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Cook

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[54] CONTROL CIRCUIT FOR LUBRICATING APPARATUS

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[58] **Field of Search** 417/12; 184/6.4; 307/141

[56] **References Cited**

UNITED STATES PATENTS

3,123,745 3/1964 Cook 317/139

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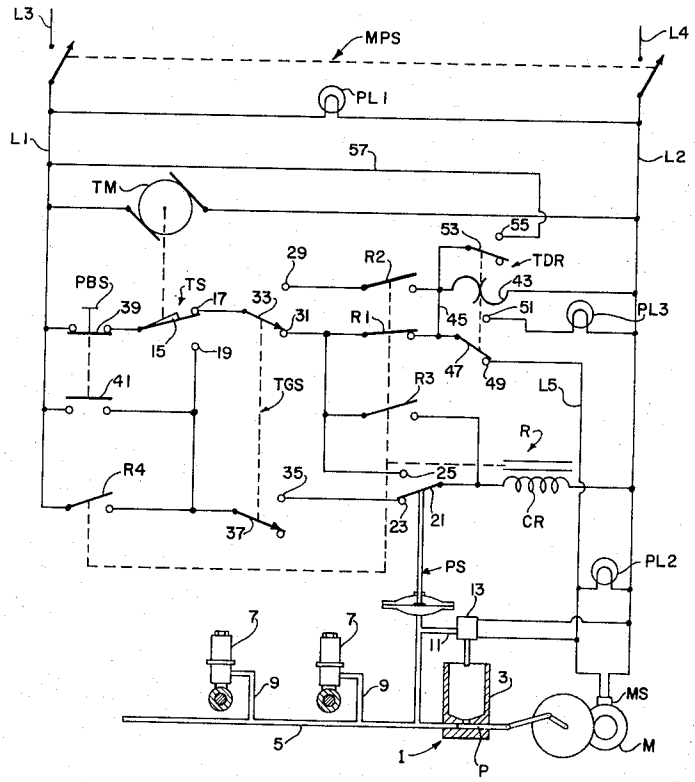
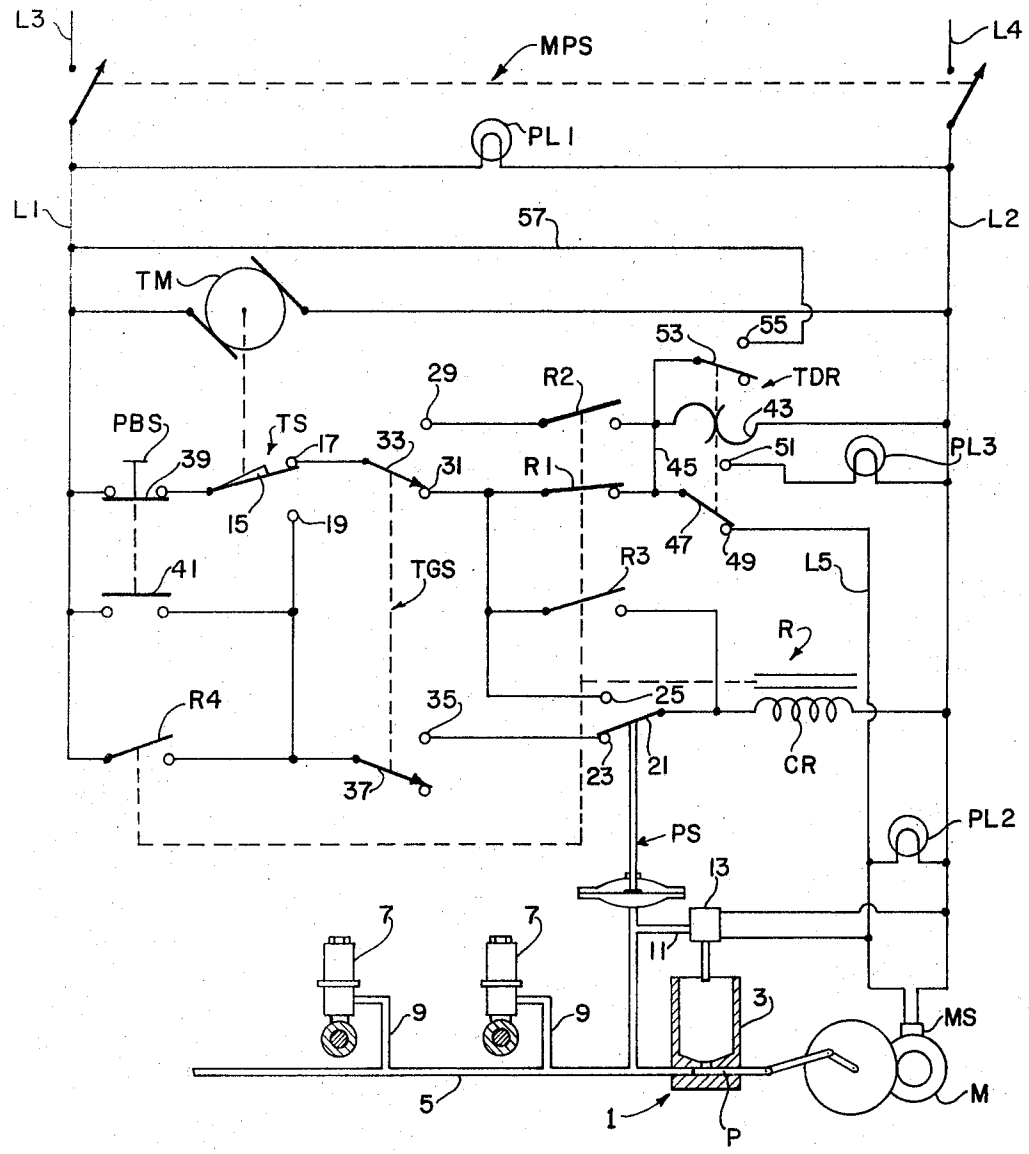
[57] **ABSTRACT**

A control for periodically initiating operation of pumping apparatus of a lubricating system and stopping the pumping apparatus in response to development of a predetermined lubrication pressure in the system. The control includes an initiating switch which is periodically actuated, e.g., by a timer, a pressure-responsive switch which is actuated in response to development of the predetermined pressure, and a relay including sets of normally open and normally closed contacts. Circuitry includes a switch which is selectively operable to provide a first mode connecting normally closed contacts of the relay in a power circuit with the pumping apparatus for actuation thereof and also connecting the relay in an operating circuit with the pressure-responsive switch and with the timer switch to cause energization of the relay when the predetermined pressure is developed and deenergization thereof when the time switch is actuated. The switch also provides a second mode of operation connecting normally open contacts of the relay in the power circuit with the pumping apparatus for actuation thereof and also connecting the relay in an operating circuit with the pressure-responsive switch and with the timer switch to cause energization of the relay when the timer switch is actuated and deenergization thereof when the predetermined pressure is developed. Accordingly, in the first mode, operation of the pumping apparatus is initiated for an initial lubrication cycle when the power is turned on, i.e., applied across the power circuit, and thereafter operation of the pumping apparatus is at periodic lubrication intervals determined by the timer. In the second mode, operation of the pumping apparatus is solely at lubrication intervals determined by the timer.

11 Claims, 1 Drawing Figure





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CONTROL CIRCUIT FOR LUBRICATING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to controls for periodically initiating the operation of an electrically actuated apparatus and stopping it in response to completion of the cycle thereof, and more particularly to a lubricating system of the type having an electrically actuated pumping apparatus for developing lubricant pressure in the system and means for periodically initiating operation of the apparatus, stopping it in response to development of a predetermined lubricant pressure in the system, and then venting the system.

The invention relates in particular to an improved control of the type disclosed in Cook U.S. Pat. No. 3,123,745 and like said patent is concerned with a lubricating system of the type having an electrically actuated pumping apparatus for pumping lubricant to one or more lubricant injectors. Such a control is useful where it is desired that the pumping apparatus of the system be automatically operated at periodic intervals, such as every hour, and automatically stopped when the injectors have cycled, without regard to the time it takes for the pumping apparatus to develop sufficient pressure to cycle the injectors.

In such applications, it is typically desired that means be provided for selecting between a first mode of operation wherein the pumping apparatus is operated to provide an initial lubrication cycle when the power is first turned on and thereafter to provide operation of the pumping apparatus at periodic lubrication intervals determined by the timer; and a second mode wherein the pumping apparatus is not started when the power is first turned on but rather is operated at lubrication intervals determined solely by the timer. To provide this dual-mode type of operation, it has heretofore been required to utilize a pair of relays each of which may operate to establish a latching circuit for the other. This requisite use of a plurality of relays provides a control which, while being entirely satisfactory in use, is more complex and thus more expensive and prone to failure than is desired, considering that in the use of controls for lubrication systems of the type described, simplicity and reliability are of paramount importance in providing assurance that lubrication will be carried out without failure.

SUMMARY OF THE INVENTION

Among the several objects of the invention may be noted the provision of an improved and greatly simplified control for a lubrication system of the type described; the provision of such a control which may also be useful in systems other than lubrication systems wherein electrically actuated apparatus is desired to be periodically actuated and wherein it is desired to provide a first mode of operation of the type above noted to cause an initial cycle when the power is first turned on and thereafter to provide operation at periodic intervals or a second mode of operation in which operation is solely at periodic intervals; the provision of such a control utilizing a single relay to achieve such dual-mode operation; the provision of such a control which effectively prevents the controlled apparatus from restarting even though the timer switch should be reclosed when the cycle-responsive switch is open, i.e., requiring that the timer switch open and close again before the apparatus is once more started; the provision of such a control including means for stopping the apparatus if it should fail to complete a cycle within a predetermined time; the provision of such a control including means for signalling such a failure to complete a cycle; and the provision of such a control which is exceedingly simple, long lasting, and reliable in operation. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, the present invention is useful in a lubricating system of the type comprising electrically actuated pumping apparatus for developing lubrication pressure in the system, the control being adapted for periodically initiating operation

of the pumping apparatus and stopping it in response to a development of a predetermined lubrication pressure in the system, and then venting the system. The control includes a timer switch, a timer for periodically actuating the timer switch, and a pressure-responsive switch including first and second sets of contacts adapted to close and to open, respectively, in response to development of the predetermined pressure and to open and to close, respectively, upon venting of the system. The control includes a relay having respective sets of normally open and normally closed contacts. Circuit means is provided including a switch selectively operable to provide one of two modes. The first mode connects the set of normally closed contacts of the relay in a power circuit with the pumping apparatus for actuation thereof and also connects the relay in an operating circuit with the first set of contacts of the pressure-responsive switch and with the timer switch to cause energization of the relay upon development of the predetermined pressure and to cause deenergization of the relay when the timer switch is actuated. In the second mode, the switch connects the set of normally open contacts of the relay in the power circuit with the pumping apparatus for actuation thereof and also connects the relay in an operating circuit with the second set of contacts of the pressure-responsive switch and with the timer switch to cause energization of the relay when the timer switch is actuated and deenergization of the relay upon development of the predetermined pressure. Accordingly, in the first mode, operation of the pumping apparatus is initiated for an initial lubrication cycle in response to connection of the power source across the power circuit and thereafter operation of the pumping apparatus is at periodic lubrication intervals determined by the timer. In the second mode, operation of the pumping apparatus is solely at lubrication intervals determined by the timer.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a schematic and diagrammatic illustration of a system of the type described and circuitry of the present control.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, a lubricating system in which the invention is incorporated is shown to comprise an electrically actuated pumping apparatus **1** for pumping lubricant from a reservoir **3** through an injector supply line **5** to a plurality of lubricant injectors **7**, branch lines **9** connecting line **5** to the individual injectors. Each injector is of a type which receives lubricant from the line **5**, and which operates in response to development of a predetermined injector-cycling pressure in line **5** to inject a measured charge of lubricant, and which depends for resetting and reloading with another measured charge of lubricant upon relief of pressure in the line **5** subsequent to injection. Injectors of this type are well known and require no further description, their detailed construction not being material to this disclosure. A disclosure of an injector of this type which may be used will be found in U.S. Pat. No. 2,637,413. For venting pressure from line **5**, a line **11** including a solenoid vent valve **13** is provided.

As herein illustrated, the electrically actuated pumping apparatus **1** comprises a reciprocating pump P driven by an electric motor M. However, it will be understood that pump P might be driven, for example, by a compressed-air-operated motor with an electrically actuated valve controlling the operation of the motor.

A control of the present invention for periodically initiating operation of motor M to drive the pump P and stopping the motor in response to development of injector-cycling pressure in line **5** is shown to comprise a timer switch TS which constitutes a cycle initiating switch and is adapted to be periodically actuated by a timer motor TM.

Timer switch TS is shown to comprise a blade **15** normally closed on a contact **17** thereby to provide a set of normally closed contacts, the blade being periodically actuated by timer

motor TM by means of a cam (not shown) or an equivalent drive means so as to open from contact 17 and close on another contact 19 which, with the blade 15, provides a set of normally open contacts. Operation is such that the normally closed and normally open contacts of the timer switch TS are adapted to open and to close, respectively, for a relatively short time interval when the timer switch is actuated. The timer motor TM is connected across a pair of leads L1 and L2. Each of these leads is adapted to be connected across an AC power source by means of a pair of power leads L3 and L4, respectively, by the closing of ganged sections of a main power switch generally designated MPS. A pilot light PL1 connected across leads L1 and L2 is energized when there is voltage across these leads thereby to indicate that the control has been turned on by closing of switch MPS.

Switch TS may be adapted to be actuated not by timer motor TM but instead by a counter responsive to a number of operations by a machine which is adapted to be lubricated by the present system. As a further alternative, switch TS may instead by controlled by a cam, etc., of the lubricated machine.

The control includes a pressure-responsive switch PS responsive to lubricant pressure in line 5 so as to be cycle-responsive. Switch PS includes a switch blade 21 normally closed on a contact 23, thereby providing a first set of normally closed contacts, and which is adapted to open from contact 23 and to close on another contact 25 in response to development of a predetermined lubricant pressure in line 5 of the system. Contact 25 and blade 21 together provide the pressure switch with a second set of normally open contacts. Blade 21 recloses on contact 23 when the system is vented through operation of solenoid-operated vent valve 13.

The control further comprises a relay, generally indicated R, having a normally closed set of contacts R1 and three normally open sets of contacts R2, R3, and R4, all of which sets are adapted to be operated by energization of the coil CR of relay R. Connection of the sets of contacts R1 to R4 are described below.

Also included in the control is a double-throw toggle switch indicated generally TGS having a first single-pole double-throw switch section having a pair of contacts 29 and 31 each respectively connected with one of the respective sets of relay contacts R2 and R1. A switch blade 33 is operable to close on either one of contacts 29 and 31. Blade 33 is connected in a circuit with the normally closed contacts, i.e., contact 17 and switch blade 15 of cycle-initiating timer switch TS. Switch TGS has a second switch section including a contact 35 and a switch blade 37 ganged for concomitant operation with blade 33. Contact 35 and blade 37 are connected across leads L1 and L2 in a circuit including normally open relay contacts R4, switch blade 21 closed on contact 23, and relay coil CR.

Switch TGS is selectively operable to provide one of two modes of operation of the control. In the position shown, the pumping apparatus 1 is operated to provide an initial lubrication cycle when the power is first turned on by closing of power switch MPS. Thereafter, operation of the pumping apparatus 1 is at periodic lubrication intervals determined by timer switch TS. In the other position of switch TGS, the pumping apparatus 1 is operated solely at intervals determined by timer switch TS.

Connected between blade 15 of timer switch TS and lead L1 are a set of normally closed contacts 39 of a pushbutton switch PBS. The latter provides a manually operable means for initiating a lubrication cycle. Switch PBS includes a further set of contacts 41 which are normally open and which are connected in a circuit between contact 19 of switch TS and lead L1. Contacts 41 and contacts 39 are adapted to be concomitantly closed and opened, respectively, when switch PBS is manually actuated. An alternative connection of pushbutton switch PBS providing more convenient routing of leads in a particular system configuration is as follows: normally closed contacts 39 are connected in the lead between relay contacts R3 and relay coil CR; and normally open contacts are connected in a circuit between contact 29 and the junction of contacts 39 with relay coil CR. When this alternate connection is used, blade 15 is connected directly to lead L1. In either connection, switch PBS functions as switch means interconnected in a circuit with initiating switch TS and with toggle switch TGS and is manually operable to initiate a lubrication cycle.

The control is provided with a time delay relay, indicated generally TDR, which is shown merely for purposes of illustration as having a thermal element 43 connected in a circuit including relay contacts R2 between toggle switch contact 29 and lead L2. The side of element 43 which is interconnected with normally open relay contacts R1 is also interconnected to normally closed relay contacts R1 via a circuit connection 45. Switch blades of two sets of contacts are adapted to be concomitantly actuated after a predetermined time delay period following energization of element 43. A first set of these contacts includes a switch blade 47 normally closed on a contact 49 to close a power circuit including a power lead L5 which, together with lead L2 provides power for energization of pump motor M. For this purpose, connected across leads L5 and L2 is a motor solenoid or starter MS which, when energized, is operable to effect starting of pump motor M. A pilot light PL2 connected across leads L5 and L2 is energized when there is power across these leads and thereby indicates that motor M is in operation. When actuated by element 43, switch blade 47 is opened from contact 49 and closed on a contact 51. A pilot light PL3 connected between contact 51 and lead L2 is energized in response to closing of blade 47 on contact 51 thereby to serve as signal means for indicating operation of the time delay relay TDR.

A further switch blade 53 of this time delay relay is adapted to be operated by element 43 concomitantly with blade 47 so as to close on a contact 55. Blade 53 is interconnected with the side of element 43 which is connected to relay contacts R2 and contact 55 is tied to lead L1 by means of a circuit connection 57 so that, when blade 53 closes on contact 55 after a predetermined time delay interval, a latching circuit is established for maintaining energization of element 43. While time delay relay TDR has been described as having a thermal element 43 for the purpose of simplifying illustration, this time delay relay TDR may instead comprise a conventional solid state or other suitable type of comercially available time delay relay.

In operation of the control, it may first be assumed that toggle switch TGS is in the position shown and that main power switch MPS is in the open position shown. If switch MPS is then closed, power is applied across leads L1 and L2, indicated by pilot light PL1, and timer motor TM is thereby started. Since blade 15 of timer switch TS is closed on contact 17, an operating circuit for motor starter MS is immediately established through contacts 39 of pushbutton switch PBS, blade 15 closed on contact 17, blade 33 of toggle switch TGS closed on contact 31, normally closed contacts R1 of relay R, blade 47 closed on contact 49, and lead L5.

The resultant energization of motor starter MS is indicated by pilot light PL2. Valve 13 is also energized by virtue of its connection across leads L5 and L2 and therefore closes to permit build-up of pressure in line 5. Motor M is started by starter MS and then drives pump P to supply lubricant under pressure in line 5. The pressure in line 5 attains a value sufficient to operate the injectors 7 and then continues to develop until pressure-responsive switch PS is operated by a predetermined pressure in the system, causing blade 21 to open from contact 23 and to close on contact 25. When this occurs a circuit for energizing coil CR of relay R is established through contacts 39, blade 15 closed on contact 17, blade 33 closed on contact 31, blade 21 closed on contact 25, and coil CR. This causes relay contacts R1 to open and contacts R2, R3, and R4 to close. Closing of contacts R3 establishes a holding circuit for relay R to maintain coil CR in its energized condition.

The opening of contacts R1 from the foregoing operation deenergizes motor starter MS so that motor M and pump P stop. Valve 13 is also deenergized to vent line 5 and blade 21

of pressure switch PS recloses on contact 23. As will be apparent, even if timer switch blade 15 remains closed on contact 17 after pressure switch PS has been operated, motor M cannot be reenergized until blade 15 opens from contact 17. This occurs when timer switch TS is periodically actuated by timer motor TM, causing blade 15 to close for a time on contact 19 and then reclose on contact 17. When blade 15 opens from contact 17, the latching circuit through closed relay contacts R3 is broken and relay coil CR becomes deenergized, permitting each of relay contacts R1–R4 to return to the normal position shown. The resultant reclosing of contacts R1 again establishes a circuit for energizing pump P after blade 15 recloses on contact 17. A normal lubrication cycle is then carried out as described above.

It may be noted that whenever pump P is energized through contacts R1, so also is element 43 of time delay relay TDR. If a normal lubrication cycle is not carried out within a predetermined time interval to cause actuation of pressure switch PS for deenergizing pump P, the continued energization of element 43 of the delay relay causes blade 47 to open from contact 49 to break the power circuit for pump P and to close on contact 51, energizing pilot light PL3 to signal that the time delay relay has operated. Concomitantly, blade 53 closes on contact 55 to establish a latching circuit from lead L1 through lead 57 thereby to maintain element 43 in its energized condition thus preventing further operation of the control. Resetting may subsequently be accomplished by opening main power switch MPS, thereby causing deenergization of element 43 so as to return blades 47 and 53 to their normal positions. When switch MPS is reclosed, a lubrication cycle will thereupon be normally carried out (except in the unlikely situation that timer switch blade 15 may not have reclosed on contact 17) and thereafter, lubrication cycles are effected under control of timer switch TS.

It is significant that, in the use of a lubrication system for a machine which is subject to periodic shut-down, perhaps for long periods, the foregoing mode of operation is advantageous in that proper lubrication is assured at the very start of operation of the machine, it being sufficient thereafter to provide only periodic lubrication. On the other hand, where shutdowns occur frequently, it may be disadvantageous to carry out a lubrication cycle each time the machine is reenergized. In such instances, it is desirable that automatic lubrication of the machine be carried out solely at periodic intervals. To provide this second mode of operation, toggle switch TGS is switched to the position opposite from that shown in the drawing. Assuming that switch TGS has thus been switched so that blade 33 is closed on contact 29 and blade 37 is closed on contact 35, operation is as follows.

Assuming main power switch MPS to be closed, the voltage across leads L1 and L2 causes energization of timer motor TM. It may be observed that the normally open set of contacts defined by blade 21 and contact 25 of pressure switch PS, and which close on completion of a cycle of operation, are no longer connected in the operating circuit for relay coil CR since blade 33 has been opened from contact 31. However, since blade 37 has been closed on contact 35, the set of normally closed contacts defined by blade 21 and contact 23, and which open on completion of a cycle, are now instead connected in an operating circuit for relay coil CR. Hence when operation of timer motor TM causes blade 15 of timer switch TS to open from contact 17 at the end of the timing interval and then close momentarily on contact 19, a circuit across lines L1 and L2 for energizing relay coil CR is established through the normally closed contacts of pushbutton switch PBS, blade 15 closed on contact 19, blade 37 closed on contact 35, blade 21 closed on contact 23, and the relay coil CR.

Energization of coil CR causes relay contacts R1 to open and contacts R2–R4 to close. Closed contacts R4 set up a latching circuit across lines L1 and L2 for maintaining coil CR energized, this circuit including closed contacts R4, blade 37 closed on contact 35, blade 21 closed on contact 23, and coil CR. Thus when timer switch blade 15 opens again from contact 19 after a relatively short interval and thus recloses on contact 17, coil CR is maintained energized.

The foregoing energization of coil CR resulting in the closing of contacts R2 of the relay provides a power circuit for energizing motor starter MS to cause operation of lubrication of pump P. Valve 13 is also energized. This circuit across leads L1 and L2 includes the closed contacts of pushbutton switch PBS, time switch blade 15 closed on contact 17, toggle switch blade 33 closed on contact 29, closed contacts R2, delay relay blade 47 closed on contact 49 and lead L5. When the injectors 7 have operated and pressure in line 5 reaches a predetermined level, pressure switch PS is operated, causing blade 21 to open from contact 23 and to close on contact 25 thereby deenergizing coil CR to effect opening of relay contacts R2 and thus terminating operation of motor M. Valve 13 is also deenergized to vent line 5 and blade 21 of pressure switch PS then recloses on contact 23. Motor M may not be reenergized until blade 15 opens once again from contact 17 and closes momentarily on contact 19 to reenergize coil CR. Such operation results periodically from operation of timer motor TM and a normal lubrication cycle is then carried out each time as described above. Accordingly, lubrication is carried out automatically solely at periodic lubrication intervals determined by the timer switch.

As in the first mode, this second mode of operation also results in energization of time delay relay element 43 so that, if a normal lubrication cycle is not carried out within a predetermined time interval, continued energization of element 43 will open blade 47 from contact 49 to effect stopping of motor M, all as described previously.

Also as in the first mode, this second mode permits manual operation of pushbutton switch PBS to initiate a lubrication cycle if that is desired.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A control for periodically initiating operation of an electrically actuated apparatus and stopping it in response to completion of a cycle thereof comprising:

an initiating switch;

means for periodically actuating said initiating switch;

a cycle-responsive switch adapted to be actuated in response to completion of a cycle of said apparatus;

a relay including respective sets of normally open and normally closed contacts;

circuit means including switch means selectively operable to provide a first mode connecting said set of normally closed contacts in a power circuit with said apparatus for actuation thereof and also connecting said relay in an operating circuit with said cycle-responsive switch and with said initiating switch to cause energization of said relay upon completion of a cycle of said apparatus and deenergization thereof when said initiating switch is actuated;

and a second mode connecting said set of normally open contacts in said power circuit with said apparatus for actuation thereof and also connecting said relay in an operating circuit with said cycle-responsive switch and with said initiating switch to cause energization of said relay when said initiating switch is actuated and deenergization thereof upon completion of a cycle of said apparatus;

whereby said first mode initiates operation of said apparatus for an initial cycle in response to connection of a power source across said power circuit and thereafter causes operation of said apparatus at periodic intervals determined by said timer means and whereby said second

mode causes operation of said apparatus solely at periodic intervals determined by said timer means.

2. A control as set forth in claim 1 wherein said cycle-responsive switch includes first and second sets of contacts adapted to close and to open, respectively, in response to said completion of a cycle of said apparatus, said first set of contacts being connected, when in said first mode, in said operating circuit for said relay and said second set of contacts being connected, when in said second mode, in said operating circuit.

3. A control as set forth in claim 2 wherein said relay includes a further set of normally open contacts connected in a circuit across said first set of contacts to provide a latching circuit for said relay.

4. A control as set forth in claim 3 wherein said switch means comprises a first single-pole, double-throw switch section having a pair of contacts each respectively connected to one contact of said respective sets of relay contacts and a switch blade operable to close on either one of said pair of contacts, said blade being connected in a circuit with said initiating switch.

5. A control as set forth in claim 4 wherein said initiating switch includes respective sets of normally closed and normally open contacts, said switch blade being connected in a circuit with the normally closed contacts of said initiating switch, said relay including a still further set of normally open contacts connected in a circuit across the normally open contacts of said initiating switch, said switch means including a second switch section having contacts which are open in said first mode and closed in said second mode to connect said still further set of normally open relay contacts and said second set of contacts of the cycle-responsive switch in said relay operating circuit when in said second mode.

6. A control as set forth in claim 5 wherein said normally closed and normally open contacts of said initiating switch are adapted to open and to close, respectively, for a relatively short interval when said initiating switch is actuated.

7. A control as set forth in claim 1 further comprising time delay means for breaking said power circuit in response to operation of said apparatus for a predetermined time interval without actuation of said cycle-responsive switch.

8. A control as set forth in claim 7 further comprising signal means adapted to be actuated in response to operation of said time-delay means.

9. A control as set forth in claim 1 further comprising manual switch means interconnected in a circuit with said initiating switch and with the first said selectively operable switch means, said manual switch means being manually operable to initiate a cycle of operation of said apparatus.

10. A control as set forth in claim 1 wherein said means for periodically actuating said initiating switch comprises a timer motor.

11. In a lubricating system of the type comprising electrically actuated pumping apparatus for developing lubrication pressure in the system, a control for periodically initiating operation of the pumping apparatus and stopping it in response to development of a predetermined lubrication pressure in the system, and then venting the system, comprising:

a timer switch;

means for periodically actuating said timer switch;

a pressure-responsive switch including first and second sets of contacts adapted to close and to open, respectively, in response to development of said predetermined pressure in the system and to open and close, respectively, upon venting of the system;

a relay including respective sets of normally open and normally closed contacts;

circuit means including means selectively operable to provide a first mode connecting said set of normally closed contacts in a power circuit with said apparatus for actuation thereof and also connecting said relay in an operating circuit with said first set of contacts of the pressure-responsive switch and with said timer switch to cause energization of said relay upon development of said predetermined pressure and deenergization thereof when said timer switch is actuated; and a second mode connecting said set of normally open contacts in said power circuit with said apparatus for actuation thereof and also connecting said relay in an operating circuit with said second set of contacts of the pressure-responsive switch and with said timer switch to cause energization of said relay when said timer switch is actuated and deenergization thereof upon development of said predetermined pressure;

whereby said first mode initiates operation of said pumping apparatus for an initial lubrication cycle in response to connection of a power source across said power circuit and thereafter causes operation of said pumping apparatus at periodic lubrication intervals determined by said timer means and whereby said second mode causes operation of said pumping apparatus solely at periodic lubrication intervals determined by said timer means.

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