

(51) International Patent Classification:
F02N 15/00 (2006.01) *F02N 11/08* (2006.01)(21) International Application Number:
PCT/US2010/021690(22) International Filing Date:
22 January 2010 (22.01.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: KEYLESS-GO IGNITION SWITCH WITH FAULT BACKUP

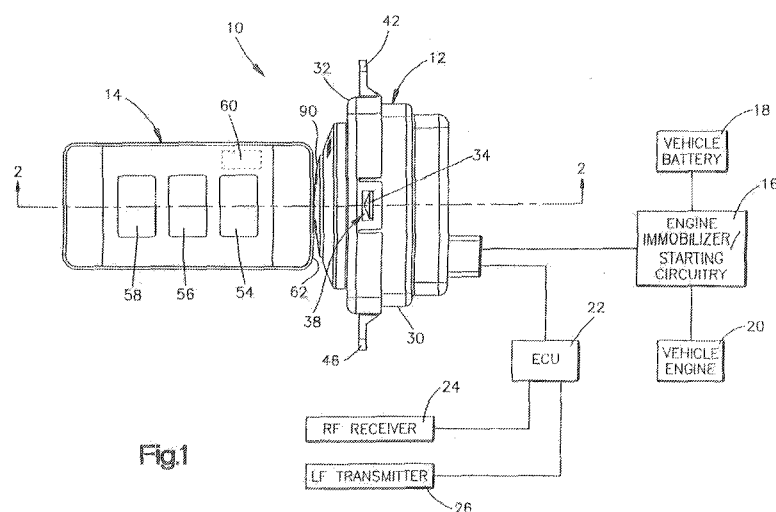


Fig.1

(57) Abstract: A vehicle ignition system includes a fob for transmitting an identification code. The fob includes a low frequency transceiver circuit and low frequency antenna. An ignition module is provided including, a housing, switch contacts and a push button slidably mounted in the housing and arranged so that pushing of said button closes said switch contacts. A LF coil is provided and is axial and stationary within the housing and is located inside of the push button. An ignition module circuit provides power to the fob and establishes low frequency communications with the fob via the LF coil. An immobilizer circuit is operatively coupled to the ignition module for permitting or preventing actuation of the ignition system in response to the low frequency Communications with the fob and the ignition module.

KEYLESS-GO IGNITION SWITCH WITH FAULT BACKUP**Related Application**

This application claims priority from U.S. Lumley et al. Patent Application Serial No. 12/361,839, filed January 29, 2009, the subject matter of which is
5 incorporated hereby incorporated by reference in its entirety.

Technical Field

The present invention relates to a vehicle ignition system and is particularly directed to a keyless-go ignition switch assembly having a fault backup capability.

Background

10 Vehicle ignition systems that use a unique, physical key to start the vehicle engine are well known in the art. Also, electrical key fobs for controlling locking and unlocking functions of the vehicle doors are known. Recently, vehicle keyless-go systems have been developed that include a fob carried by a vehicle operator. As the operator approaches the vehicle, the vehicle lock/unlocking
15 system detects the operator.

Authentication/identification between the vehicle system and fob carried by the operator is accomplished "hands-free", i.e., without the operator touching the fob. Once inside the vehicle, if the fob carried by the operator is the correct fob associated with that vehicle, the vehicle can be started with a simple push of a start
20 button, i.e., no form of a physical key need to be inserted into an ignition switch to get the vehicle ignition started. Thus, such systems have become known as, "keyless-go" ignition systems.

As part of the verification process between the keyless-go ignition assembly and the operator fob, the keyless-go assembly and the fob communicate via radio
25 signals to verify identification ("ID") codes. For example, the fob may send a coded ID signal via a radio signal to the keyless-go ignition assembly. The keyless-go ignition assembly will determine if the received ID code is a valid ID from a fob associated with that vehicle. If the ID code is a valid code, as determined via a comparison against a prestored code, the ignition assembly will
30 allow the vehicle engine to be started. If the received ID code is not valid, i.e., the

received code does not match the prestored code, the ignition assembly will not allow the vehicle engine to be started.

Summary of the Invention

5 In accordance with the present invention, a keyless-go ignition switch assembly having a fault backup capability is provided. An ignition module determines that the fob battery is dead and establishes short range LF/LF communications with the fob to both energize the fob and verify the fob so as to permit engine start.

10 In accordance with an example embodiment of the present invention a vehicle ignition system comprises fob including a low frequency transceiver and an ignition module including a low frequency transceiver. A control circuit associated with the ignition module is provided for activating the low frequency transceiver of the ignition module to transmit a low frequency energy signal to the fob to energize the fob. The fob low frequency transceiver, upon receiving the low frequency
15 energy signal from the low frequency transceiver of the ignition module, transmits a low frequency response signal. The control circuit includes a verification device to verify that the fob is a fob associated with that vehicle based on the low frequency response signal.

20 In accordance with another example embodiment of the present invention, a vehicle ignition system includes a fob for transmitting an identification code. The fob includes a low frequency transceiver circuit and low frequency antenna. An ignition module is provided including, a housing, switch contacts and a push button slidably mounted in the housing and arranged so that pushing of said button closes said switch contacts. A LF coil is provided and is axially stationary within
25 the housing and is located inside of the push button. An ignition module circuit provides power to the fob and establishes low frequency communications with the fob via the LF coil. An immobilizer circuit is operatively coupled to the ignition module for permitting or preventing actuation of the ignition system in response to the low frequency communications with the fob and the ignition module.

In accordance with another example embodiment of the present invention, a vehicle ignition module is provided comprising a fob having radio frequency transmitter and low frequency transceiver. The fob responds to a low frequency interrogation signal by transmitting a radio frequency response signal having a unique fob identification code and transmits a low frequency response signal when placed in proximity to low frequency signal source. An ignition module is provided including a radio frequency receiver, a low frequency transmitter, and a low frequency transceiver. The ignition module first generates a low frequency interrogation signal from the low frequency transmitter and monitors for a radio frequency response signal using the radio frequency receiver, and, if no radio frequency response signal is received by the radio frequency receiver, generates a low frequency interrogation signal from the low frequency transceiver and monitors for a low frequency response signal by the low frequency transceiver. The ignition module permits engine start if either a radio frequency response signal is received or a low frequency response signal is received.

Brief Description of the Drawings

The foregoing and other features and advantages of the present invention will become apparent to those skilled in the art to which the present invention relates upon reading the following description with reference to the accompanying drawings, in which:

Fig. 1 is a top plan view of a keyless-go ignition assembly and fob made in accordance with one example embodiment of the present invention;

Fig. 2 is a side elevational view of the keyless-go ignition assembly and fob (with certain detail missing) in section shown in Fig. 1 taken along lines 2-2;

Fig. 3A is a front view of the ignition module of Fig. 1; and

Figs. 3B and 3C are side sectional views of the ignition module of Fig. 3A taken along sectional lines 3B-3B and 3C-3C of Fig. 3A, respectively.

Detailed Description

Referring to Fig. 1, a keyless-go assembly 10 includes an ignition module 12 and an associated vehicle owner fob 14. The ignition module 12 is

operatively coupled to an engine immobilizer/starting circuitry 16 that is, in turn, operatively coupled between the vehicle battery 18 and the vehicle engine 20. When the ignition module 12 provides an engine start signal to the engine immobilizer/starting circuitry 16, the vehicle engine 20 can be started via the vehicle battery in the known manner. When the ignition module 12 provides a disable signal to the engine immobilizer/starting circuitry 16, the vehicle engine 20 cannot be started. As a default condition, the ignition module 12 provides the disable signal to the engine immobilizer/starting circuitry 16.

Also connected to the ignition module 12 is an electronic control unit ("ECU") 22, such as a microcontroller, that provides and controls wireless communications between the fob 14 and the ignition module 12 under "normal" operating circumstances, i.e., when the fob is operating under full, self-contained, battery power. The ECU 22 is controllably connected to a radio frequency ("RF") receiving circuit 24 located within the vehicle cabin for receiving RF transmitted signals from the fob 14. The RF receiving circuit could be included within the ECU 22. The ECU 22 is also controllably connected to a low frequency ("LF") transmitting circuit 26 that is located within the vehicle cabin such as in a central location of the vehicle cabin.

When activated, the LF transmitter 26 transmits an LF interrogation signal within the cabin area of the vehicle. A fob 14 located within the vehicle cabin will receive the interrogation signal and will respond by transmitting a RF response signal. The RF response signal is received by the RF receiver 24. The RF response signal transmitted by the fob 14 includes an identification code ("ID") of the fob 14. The ECU compares that received ID code against a predetermined ID code to determine if the fob 14 is the one associated with that vehicle. If it is, then vehicle starting is permitted. If not, vehicle starting would not be permitted.

The ignition module 12 includes a housing 30 and a front cover 32 arranged to snap fit onto the housing 30. The cover 32 snap fits onto the housing 30 visa-via raised tabs 34, 36 extending from opposite sides of the housing 30 that are received into and capture in openings 38, 40, respectively, of the cover 32, when the cover is placed onto the housing 30. All four sides of the housing 30 and cover 32 could

have the raised tabs and corresponding receiving openings to achieve a snap fit closure if desired. The cover 32 further includes mounting tabs 42, 44, and 46, for mounting and securing the ignition module 12 into the dash board (not shown) of a vehicle. Other types of mounting arrangements could, of course, be used such as
5 snap fitting, etc.

The fob 14 is carried by the vehicle operator. The fob 14 includes electronic circuitry 50 mounted on a printed circuit board ("PCB") 51 including a microcontroller 52 for controlling the fob's several functions. Those skilled in the art will appreciate that the control functions of the fob 14 could also be
10 accomplished using discrete circuitry or an application specific integrated circuit ("ASIC"). The fob 14 includes several buttons 54, 56, and 58 that a vehicle operator could use could to control vehicle convenience functions controlled by the fob 14 such as door locking/unlocking, etc.

Another function controlled by the fob is passive control of the vehicle's
15 ignition system. Passive control of the vehicle's ignition system is a semi-automatic function. When the vehicle operator is inside of the vehicle cabin and the operator pushes the ignition module to start the vehicle, the LF interrogation signal is transmitted to detect if the correct fob 14 associated with that vehicle is present. This is done by monitoring for the RF signal received from
20 the RF receiver 24 and code verification. If there is verification, the vehicle ignition system starts the vehicle.

The fob 14 includes an LF antenna 60 located near one end 62 of the fob 14. Part of the electronic circuitry 50 of the fob 14 is arranged to receive the low frequency ("LF") interrogation signal and to determine if the LF interrogation
25 signal is being sent from its associated vehicle. The fob 14 includes an RF transmitter 53. When the fob 14 receives an LF interrogation signal from an associated vehicle, it responds by transmitting a radio frequency ("RF") response signal. All of the electronic circuitry of the fob 14 is powered by an internal battery 64.

30 If the internal battery 64 of the fob 14 is completely drained, i.e., dead, then the fob 14 cannot respond to the LF transmitted signal from the LF transmitter 26

and cannot provide an RF response signal to the RF receiver 24. In that case, the ignition module 12 would remain in the default condition of retaining the starting circuit immobilized.

5 In accordance with an example embodiment of the present invention, the ignition module 12 further includes a printed circuit board ("PCB") 70 mounted and secured against a detent portion 72 of the housing 30. The PCB 70 has mounted thereto electronic circuitry 74 for carrying out the functions of the ignition module 12. Those skilled in the art will appreciate that the control functions of the ignition module 12 could also be accomplished using discrete circuitry or an
10 application specific integrated circuit ("ASIC"). The ignition module 12 includes a LF antenna 80 mounted to the PCB 70 using, for example, three legs 82, 84, 86, that space the antenna away from the PCB 70. Electrical contact is made between the coil 80 and circuitry 74 via compliant pins 83, 85, 87.

The ignition module 12 further includes a start button 90 that is slidably
15 received axially within the housing 30 and cover 32. The cover 32 includes an opening 96 that permits a first portion 98 of the start button 90 to protrude through the opening so as to be accessible to the vehicle operator when the button 90 is not being pushed inward. The button 90 includes a second portion 100 that is stepped and has a diameter larger than the diameter of the opening 96 in the cover 32 so as
20 to retain the button 90 within the housing 12 at all times. A third portion 102 of the button 90 slidably engages surfaces within the housing 30 and cover 36 so as to axially slide when pushed. An elastomeric switch member 110 is mounted between the PCB 70 and the push button 90 to resiliently bias the button 90 toward and against the cover 32. The elastomeric switch member 110, in addition to
25 providing a bias force to the push button 90 includes switch contacts that are open when the button 90 is not pushed and closed when the button 90 is pushed inward. Therefore, the circuitry 74 can determine when the push button is activated by the vehicle operator by monitoring the elastomeric switch member 110.

The outer diameter 120 of the LF coil 80 is less than the inner diameter 122
30 of the push button 90. The axially length of the legs 82, 84, 86 are such that the

coil 80 is always located axially inside of the axially length of the push button 90 whether the push button is pressed or not.

A plurality of compliant pins 130 of a connector 132 provide a connection from the circuitry 74 on the PCB 70 to external circuitry such as the ECU 22 and the engine immobilizer/starting circuitry 16.

As mentioned, if the internal battery 64 of the fob 14 is completely drained, i.e., dead, then the fob 14 cannot respond to the LF transmitted signal from the LF transmitter 26 and cannot provide an RF response signal to the RF receiver 24. In accordance with an example embodiment of the present invention, the fob 14 is placed directly in contact with the ignition module 12 such that the side 62 contacts the push button 90. This places the LF antenna 60 inside the fob 14 closest to the ignition module. The vehicle operator then pushes the ignition module button 90 all the way in as if to start the vehicle with fob 14.

The ignition module, at first, does not "know" that is being pushed by the fob 14 as opposed to being pushed by a vehicle operator's finger. The ignition module attempts to locate a fob by transmitting a LF interrogation signal using the LF transmitter 26 and monitoring for a response signal via the RF receiver. However, when no RF response signal is received, the ignition switch 12 then goes to fault check process.

In accordance with the present invention, the fault check process, the LF coil 80 is energized with an interrogation signal. This is a low power signal that only travels a relatively short distance that would not normally be received by a fob carried by a vehicle operator. However, the LF signal provided by the coil 80 is received by the fob 14 that is pushing in on the button 90. The transmitted LF signal from the coil 80 is used by the fob to energize the fob such that the fob can transmit back to the ignition module LF response signal. The ignition module monitors for the LF response signal back from the fob. If the LF response signal includes appropriate ID information, the vehicle will be started since the switch 110 is already pressed closed.

As should be appreciated, in this fault mode, the ignition module has switched from a LF/RF communications mode to a LF/LF communications mode

and the LF from the ignition module is used to provide operating power to the fob which would otherwise be dead.

From the above description of the invention, those skilled in the art will perceive improvements, changes and modifications. Such improvements, changes
5 and modifications within the skill of the art are intended to be covered by the appended claims.

Having described the invention, the following is claimed:

1. A vehicle ignition system comprising:
 - a fob including a low frequency transceiver;
 - an ignition module including a low frequency transceiver; and
 - control circuit associated with said ignition module for activating said low frequency transceiver of said ignition module to transmit a low frequency energy signal to said fob to energize said fob,
 - said fob low frequency transceiver, upon receiving the low frequency energy signal from said low frequency transceiver of said ignition module, transmitting a low frequency response signal,
 - said control circuit including a verification device to verify that said fob is a fob associated with that vehicle based on the low frequency response signal.
2. The vehicle ignition system of claim 1 wherein said ignition module further includes a push button and sensor for sensing depression of said push button, said control circuit connected to said sensor for sensing depression of said push button and activating said low frequency transceiver of said ignition system in response to sensed depression of said push button.
3. The vehicle ignition system of claim 2 wherein said ignition module further includes a low frequency antenna located within said push button and mounted to remain axially stationary when said push button is depressed.

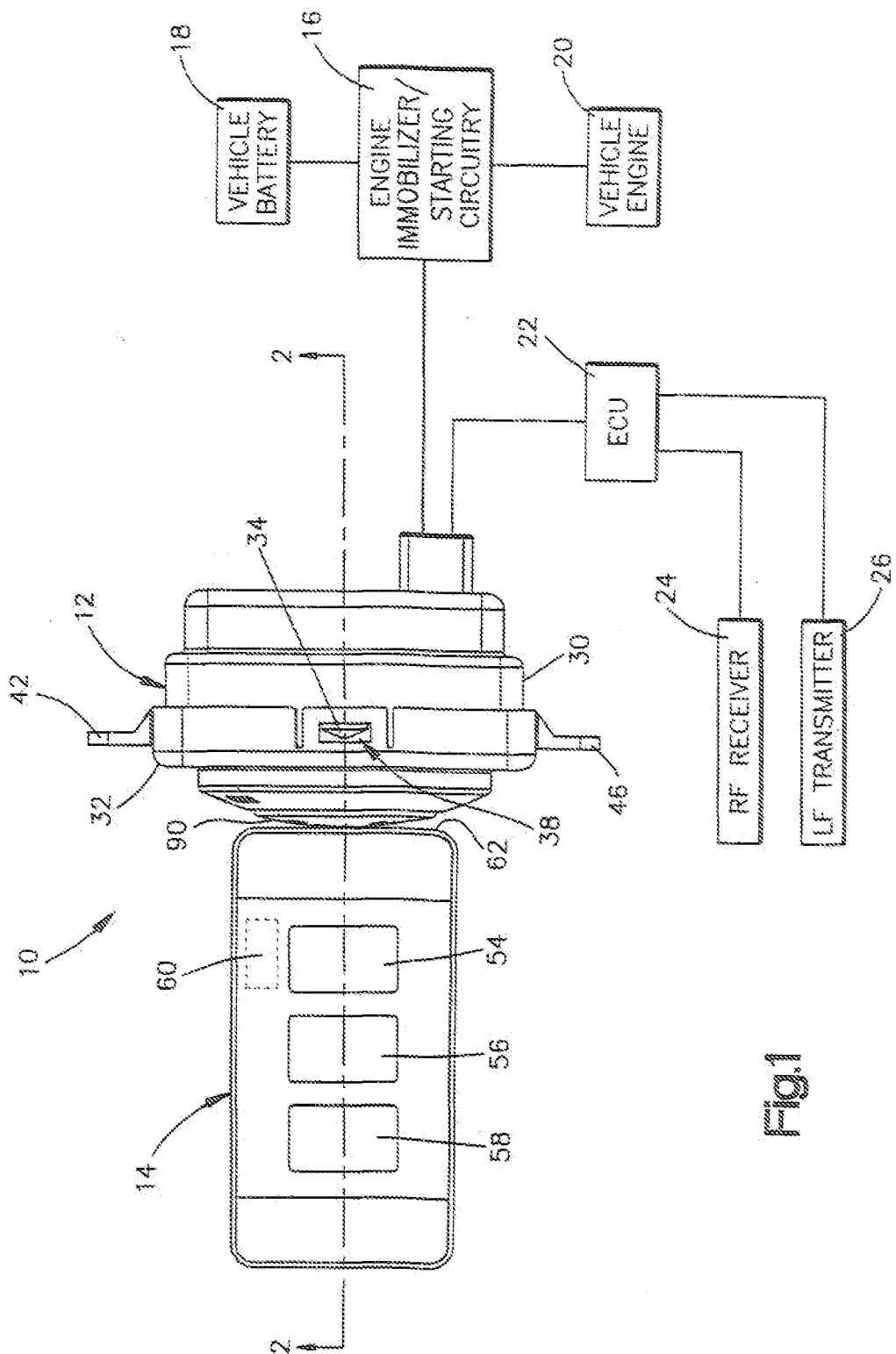
4. A vehicle ignition system comprising:
- a fob for transmitting an identification code, said fob including a low frequency transceiver circuit and a low frequency antenna;
 - an ignition module including,
 - (a) a housing;
 - (b) switch contacts;
 - (c) a push button slidably mounted in said housing and arranged so that pushing of said push button closes said switch contacts;
 - (d) a low frequency coil mounted so as to be axially stationary within said housing and located inside of said push button;
 - (e) an ignition module circuit to establish low frequency communications with said fob via said low frequency coil; and
 - an immobilizer circuit operatively coupled to the ignition module for permitting or preventing actuation of said ignition system in response to the low frequency communications between said fob and said ignition module.

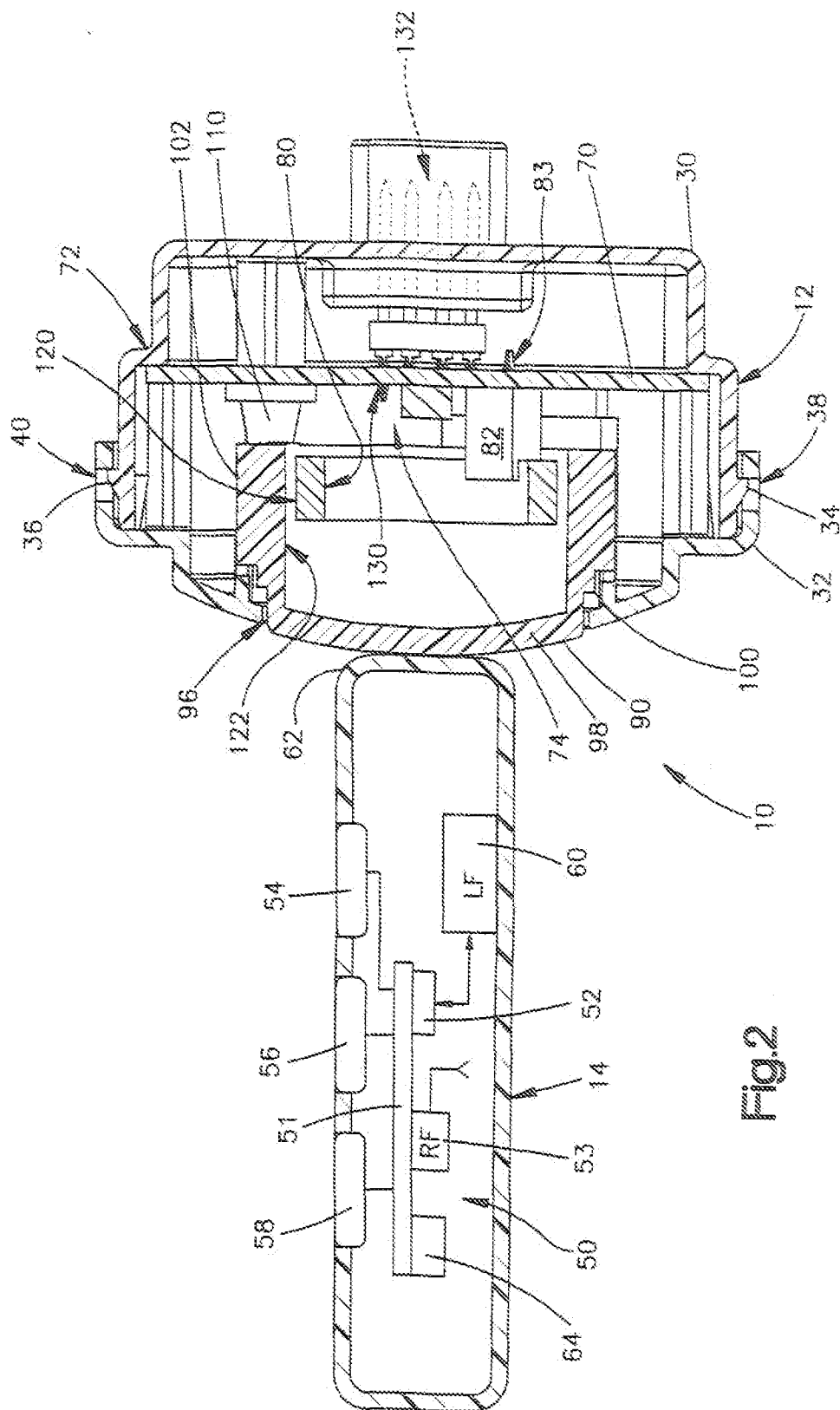
5. The vehicle ignition system of claim 4 wherein said ignition module circuit provides an initial low frequency signal to be transmitted from said low frequency coil when said push button is depressed, the initial low frequency signal energizing said fob, said fob transmitting a response signal back to said ignition module upon being energized by the initial low frequency signal.

6. A vehicle ignition module comprising:
- a fob having radio frequency transmitter and low frequency transceiver, said fob responding to a low frequency interrogation signal by transmitting a radio frequency response signal having a unique fob identification code and transmitting a low frequency response signal when placed in proximity to low frequency signal source;
 - an ignition module including a radio frequency receiver, a low frequency transmitter, and a low frequency receiver, said ignition module,
 - (a) first transmitting a low frequency interrogation signal from the low frequency transmitter and monitoring for a radio frequency response signal using the radio frequency receiver, and
 - (b) if no radio frequency response signal is received by the radio frequency receiver, generating a low frequency a low frequency power signal and monitoring for a low frequency response signal by the low frequency receiver,
- said ignition module permitting engine start if either a radio frequency response signal is received or a low frequency response signal is received.

7. The vehicle ignition module of claim 6 wherein said radio frequency response signal and said low frequency response signal both include identification codes and wherein said ignition module includes a circuit to compare the received identification codes against a predetermined code to determine if response signal indicates that the fob is associated with that vehicle.

8. The vehicle ignition module of claim 6 wherein said ignition module includes a housing, switch contacts, a push button slidably mounted in said housing and arranged so that pushing of said push button closes said switch contacts, a low frequency coil mounted so as to be axially stationary within said housing and located inside of said push button, and an ignition module circuit to provide the low frequency power signal to said fob via said low frequency coil.





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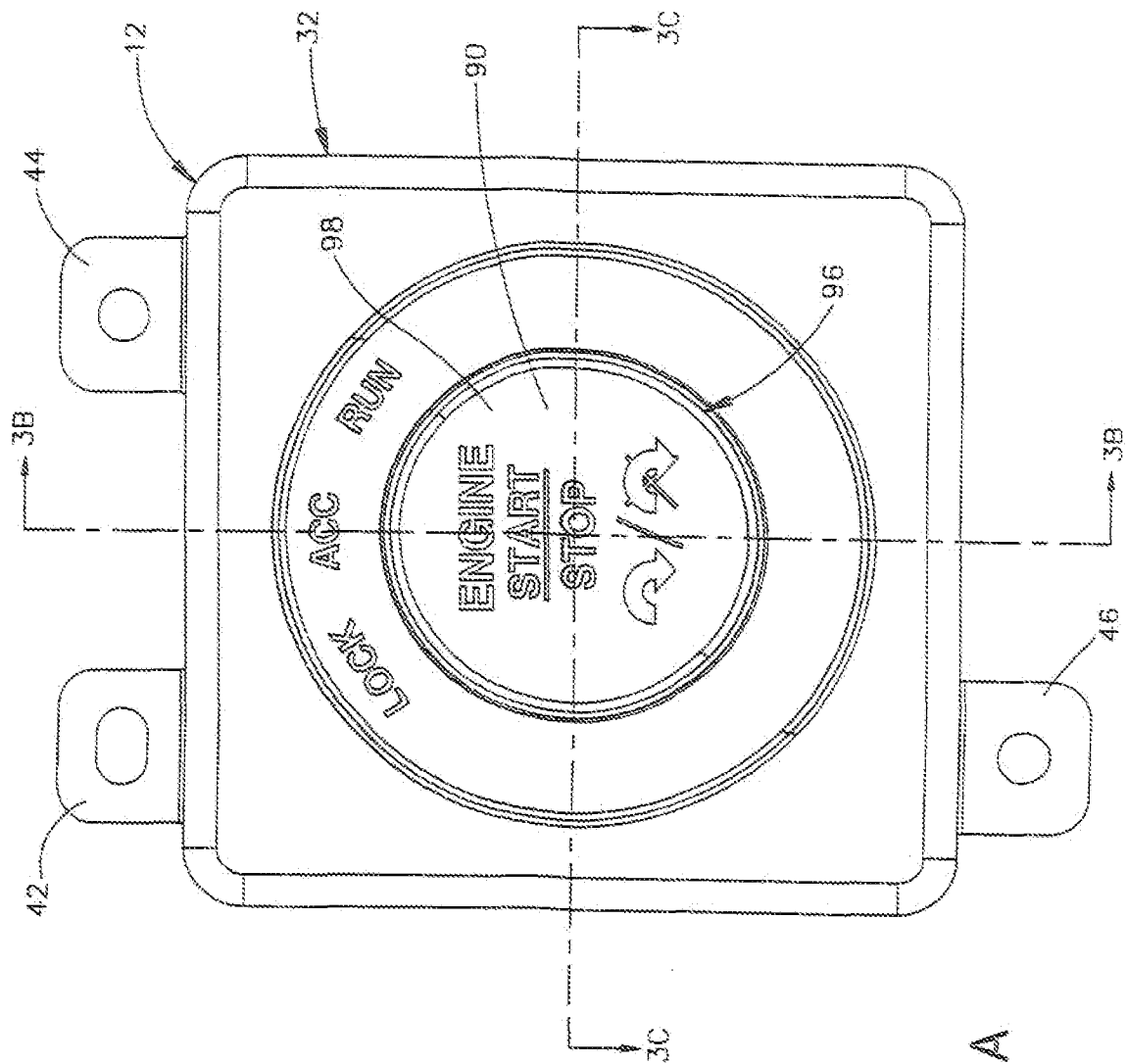


Fig.3A

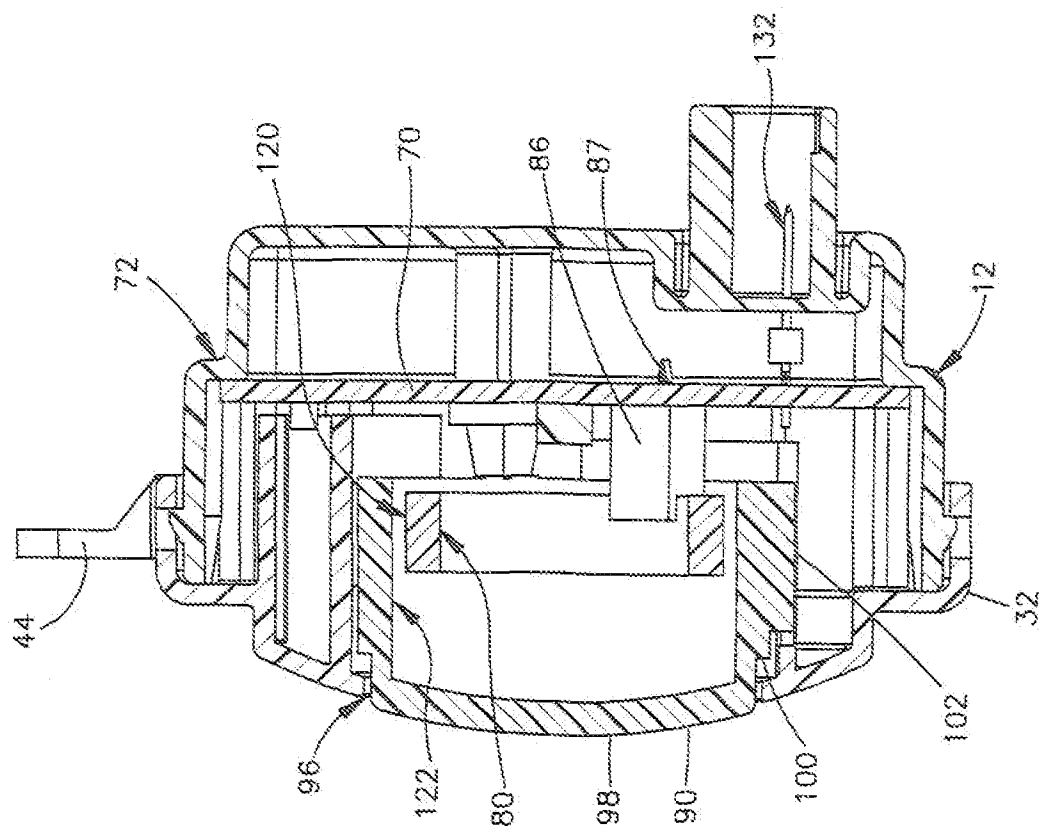


Fig. 3B

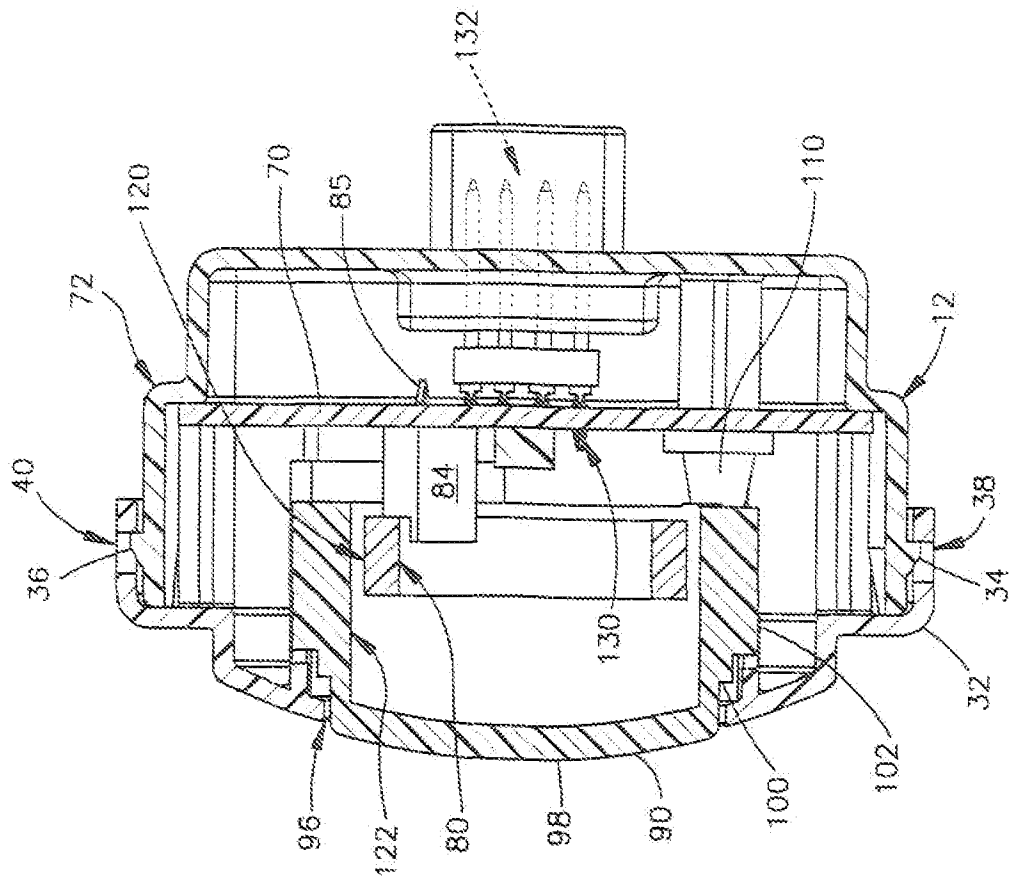


Fig. 3C