April 27, 1954 L. I. KNUDSON 2,677,078

ELECTRICAL APPARATUS

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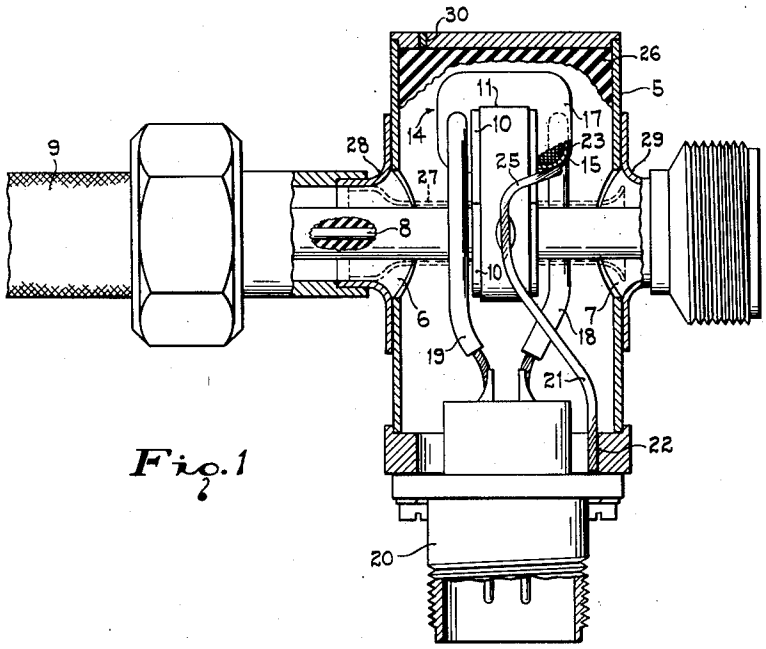

Fig. 1

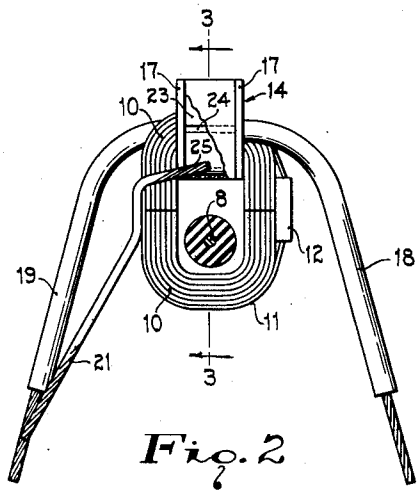

Fig. 2

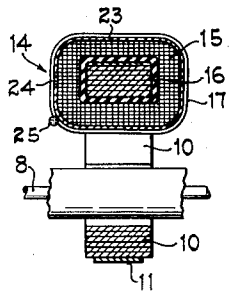

Fig. 3

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ELECTRICAL APPARATUS

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3 Claims. (Cl. 317—206)

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This invention relates to electrical apparatus and more particularly to an induction device adapted for use by way of example in apparatus for investigating the operation of the ignition system of an internal combustion engine or the like.

One of the objects of the present invention is to provide a novel apparatus for magnetically, i. e., inductively picking up electrical energy from an electrical conductor which means are so constructed as to substantially eliminate the effects of capacity components.

Another object of the invention is to provide novel apparatus of a simplified nature which may be readily associated with an electrical conductor and adapted to respond to changes in the flow of energy through the conductor.

A further object is to provide a novelly constructed radio shielded unit for picking up energy by induction from a single electrical conductor and which may be readily associated with a radio shielded conductor.

Still another object is to provide a novel transformer device which may be readily and quickly inserted in the input lead for an internal electric spark plug or other electrical conductor for generating signals in a circuit which is wholly free of direct electrical connection to said conductor, said signals being in response to voltage variations in said conductor.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in conjunction with the accompanying drawing. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

In the drawings wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a side elevational view partly in section and with parts broken away showing one form of device embodying the invention.

Fig. 2 is a detail elevational view with parts broken away and partly in section showing the coil and core structure of the device shown in Fig. 1 as viewed from the right in said figure; and

Fig. 3 is a section taken substantially on line 3—3 of Fig. 2.

The single embodiment of the invention illustrated in the drawings, by way of example, is designed for use in conjunction with a radio shielded ignition system of an internal combustion engine but it is to be understood that the invention is not limited to use in such environment. The device as shown comprises a metallic casing 5 which serves as a shield for intercepting electrical and magnetic emanations which would interfere with radio reception and may be fabricated in any suitable manner, and said casing is preferably provided with oppositely disposed outlets or openings 6 and 7 for the the passage of an electric conductor 8 which is preferably insulated as shown. In order that conductor 8 may be conveniently and quickly inserted in a spark plug circuit, for example, of an ignition system, outlet 6 is adapted for connection with a short length of flexible metallic tubing 9 through which cable 8 may extend and terminate in a plug connector (not shown) of the type commonly used for making connection to a shielded spark plug. Outlet 7 is adapted to threadedly receive a barrel or socket (not shown) of the type found on shielded spark plugs in common use and adapted to receive the terminal of a spark plug lead for connection with the other end of cable 8.

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A novelly constructed induction coil unit is mounted within casing 5 in operative relation to cable 8 in such a manner that the coil thereof will be energized in response to variations in the flow of current in the cable and so that the current picked up by the coil will be substantially free of capacity components. The illustrated coil unit comprises a two-part laminated core 10—10, the two U-shaped parts of which are secured together in any suitable manner such as by means of a metallic strap 11 and a clamp 12 which joins the ends of the strap to form a continuous ring shaped metal core of metallic flux conducting material. The conductor 8 passes through the central opening in core 10 so that the latter will serve as a path for the lines of magnetic flux created around the conductor by the flow of current therethrough. Core 10, 10 may be fabricated by first wrapping a continuous metal strip around a mandrel having the desired size and thereafter cutting the same into two parts to permit mounting of the coil to be next described. It will be understood, of course, that the core may be fabricated in other known ways and, if desired, the laminations may extend at right angles to those illustrated and consist of flat rectangular stampings, split for mounting in a pre-wound coil.

A coil 14 has a winding 15 which surrounds a section of one of the U-shaped parts of core 10, the same being tightly wound on an insulating sleeve 16 and between two insulating end guides 17—17. Said sleeve and guides may be cemented to the core structure or otherwise suitably secured in place thereon. In a suitable embodiment for use in the spark plug circuit of a large aircraft engine, coil winding 15 was constituted by about 1400 turns of No. 38 or No. 40 copper

wire. As shown, the ends of winding 15 are connected by means of leads 18 and 19 to a pair of terminals of a plug and socket connector, only the plug part 20 of which is illustrated as being secured in an opening in the wall of casing 5. If desired, the low potential end of the coil winding may be connected to ground through casing 5. Core 10 is also connected to ground by a lead 21 which is soldered or otherwise suitably secured to the casing at 22.

In order to substantially eliminate the capacity components in the currents induced in coil 14, a discontinuous metallic sleeve 23, preferably a steel sleeve, surrounds the winding 15. Said sleeve is split at 24 and is connected to ground by a lead 25 which may be an extension of lead 21. A protective covering of tape may also be wound around the coil and sleeve structure to reinforce the same structurally. Shielding sleeve 23 is effective to pick up the electro-static capacity radiations emanating from conductor 8 and carries the same to ground so that the current induced in winding 15 is substantially free of any capacity components.

The coil unit and cable may be properly positioned and resiliently supported in casing 5 by a yieldable insulating compound 26. The latter is preferably injected into casing 5 under pressure through a small opening 30 while the casing is substantially evacuated so that the entire space within the same will be filled with the compound. The latter may be injected in liquid form and permitted to set to solid form either with or without the application of heat. There are a number of known compounds suitable for this purpose, such as for example, polymerized cashew-nut shell oil. The openings 6 and 7 may be closed with suitable covers (not shown) during the filling step and said covers may support a greased rod of suitable size in the place of cable 8, so that when removed a suitable passage will be provided for the cable.

In operation, whenever there is a change in the amount of current flowing through conductor 8, there will be a corresponding variation in the magnetic flux lines surrounding the conductor and hence passing through coil 14. If the variation is sufficiently rapid and of appreciable magnitude, a flow of current will be induced in winding 15 when the same is cut by the magnetic flux lines. When conductor 8 forms a part of a spark plug lead, for example, the circuit including coil 14 is shocked into excitation whenever there is a flow of energy through the conductor causing the spark plug to fire. The signal thus picked up by coil 14 may be usefully employed in apparatus for investigating the operation of the entire ignition system of the engine.

The electrostatic shield may, if desired, take a different form from the sleeve 23 around the coil. For example, the shield may be in the form of a metal tube 27 as illustrated by dotted lines in Fig. 1. The enlarged end of said tube is soldered or otherwise suitably secured to the nipple 28 of opening 6 and extends through the central opening of core 10 to a position relatively close to the nipple 29 around opening 7. The free end of tube 27 will, of course, be additionally supported and insulated from the casing by the filling compound 26. The shield may also consist of two telescoping tubes, each secured to one of the nipples 28 or 29 in the same manner that tube 27 is secured. At the telescoping ends, the tubes may have a sufficient difference in diameters to permit the compound 26 to insulate them from one another.

There is thus provided a novel and efficient energy pick-up device which may be suitably designed for ready and quick installation in an electric lead for detecting variations in the flow of current through the lead. Novel means are also provided in the inductive pick-up unit comprehended for eliminating capacity components from the induced energy. The unit is of relatively simple and compact construction and yet sturdy and reliable.

Although only one embodiment of the invention has been illustrated and described in the accompanying drawings and the foregoing specification, it is to be expressly understood that the invention is not so limited. It is not necessary, for example, to provide a complete shielding casing in all installations. Various other changes may be made particularly in the design and arrangement of the parts illustrated without departing from the spirit and scope of the invention as it will now be understood by those skilled in the art. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. Apparatus of the class described comprising a metallic casing having cable outlets in opposite sides thereof, an electrical conductor supported in the casing and extending between said outlets, a laminated core of magnetic flux conducting metal completely surrounding a section of said conductor in said casing, a coil closely surrounding only a portion of said core and insulated therefrom, a double-ended longitudinally-split metallic sleeve substantially surrounding the periphery of said coil, means electrically connecting said core and sleeve to the casing, an electrical outlet in the wall of said casing having at least one contact electrically connected to the high potential end of said coil, and yieldable electrical insulation completely filling the remaining space in said casing and supporting said coil and core therein.

2. An induction coil unit as defined in claim 1 wherein said core comprises two cooperating U-shaped parts.

3. An induction coil unit as defined in claim 1 wherein said core comprises two cooperating U-shaped parts, said parts being secured together by means including a metallic strap.

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