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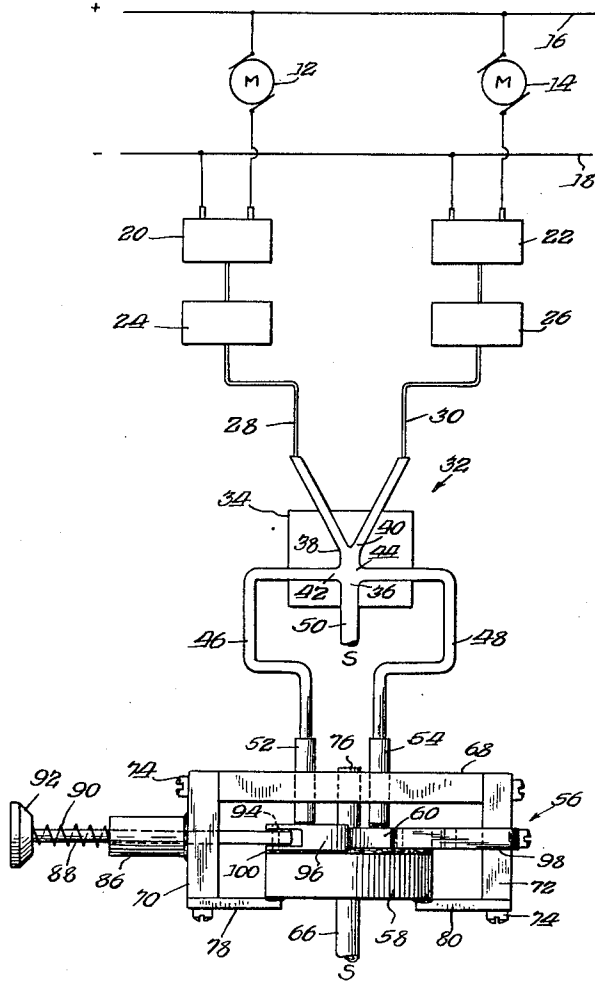
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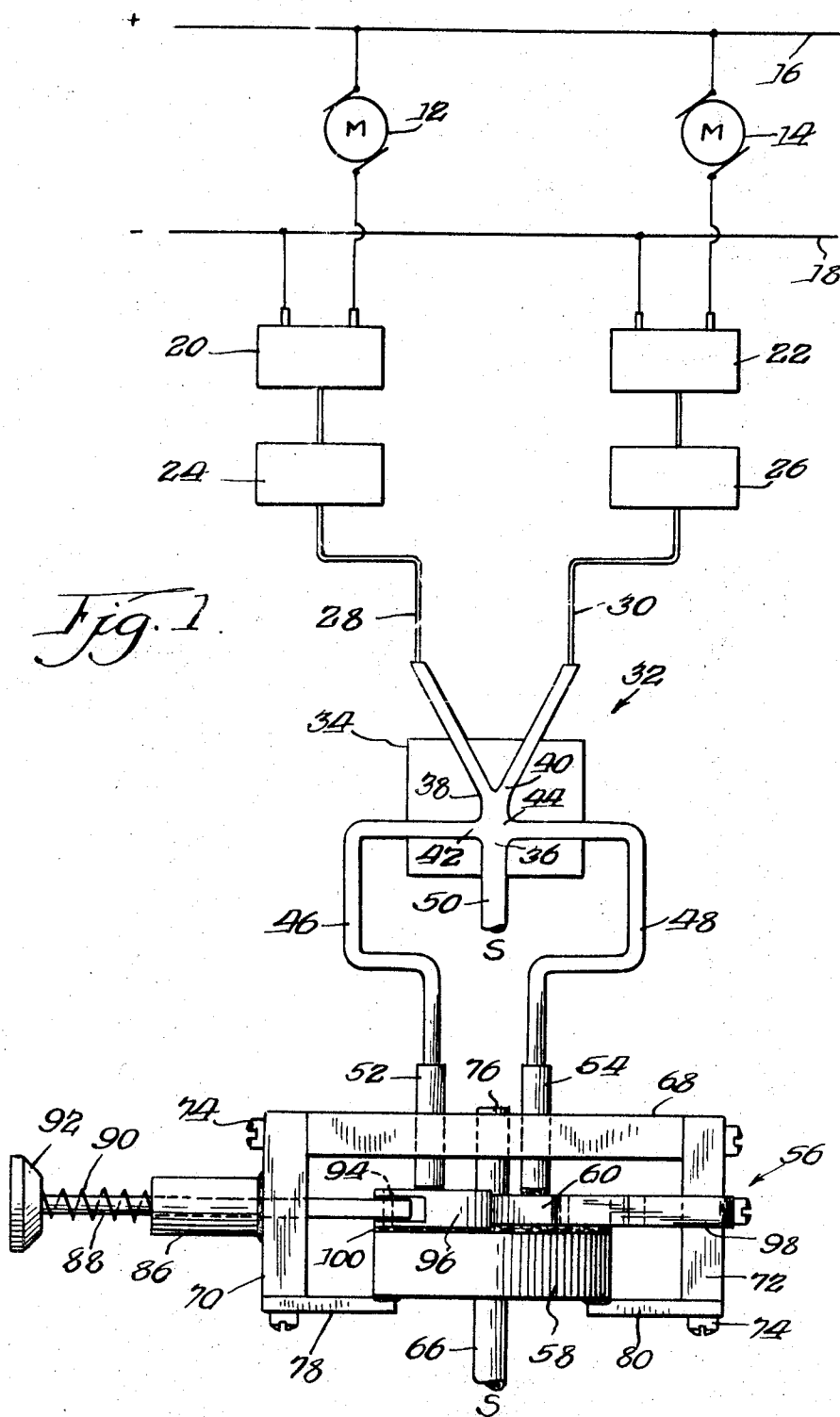
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[54] **FLUIDIC SEQUENTIALS SWITCHING SYSTEM**
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[52] U.S. Cl..... **137/81.5,**
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[50] Field of Search..... **137/81.5,**
608

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ABSTRACT: A fluidic switching system for providing sequential fluid signals to operate electrical switchgear or other fluid-actuated devices. A fluidic control unit, consisting of one or more bistable fluidic relays, is associated with a sequential switching device. Each of the relays includes a pair of control ports and a pair of associated signal ports. When a fluid control signal appears at a control port, the fluid output signal of the relay is switched to the respectively associated signal port. Each operation of the sequential switching device causes one of the control ports to become connected to a source of control signal fluid, while the other control port is simultaneously disconnected therefrom. Thus, each operation of the switching device causes switching of the relay, and consequent actuation of one, and deactuation of another, of the fluid-actuated devices.





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Fig. 2.

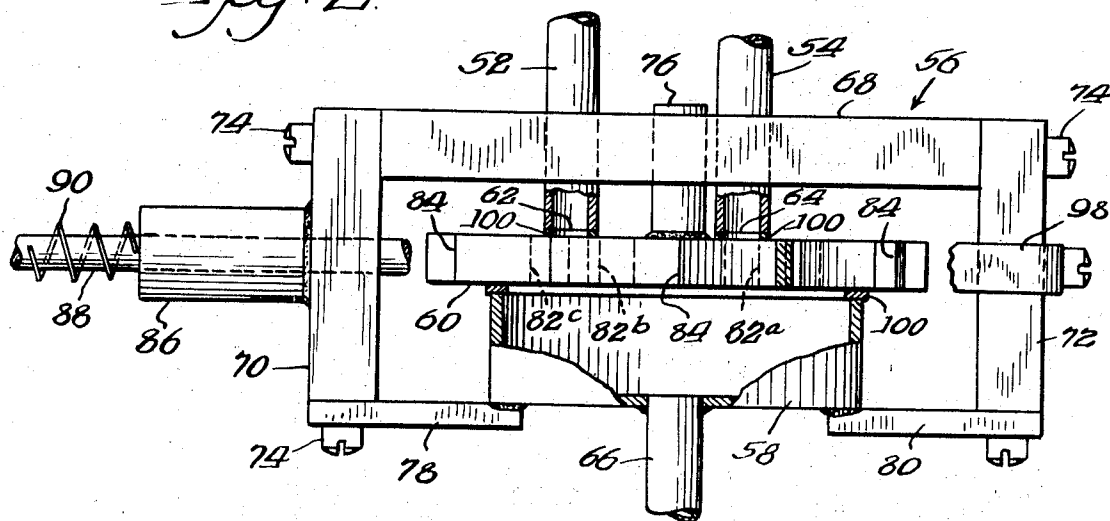
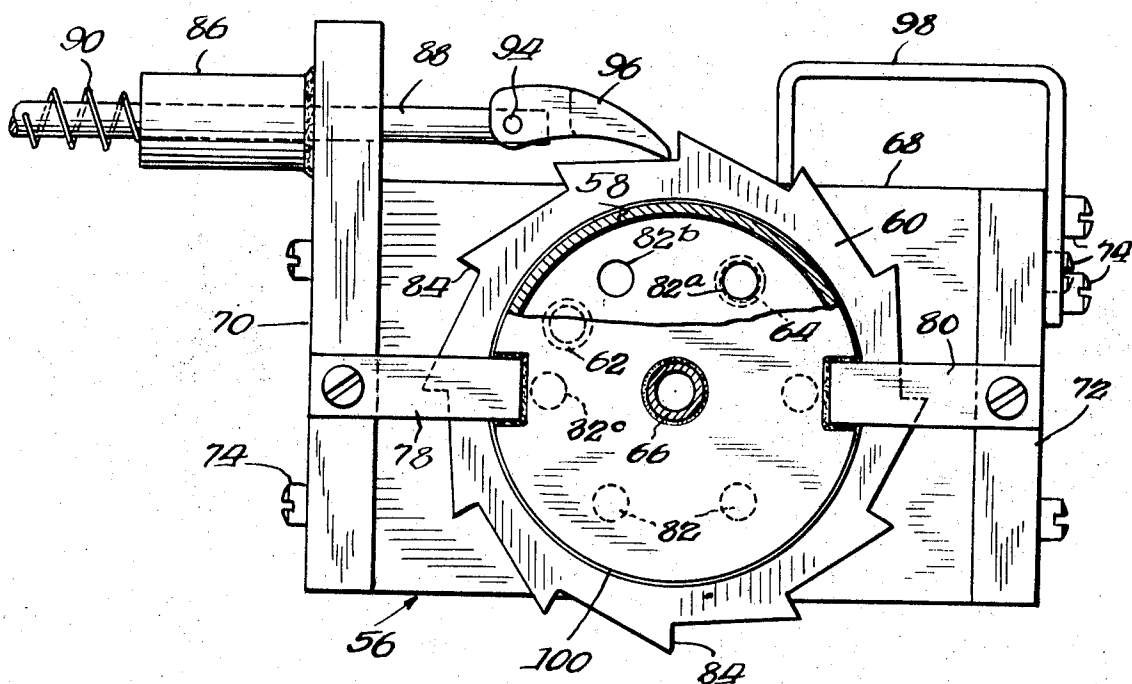


Fig. 3.



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FLUIDIC SEQUENTIALS SWITCHING SYSTEM

BACKGROUND-SUMMARY-DRAWINGS

This invention relates to fluidic switching systems, and, in particular, to a sequential switching system, employing fluidic relay elements and a sequential fluid switching device.

In the control of electrical motors for fans, compressors, pumps and other similar equipment, it is often desirable to effect remote switching. In addition, such apparatus is often installed in pairs for alternate use, in order to distribute wear and to allow for repair and maintenance without interrupting service. The same considerations also apply to pneumatic or hydraulic motors, and while the present invention will be discussed in the context of the control of electrical equipment, it should be understood that the invention would be equally suitable for use in connection with hydraulic or pneumatic equipment.

It has been discovered that remote switching between two or more electric motors can be efficiently accomplished through the use of fluidic control systems. Such systems are characterized by relative simplicity and rugged reliability, and in many instances may be cheaper than corresponding electrical or mechanical control devices. The present invention employs well-known fluidic amplifiers or relay elements, in conjunction with a novel sequential switching device, to accomplish electric motor control.

In accordance with the present invention, there is provided a pair of fluid-actuated electrical switches which serve to control the on-off states of a pair of electric motors. It may be assumed, for purposes of this discussion, that the motors are the prime movers for a pair of compressors, and that it is desired to alternate usage of the compressors. The electrical switches may be directly fluid-actuated, or may be linked with separate fluid actuating units which are responsive to fluid signals for opening and closing the switches.

The fluid signals for transmission to the actuating units or switches are generated in a fluidic control device which is comprised of one or more fluidic amplifiers or relays. These fluidic relays are preferably of the bistable type, including a pair of outlet or signal ports, and a pair of control ports. In such a relay, when a control signal appears at one of the control ports, a fluid signal then appears at the signal port associated with that control port. In order to provide control signals for use in the fluidic relay element, the present invention contemplates a novel sequential switching device. During each operation of the switching device, one of the control ports of the fluidic relay element is connected to a source of control signal fluid, while the other control port of the relay is simultaneously disconnected therefrom. Thus, each operation of the sequential switching device causes the relay element to switch, producing a fluid signal for one of the actuating devices or switches. Such a system not only provides for remote fluidic control of the compressor motors, but results in a built-in memory respecting which of the compressors was in service last. For example, assuming that both compressor motors have been turned off, the operator has only to actuate the switching device in order to insure that the motor which was last out of service becomes placed in service upon resumption of activity.

The foregoing and additional structural features and advantages of the present invention will be more fully understood by considering the remainder of the specification and the claims, with illustrative reference to the drawing, in which:

FIG. 1 is a schematic diagram of a sequential fluidic switching system constructed in accordance with the present invention;

FIG. 2 is a plan view, slightly enlarged and partly broken away, of a sequential switching device forming a part of the system illustrated in FIG. 1; and

FIG. 3 is an end elevation thereof, partly broken away.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT

With reference to FIG. 1, there is shown a sequential fluidic switching system constructed in accordance with the present invention. It will be assumed that the illustrated system is intended to control the operation of a pair of electric motors 12 and 14, although it should be understood that the illustrated system could also be employed for the control of other equipment as well, as for example, the opening and closing of valves in the power circuit of a hydraulic motor.

The motors 12 and 14 are connected across a pair of electrical power lines 16 and 18, and their off-on states are respectively controlled by a pair of electrical switching devices 20 and 22. The switching devices 20 and 22 may be of a type which is directly responsive to a fluid signal for actuation, or may be of the type illustrated, requiring separate fluid actuating units 24 and 26. In the illustrated system, the actuating units 24 and 26 are mechanically linked to the switches 20 and 22 and are responsive to fluid signals to operate the switches. Thus, when a fluid signal is present in the conduit 28, the actuating unit 24 responds to close the switch 20, resulting in a flow of electrical current to the motor 12; similarly, the presence of a fluid signal in the conduit 30 will cause the motor 14 to operate.

The conduits 28 and 30 are connected to a fluidic control unit generally designated by the numeral 32. The fluidic control unit 32 includes one or more fluidic amplifiers or relays 34 which are preferably of the bistable type. Thus, as illustrated, the relay 34 includes an inlet or supply port 36, a pair of outlet or signal ports 38 and 40, and a pair of control ports 42 and 44. The outlet or signal ports 38 and 40 are respectively connected to the conduits 28 and 30, while the control ports 42 and 44 are respectively connected to control signal conduits 46 and 48. The inlet port 36 is connected to a supply conduit 50 which communicates with a source of fluid (not shown).

The relay 34 may be of a type constructed in accordance with the well-known Coanda effect, which is inherently bistable in operation. That is, a stream of fluid entering the relay 34 through the supply conduit 50 and emerging from the inlet port 36 will continue to exit through a given one of the signal ports 38 or 40, even in the absence of a control signal at the control ports 42 and 44. Such a relay, due to the Coanda effect, requires only a momentary control pulse at one of the control ports for stable operation. The relay 34, however, may also be of a type, as illustrated, which is inherently unstable, and which requires a continuous control signal in order to remain completely stable with respect to one or the other of the signal ports 38 or 40. Thus, assuming that a stream of fluid is emerging from the inlet port 36, and assuming further that a control signal is continuously present at the control port 42, the stream of fluid will exit from the relay at the signal port 40. If the control signal is removed from the conduit 46 and if a similar signal appears in the conduit 48, the resultant stream of fluid issuing from the control port 44 will cause the main fluid stream to deflect so as to exit through the signal port 38.

The control signal conduits 46 and 48 respectively terminate in sleeves 52 and 54 which form a part of a sequential switching device generally indicated by the numeral 56. The switching device 56 includes a fluid supply chamber 58 and a rotatable disc 60 which is interposed between the supply chamber and the free ends of the conduits 52 and 54. The ends of the conduits 52 and 54 serve to define outlet ports 62 and 64 respectively. The fluid supply chamber 58 is connected to a supply conduit 66 which communicates with a source of fluid (not shown). As will become apparent hereinafter, the rotatable disc 60 is suitably apertured so that, upon rotation thereof, the outlet ports 62 and 64 are sequentially connected and disconnected with the supply chamber 58.

Turning now to FIGS. 2 and 3, the sequential switching device 56 is there shown in greater detail. The switching device 56 includes a frame consisting essentially of a front

plate 68 and a pair of side plates 70 and 72, joined together with suitable fastening means such as screws 72. The disc 60 is mounted for rotation upon a shaft 76 which is journaled in the front plate 68. The supply chamber 58 is maintained in association with the back face of the disc 60 by a pair of struts 78 and 80 which are respectively attached to the side plates 70 and 72.

As can best be seen from FIG. 3, the rotatable disc 60 has a plurality of spaced apertures 82 and a perimetric set of ratchet teeth 84. In the embodiment illustrated, the disc 60 has six apertures 82 and 12 teeth 84. These numbers, however, may vary, so long as there are two teeth for each aperture. As can be seen, a rotation of the disc 60 in an amount equal to the angular increment between an adjacent pair of the teeth 84 will cause a corresponding angular displacement of each of the apertures 82 equal to one-half the angular increment between an adjacent pair of apertures.

The sleeves 52 and 54 are positioned with respect to the disc 60 such that, when one of the outlet ports 62 and 64 is in registry with one of the apertures 82, the other outlet port is positioned midway between an adjacent pair of apertures. In the position of the disc 60 illustrated in FIG. 3, the outlet port 64 registers with the aperture 82a, while the outlet port 62 is between the apertures 82b and 82c. Upon rotation of the disc 60 through an angle of 30° the aperture 82c will be moved into registry with the outlet port 62, and the outlet port 64 will assume a position between the apertures 82a and 82b. In this manner, each rotation of the disc 60 through an angular increment of 30° (360° divided by the total number of teeth 84) causes one of the outlet ports 62 or 64 to be connected with the supply chamber 58, and the other to be disconnected therefrom.

Affixed to the upper portion of the side plate 70 is a guideway 86 which serves to maintain and guide a plunger shaft 88 which passes through the side plate 70. The shaft 88 is biased with a compression spring 90 for axial movement, and terminates in a plunger button or knob 92 (FIG. 1). Attached to the other end of the shaft 88 by means of a pin 94 is a pawl 96. The pawl 96 is adapted for engagement with the teeth 84 of the disc 60. Thus, with each full axial movement of the shaft 88, the disc 60 is caused to rotate through 30°. Attached to the other side plate 74 is a generally bracket-shaped ratchet spring 98 which serves the dual functions of providing a forward bias against forward rotation of the disc 60 and a reverse stop which prevents rotation of the disc in the opposite direction. Thus, the ratchet spring 98 provides for positive positioning of the apertures 82 with respect to the outlet ports 62 and 64.

In order to provide for fluid sealing on both sides of the disc 60, annular rings of felt or other suitable material 100 may be inserted about the peripheries of the chamber 58 and the sleeves 52 and 54.

As is apparent from the foregoing description, each time the switching device 56 is operated by plunging the shaft 88, the fluidic relay 34 is caused to switch. With the disc in the position shown in FIG. 3, the outlet port 64 of the switching device 56 is in fluid communication with the supply chamber 58, and a fluid control signal is present in the conduit 48. Thus the stream of control fluid emerging from the control port 44 causes deflection of the main fluid stream emerging from the inlet port 36, and causes the latter to exit from the relay 34 through the outlet or signal port 38. This fluid signal is com-

municated through the conduit 28 to the actuator 24, causing the switch 20 to close and supply electrical current to the motor 12. If the switch device 56 is operated by depressing the button 92, the resultant rotation of the disc 60 causes connection of the outlet port 62 with the supply chamber 58, and simultaneous disconnection of the port 64 with the supply chamber. The resultant fluid control signal in the conduit 46 causes switching of the relay 34 so that a fluid signal is communicated to the actuating unit 26 to turn on the motor 14. At the same time, the switching of the relay 34 causes the motor 12 to be turned off.

Thus it can be seen that this novel sequential switching system provides for remote fluidic control of a pair of electric motors, using elements which are extremely simple and which are characterized by few moving parts. The system is economical and requires little maintenance due to the fact that it employs fluidic relay elements.

Although an embodiment constructed in accordance with the present invention has been described with the requisite particularity, the disclosure is of course only exemplary. Consequently, numerous changes in details of construction, in size, configuration and arrangement of components and materials, and in modes of application will be apparent to those familiar with the art and may be resorted to without departing from the scope of the invention as set forth in the following claims.

I claim:

1. A sequential switching system for switching a pair of separate operative devices for alternating, sequential use comprising:

a pair of switches each adapted to be actuated by the presence of a fluid signal and deactuated by removal of the fluid signal, each of said switches being connected to one of said separate operative devices for on-off control thereof;

a bistable fluidic relay comprising an inlet port connected to a fluid supply, a pair of control ports, and a pair of outlet ports, each of said outlet ports being connected for transmission of a fluid signal for actuation of a predetermined one of said switches, said bistable fluidic relay being responsive to receipt of fluid input at one of said control ports to effect transmission of a fluid signal by only one of said outlet ports and responsive to receipt of fluid input at the other of said control ports to effect transmission of a fluid signal by only the other of said outlet ports;

a disc rotatable in one direction only and interposed between said control ports and a source of fluid, said disc having a plurality of angularly-spaced fluid-communication apertures and

manually-actuable means for sequentially rotating said disc in said one direction through a discrete angular increment with each manual actuation of said means, said control ports and said apertures being disposed such that each rotation of said disc through said discrete angular increment connects an alternate one of said control ports with said source of fluid through one of said apertures while simultaneously disconnecting the other of said control ports from said source of fluid thereby causing said bistable fluidic relay to effect actuation of one of said switches and deactuation of the other of said switches.