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PROTECTIVE CIRCUIT FOR BOATS

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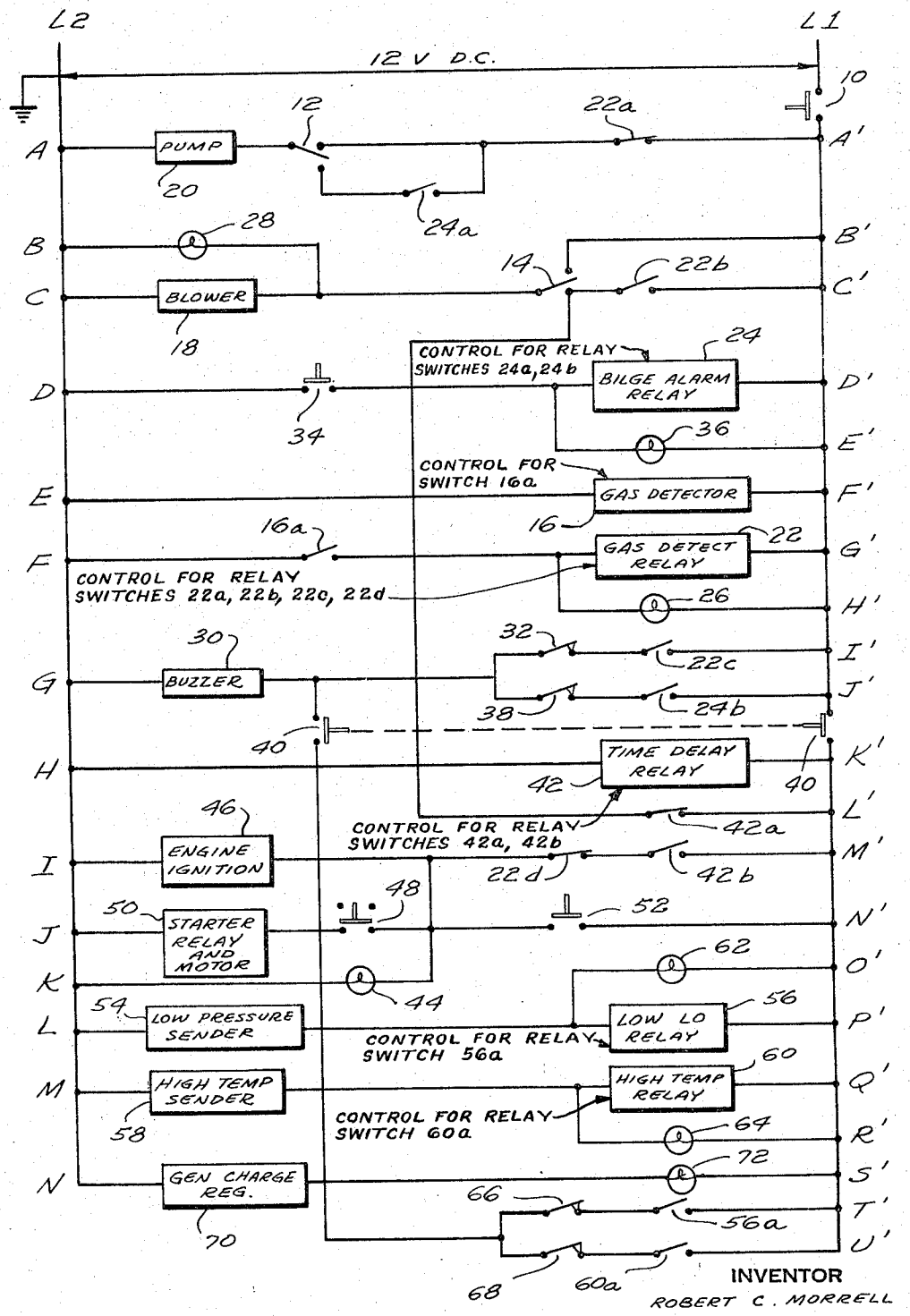

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PROTECTIVE CIRCUIT FOR BOATS

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This invention relates to an electrical protective system which forms a part of a starting circuit for an internal combustion engine utilizing a fuel having a flash point below 150° F. The invention describes a safe, automatic/semi-automatic procedure for starting an engine which may conveniently be the engine of a power boat, but it should be abundantly clear that the invention is equally applicable to auxiliary engines which drive generators, pumps or air compressors as well as the engine or engines used for main propulsion. Therefore, throughout this description, it should be recognized, even though not specifically recited, that the invention may be used with all of the aforementioned. With the invention, it is contemplated that the boat's engine can be started only after a predetermined time interval, set by the delay cycle of a time delay relay, has elapsed subsequent to the closing of an ignition switch, and further only when any fuel vapor that may be present in the bilge compartment of the boat is within the safe concentration level. Due to this circuitry, the danger of accidentally detonating any accumulated explosive mixture of fuel vapor which gathers in the bilges of power boats is substantially eliminated.

It has been found that during periods in which the engine is in operation, as well as during periods of non-operation, dangerous quantities of fuel vapor have a tendency of gathering in the boat's bilge compartment. Either through neglect, undue haste, or unawareness, the operator in all too many cases will start the engine without first clearing the bilge compartment of these accumulated fuel mixtures or continue operation after the dangerous condition arises, with the effect, the operator, passengers or both may be injured and loss or damage may result to the vessel due to an explosion of the fuel vapor and/or fire. With regard to such occurrences, it should be kept in mind that regulations, such as United States Coast Guard Regulation 46 CFR 182.15–45(*d*), requiring a definite vapor clearing period to elapse before engine operation, have been promulgated. From the ensuing description, it will be readily apparent that this invention provides an automatic/semi-automatic means of complying with the foregoing regulation.

It is therefore an object of this invention to provide a novel system which will initiate the operation of various components to eliminate or at least minimize the fire and explosion hazard precipitated by a dangerous accumulation of fuel vapor in the bilge compartment during both the starting and subsequent operation of the boat's engine. In carrying out this object, I provide a time delay relay which may provide for the continuous operation of a blower, to clear the accumulated fuel vapor, during the time delay cycle. Additionally, by the implementation of a fuel vapor detector that controls the operation of a relay which in turn controls the operation of the blower, the blower will also operate during periods when the fuel vapor detector is operative. Therefore, as will be brought out later in the description, the engine cannot be started while the blower, during automatic operation of the circuit, is clearing the bilges of off limit explosive vapors.

Another object is the provision of means to both sense a high bilge water level and to reduce such level to a safe condition provided the gaseous vapor concentration permits.

A further object is the provision of means to automatically shut down the engine after operation commences, if the fuel vapor concentration should become dangerous.

A still further object is to provide suitable indicating means that automatically apprise the operator of various off limit conditions, such as fuel vapor concentration, high bilge water level, etc., both before and during operation of the boat. To carry out this object, I preferably provide a buzzer and a series of lights to give both an audible and visual indication of the conditions, as above. Since the main control panel carries the vital navigational equipment, these lights are preferably carried by an auxiliary panel in the cockpit of the boat.

Other objects and advantages of the invention will be apparent readily come to mind during the course of the following description.

In carrying out this invention and the above objects, my circuit preferably comprises a fuel vapor detector for sensing dangerous concentrations of fuel vapor and a time delay relay for delaying the operation of the engine for a predetermined time after the ignition switch is closed. A blower, which will operate during the time delay period, when automatically controlled, and operate at all times when fuel vapor is sensed, is included in the circuit to remove fuel vapor from the boat's bilge compartment so that the hazard of fire and/or explosion is substantially eliminated when starting the engine. Further, a pair of relay switches are placed in series with the engine starter switch, with the relay switches being closed to complete the circuit to the starter only when fuel vapor is not being sensed and after the time delay period has elapsed.

In the accompanying drawing, which both illustrates and forms a part of this invention, there is shown in the figure a sequence circuit diagram of my invention. In this figure, like references are employed to designate like and associated parts throughout.

In the drawing, I show what is considered to be the preferred circuit diagram of my protective system, a system which is readily adaptable for use as a starting circuit of a power boat. For ease in description and so as to provide a clear understanding of the circuit's operation, each junction along the lines L1 and L2 is denoted by a letter, the letters along the positive line L1 being primed. In this manner, the operation of line A–A', for example, may be described without having to designate each electrical connection with a numeral.

Across the lines L1 and L2, there is a constant D.C. voltage source, which is, in the preferred embodiment, an ordinary 12-volt battery, but it should be obvious that batteries of 6, 24 and 32 volts may be used rather than the preferred 12-volt battery. In series with the power source and the control circuit is a master switch **10** which controls the operation of the entire circuit. This switch is a normally open, manually operated switch and is closed by the operator to initiate the operation of the protective circuit and to allow for subsequent starting of the boat's engine. As is the case with all the various components of my circuit, to be hereinafter referred to, the switch is only diagrammatically shown. The diagrammatic showing is considered adequate since the particular construction of the components is not considered as forming a part of the invention. This invention lies primarily in the electrical assemblage of the specific components and the operation thereof in the circuit.

As was brought out earlier by the brief reference thereto, I provide an auxiliary control panel and the manual operator for the master switch is carried thereby. On this control panel, which is preferably separate and distinct from the main panel, I also place the operators for the switches later referred to and the various indicator lights, which will be discussed below.

While it is necessary to provide for the monitoring of various prevailing conditions, such as fuel vapor concen-

tration, bilge water level, oil pressure, cooling temperature, etc., during the operation of the boat, I have found that it is also desirable to monitor at least some of these conditions while the boat is at anchor and the engine is inoperative. The monitoring during both these periods will now be described.

Circuit operation prior to closing the ignition switch

While the boat is at anchor and attended by the operator, it may be desirable to monitor both the fuel vapor concentration and water level in the boat's bilge compartment, as previously mentioned. For this purpose, I provide both an automatic and manual mode of operation which will be determined by the AUTO-MANUAL switches **12** and **14** located in lines A–A′ and C–C′, respectively. (The manual operation is provided when the contact arm of each switch is in the "up" position on the drawings and automatic in the "down" position.) The switches **12** and **14** are independent of one another rather than ganged together, and therefore may assume any of the various combinations of AUTO-MANUAL, AUTO-AUTO, etc., to afford varying types of operation.

When the master switch **10** is closed, power is delivered at each junction A′–J′ in line L1 and made available to the fuel vapor detector **16** in line E–F′, and the blower **18** in line C–C′ so as to provide for the monitoring and controlling of a fuel vapor concentration in the bilge compartment. Power is also delivered to the pump **20** in line A–A′ and the operation of the pump to relieve the bilge of water will be described later.

Many types of gas vapor detectors are commonly used to sense the presence of dangerous vapor concentrations, as for example, detectors incorporating a bimetallic element and a catalyst. Conveniently, the bimetal forms the contact arm of a switch and due to the action of fuel vapor on the catalyst, the bimetal is heated, closing the switch, and providing an indication of the presence of such vapor. Further, the detector may comprise a Wheatstone bridge resistance thermometer which will indicate a rise in temperature of a catalyst due to the presence of a combustible gas on the catalyst.

The above are merely exemplary of the operation of a typical vapor detector which may be used with my invention, but again, the invention is not directed to the construction of the various components, but rather the operation of the electrical assemblage of components.

The vapor detector which may be used with the invention, but the invention is not to be limited thereto, is a Heathkit Fuel Vapor Detector, number MI–41, 1964 Heathkit catalogue, identified as 81/40.

Detector **16** is sensitive to the presence of a fuel vapor concentration in the bilge compartment and when any such concentration exceeds what is considered to be safe level the detector will function, in a manner similar to Example No. 1 above, to close the normally open vapor detector switch **16***a* in line F–G′. The closing of switch **16***a* causes the energization of the vapor detector relay **22**, in series relation to the switch **16***a*, with the relay, in turn controlling its associated switches **22***a–d*.

As seen on the drawing, the relay switches **22***a* and **22***d* are normally closed with relay switches **22***b* and **22***c* being normally open. As should be apparent, upon energization of relay **22**, its associated switches will assume the opposite condition to provide blower operation so as to clear the bilge of the accumulated fuel vapor and further prevent engine operation, which is of prime importance.

With the master switch **10** closed and both the switches **12** and **14** in the MANUAL operating mode (contact arm up on the drawing) the blower **18** will be continuously operative, it being directly controlled by the master switch **10**. In this mode, pump operation will be directly controlled by relay **22** and relay switch **22***a*; therefore, during normal conditions, when relay **22** is in the unenergized state, the pump will also be continuously operating since switch **22***a* is normally closed. Being that it is

ill advised to operate water pumps without the presence of water, switch **12** should desirably be kept in the automatic position (contact arm down) so that the pump will operate under the control of switch **24**. But regardless of the mode determined by switch **12**, the pump cannot operate during periods in which vapor is sensed and relay **22** is energized, for line A–A′ will be open at switch **22***a*.

In AUTOMATIC operation, as determined by switches **12** and **14**, and under normal conditions (neither a high water level nor high vapor concentration) both the relays **22** and **24** will be unenergized so that both the blower and pump are inoperative.

During periods when a high fuel vapor concentration is sensed, relay **22** becomes energized, normally open relay switch **22***b* closes and the blower **18** begins operation and continues to operate until switch **22***b*, again, opens. As mentioned above, during this period, the pump will not operate.

With a normal fuel vapor condition and assuming a high water level in the bilge compartment, the normally open switch **34**, which may be a float switch, will close to energize relay **24**, the relay in turn causing the normally open relay switch **24***a* to close. At this time, the pump **20** will operate and continue operation until the water level drops and switch **34** opens.

From the above, it is seen that I conveniently monitor various dangerous conditions in the bilge compartment and provide means in the form of a blower and pump which restore a safe operating condition.

So that the operator will have knowledge of these monitored conditions, I provide for both visual and audible indications, the former being afforded by a series of lights that are conveniently located on the auxiliary panel board in the boat's cockpit.

Upon energization of relays **22** and **24** due to the closure of switches **16***a* and **34**, respectively, the normally open relay switches **22***c* and **24***b* will close to provide a closed path between lines **L1** and **L2**, and the resultant sounding of the buzzer **30**. Simultaneously therewith, the lights **26** and **36**, in parallel with the relays, will glow. Therefore, by means of the lights and buzzer the operator will be provided with information of the dangerous condition being monitored. After being aware of the monitored condition, the buzzer may be eliminated from the circuit by opening the silence switch **32** and/or **38** as the case may be. This will in no way affect the visual indication provided by the lights **26** and **38** as these lights will glow as long as their associated relay is energized.

The operation of blower **18** is at all times indicated by light **28** in parallel therewith and this light, after the ignition switch **40** is closed with switch **14** in the automatic position, will go out, during normal conditions, to indicate the end of the delay cycle and that the motor may be started.

Circuit operation after closing the ignition switch

With the master switch **10** remaining in the closed position, the ignition switch **40** may be closed to thereby provide power along the extent of line **L1**. The ignition switch is in the form of a pair of switches that are ganged together with one switch of the pair closing the circuit path from buzzer **30** to relay switches **56***a* and **60***a* so that an audible signal, to be brought out later, may be provided.

When the ignition switch is closed, the delay cycle as provided by time delay relay **42** will commence. During the delay period, which in the preferred embodiment is of a five minute duration, the engine cannot be started since relay switch **42***b* in series with the starter button **48** remains in the normally open condition. Further associated with the time delay relay is the relay switch **42***a* which is in series with the blower **18**, when switch **14** is located for automatic operation. Therefore, when switch **14** is in the automatic position, the time delay relay **42** provides for the operation of the blower to clear any fuel

vapor accumulation from the bilge compartment prior to the starting of the engine.

At the termination of the delay period, assuming a normal condition to exist, i.e., normal fuel vapor concentration present, the blower will cease its operation and the engine may be started since the relay switches **42***a* and **42***b* will open and close, respectively. This condition will be indicated by the blower operating light **28** going out and simultaneously therewith, the running light **44** will go on. At this time, the engine ignition **46** is energized and the starter button **48** may be depressed, energizing the starter relay **50** and starting the motor (not shown).

If at the end of the delay period, a normal condition does not exist, the relay switches **42***a* and **42***b* will nevertheless open and close, respectively, but the blower will continue operation through line C–C′, since relay **22** will be energized and the normally open relay switch **22***b* will be closed. Therefore, the blower operating light **28** will remain on, the normally closed relay switch **22***d* will be open and the starter circuit will be maintained in the open condition.

Once the motor has been started and during the subsequent operation, it is possible that fuel vapor of such concentration that will be monitored may gather in the bilge compartment. If such occurs, this vapor will be monitored by detector **16** with the result, relay **22** will again be energized, causing among other things, operation of the blower through the closed relay switch **22***b* and a shut down of the engine since the starter circuit will open upon the opening of relay switch **22***d*. The occurrence of a shut down during an emergency situation may be disastrous and therefore I provide a second starter switch **52** in parallel with and effectively by-passing the protective features of the circuit (relay switches **22***d* and **42***b*), whereby the engine may be started immediately.

Since it is obviously not good practice to start the engine while there is a dangerous fuel vapor concentration present and since fuel vapor tends to gather during operation, it may be desirable to locate the switch **14** in the manual position after the delay cycle has run and the engine has been started. In this manual position, as brought out above, the blower **18** is continuously operative and therefore continuously clearing the bilge compartment of fuel vapor, with the desired result that little or no vapor will accumulate.

As should be apparent, the bilge water level is continually being monitored during operation and as mentioned above, the pump will relieve an accumulation except during periods when vapor is sensed and relay **22** operative.

Up to this point, the description of my protective circuit has been limited to a discussion of the circuit's operation under abnormal conditions created by either a high fuel vapor concentration or a high water level in the bilge compartment of the boat. From the following, it will be seen that my circuit is also capable of monitoring additional operating conditions after the engine is started and these are brought out below.

Responsive to a low lubricating oil pressure, I provide a pressure switch **54** located in line L–P′. The switch may take any form, as for example, a conventional vacuum operated switch which, under normal conditions, when the engine of the boat is at an operating speed, will be in the open condition. During periods in which the pressure is low, when the ignition switch is initially closed, the switch will be closed to thereby energize the coils of the oil pressure relay **56**. When the relay is energized, the light **62** in parallel therewith will glow, indicating to the operator, a low pressure condition. The operator is further apprised of this low pressure by the sounding of buzzer **30**. The buzzer sounds upon the closing of relay switch **56***a* in line G–T′, which switch is controlled by the relay **56**.

Since the relay **56** will be energized and switch **56***a* closed immediately after closure of the ignition switch **40** and remain energized for the period it takes for the engine to attain an operating speed, the sounding of the buzzer **30** will perform an additional function, i.e., to discourage tampering or theft of the boat.

In line M–Q′, I provide a high temperature sensor **58** which may be a switch in the form of a bimetal and a contact, for example. The switch is to be normally open when the temperature of the fluid in the cooling system is within the permissible range. The switch, being subjected to a dangerously high cooling temperature, will close to energize the coil of high temperature relay **60** and close the normally open relay switch **60***a*. The existence of this high temperature will be indicated by light **64** in parallel with relay **60** and buzzer **30** which sounds upon the closure of switch **60***a*.

The audible indication provided upon the closure of switch **56***a* and/or **60***a* may be eliminated by opening the silence switches **66** and/or **68** in series therewith, as discussed in connection with switch **32**, etc. Similarly, the opening of switches **66** and **68** will in no way affect the operation of light **62** and **64**, which will glow during the period their associated relays are energized.

My protective system further includes a generator charge regulator **70** in series with a light **72** which indicates a discharge of the electrical power source. Preferably, this regulator is to be independent of the buzzer **30** for the regulator is normally operative during maneuvering operations at slow speeds, as would be apparent to the operator.

It should be understood that visual "idiot light" alarms have, for some time, been used in automotive applications in lieu of pressure and temperature gauges and therefore, novelty resides with regard to the concept that the above visual alarms, indicating off limit conditions, are centralized on a common control panel with the other features of the system.

From the foregoing description, it should be apparent that I have provided a relatively simple protective circuit. The circuit functions in a manner to both initiate the operation of various components to eliminate certain faults and in all cases, provides an indication of the faults as may arise during the starting of the power boat and subsequent operation. The indications are provided by both visual and audible means so that the occurrence of any fault will not go unnoticed.

In broad terms, the circuit comprises a blower which is operative during the delay cycle of a time delay relay and further, during periods when the detector is sensing a dangerously high concentration of fuel vapor. In conjunction with the vapor detector is a relay which, with such high cencentration being sensed, maintains the engine ignition circuit in an open state. The engine ignition circuit is further maintained in the open condition during the delay cycle by the incorporation of a second relay switch. Therefore, by means of the vapor detector and time delay relay, I provide a system which automatically controls the starting time of the engine and prevents operation unless normal conditions prevail.

Having fully described my invention, it is to be understood that the form as shown and described is to be taken as the preferred example. It is also to be understood that the components which have been described above are well-known in the art as is their structure and operation. Therefore, this invention is not directed to any one component per se, but rather to the combination of such components in a protective circuit to provide a new and unobvious result. Obviously, various changes in the circuit may be resorted to without departing from the spirit of my invention as defined by the scope of the annexed claims.

I claim:

1. A protective circuit for use with power boats of the type having a bilge compartment and an engine which

comprises: a starting circuit which includes an electrical source of energy and a starter switch for starting the engine of the power boat, said starter switch connected to said source in series relationship by electrical circuit means, an ignition circuit for said engine including an ignition switch, a time delay relay having a predetermined time delay cycle, said time delay relay connected in series with said ignition switch so that upon closing the ignition switch the relay will become energized and commence the delay cycle for maintaining the starting circuit in an open condition so as to delay the operation of the engine until the termination of said cycle, and a blower for clearing the bilge of any accumulated fuel vapor concentration, said blower having a first circuit controlled by said time delay relay so that the blower will operate during the delay cycle, a detection circuit including a gas detector for sensing gaseous fuel vapor concentration, a pump, and means responsive to said gas detector during a period when the detector is sensing a dangerous fuel vapor concentration for causing the blower to operate through a second blower circuit, maintaining said starting circuit in an open condition and preventing the pump from operating, and said electrical circuit means connecting said detection and ignition circuits to said source.

2. A protective system for use with a power boat of the type having a bilge compartment, an engine and a starting circuit for the engine including a source of electrical energy and an engine starter switch connected in series relationship, said protective system comprising: an ignition switch, a time delay relay having a predetermined time delay cycle connected in series relationship with said ignition switch, said time delay relay being energized upon the closing of said ignition switch to commence the time delay cycle for maintaining the starting circuit in an open condition during said delay cycle, a blower for evacuating the bilge compartment of any dangerous concentration of gaseous fuel vapor, said blower having a circuit controlled by said time delay relay so that during operation of said relay the blower circuit will be closed and the blower will operate during said predetermined delay cycle, a fuel vapor detector for detecting a gaseous fuel vapor in the bilge compartment, means responsive to said detector during a period when the detector is sensing gaseous vapor of a dangerous concentration for maintaining the starting circuit in an open condition, said blower having a second circuit controlled by said responisve means so that during said period the blower will be operated to relieve the bilge of said dangerous concentration, and a pump for discharging an excessive accumulation of liquid from the bilge compartment, said pump being electrically connected to said responsive means so that said pump will be inoperative during said period.

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