March 9, 1943. H. H. BROWN 2,313,121

PROTECTIVE DEVICE FOR OIL LUBRICATING SYSTEMS

Filed Jan. 26, 1942

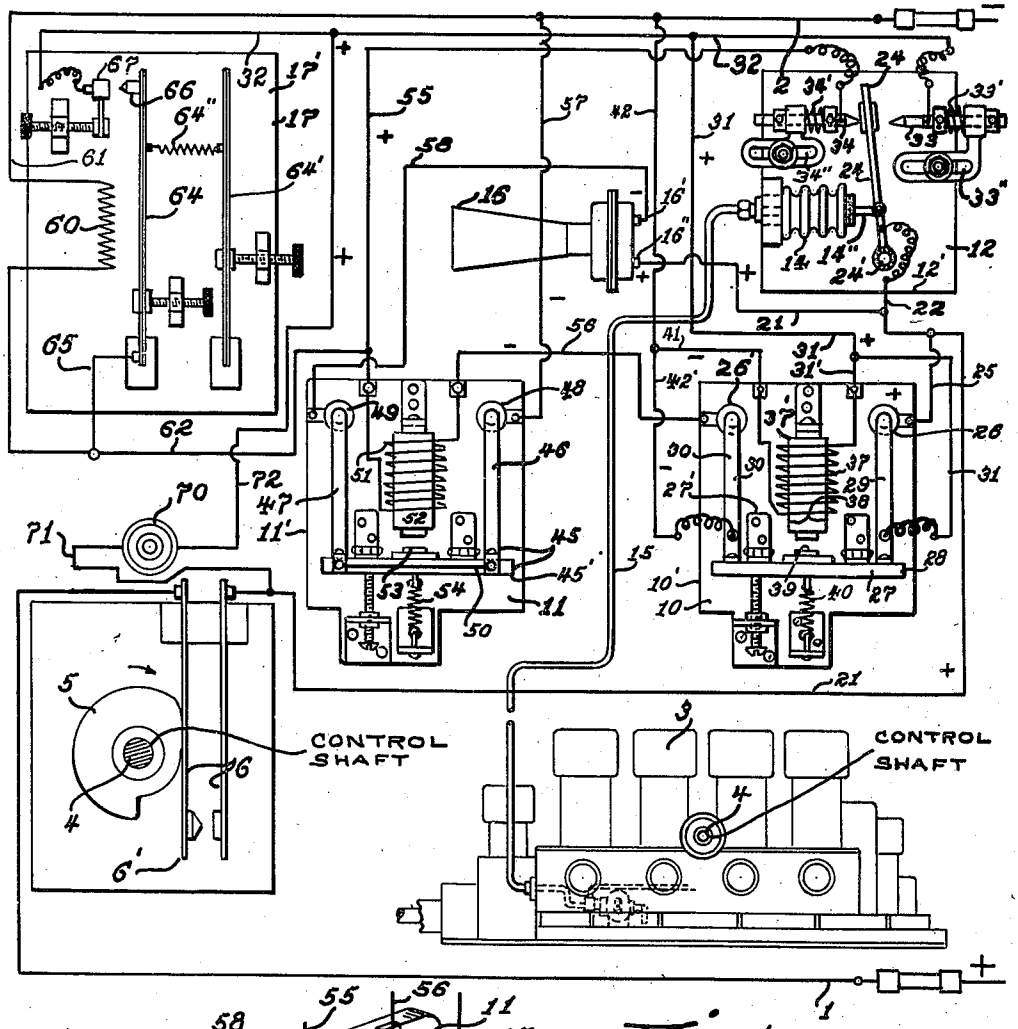


Fig. 1.

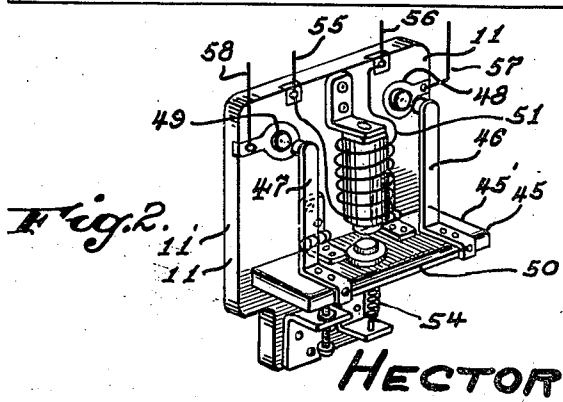


Fig. 2.

Inventor

HECTOR H. BROWN

Witness

By Edwin F. Samuels

Attorney

Patented Mar. 9, 1943 2,313,121

UNITED STATES PATENT OFFICE

2,313,121

PROTECTIVE DEVICE FOR OIL LUBRICATING SYSTEMS

Hector H. Brown, Baltimore County, Md.

Application January 26, 1942, Serial No. 428,263

13 Claims. (Cl. 177—311)

This application is in part a continuation of my co-pending application, No. 402,149 filed July 12, 1941. The invention relates to an oil pressure alarm system capable of use with various machines having an oil pressure lubricating system. Such machines include prime movers and other machines. The present system has, however, been developed with particular reference to use with the type of internal combustion motor known as a Diesel engine.

While it is capable of more general application, it is regarded as of interest that the form of oil pressure alarm system herein disclosed was devised to meet the requirements of certain Diesel engine installations of the marine type. In such installations, the engineer in charge operates under orders received by signal from the bridge or pilot house so that the continual operation of an oil pressure alarm would be confusing, to the extent that the old type of low pressure alarm which sounds whenever the oil pressure drops as in maneuvering would be confusing and objectionable to the extent that would cause the alarm to be disconnected at such times with a considerable chance that it would be forgotten so that the engineer would not receive notice of a subsequent loss of lubricating oil pressure and under such circumstances could not prevent serious damage to the engine on account of failure of the lubricating system.

While visual alarms, as red lights, may be used, they are frequently overlooked or the bulbs burn out or if the signals are so intense as to demand attention, the system should be shut off as objectionable in maneuvering as would a low pressure sound alarm with consequent lack of notice and resulting damage to the engine in the event of loss of oil pressure.

The object of the invention is to provide an oil pressure alarm system in which the alarm sounds or operates when and only when the lubricating oil pressure is insufficient or becomes insufficient for safe lubrication of the engine during operation, or when the lubricating system is inoperative at the time of starting.

Particular emphasis has been placed on the application of the system of the invention to Diesel engines on account of the high bearing pressures employed and the consequent immediate and extensive damage which results from faulty lubrication.

The alarm system of the invention, in the preferred form in which the invention has been practiced, comprises a high-low pressure switch in which the switch arm or moving member is normally in contact with the low pressure terminal, and moves almost instantaneously to contact with the high pressure terminal when a satisfactory operating pressure is reached; thereafter, it moves back into contact with the low pressure terminal if lubricating oil pressure drops below what may be regarded as a reasonably safe minimum pressure for lubrication. Other methods of controlling the circuit in response to predetermined changes of lubricating oil pressure being contemplated, the practical form in which the system has been operated includes a delay relay operated or closed by contact of the said high-low switch arm with the high pressure terminal due to build up of the oil pressure to the operating standard, a second or alarm relay operated by subsequent return of the high-low pressure switch arm to contact with the low pressure terminal due to a predetermined loss of said pressure, and a horn or other suitable alarm, a thermostatic switch being also provided to connect the low pressure terminal of the high-low pressure switch to the ground through the alarm or otherwise actuate the alarm at the time of starting in case of loss of oil or occurrence of leakage while the engine has been idle.

While the thermostatic switch or the equivalent is regarded as an essential precaution, other alarms or indicating means for this purpose may be employed, such thermostatic or similar devices not being regarded as an essential part of the new combination in its broader scope.

It is of particular importance that there can be no alarm otherwise than through the thermostat or equivalent device used for the purpose just stated, until the oil pressure has been built up by the operation of the engine, to a predetermined pressure and is thereafter dropped to a lower pressure which is predetermined as harmful or unsafe to the extent that the engineer should be notified. In this way, repeated soundings of the alarm in maneuvering as in reversing or slowing down are prevented. The system is preferably controlled by a switch operated by the starting valve control or some part of the engine which changes position or condition in starting and stopping. Starting thus places the system in operation and stopping of the engine cuts off the alarm system or disconnects it permitting it to return to normal. While the method just stated of controlling the alarm system has important advantages, the master or control switch may be otherwise operated.

In operation, neither relay is energized until the high-low pressure switch engages the high

pressure terminal. The current then operates the delay relay switch which places the delay relay coil in circuit to remain in circuit so long as the engine is running. Thereafter, if the lubricating pressure is lost or drops to the predetermined extent before the engine is stopped, the alarm relay is operated closing the alarm relay switch which places the horn or other alarm in circuit operating the alarm. When the engine is stopped as by operating the control, the system returns to its initial position.

The system as shown is entirely electrical and there is no opportunity for failure and it is particularly notable that no alarm can be sounded or otherwise operated except in cases of harmful loss of lubricating oil pressure. While details of an alarm system are shown, the principles of the invention whereby the alarm is actuated may be applied to any other suitable safety device as a provision for automatically stopping the engine. In marine installations, the use of an alarm to notify the engineer of the necessity for stopping his engine is the preferred practice.

In the drawing:

Fig. 1 is a diagrammatic view of the system,

Fig. 2 is a perspective view of a relay adapted to the purposes of the invention.

Referring to the drawing by numerals, the circuit includes plus and minus busses 1 and 2, suitable differences of potential therein being established and maintained by a generator or in any suitable manner. A Diesel engine 3 or other machine being lubricated is indicated diagrammatically. This engine or other machine has a control shaft 4, which may be treated as representing any member the position or condition of which is changed in starting and in stopping the machine or engine. This control shaft 4 which, in the form of the invention shown, is rocked through a short arc in stopping and starting, is provided with a cam 5 or other suitable member by which the master or control switch 6, controlling the alarm circuit, is closed, and caused to remain closed throughout the period during which the engine is in operation. By closing this switch, the alarm system to be described is placed in operative condition and retained in operative condition until the control shaft, which operates the starting valve, throttle or the like is turned or rocked to the proper position to stop the engine. In the form shown the shaft 4 is turned clockwise or right handed as seen in Fig. 1 in starting and in either direction for stopping, and switch 6 is given a tendency to open by spring means as the resilience of cam engaging arm 6.

The alarm system of the invention, as already pointed out, includes in connection with the circuit an example of which is to be described, a delay relay 10, a second relay 11, a high-low pressure switch 12, operated by a pressure element 14, suitably connected as at 15 to the oil pressure lubricating system of the engine machine 3 and a horn or other suitable alarm 16.

The system as shown is also provided with a thermostatic switch assembly 17 to prevent damage due to leaks or loss of lubricating pressure while the machine or engine is idle, this switch operates to sound the alarm in case of delay in building up the oil pressure after the engine is started and the circuit is closed at 6. These are examples of various equivalent units.

The details of this and other unit assemblies will be hereinafter more fully described.

Having reference to the alarm circuit as illustrated, the positive buss 1, is connected through the control switch 6 by means of a conductor 21 to the positive terminal of the horn or other alarm 16. In the form of circuit shown, the conductor is also connected by branch connection 22 to the swinging arm 24 of the high-low pressure switch 12. A second branch connection 25 connects the conductor 21 to the positive pole 26 of the switch 28 of delay relay 10, this switch 28 is of the double blade type having blades 29 and 30 engaging poles 26 and 26', these blades are mounted on the rocking base bar 27 of non-conducting material. The blade 29, as shown, is connected by conductors 31 and 31' to the plus side of coil 37 and its contact 26 is connected by conductor 21 to positive buss 1. Coil 37 is connected on its minus side to buss 2 by conductor 41, 42. High pressure contact 33 is connected to main 32 which is normally dependent for its energization on the closing of contact at the high pressure terminal 33 of the high-low pressure switch 12. Main 32 is connected by conductors 31 and 31' to the plus side of coil 37 of electro magnet 37' of relay 10, said magnet having a core 38. Rocking base bar 27 is retracted by spring 40 tending to open the switch. Core 38 attracts armature 39 on bar 27 to close the switch 28 which is opened by spring 40.

The second blade 30 of the double blade switch 28 is connected at or near its pivot end near bar 27 to the conductor 42, so that when the delay relay switch 28 has been closed and high pressure contact 33 having been previously in circuit is thrown out of contact, the current flows through coil 37 by way of conductor 21 to conductor 25 through terminal or contact 26, to blade 29 and by way of blade 29 to conductor 31 and hence through conductor 31' to coil 37 and back by way of negative conductors 41 and 42, to the negative buss 2, thus holding the switch closed. In other words, when the high pressure terminal 33 has been engaged by the switch arm 24, and delay relay switch 28 is closed, magnet 37 continues to be energized, and switch 28 remains closed until control switch 6 is opened as by stopping the engine or the machine by operation of control shaft 4.

The purpose of the alarm relay 11 is to operate in combination with the delay relay 10 to control the timing of the sounding of the alarm 16 to take place after operating pressure has been generated in the lubricating oil system but not until pressure has thereafter dropped to an extent which would be dangerous to the machine or engine thus lubricated. An exception to this is when there is a loss of oil or a leak becomes effective while the engine is not running. To operate the alarm under these circumstances, the thermostat assembly 17 has been provided, other time control or delay means being available.

The alarm relay 11 as employed includes a switch 45, preferably of the two pole variety having blades 46 and 47 and contacts 48 and 49, said switch shown in Fig. 1 may be closely similar to the switch 28 except that the blades 46, 47 mounted on rocking bar 45' which may be of non-conducting material are connected by conductor 50, blades 29 and 30 of switch 28 being insulated from each other. The alarm relay has been called the second relay.

The coil 51 of relay 11 has a core 52 and the switch has an armature 53 on rocking bar 45'

for closing the switch 45 which is opened by spring 54. The plus side of the coil 51 is connected by a conductor 55 to the low pressure contact 34. The other or negative terminal of coil 51 is connected by conductor 56 to the pole 26' of the switch 28 of delay relay 10 which at all times when the switch 28 is closed is connected through blade 30 to negative conductor 42, 42' which leads to negative bus 2. Thus the energization of the coil 51 closing switch 45 of the alarm relay is dependent on the existence of low pressure in the lubricating system and on the simultaneous closed condition of switch 28 of delay relay 10 which is in turn dependent on the condition that high-low switch 12 must first have been closed at the high pressure terminal which could only be due to high or operating pressure having been generated in the lubricating system. This refers to normal operation.

The switch 45 to be closed by energization of coil 51 is normally held open by spring 54. The blades 46 and 47 of this switch are conducting members connected together by conductor 50. The pole 48 of this switch is connected by a conductor 57 to the negative bus 2, and the pole 49 is connected by conductor 58 to the negative terminal of the alarm 16'.

The positive terminal 16'' has already been described as connected by conductor 21 to the switch 6 and hence to buss 1 which means that terminal 16'' is always connected to the source of energization whenever the switch 6 is closed, i. e., throughout the operation of the engine or the machine to be protected.

In case of loss of pressure during the period when the machine or engine is not in operation, as by leakage of oil overnight, or during any other period of inoperativeness, at starting the high-low pressure switch arm 24 will remain in contact with the low pressure terminal 34 and the alarm will not sound as a result of the operation of the new alarm system just described. To avoid loss by injury to the machine or engine under the circumstances, a thermostatic switch 17 has been provided. This switch, in the form shown, has a heating coil or time element 60 connected by conductor 61 to the negative buss 2 and connected at its opposite terminal 62 to the plus connection 55 of coil 51 which leads to the low pressure terminal 34 of high-low pressure switch assembly 12, which is connected to the positive buss through the switch arm 24 at all times, except when the operative, i. e., satisfactory lubricating pressure prevails in the lubricating system to which pipe 15 and bellows 14 are connected.

The thermostatic switch assembly 17, which is for emergencies only as when the system becomes defective during periods when the engine is not running, includes thermostatic switch arms 64, 64' of well known construction. Switch arm 64 is connected by conductor 65 to conductor 62 which leads to low pressure terminal 34. Switch arm 64 carries a moving contact 66 which co-operates with a stationary contact 67 connected to the main 32, which, in the circuit shown, is the main the energizing connection to which is made and broken at high pressure contact 33 of the high-low pressure switch assembly 12, but main 32 is also connected by conductors 31 and 31' to the coil 37 of delay relay 10, coil depends on thermostat not the thermostat on the coil. The circuit shown, is an example of an operative circuit for this purpose. Assuming that, at the time of starting, due to a leak or other defect, pressure in the lubricating system does not build up and switch arm 24 remains in contact with low pressure terminal 34, coil 60 thus becomes heated and the thermostatic switch or equivalent time switch 64 is closed, making a circuit through the delay relay coil closing switch 28 and the low pressure switch arm 24 being still in contact with low pressure terminal 34 of the high-low pressure switch 12, the alarm relay coil 51 is energized closing the alarm relay switch 45 and grounding the horn or alarm 16 which is thus operated, the plus terminal of the alarm being connected to positive buss 1 through conductor 21 when the switch 6 is closed.

The drawing also shows a test button or test switch 70 which is normally open and which is connected to the positive buss 1 by conductor 71 on the plus side of switch 6, being connected at its opposite side by conductor 72 to the main 32 which, as aforesaid, is connected by conductor 31 to the coil 37, and is normally energized through high pressure terminal 33 of high-low switch 12. By pressing the button 70 and closing the switch of which it is a part, the system may be tested at any time, in fact, the closing of the test button switch 70 and likewise the closing of the thermostatic switch 17 is equivalent to shorting the high pressure contact 33 of high-low pressure switch 12 and this shorting of contact 33' when low pressure contact 34 is in circuit serves to operate both relays and to sound the alarm, assuming that the circuit is in order. Thus a test may be applied to the circuit at any time when the engine is not in operation by putting switch to the "on" position and generally done before starting to ascertain that the alarm circuit is in order. If the alarm sounds on pressing the button 70, the system is in order.

The units, particularly the high-low pressure switch 12, the delay relay 10, alarm relay 11, and thermostatic switch 17 will now be more specifically described.

Having particular reference to the high-low pressure unit 12, this comprises a suitable plate or support 12' on which is mounted an expansible container or bellows 14 connected by a tube 15 to the oil pressure lubricating system of the engine 3 or other machine to which the system is applied, the tube conducts the lubrication oil pressure in the lubricating oil system of the engine to the bellows.

The bellows 14 is connected as by rod 14'' to a swinging lever 24 pivoted at 24' and connected to the conductor 22, as shown, or in any suitable manner. The high-low pressure terminals 33, 34 are on opposite sides of lever 24 and in the path thereof and may be spring pressed as shown to provide for yielding to the contact of lever 24 and for advancement in contact therewith up to a pretermined point so that the lever 24 is shifted or moved instantaneously from one contact 34 to the other contact 33. The terminals 33, and 34 are also referred to as contacts.

The bellows 14 is so constructed as to resist expansion to an extent sufficient to make contact of lever 24 with low pressure terminal 34 up to the point of an operative lubricating oil pressure and from this pressure the bellows expands instantaneously to a sufficient extent to move the lever 24 from low pressure contact 34 into contact with high pressure terminal 33. The springs operating the terminals 33', 34' and these terminals may be mounted for adjustment to meet the conditions stated. Suitable adjustments by means of slots 33'' and 34'' being shown. The low pres-

sure terminal 34 is shown as connected to a conductor 55, already described. The high pressure terminal 33 is connected to the main or conductor 32.

The delay relay 10 may be supported on a suitable non-conducting plate 10', this relay comprises an electro-magnet mounted on the plate 10' and consisting of a core 38 and a coil 37 surrounding the core and connected at one end as by conductors 31' to the conductor 31, already described, and connected at its other end as by branch conductor 41 to the conductor 42, leading to the negative buss 2.

The electromagnet 37' has an armature 39 mounted on a rockable bar 27 hingedly supported on said plate 10' as by means of hinges 27'. This bar 27 is of non-conducting material and moved in opposition to the attraction of the magnet by a spring 40. The magnet core being shown at 38.

The rockable bar 27 carries conducting blades 29 and 30 which are insulated from each other and which co-operate with terminals 26, 26', respectively. The blades 29, 30 are connected near the rockable bar 27 to conductors 31 and 42' respectively and the terminals 26, 26' are connected to conductors 25 and 56, the latter leading to coil 51 of the alarm relay to be described. Also referred to as the second relay.

The alarm relay 11 which is closely similar to the delay relay 10, except for the conductor 50 in the former, which connects the blades 46, 47, is shown in perspective in Fig. 2. This relay 11 is mounted on a non-conducting plate 11' which carries a rockable non-conducting bar 45' which is hingedly mounted on plate 11' as shown and provided with switch blades 46, 47, which co-operate with terminals 48, 49, on said plate. These blades 46, 47, are connected together by conductor 50 and are actuated by an electro-magnet comprising a coil 51 and core 52, which co-operates with an armature 53 on the rockable bar 45'. Said bar receives from spring 54 a tendency opposed to the attraction of the coil. The terminals of the coil are connected to conductors 55, 56, already described and the switch terminals or poles 48, 49 are connected to conductors 57, 58, which have also been described, said poles or terminals are also referred to as contacts.

The thermostatic switch assembly 17 may be mounted on a non-conducting plate 17'. In the form shown, it consists of bi-metallic arms 64, 64' connected together by spring 64''. These arms when heated by coil 60, to which they are intended to be closely related, are distorted in a well known manner, the predetermined amount of heating causing the contact 66, carried by arm 64, to engage the stationary contact 67, closing the switch in the manner already described. The coil 60 is connected to conductors 61, 62, already described and the switch arm 64 is connected by conductor 65 to the conductor 62. Stationary contact 67 is connected to main 32. The details are for example only.

In operation, as already suggested, the switch 6 having been closed as by placing the engine in operation in any suitable manner as by turning the shaft 4 through a suitable arc. Thus the plus terminal 16'' of the horn is connected to positive buss 1, likewise the high-low pressure switch arm 24. Assuming that the lubricating system is in order and likewise the alarm system, the high-low pressure switch arm 24 remains in contact with the low pressure terminal 34 and neither relay is energized until the machine is started and lubricating oil pressure is built up. Immediately thereafter said arm 24 swings instantaneously into contact with the high pressure terminal 33, contact being broken between the arm 24 and low pressure contact 34. The contact at 24, 33, sets up a current in the delay relay coil 37 closing the switch 28 and holding it closed so long as high pressure or operative pressure is maintained in the lubricating system, and relay 11 is not energized.

If the engine is stopped as by operation of the control shaft 4, the master or control switch 6 will be opened and the alarm system returns to normal, however, if for any reason, during operation of the machine or engine the lubricating oil pressure drops below what may be regarded as the desired safe operating pressure, the arm 24 swings to the left, breaking contact with high pressure terminal 33 and closing contact with low pressure terminal 34. However, the contact between arm 24 and terminal 33 having once been made, as by the building up of the pressure in the system, the delay relay switch 28 remains closed by the passage of current from conductor 21 which is connected to the positive buss, said current passing from conductor 21 through conductor 25 to terminal 26 along the blade 29 to conductor 31 and hence through coil 37 back to the negative buss 2 by way of conductors 41, 42.

Closing the contact between arm 24 and low pressure terminal 34 when the delay relay switch is closed sets up a current through the second relay coil 51 which receives current by way of conductor 21 through the arm 24 and terminal 34 which is connected by conductor 55 to the coil 51 of the alarm relay. The coil is shown as grounded by way of conductor 56 and delay relay terminal 26' which is connected by switch blade 30 to the minus conductors 42' and 42 which lead to negative buss 2.

By thus energizing the coil 51 the alarm relay switch 45 is closed, grounding the negative terminal of the horn or other alarm 16 by way of conductor 58, terminal 49, and switch blades 47, 46, the latter being connected by conductor 50. Switch blade 46 is in contact with pole 48 connected by minus conductor 57 to the negative buss 2. As already pointed out, the positive terminal of the alarm 16 is connected at all times when the control switch 6 is closed by way of conductor 21 and switch 6 to the positive buss 1.

It will thus be apparent that the control switch being closed in a suitable manner as by operation of the control shaft of the engine or machine, the system is in operative condition but there is no current through either of the respective relays until pressure has been built up to the desired operating pressure when the switch arm 24 swings into contact with the high pressure terminal 33. By this contact the coil 37 is energized closing the delay relay switch which remains closed as long as the engine is in operation with suitable oil pressure. If, however, the oil pressure drops below what has been regarded as a safe operating pressure the high-low pressure switch being set accordingly, the switch arm 24 swings into contact with the low pressure terminal 34 and the switch 28 remaining closed, the alarm relay switch is closed grounding the horn and completing the connection thereof whereby the alarm is sounded and will continue to sound until the engine is stopped or the circuit is broken by some means not included in the system illustrated. Preferably, the parts would be encased so they could not be tampered with without cutting the wires.

We thus have a system mainly quiescent so long as suitable oil pressure is maintained, but which, when pressure has once been built up to the operative point, is in condition to sound the alarm when and if the lubricating pressure drops below the predetermined safe limit during the period of operation of the machine or engine. The second relay 11 is not in circuit till pressure drops below standard after first building up to standard.

If, by any chance, the system becomes inoperative, during the period in which the machine or engine is not running so that on starting the lubricating oil pressure does not build up to what is as the normal operative pressure to which the high-low pressure switch would be set, the continued contact at terminal 34 causes the coil 60 of the thermostatic switch to be heated operating the switch 17 and sounding the alarm before damage can result. Other types of time switch may be employed instead of the thermostatic switch 17 and other means may be used to indicate the lack of initial pressure in the system and protective means other than an alarm may be used and the circuit is subject to variation.

I have thus described specifically and in detail a single embodiment of the high-low pressure oil lubricating pressure alarm system of the invention, the description being specific and in detail in order that the manner of constructing, applying, operating and using the invention may be fully understood, however, the specific terms herein are used in a descriptive rather than in a limiting sense, the scope of the invention being defined in the claims.

What I claim as new and desire to secure by Letters Patent is:

1. A protective circuit for the oil pressure lubricating system of a machine comprising a high-low pressure switch, a delay relay having connections whereby its switch is closed when said high-low pressure switch is closed at its high pressure contact, means thereafter holding the delay relay closed when the circuit is broken at the high pressure contact, a second relay having its coil connected for energization through the delay relay switch and the low pressure contact of the high-low pressure switch whereby the switch of said second relay is closed when the circuit is closed through said low pressure contact after the circuit through the high pressure contact has been closed and opened at said control, and a protective unit adapted to be electrically operated and having connections whereby it is energized when said second relay is closed.

2. A protective circuit for the oil pressure lubricating system of a machine comprising a high-low pressure switch, a delay relay having connections whereby its switch is closed when said high-low pressure switch is closed through its high pressure contact, means thereafter holding the delay relay closed when the circuit is broken at the high pressure contact, a second relay having a coil connected for energization through the delay relay switch and the low pressure contact of the high-low pressure switch whereby the switch of the second relay is closed when the circuit is closed through said low pressure contact after the circuit through the high pressure contact has been closed and opened at said contact, and a protective unit adapted to be electrically operated and having connections whereby it is energized when said second relay is closed said circuit including a master switch connected to the machine to be protected, to be closed automatically throughout the period of operation of said machine and means for automatically opening both relays when the circuit is broken at the master switch.

3. A protective circuit for the oil pressure lubricating system of a machine comprising a high-low pressure switch, a delay relay having electrical connections whereby its coil is energized through the high pressure contact of said switch closing the delay relay switch when the circuit is closed at said contact, electrical connections for thereafter energizing the coil of said delay relay holding the delay relay switch closed when the circuit is broken at the high pressure contact of the high-low pressure switch and closed at the low pressure contact of said latter switch, an alarm relay having electrical connections whereby its coil is connected to the circuit through the low pressure contact of said low pressure switch when the latter is closed on the low pressure side, said alarm relay being oppositely connected through said delay relay when closed thus completing the circuit through the alarm relay coil, closing the alarm relay switch, and an alarm unit having connections whereby it is operatively connected to said circuit through the switch of said delay relay when closed.

4. A protective circuit for an oil pressure lubricating system of a machine comprising a high-low pressure switch, a delay relay having electrical connections whereby its coil is energized through the high pressure contact of said switch when the latter is closed at said contact, electrical connections for energizing the coils of said delay relay holding the relay switch closed after the circuit is broken at the high pressure contact of the high-low pressure switch and closed at the low pressure contact of the same, and a second relay having electrical connections whereby its coil is connected to the circuit and energized through the low pressure contact of said high-low pressure switch closing the switch of said second relay when the high-low pressure switch is closed on the low side, the coil of said second relay being oppositely connected through said delay relay to complete the circuit through the second relay coil and a protective unit adapted to be electrically operated and being operatively connected to said circuit through the switch of said delay relay, said protective circuit having a master switch connected to the machine thus lubricated to be controlled thereby to close the switch when the machine is started and hold it closed throughout said operation and a time switch connected to the low pressure contact of the low pressure switch and otherwise connected to the circuit to operate the protective unit when the low pressure switch remains in contact beyond a predetermined time period after the machine is started.

5. A protective circuit for an oil pressure lubricating system of a machine comprising a high-low pressure switch, a delay relay having electrical connections whereby its coil is energized through the high pressure contact of said switch when the latter is closed at said contact, electrical connections for energizing the coil of said delay relay holding the relay switch closed after the circuit is broken at the high pressure contact of the high-low pressure switch and when said switch is closed at the low pressure contact, a second relay having electrical connections whereby its coil is connected to the circuit through the low pressure contact of said low pressure switch, to be energized, closing the switch of said

second relay when the high low pressure switch is closed on the low pressure side, said second relay being oppositely connected through said delay relay to complete the circuit through the coil of said second relay, a protective unit operatively connected to said circuit through the switch of said delay relay, and a test switch with connections for energizing the coils of said relays to close the switches and sound the alarm when the machine is idle.

6. In a protective circuit for an oil pressure lubricating system of a machine, a high-low pressure switch connected for operation by the pressure in said system, a delay relay and a second relay, the delay relay having its coils connected for energization through the high pressure contact of said switch to close the delay relay switch when the high-low pressure switch is closed at the high pressure contact, said delay relay switch having a plurality of moving conductors mounted thereon and insulated from each other and corresponding contacts for said conductors likewise insulated, one said conductor having electrical connections for connecting and thus energizing the delay relay coil through its said contact to hold the delay relay switch closed after the high pressure contact is opened and the other conductor and its contact being in circuit with the coil of the second relay which is also in circuit with the low pressure contact of the high-low pressure switch whereby the switch of the second relay is closed when the high-low pressure switch is closed on the low pressure side, after first being closed and thereafter opened on the high pressure side, and a protective unit adapted to be electrically actuated and being connected through the switch of the second relay to be energized when the latter is closed.

7. A protective circuit for an oil pressure lubricating system of a machine comprising a high-low pressure switch connected for operation by the pressure in said system, a delay relay, a second relay, the delay relay having its coil connected for energization through the high pressure contact of said switch to close the delay relay switch when the high-low pressure switch is closed at the high pressure contact, said delay relay switch having a plurality of moving conductors mounted on the moving member of the delay relay switch and insulated from each other and corresponding contacts for said conductors likewise insulated, one said conductor having electrical connections for connecting and thus energizing the delay relay coil through its said contact to hold the delay relay switch closed after the high pressure contact is opened and the other conductor and its contact being in circuit with the coil of the second relay which is also in circuit with the low pressure contact whereby the switch of the second relay is closed when the high-low pressure switch is closed on the low pressure side, after first being closed and then opened on the high pressure side, and a protective unit adapted to be electrically actuated and being connected to the switch of the second relay to be energized when the latter is closed, a master switch in said circuit connected to a machine thus lubricated to be closed when the machine is started and opened when it is stopped.

8. In a protective circuit for an oil pressure lubricating system of a machine, a high-low pressure switch, a delay relay, a second relay, the delay relay having its coil connected for energization by closing the circuit through the high pressure contact of said switch to close the delay relay switch when the high-low pressure switch is closed at the high pressure contact, said delay relay switch having a plurality of moving conductors mounted on the moving member of the switch, said members being insulated from each other, and corresponding contacts for said conductors, likewise insulated, one said conductor having electrical connections for connecting and thus energizing the delay relay coil through its said contact to hold the delay relay switch closed after the high pressure contact is opened and the other conductor and its contact being in circuit with the coil of the second relay which is also in circuit with the low pressure contact whereby the circuit through the coil of the second relay is closed when the high-low pressure switch is closed on the low pressure side, after first being closed and later opened on the high pressure side, a protective unit adapted to be electrically actuated and being connected to the switch of the second relay, to be energized when the latter is closed, and a time control switch connected to the low pressure contact to be energized and closed when the low pressure contact is closed, the contact of said time switch being connected in parallel with the high pressure contact to close the relays and sound the alarm when the high-low pressure switch remains in circuit at its low pressure side for a predetermined period after starting the machine.

9. A protective circuit for the oil pressure lubricating system of a machine comprising a high-low pressure switch having high and low pressure contacts and an arm connected to a source of electricity to have alternate engagement with said contacts on corresponding variations of pressure in said system, a delay relay, a second relay, and an electrically actuated protective unit, the delay relay having circuit closing means including a connection to a source of electricity through the high-pressure terminal of the high-low pressure switch and connections whereby the delay relay is held in closed position after the said high-low pressure contact is opened, said delay relay also having a connection to the coil of the second relay which coil is oppositely connected to the low pressure contact to energize the second relay when the low pressure contact is closed, the second relay comprising a switch connected to energize the protective unit when said latter switch is closed.

10. A protective circuit for a pressure lubricating system for a machine; comprising a high-low pressure switch having high and low pressure contacts and a moving arm operated by the pressure and connected to the circuit a delay relay having its coil connected to be energized through the said high pressure contact when engaged by said arm, thus closing the switch of said delay relay, other electrical connections through the delay relay switch to said coil to be closed when said relay is closed to energize the coil of said relay to hold said relay closed after the said high pressure contact is opened, a second relay the coil of which has energizing connections through said delay relay switch and through the low pressure contact of the high-low pressure switch, to be closed when the delay relay switch and the high-low pressure switch are both closed, the latter at said low pressure contact and a protective unit with connections whereby it is placed in circuit and operatively

energized when the switch of the second relay is closed.

11. A protective circuit for a pressure lubricating system for a machine; comprising a high low pressure switch having high and low pressure contacts and a moving arm operated by the pressure and connected to a source of electricity a delay relay having its coil connected to be energized through the said high pressure contact when engaged by said arm, thus closing the switch of said delay relay, other electrical connections through the delay relay switch to said coil to be closed when said relay is closed to energize the coil of said relay to hold said relay closed after the said high pressure contact is opened, a second relay the coil of which has energizing connections through said delay relay switch and through the low pressure contact of the high-low pressure switch to be closed when the delay relay switch and the high-low pressure switch are both closed, the latter at said low pressure contact, a protective unit with connections whereby it is placed in circuit and operatively energized through the switch of the second relay when the latter is closed, and a master switch controlling said circuit and connected to the machine to be closed and opened as the machine is started and stopped, and means tending to hold both relays open and to be overcome by the attraction of the respective magnets when their coils are in circuit.

12. A protective circuit for a pressure lubricating system for a machine; comprising a high-low pressure switch having high and low pressure contacts and a moving arm operated by the pressure and connected to the circuit, a delay relay having its coil connected to be energized through the said high pressure contact when engaged by said arm, thus closing the switch of said delay relay, other electrical connections through the delay relay switch to said coil to be closed when said relay switch is closed to energize the coil of said relay to hold said relay closed after the said high pressure contact is opened, a second relay the coil of which has energizing connections through said delay relay switch and through the low pressure contact of the high-low pressure switch to be closed when the delay relay switch and the high-low pressure switch are both closed, the latter at said low pressure contact and a protective unit with connections whereby it is placed in circuit and operatively energized through the switch of the second relay when the latter is closed, and a master switch controlling said circuit and connected to the machine to be closed when the machine is started and opened when the machine is stopped, and means for returning the circuit to its initial condition when the machine is stopped.

13. In a protective circuit for an oil pressure lubricating system of a machine, a high-low pressure switch having a moving conductor connected to the circuit and a pressure element connected to the lubricating oil pressure, to be operated thereby, and carrying said conductor, said switch also having high and low pressure contacts to be engaged by said conductor at different pressures, respectively at, and below the operative pressure of said lubricating oil system, a protective element electrically actuated, and a delay relay and other circuit changing means, the low pressure contact of the high-low pressure switch and the switch of the delay relay and said circuit changing means being connected in controlling relation to the protective element to close the circuit therethrough and actuate the protective unit when said high-low pressure switch is closed on the low pressure side and the delay relay switch is closed, the delay relay switch being connected to the high pressure contact to be closed when the circuit is closed on the high pressure side of said switch and said delay relay having means for holding said delay relay switch closed after contact is broken at the high pressure side of said high-low pressure switch whereby said protective unit is operated when circuit has been closed through the high pressure contact of said high-low pressure switch and thereafter closed through the low pressure contact of said high-low pressure switch, a master switch in said circuit, and additional means for returning the circuit to normal when the master switch is opened.

HECTOR H. BROWN.