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SAFETY CIRCUIT

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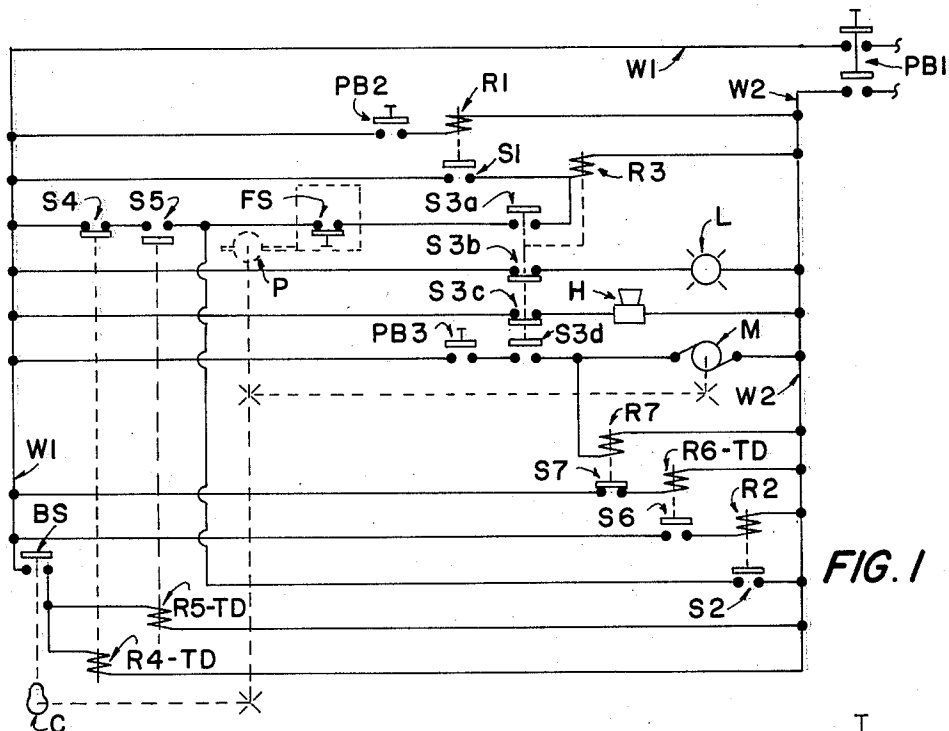


FIG. 1

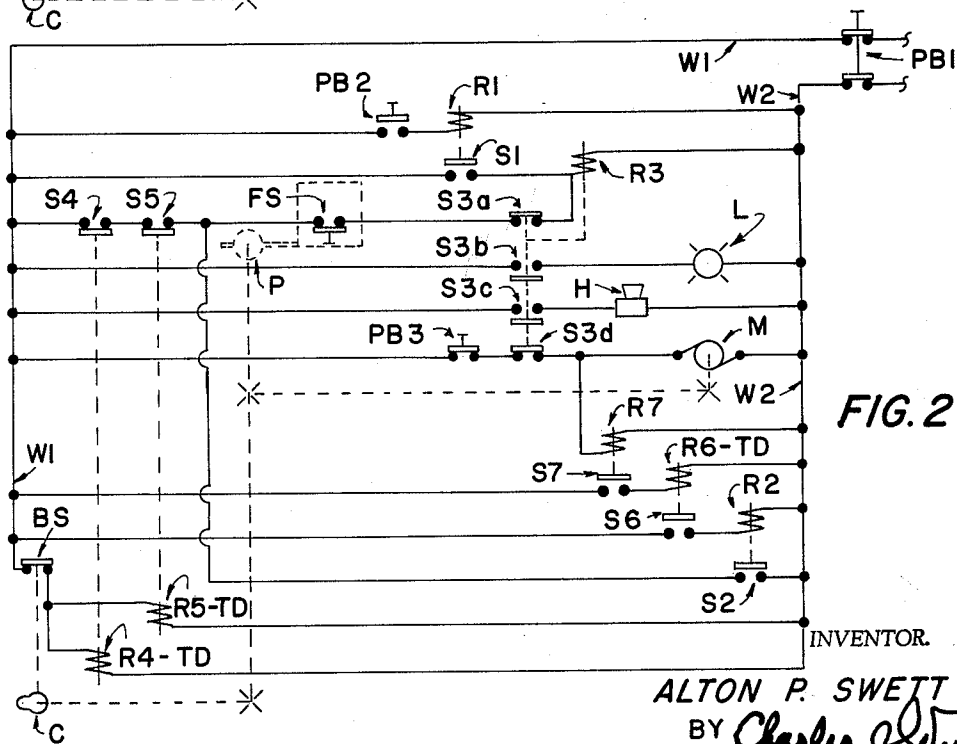


FIG. 2

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1

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SAFETY CIRCUIT

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This invention relates to a protective circuit, and more specifically to one which will shut down an electrical drive due to fluid pump failure or when the fluid supply therefor drops below a predetermined minimum.

It is an object of this invention to provide a protective circuit which will cut the power to an electric motor and, at the same time, energize an audible and a visual alarm due to failure of a fluid pump or insufficient liquid reserve.

Another object is to provide a protective circuit of this type in which there is a time delay between failure and power cut-off to prevent accidental disconnect and shut-down of the motor.

Since fluid delivery systems normally utilize a reciprocating or rotary pump which would operate a sensing switch in the novel arrangement, it is conceivable that failure may occur with the sensing switch in the open or closed position. Therefore, it is an object of this invention to provide a protective circuit of the aforementioned type which is universally sensitive to failure of the fluid pump.

These and other objects will become apparent by referring to the following description and drawings, in which—

FIGURE 1 is a diagrammatic view of the circuit, deenergized, with the switches in their normal and inoperative positions, and

FIG. 2 is similar to FIG. 1 when the circuit and motor are operative.

The novel circuit will be described in its preferred form, in connection with an electric motor driven compressor, as a lubricator protective circuit. It should be fully realized that a circuit of this type may be incorporated in many similar systems where the quantity and the delivery of a fluid are of great import. In the following circuit, should there be a failure in the lubricator or should the supply of lubricant fall below a predetermined safe level, the appropriate switch will open and thus interrupt current to the drive motor and simultaneously energize the audible and visual alarms. The audible alarm is to call attention to the fact that the compressor has stopped due to a failure and may be common with the audible alarm for other safety circuits within the overall system. The visual alarm, however, is identified with the specific safety circuit and thus provides positive indication as to where the failure has occurred.

Referring now to the drawings, FIG. 1 provides a showing of the circuit having no power as the master circuit switch PB1 is open. All the relays are deenergized and the switches assume their normal inactivated positions. Only switches S3b, S3c, S4 and S7 are normally closed. The breaker switch BS is shown in the cammed open position, while the float switch FS is shown as being closed and the fluid is at a safe level. Switches S4, S5, S3a and the float switch FS are in series with the relay R3 which controls the current to the alarms L and H and also the drive motor M. The cam C which periodically breaks the switch BS is merely shown conventionally. Switch S3a is a current disconnect maintaining switch which is open when the relay R3 is deenergized and prevents the reenergizing of that relay, when all the other switches in that line are closed, without the use of the reset switch PB2. With the circuit off as in FIG. 1, the switch PB3 is first closed. This connects power to the motor through the circuit when the sequence switch S3d is closed. Similar circuit switches for the other safety circuits should be

2

closed at this time. The circuit may now be energized and the motor started.

The master switch PB1 is now closed to connect the main power lines W1 and W2 to the power source. Since the switches S3b and S3c are closed, the lamp L and the horn H are energized. The switch S7 being closed energizes the relay R6TD which closes the switch S6. The closing of the switch S6 energizes the relay R2 which then closes the switch S2. The maintaining switch S3a being open prevents the relay R3 from being energized to open switches S3b and S3c while closing switches S3a and S3d. The reset switch PB2 is now closed to energize the relay R1 which closes the starting switch S1. The switch S1 provides a by-pass path to momentarily energize the relay R3. It should be noted that when the reset switch PB2 is released, the relay R1 is deenergized and opens the switch S1. However, by the time the reset switch PB2 is released, the relay R3 has been energized and has closed the switches S3a and S3d and simultaneously opened the switches S3b and S3c. Closing the current disconnect maintaining switch S3a provides a temporary path to maintain the relay R3 energized, when the switch S1 opens, via the switch S2, float switch FS and the maintaining switch S3a. Closing the switch S3d connects power to the motor M and energizes the relay R7. As the motor M runs and drives the lubricator or pump P, it also drives the cam C to periodically make and break the switch BS. When the switch BS closes, the time delay relays R4TD and R5TD are energized to maintain the switch S4 closed and to now close the switch S5, respectively. When the relay R7 is energized, the switch S7 is opened, thus deenergizing the time delay relay R6TD. The time delay relay R6TD will maintain the switch S6 closed until the switches S4 and S5 are also closed. At that time the switch S6 will open and deenergize the relay R2 and open the switch S2, thus cutting off the temporary power path or circuit to the relay R3. However, the normal or operating path or circuit to the relay via the switches S4 and S5 is still provided through the float switch FS and the maintaining switch S3a. At this time the circuit is now, as is shown in FIG. 2, in the operating condition with the motor running normally.

Should the supply fall below the predetermined minimum, the pump operate below a safe speed or stop entirely, it would be considered as a failure of the system and the motor would be deenergized while the alarms would be energized as more specifically described below. Using arbitrary time intervals, the lubricator cam C normally opens the sensing switch BS once every ten seconds with the pump P delivering at a specific rate of flow. The flow rate varies with pump speed. Therefore, the opening and closing of the switch BS is at a frequency proportional to the speed or rate of discharge of the pump. Every time the switch BS opens and closes, the time delays are reset to provide the desired delay. It can be visualized that failure to the reciprocating mechanism may occur when the switch BS is either open or closed. If the switch BS were to stay closed for a period exceeding thirty seconds, the relay R4TD with the time delay would open the switch S4 and cut the power which energizes the relay R3. However, should the failure occur while the switch BS is closed for a period exceeding thirty seconds, the relay R5TD with the time delay would then open the switch S5 and also cut the power energizing the relay R3. Thus, provision is made to deenergize the relay R3 if there is a failure in the lubricator and the sensing switch BS is maintained either opened or closed beyond a predetermined time interval. Should the supply of lubricating fluid drop below a predetermined safe minimum, the float switch FS would also cut the power communication and deenergize the relay R3. When any of the switches S4, S5 or FS open, the relay R3 is deenergized and the switches S3a

and S3d are opened while the switches S3b and S3c are closed. Should the failure be of a temporary nature and the failure condition disappear, permitting the open switch in the series to reclose, the circuit would not be reenergized nor would the motor be driven because of the maintaining switch S3a which remains open and would prevent reenergizing of the relay R3 without the use of the reset switch PB2. The switches S3b and S3c would energize the two alarm systems, and the motor would remain at a standstill until the machine was checked and the motor was manually restarted.

While I have shown and described a specific form of my invention, it is to be understood that various changes and modifications may be made without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. Safety circuit for a system that includes a pump and a motor to drive the pump, comprising a sequencing switch connected to the motor for controlling the flow of power thereto, a relay for actuating the sequencing switch, a maintaining switch connected in series with the sequencing switch relay and being arranged to open and close simultaneously with the sequencing switch in response to said relay, a normally open starting circuit connected in parallel with the maintaining switch to the sequencing switch relay and having a manually operable switch for closing the starting circuit to energize the sequencing switch relay for starting the motor, a temporary running circuit connected to and closed by the maintaining switch when the motor is started and having a time delay relay switch means responsive to power flow to the motor for opening said temporary running circuit after a predetermined time interval after the motor is started, and an operating circuit connected in parallel with the temporary running circuit to the maintaining switch and having a sensing switch associated with the pump that opens and closes at a frequency relative to the speed of the pump and a time delay relay switch means responsive to the sensing switch that opens when the pump fails to run at a required speed to deenergize the sequencing switch relay to stop the pump.

2. Safety circuit according to claim 1, having alarm means, and switch means responsive to the sequencing switch relay for energizing the alarm means when the sequencing switch opens to stop the motor and pump.

3. Safety circuit according to claim 1 in which the time delay relay switch means of the operating circuit comprises a pair of time delay relays connected in parallel with each other to the sensing switch, and a pair of switches connected in series to the maintaining switch each being responsive to one of the time delay relays.

4. Safety circuit for a system that includes a pump, a motor to drive the pump and a reservoir for liquid to be pumped, comprising a sequencing switch connected to the motor for controlling the flow of power thereto, a relay for actuating the sequencing switch, a maintaining switch connected in series with the sequencing switch relay and being arranged to open and close simultaneously with the sequencing switch in response to said relay, a normally open starting circuit connected in parallel with the maintaining switch to the sequencing switch relay and having a manually operable switch for closing the starting circuit to energize the sequencing switch relay for starting the motor, a temporary running circuit connected to and closed by the maintaining switch when the motor is started and having a time delay relay switch means responsive to power flow to the motor for opening said temporary running circuit after a predetermined time interval after the motor is started, an operating circuit connected in parallel with the temporary running circuit to the maintaining switch and having a sensing switch associated with the

pump that opens and closes at a frequency relative to the speed of the pump and a time delay relay switch means responsive to the sensing switch that opens when the pump fails to run at a required speed to deenergize the sequencing switch relay to stop the pump, said operating circuit having a float switch associated with the reservoir and connected in series with the maintaining switch that opens when the liquid level in the reservoir is below a predetermined minimum to deenergize the sequencing switch relay.

5. Safety circuit according to claim 4, having alarm means, and switch means responsive to the sequencing switch relay for energizing the alarm means when the sequencing switch opens to stop the motor and pump.

6. Safety circuit according to claim 4 in which the time delay relay switch means of the operating circuit comprises a pair of time delay relays connected in parallel with each other to the sensing switch, and a pair of switches connected in series to the maintaining switch each being responsive to one of the time delay relays.

7. Safety circuit for a system that includes a pump, a motor to drive the pump and a reservoir for liquid to be pumped, comprising a sequencing switch connected to the motor for controlling the flow of power thereto, a relay for actuating the sequencing switch, a maintaining switch connected in series with the sequencing switch relay and being arranged to open and close simultaneously with the sequencing switch in response to said relay, a normally open starting circuit connected in parallel with the maintaining switch to the sequencing switch relay and having a manually operable switch for closing the starting circuit to energize the sequencing switch relay for starting the motor, a temporary running circuit connected to and closed by the maintaining switch when the motor is started and having a time delay relay switch means responsive to power flow to the motor for opening said temporary running circuit after a predetermined time interval after the motor is started, and an operating circuit having a float switch associated with the reservoir and connected in series with the maintaining switch that opens when the liquid level in the reservoir is below a predetermined minimum to deenergize the sequencing switch relay.

8. Safety circuit according to claim 7, having alarm means, and switch means responsive to the sequencing switch relay for energizing the alarm means when the sequencing switch opens to stop the motor and pump.

9. Safety circuit according to claim 7 in which the time delay relay switch means of the operating circuit comprises a pair of time delay relays connected in parallel with each other to the sensing switch, and a pair of switches connected in series to the maintaining switch each being responsive to one of the time delay relays.

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