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[54] **RADIO-CONTROLLED REMOTE ENGINE
STARTING APPARATUS**
8 Claims, 2 Drawing Figs.

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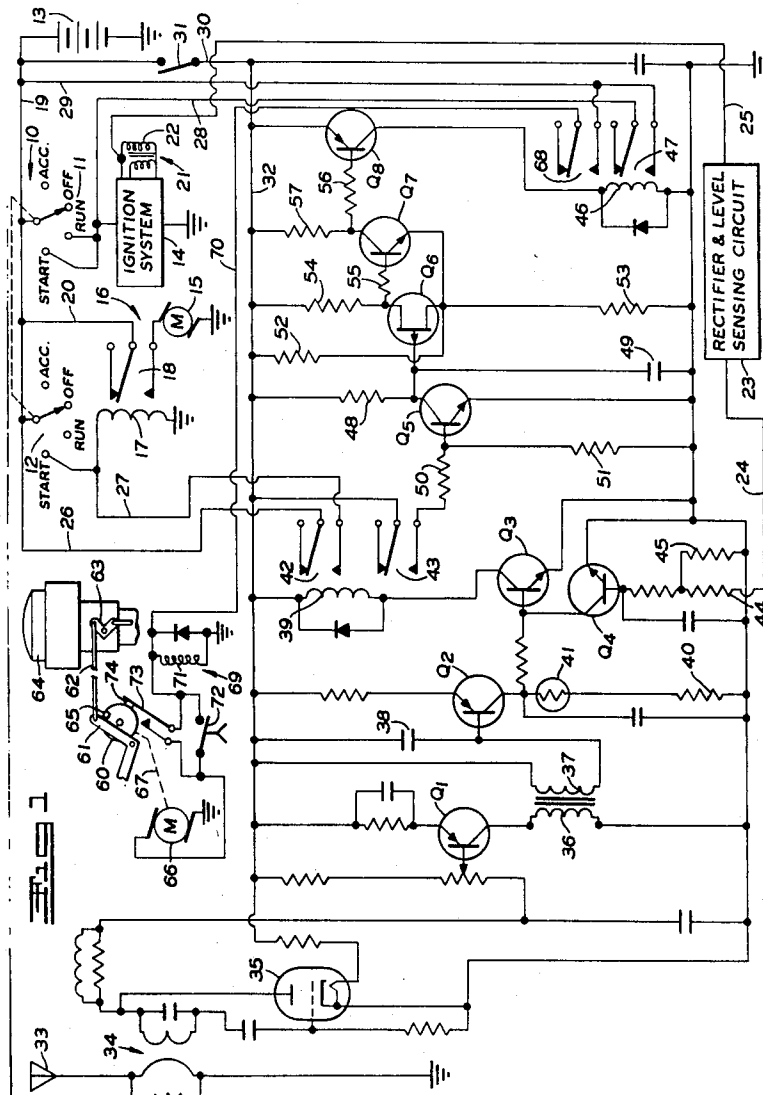
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179B, 179G; 290/38

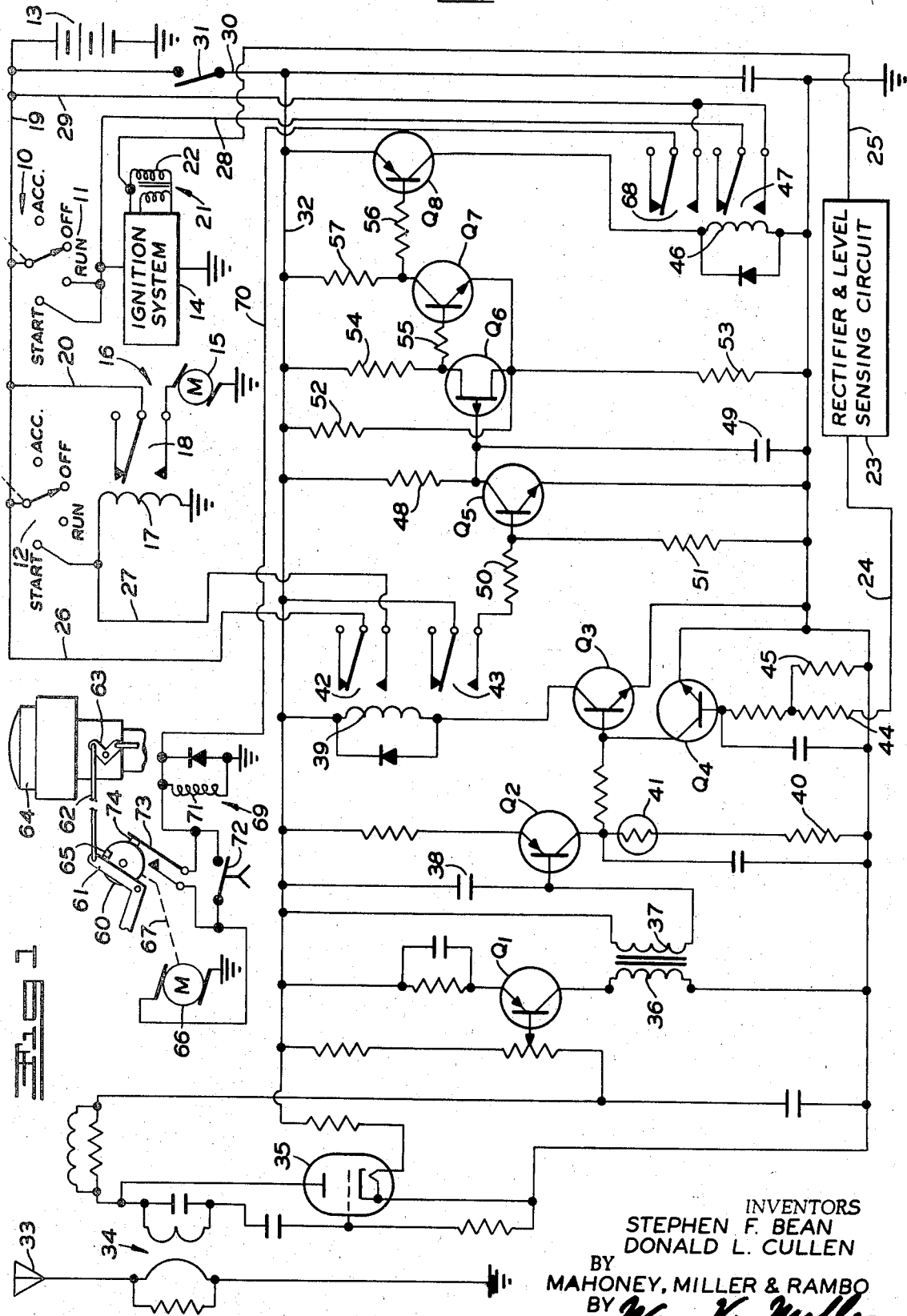
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ABSTRACT: Remote starting of an automobile engine is accomplished by remote radio control apparatus which includes an operator-actuated switch controlled RF transmitter and a tuned receiver which energizes the starter and ignition system in response to a transmitted signal. The transmitter emits an RF carrier signal which may be in the frequency range of 200–300 MHz, or the 27 MHz. Citizen's Band and which is modulated by a low frequency signal in the range of 10–20 kHz. with the RF carrier and low frequency signals selected to provide a combination peculiar to a specific transmitter-receiver combination. The receiver includes an RF section tuned to the preselected RF carrier which rejects all other carrier signals and a low frequency detector section which is tuned to the specific low frequency signal and thus provides an output signal in response to receipt of the specific frequency-combination signal. This signal activates first and second relay circuits for energization of the engine starter and ignition system, respectively. Both relay circuits are connected to bypass the conventional key-lock type ignition switch; however, the second relay circuit incorporates an electronic time delay which disables the circuit after a predetermined time interval and disconnects the ignition system thereby stopping the engine unless the key has been utilized in the interim to operate the ignition lock. The first relay circuit is interconnected with the vehicle's electrical generator circuit and, in response to detection of engine operation by presence of a generated voltage, prevents further activation of the starter relay circuit.





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Sheet 2 of 2

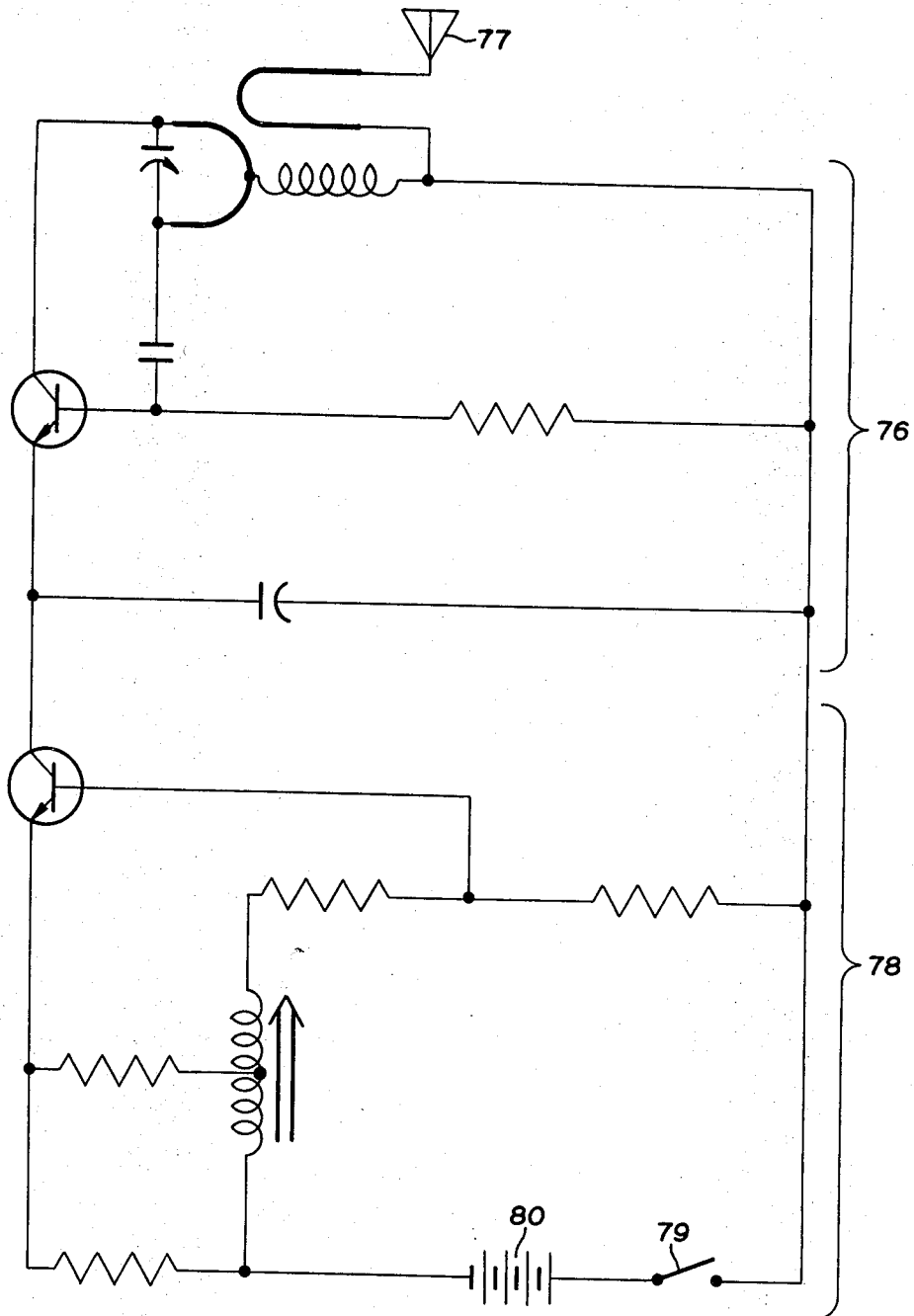


Fig. 2

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RADIO-CONTROLLED REMOTE ENGINE STARTING APPARATUS

The apparatus embodying this invention provides convenient, remote controlled starting of an internal combustion engine and is readily installed on commercially available engines without modification of the basic engine structure or auxiliary components. A primary example of an application is in connection with automotive vehicles where it is desirable to start the vehicle's engine and thus make the heating and air conditioning equipment operational by the time the vehicle operator arrives at the vehicle. The apparatus includes a portable radio transmitter effecting starting and operation of the engine through radio-receiver-controlled switch circuits connected with the engine ignition system and starting motor circuits. These switching circuits are connected in shunt relationship to the conventional key-lock type ignition lock of an automotive engine and perform similar functions in energization of the starting motor circuit and the ignition system in response to receipt of a radio signal wave having a selected frequency characteristic. The radio signal wave preferably comprises a low-frequency modulated RF carrier wave with the modulation and carrier wave frequencies selected on the basis of providing a specific frequency characteristic which will not likely be subject to interference and thus avoid the possibility of erroneous engine starting. A radio transmitter emitting the particular frequency characteristic for a specific apparatus is also provided and would normally be of a construction facilitating portability as it may often be carried by the operator in the case of an automotive vehicle and thus permits remote starting within the transmitter range capability.

In accordance with this invention, the switch circuits are designed to limit the time of operation of the engine after accomplishment of a remote start to avoid inadvertently long periods of operation should the operator fail to actuate the key-lock ignition switch within a predetermined time interval. This feature is particularly advantageous as a deterrent to unauthorized operation of the vehicle and prevents prolonged operation should the operator be inadvertently detained or should the apparatus be operated inadvertently. In addition to limiting operating time subsequent to effecting a remote start without manual operation of the key lock, the switch circuits are designed to prevent inadvertent initiation of subsequent starting operations once the engine has been started by remote control. This function is accomplished by an inhibit circuit interconnected with the switch circuits and capable of detecting continued operation of the engine to prevent a subsequent received radio signal from being effective in activating the switch circuits.

These and other objects and advantages of this invention will be readily apparent from the following detailed description of an embodiment thereof and the accompanying drawings.

In the drawings:

FIG. 1 is a schematic diagram of the electrical circuit of a radio receiver and the switch circuits embodying this invention;

FIG. 2 is a schematic diagram of the electrical circuit of a radio transmitter for the remote starting apparatus of FIG. 1.

Having reference to FIG. 1, a schematic of an electrical circuit embodying this invention is shown connected with components of the electrical system of an automotive vehicle for illustration of its utilization. These components are only diagrammatically shown as this type of electrical system and the component structure are well known and a detailed disclosure is not essential to an understanding of this invention. Included in the vehicle's electrical system is an ignition switch 10 of the key-lock type having two multiple-position switch sections 11 and 12 with respective movable contacts that are mechanically interconnected for simultaneous operation. Both movable contacts are connected in the vehicle's electrical system to receive electrical power which during the engine starting phase is provided by a storage battery 13. After the engine

starts, electrical power will be provided by the conventional vehicle's generating system (not shown) which includes a generator and associated control system. Connected to one switch section 11 is the ignition system 14 which includes the sparking devices for the engine. The ignition system 14 also includes a conventional ignition coil 21 having a high voltage secondary winding 22. Included in the starting motor circuit of the electrical system is a conventional starting motor 15, which is mechanically coupled with an engine (not shown) through the conventional automatic disengaging gear mechanism (not shown), which is energized through a solenoid switch 16. This solenoid switch comprises a solenoid coil 17 and a set of normally open contacts 18 which are connected in series circuit with the starting motor 15 and the battery 13 through suitable electrical conductors illustratively designated as 19 and 20. The coil 17 is connected to a contact of one switch section 12 and, when energized through operation of the ignition switch 10, closes the contacts 18 resulting in energization of the starting motor 15 and cranking of the engine.

In the normal operation of the conventional electrical system components just described, the key is inserted in the ignition switch 10 and operated to initially displace the movable contacts of the two sections 11 and 12 from the "OFF" position to the "START" position thereby simultaneously energizing the ignition system 14 and the solenoid coil 17. Energization of coil 17 causes contacts 18 to close thus energizing starting motor 15 resulting in cranking of the engine. When the engine has started the ignition switch 10 is turned to the "ON" position and the engine will then continue to operate until placed in the "OFF" position.

The apparatus of this invention is designed to be connected in circuit with the starting motor circuit and the ignition system to effect energization thereof with the ignition switch 10 in the "OFF" position. When so connected, the apparatus bypasses the ignition switch and is operative to energize the starting motor 15 and the ignition system through connection with appropriate terminals of the engine components through interconnecting pairs of conductors 26, 27 and 28, 29. Conductors 26 and 29 are connected to the electrical power source battery 13 through conductor 19 with conductor 27 connected to the solenoid coil 17 and conductor 28 connected to the ignition system 14. Both pairs of conductors are connected with respective switch contacts that are selectively operable to complete the necessary electrical circuits. These connection terminals are easily identified in most automotive vehicles thereby facilitating installation of the apparatus. In addition to the connections previously discussed, the ignition system 14 is connected with the apparatus to provide a voltage signal and the apparatus is also connected to the battery 13 through a conductor 30. The present embodiment of the apparatus is designed to operate on the 12 volt d.c. system conventionally available in automotive vehicles. A disconnect switch 31 may be interposed in this conductor to disable the apparatus. For purposes of the following detailed description of the apparatus, it will be assumed that switch 31 is closed and electrical power of appropriate voltage is applied to the main power bus 32. Although not otherwise described, suitable return ground connections or conductors are provided as necessary to complete the various electrical circuits.

The apparatus comprises a radio receiver which controls the functioning of two switch circuits in response to receipt of a radiated signal having the desired frequency characteristics which is an RF carrier wave modulated by a relatively low-frequency amplitude signal. The carrier wave may advantageously be in the 200-300 mHz. range or 27 mHz. Citizen's Band while the low-frequency signal is in the 10-20 kHz. range with this carrier band authorized by the FCC for the intended purpose. The illustrated radio receiver designed for the 200-300 mHz. range and which may be of the super-regenerative type, includes a tuned frequency RF stage and a low-frequency detector stage driven by the RF stage and providing an output signal for control of the switch circuits.

Forming the RF stage is an antenna 33 coupled by an inductor 34 to the control grid of an RF amplifier tube 35 with the grid circuit and inductor having component values selected to provide a tuned circuit which effectively rejects all radio wave signals of frequencies other than the specifically selected frequency. The plate output of the tube 35 is fed to the base biasing circuit of a transistor Q_1 in a low-frequency amplifier stage. The collector of transistor Q_1 is connected in series with the primary winding 36 of a low-frequency inductor. The secondary winding 37 is connected in series circuit with a capacitor 38 thus forming a tuned circuit with a design resonant frequency of the selected low-frequency modulation signal.

Detection of a modulation signal of the selected low-frequency produces an output signal in the tuned inductor 37 and capacitor 38 circuit which forms the base biasing circuit of a driver transistor Q_2 in a first switch circuit. Transistor Q_2 is normally cut off and the collector which is connected to the base of a switching transistor Q_3 will be substantially at ground potential. This maintains transistor Q_3 in a cut-off state. Transistor Q_3 is connected in series with a relay coil 39 and when in a conducting state completes a circuit for energization of the coil. Application of an output signal to the base of transistor Q_2 switches this transistor to a conductive state and current flowing through the collector resistor circuit including the resistors 40 and 41 provides a forward bias which triggers transistor Q_3 to a conductive state and energizes relay coil 39.

Relay coil 39 is associated with two normally open contacts 42 and 43 and, when energized, maintains these contacts closed. Contact 42 is connected in circuit with the pair of conductors 26, 27 and, when closed, completes a circuit for energization of the starting motor circuit as previously described. Consequently, a radio signal of the desired frequency characteristic received at the antenna 33 of the radio receiver results in operation of the switch circuit and closing of the contacts 42 for energization of the starting motor 15.

An inhibit circuit is provided to prevent recurrent operation of the switch circuits and comprises a transistor Q_4 connected in the base circuit of switching transistor Q_3 . The collector of transistor Q_4 is connected to the base of transistor Q_3 while the emitter is connected into the ground circuit and thus forms an alternate base bias circuit in parallel with the resistors 40 and 41. A base biasing circuit for transistor Q_4 includes the voltage divider network comprising series-connected resistors 44 and 45 which are connected to receive the voltage signal provided by the ignition system 14. A rectifier and level sensing circuit 23 connected in circuit with the ignition system 14 provides the voltage signal at conductor 24 connected to resistor 44. This circuit 23 connected by a conductor 25 to the secondary winding 22 of the ignition coil 21, detects the voltage pulses and through voltage level-sensing and integrating circuits of well known design produces a voltage signal which is proportionate to the operating speed of the engine. With the base of transistor Q_4 connected to the midpoint of the series-connected resistors 44 and 45, a voltage signal produced by the ignition system 14 through the circuit 23 and exceeding a minimum value attained at about engine idle speed will forward bias the normally cut-off transistor Q_4 to a conducting state and effectively ground the base of transistor Q_3 to a conducting state and effectively ground the base of transistor Q_3 , thereby switching this transistor to a non-conducting state. Transistor Q_3 will thus be switched to and maintained in a non-conductive state irrespective of the operating state of transistor Q_2 thereby deenergizing relay coil 39 and returning the contacts 42 and 43 to an open configuration. Maintaining contact 42 open prevents further energization of starting motor 15 and this condition will be maintained for as long as the ignition system 14 is operating as a consequence of operation of the vehicle engine and subsequently received radio-signals of the particular frequency characteristic will be ineffective. Thus, the length of time for which the radio-signal exists is immaterial as the apparatus will become ineffective for a starting operation as soon as the engine starts and drives the

alternator to produce an output voltage.

Simultaneously with energization of relay coil 39, a second switch circuit is energized through activation of a second switch element comprising the switch contacts 43. One terminal of switch contact 43 is connected to the positive voltage bus of the apparatus and supplies electrical power to the second switch circuit through interconnection with the battery 13 when the second switch element is closed. Closing of switch element 43 initially results in energization of a second relay coil 46 controlling operation of a third switch element comprising the normally open contacts 47. Energization of coil 46 causes contacts 47 to close and complete a circuit through the interconnected conductors 28 and 29 from the battery 13 to the ignition system 14 thus bypassing section 11 of the ignition switch thereby enabling operation of the vehicle engine. Closing of contacts 47 occurs concurrently with closing of contacts 43 due to the simultaneous closing of contacts 43 and the starting motor 15 and ignition system 14 will be concurrently energized for effecting an engine starting operation.

Starting of the engine as signaled by generation of a voltage at the output conductor 24 results in functioning of the inhibit circuit which, through transistor Q_4 , returns transistor Q_3 to an "OFF" or non-conducting state thus deenergizing relay coil 39 and opening contacts 42 and 43. Opening of contacts 42 deenergizes the starting motor circuit; however, opening of contacts 43 does not immediately result in deenergization of relay coil 46 and opening of contacts 47 with consequent deenergization of the ignition system 14 due to timing means incorporated in the second switch circuit. This timing means is designed to delay deenergization of relay coil 46 and the interconnected ignition system 14 for a period of time deemed adequate for the vehicle operator to reach the vehicle and utilize the manual key-lock type ignition switch 11 and bypass the remote starting apparatus.

Forming this timing means is the circuit comprising the transistor Q_5 and the timing network including the series connected resistor 48 and capacitor 49. The timing circuit controls energization of relay coil 46 through a switching circuit comprising the transistors Q_6 , Q_7 and Q_8 . In the quiescent state, with switch contacts 43 open, transistors Q_5 and Q_8 are biased to an off or non-conducting state and the relay coil 46 which is connected in series with transistor Q_8 will remain deenergized. Closing of switch contact 43 results in forward biasing of the emitter-base junction of transistor Q_5 through the biasing network comprising the series resistors 50 and 51 forming a voltage divider with the base terminal of transistor Q_5 connected to their common junction. With transistor Q_5 cut off, capacitor 49 is charged through resistor 48 to the system voltage at a rate determined by the component values of this R-C timing circuit. Switching of transistor Q_5 to a conductive state in response to closing of switch contacts 43 results in discharge of capacitor 49 and effectively dropping of the collector terminal voltage of transistor Q_5 to zero. Capacitor 49 will remain in this discharged condition as long as switch contact 43 remains closed.

Transistor Q_6 of the switching circuit is a field-effect transistor having its gating terminal connected to the common junction of resistor 48 and capacitor 49 with the source and drain terminals connected in a biasing network for transistor Q_7 . This biasing network includes the series-connected resistors 52 and 53 forming a voltage divider with the emitter terminal of transistor Q_7 connected to the common junction of resistors 52 and 53. A resistor 54 is connected in series with transistor Q_6 and this series circuit is connected in shunt relationship with resistor 52 with the base of transistor Q_7 connected to the common junction through a resistor 55 with the field-effect transistor thus controlling the emitter-base bias of transistor Q_7 . When transistor Q_6 is in a conductive state, the emitter-base junction of transistor Q_7 is reverse biased and Q_7 will be in a non-conductive state but when Q_6 becomes non-conductive the emitter-base junction of Q_7 will become forward biased and Q_7 will be switched to a conductive state. The

base of transistor Q_8 is connected through a resistor 56 to the collector terminal of transistor Q_7 which is also connected to the positive voltage bus through a resistor 57 and Q_7 thus controls the emitter-base junction bias of Q_8 . When transistor Q_7 is non-conductive, Q_8 will also be non-conductive but will be switched to a conductive state when Q_7 becomes conductive and thus energize the relay coil 46.

In the normal quiescent state of the second switch circuit with contacts 43 open, transistor Q_3 is non-conductive permitting capacitor 49 to charge to the system voltage and maintain the field-effect transistor Q_6 in a conductive state. With Q_6 conducting, transistor Q_7 will be biased to a non-conducting state and transistor Q_8 will be cut off. In this state, relay coil 46 will be deenergized as will the ignition system since contacts 47 will be open. Closing of contacts 43 results in forward biasing of the emitter-base junction of transistor Q_3 which will now switch to a conductive state and discharge capacitor 49 to a point where the field-effect transistor Q_6 will become non-conducting resulting in forward biasing of the emitter-base junction of transistor Q_7 . Transistor Q_7 thus becomes conductive and switches transistor Q_8 to a conductive state resulting in energization of relay coil 46 with consequent closing of contacts 47 and energization of the ignition system 14. Energization of the ignition system 14 occurs substantially simultaneously with closing of contacts 43 and energization of the starting motor circuit through closing of contacts 42. The second switching circuit will remain in this state with Q_8 conducting as long as contacts 43 remain closed due to receipt of an appropriate RF signal by the apparatus resulting in energization of relay coil 39.

Opening of contacts 43 along with contacts 42 due to deenergization of relay coil 39 which occurs when the appropriate RF signal is no longer received, does not immediately result in switching of transistor Q_8 to a non-conductive state due to operation of the timing circuit. Opening of contacts 43 immediately returns transistor Q_3 to a non-conducting state but the field-effect transistor Q_6 does not immediately return to a conductive state due to the time required for capacitor 49 to charge to a predetermined minimum voltage. This time delay is determined by the component value of resistor 48 and capacitor 49 with these values selected to provide an 8—10 minute delay in a preferred embodiment of the apparatus before transistor Q_6 returns to a conductive state and thus cuts off transistor Q_7 and switches transistor Q_8 to a non-conductive state resulting in deenergization of relay coil 46 and consequent deenergization of the ignition system 14. This time interval is deemed adequate for operation of the vehicle to provide the desired warm up and either heating or cooling and for the operator to return to the vehicle and insert his key in the ignition switch 11 for manual operation thereof to continue normal vehicle engine operation. If this selected time interval should expire before the ignition switch 11 is thus manually actuated, the second switch circuit will be effective in deenergizing the ignition system 14 thus stopping the engine and preventing unnecessarily prolonged idle operation. This completes a detailed description of the basic form of the remote starting apparatus which is capable of starting a vehicle engine and maintaining operation of the engine for a predetermined time interval. This is accomplished by energization of the starting motor circuit simultaneously with the ignition system in bypass relationship to the conventional key-lock ignition switch.

While the apparatus described is fully effective for most vehicles that are in optimum operating condition, there are instances and certain types of engines which require initial or concurrent actuation of the carburetor mechanism to effect engine starting. This is manually accomplished through actuation of the accelerator linkage which concurrently sets the automatic choke and idle advance and actuates the fuel boost pump. In a preferred form of the apparatus of this invention as disclosed in FIG. 1 of the drawings, a mechanical mechanism for actuating the accelerator linkage is also provided and includes a cam wheel 60 which is mounted to operatively engage

a pivoted lever arm 61 of the accelerator linkage which is diagrammatically illustrated. A motion transmitting link 62 connects a free end of the arm 61 with the actuating mechanism 63 on a carburetor 64. The cam wheel 60 is provided with a lug 65 engageable with lever arm 61 to effect pivoting of the arm as a consequence of rotation of the cam wheel. Rotation of the cam wheel 60 is effected by an electric motor 66 drivingly connected to the wheel through a suitable mechanical linkage 67 which may include a gear reduction unit (not shown) to obtain the desired cam wheel speed. Electrical power for operation of the motor 66 is supplied by the battery 13 through a set of normally open switch contacts 68 which are controlled by the relay coil 46 and a control circuit 69 connected by the interconnecting conductor 70. This control circuit includes an operating coil 71 of a time-delay relay and its normally open contact 72 and normally closed contacts 73 of a cam actuated switch. The contacts 72 and 73 are connected in parallel to each other and in series with the motor 66. This relay is of a type which immediately closes the contact 72 upon energization of the coil 71 with this contact again opening after expiration of a predetermined time interval after energization of the coil 71. Contact 72 is connected in series with the motor 66 which is thus energized. Contacts 73 are actuated by a lug 74 mounted on the cam wheel 60 and will close a short time after the cam wheel begins to rotate and before the relay contact 72 opens, thus maintaining operation of the motor 66. When the cam wheel 60 completes one revolution, the lug 74 opens the contacts 73 resulting in deenergization of the motor 66 thus preventing more than one actuation of the accelerator linkage during a time interval determined by the second switching circuit with the operation of this mechanism being initiated by closing of the relay contacts 68 concurrently with contacts 47 upon energization of relay coil 46. Limitation of this mechanism to only one accelerator actuation is necessary to prevent flooding of the engine which could result from multiple operation of the fuel boost pump in the carburetor.

Operation of the remote starting apparatus is initiated upon receipt of an RF signal modulated by a low-frequency signal having a specific composite frequency characteristic. Such a signal in the 200—300 mHz. range may be provided by a radio transmitter such as is illustrated in FIG. 2 and is designed to match the specific frequency characteristic of the receiver of a particular starting apparatus. This transmitter is of relatively low power to limit its effective operating range and thus avoid interference with other electronic equipment and comprises a carrier frequency oscillator section 76 coupled to a transmitting antenna 77 and a low-frequency oscillator section 78 which is coupled to amplitude modulate the RF carrier wave. A single operate-transmit switch 79 connects a battery 80 to both oscillators and thereby provides the necessary power for operation and emission of the RF signal. Construction and operation of such a transmitter is well known and is, therefore, not further described other than to note that a transistorized design is utilized to minimize electrical power requirements.

It will be readily apparent from the foregoing detailed description that a novel remote starting apparatus for vehicle engines is provided by this invention. This apparatus enables remote starting of an engine and incorporates an automatic shut-off feature which prevents unnecessarily prolonged operation after starting if the operator fails to return to the vehicle and mechanically actuate the ignition switch. The apparatus is of simple, rugged construction with low electrical power requirements.

According to the provisions of the patent statutes, the principles of this invention have been explained and have been illustrated and described in what is now considered to represent the best embodiment. However, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. A remote-controlled starting apparatus for an internal

combustion engine provided with an ignition system including a manually operated ignition switch and a starting motor circuit including a manually operated actuating switch which apparatus comprises:

- A. a radio receiver tuned to receive and detect a radiated wave signal of preselected frequency characteristic and form an output signal in response to said radiated signal;
- B. a first switch circuit connected to said radio receiver to receive said output signal and including first and second normally-open switch elements activated to a closed configuration upon receipt of said output signal, said first switch element connectable in the starting motor circuit in shunt relationship to the actuating switch for energization of the starting motor circuit when said first switch element is closed; and
- C. a second switch circuit connected to said second switch element and energized when said second switch element is closed, said second switch circuit including:
 1. a third normally-open switch element activated to a closed configuration when said second switch element is closed and connectable in the ignition system in shunt relationship to the ignition switch for energization of the ignition system when said third switch element is closed; and
 2. timing means interposed therein for controlling activation of said third switch element, said timing means normally permitting activation of said third switch element and deactivating said third switch element a predetermined time after deactivation of said second switch element to an open configuration.
2. A remote-controlled starting apparatus according to claim 1 wherein said radio receiver is responsive to a radiated wave signal comprising a relatively high frequency carrier wave modulated by a relatively low frequency modulation signal.
3. A remote-controlled starting apparatus according to claim 2 wherein said radio receiver includes a tuned RF section responsive only to a specific carrier wave and a tuned low frequency detector section responsive only to a specific modulation signal thereby providing an output signal only in

response to a specific composite radiated wave signal.

4. A remote-controlled starting apparatus according to claim 1 wherein said first switch circuit includes an inhibit circuit interconnected therein to prevent normal activation of said first and second switch elements in response to said output signal, said inhibit circuit responsive to a minimum voltage signal in performing its inhibit function and connectable with the ignition system to receive the voltage signal therefrom when the engine is operating above a minimum speed.
5. A remote-controlled starting apparatus according to claim 1 wherein said first switch circuit includes a relay solenoid coil energizable in response to receipt of said output signal and said first and second switch elements are respective normally open contacts which are closed by energization of said coil.
6. A remote-controlled starting apparatus according to claim 1 wherein said second switch circuit includes a relay solenoid coil energizable in response to closing of said second switch element and said third switch element comprises a normally open contact closed by energization of said relay coil of said second switch circuit.
7. A remote-controlled starting apparatus for an internal combustion engine also provided with a carburetor having a manually actuated control mechanism according to claim 1 which includes a mechanical mechanism selectively engageable with the carburetor control mechanism for effecting actuation thereof and an electrical control system coupled with said mechanical mechanism and interconnected in said second switch circuit to effect operation of said mechanical mechanism concurrently with energization of said second switch circuit.
8. A remote controlled starting apparatus according to claim 7 wherein said mechanical mechanism includes an electric driving means and said electrical control system includes a fourth normally-open switch element activated to a closed configuration when said second switch element is closed for completing a circuit for energization of said electric driving means and a cyclic switch interposed in circuit with said electric driving means and being mechanically coupled with said mechanical mechanism to interrupt the circuit in response to a single cyclic operation thereof.

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