate electrode of the SCR 114 through the series circuit comprising a resistor 130 and another diode 132. The diode 132 is poled so that the cathode electrode thereof is connected to the gate electrode of the SCR 114. Connected between the lead 106 and the junction of the diode 126 and resistor 130 is a capacitor 134. Connected between the gate electrode of the SCR 114 and the lead 106 is a series circuit comprising a resistor 136 and a variable resistor 138. The variable resistor 138 is provided to adjust the time constant of the circuit so that the delay will be sufficiently long to permit the energy source 14 to recycle after a gun has been operated, in noted in detail below.

The disabling means 112 is identical in structure and operation to the disabling means 110 and similar elements are designated by the same reference numeral as is the disabling means 110 but prefaced with the digit 3. For example, the diode 3126 of the disabling means 112 corresponds to the diode 126 of the disabling means 110. It is to be noted that the lead 3105 connects the junction 3102 with the solenoid winding of the solenoid operated valve 26 at the junction 3104. The other side of the winding of the solenoid valve 26 is connected to the lead 90 through the leads 106 and 108 similarly to the winding of the solenoid valve 24.

As noted above, the control apparatus 10 is also operable to open the solenoid valve 16 on the energy source 14 in response to the operation of either the first switch means 50 or the second switch means 52. Accordingly, the winding of the solenoid valve 16 is connected in series with an AC source 140 between the anode and cathode terminals of a triac 142. (As is well known, a triac comprises a pair of SCR's connected in inverse parallel relationship with the gate electrodes of the SCR's tied together.) The gate electrode of the triac 142 is connected to the cathode electrode thereof through the series connected secondary windings 144B and 144C of a transformer 144. One side of the primary winding 144A of the transformer 144 is connected to the lead 66 by a lead 146 through a resistor 148. The other side of the winding 144A is connected to the anode electrode of a triac 150 by a lead 152. The cathode electrode of the triac 150 is connected to the lead 106. The gate electrode of the triac 150 is connected to the junctions 104 and 3104 via a lead 154 and respective resistors 156 and 158.

In operation, it will be assumed that the operator of the gun 28 actuates the switch 36 prior to the operator of the gun 30 operating the switch 40. Additionally, it will be assumed that the energy source 14 is operating and is at the required operating pressure. The control apparatus 10 is energized by closing the switch 70. Thus, the pilot lamp 68 will be connected across the energized leads 66 and 62 and will be illuminated to indicate that power is available. Additionally, a DC voltage of the proper polarity will appear between the leads 116 and 106 via the bridge rectifier 118 and transformer 60 to cause the respective SCR's 114 and 3114 to conduct when they are triggered.

When the switch 36 is closed by the operator of the gun 28, current flows through the primary winding 76A of the transformer 76 through the circuit comprising lead 72, winding 76A, resistors 80 and 82, lead 84, the normally closed contacts 78A of the relay 78, lead 88, through the switch 36 to lead 90 back to the energized lead 62. The current flowing

through the winding 76A will cause a corresponding current to flow through the windings 76B and 76C thereby triggering the SCR's 98 and 100 on and off on alternate half cycles of the input alternating current wave. Thus, current will flow through the winding of the solenoid valve 24 through the circuit including the energized lead 72, one of the diodes 92 or 94 depending upon the polarity of the signal at that point, through the conducting SCR 100 or 98, lead 105, the winding 24, and leads 106, 108 and 90 to the energized lead 62.

Current also flows through the resistor 158 and the lead 154 to the gate electrode of the triac 150 thereby gating the triac 150 on to conduct. Accordingly, current flows through the primary winding 144A of the transformer 144 through the circuit including the energized lead 66, lead 146, resistor 148, the winding 144A, the lead 152, triac 150, leads 106, 108 and 90 to the energized lead 62. This causes a corresponding current to flow in the windings 144B and 144C and the triac 142 thereby gating the triac 142 on or to its conducting state. Hence, current will flow through the winding of the valve 16 from the source 140 through the triac 142. Thus, in accordance with one aspect of the invention both valves 16 and 24 will open thereby permitting the fluid in the hydraulic energy source 14 to flow to the rivet gun 28 to operate the same. Simultaneously with current flowing through the windings of solenoid valves 24 and 16, current flows from the junction 104 through the current limiting resistor 128 and the diode 126 to capacitor 134 to charge the same. That is, capacitor 134 is charged by the pulsating DC current which is rectified by the diode 126. As the charge on the capacitor 134 builds up, the triggering potential for the SCR 114 is reached and the SCR 114 is gated on. Hence, the relay winding 378 will be energized thereby opening the contacts 378A. (It is to be noted that the contacts 378A may be a magnetic reed switch.) Hence, even if the operator of the rivet gun 30 closes the switch 40 on the rivet gun nothing will happen in view of the fact that no current can flow through the primary winding 376A of the transformer 376 because of the open circuit due to the open contacts 378A.

After the rivet gun 28 has been actuated, the operator releases the switch 36 thereby breaking the circuit and removing current from the windings of the valves 24 and 16 thereby permitting the valves to close. However, the charge on the capacitor 134 leaks off slowly through the circuit including the resistor 130, diode 132 and resistors 136 and 138. The diode 126 is back biased at this point so that the charge cannot go through the diode 126. Accordingly, the SCR 114 will remain conducting albeit the switch 36 has opened until capacitor 134 can no longer supply triggering current for the SCR 114. While the SCR 114 conducts, the contacts 378A remain open so that even if the switch 40 of the gun 30 is closed, current still cannot flow through the transformer winding 376A. The resistance of the variable resistor 138 is set so that the charge on the capacitor 134 will remain above the triggering potential for the SCR 114 for an interval sufficient to permit the energy source 14 to recycle. When the charge on the capacitor 134 drops below the triggering potential for the SCR 114, the SCR stops conducting and the relay contacts 378A close. Accordingly, if the operator of the rivet gun 30 now closes the switch 40 current will flow through the winding 376A in the same manner that current flowed through the winding 76A when the operator of the gun 28 closes switch 36. The actual operation of the switch means 52 and the disabling means 112 will not be described in detail since it is identical to the operation of the respective elements 50 and 110. Thus, upon the operation of the switch 40, valves 26 and 16 will open to permit actuation of the gun 30 and relay contacts 78A will open to disable the switch means 50 for a sufficient interval of time after the switch 40 has been opened to permit recycling of the energy source 14.

FIG. 3 illustrates a modified embodiment of the control apparatus 10 of the present invention. Similar reference characters in the figures indicate identical elements. Since the operation of the circuit of FIG. 3 is substantially similar to the operation of the circuit of FIG. 2 it will not be described in detail. Only the differences in construction and operation of the circuit of FIG. 3 will be described.

Accordingly, instead of connecting the lead 84 to the terminal of the switch 36 via the normally closed contacts 78A and the lead 88, the lead 84 is connected directly to the same terminal of the switch 36. Similar comments apply to the lead 384. The anode electrode of the SCR 114 is not connected to the lead 116 through the winding of the relay 78 but is connected to one end of the winding 376D of the transformer 376 by a lead 160. The other end of the winding 376D is connected to the lead 116. Likewise, the anode electrode of the SCR 3114 is connected to one end of a winding 76D of the transformer 76 by a lead 162. The other end of the winding 76D is connected to the lead 116.

In operation, assuming that the switch 36 is closed first, the windings of the solenoid valves 24 and 16 will be energized in the same manner as before to apply the hydraulic fluid to the rivet gun 28. Additionally, the SCR 114 will begin to conduct in the same manner as before. However, when the SCR 114 begins to conduct, current flows through the winding 376D thereby saturating the core of the transformer 376. Hence, no triggering potential can be applied to the SCR's 398 and 3100 via the transformer secondary windings 376B and 376C because of the saturated core. Hence, the second switch means 52 is effectively disabled. Similar comments apply to the first switch means 50 if the switch 40 is operated first. Moreover, the cores of the transformers will remain saturated until the respective associated SCR's 114 and 3114 cease conducting thereby to permit the energy source 14 to recycle.

Accordingly, a control apparatus has been disclosed for use in combination with a single energy source and multiple devices which are operable by the source for permitting the energy source to recycle after either device has been operated.

While preferred embodiments of the invention have been shown and described herein, it will become obvious that numerous omissions, changes and additions may be made in such embodiments without departing from the spirit and scope of the present invention.

What is claimed is:

1. Control apparatus for controlling the selective and individual operation of at least a first and a second device operable from the same cyclical energy source of the type requiring a finite interval of time to recycle comprising a first switch means operable to connect the first device to the energy source to energize said first device, second switch means operable to connect the second device to the energy source to energize said second device, first disabling means responsive to the operation of said first switch means for disabling said second switch means for a preselected interval of time at least as great as the interval required for said source to recycle after the operation of said first switch means, and second disabling means responsive to the operation of said second switch means for disabling said first switch means for a predetermined interval of time at least as great as the interval required for said source to recycle after the operation of said second switch means.

2. Control apparatus as in claim 1, in which said first disabling means comprises third switch means movable from a first to a second state to disable said second switch means, and time delay means for maintaining said third switch means in the second state for said preselected interval of time after operation of said first switch means.

3. Control apparatus as in claim 2, in which said third switch means comprises a silicon controlled rectifier having an anode, a cathode and a gate electrode, biasing means, inhibit means serially connected with said biasing means between said anode and cathode electrodes for inhibiting the operation of said second switch means when said silicon controlled rectifier conducts, said time delay means comprising a resistor-capacitor circuit connected between said gate and cathode electrodes and operable by said first switch means for main-

taining said silicon controlled rectifier conductive for said preselected interval of time after operation of said first switch means.

4. Control apparatus as in claim 3, in which said inhibit means comprises a relay having contacts movable from a closed to an open state when said silicon controlled rectifier conducts to prevent operation of said second switch means.

5. Control apparatus as in claim 3, in which said second switch means comprises a silicon controlled rectifier, and circuit means including a transformer for driving said second switch means silicon controlled rectifier into conduction; said inhibit means comprising a winding for saturating said transformer when said third switch means silicon controlled rectifier conducts to prevent operation of said second switch means.

6. Control apparatus as in claim 1, in which said first switch means is operable to control a first auxiliary switch associated with said first device, and said second switch means is operable to control a second auxiliary switch associated with said second device; and main switch means responsive to the operation of said first or second switch means for connecting the energy source with said first and second auxiliary switches.

7. In combination, a first device, a second device, a cyclical energy source of the type requiring a finite interval of time to recycle, and control apparatus for selectively and individually connecting said energy source with said first and second devices; said first device comprising a first auxiliary switch for connecting said energy source with said first device to operate said first device, said second device comprising a second auxiliary switch for connecting said energy source with said second device to operate said second device; said control apparatus comprising first selectively operable switch means for operating said first auxiliary switch, second selectively operable switch means for operating said second auxiliary switch, and disabling means responsive to the operation of one of said first and said second switch means for disabling the other of said first and second switch means for a preselected interval of time at least as great as the interval of time required for said source to recycle.

8. The combination of claim 7, in which said energy source comprises main switch means responsive to the operation of said first or second switch means for connecting said energy source with said first and second auxiliary switches.

9. The combination of claim 7, in which said disabling means includes a first disabling means responsive to the operation of said first switch means for disabling said second switch means for said preselected interval of time, and second disabling means responsive to the operation of said second switch means for disabling said first switch means for said preselected interval of time.

10. The combination of claim 9, in which said first and second disabling means each comprise third switch means movable from a first to a second state to disable the other of said first and second switch means, and time delay means for maintaining the third switch means in the second state for said preselected interval of time after operation of the one of said first and second switch means.

11. The combination of claim 7, in which said first and second switch means each comprise a biasing source, at least a silicon controlled rectifier connected in series with said biasing source and the respective first and second auxiliary switches and each being operable to permit current flow to the associated auxiliary switch in response to a gating signal, and manually operable gating signal means for applying a gating signal to said silicon controlled rectifier.

12. The combination of claim 7, in which said energy source comprises a source of hydraulic pressure, said first auxiliary switch comprising a solenoid operated valve energizable in response to the operation of said first switch means, and said second auxiliary switch comprises a solenoid operated valve energizable in response to the operation of said second switch means.

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