June 29, 1943. H. M. WILKOFF 2,322,903

IGNITION HARNESS

Filed Dec. 27, 1940 2 Sheets-Sheet 1

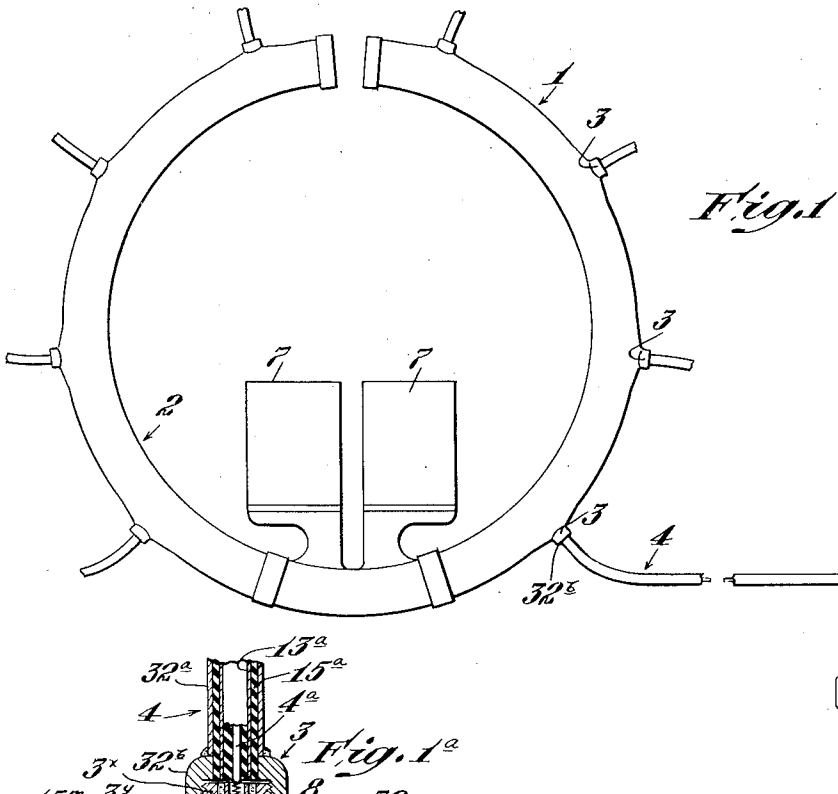

Fig. 1

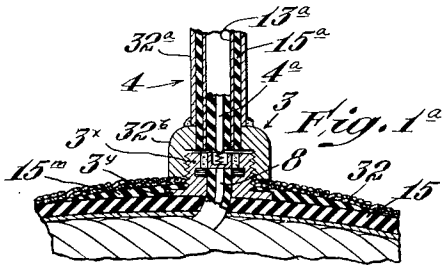

Fig. 1a

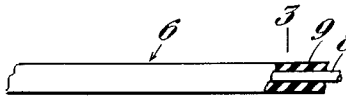

Fig. 2

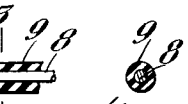

Fig. 3

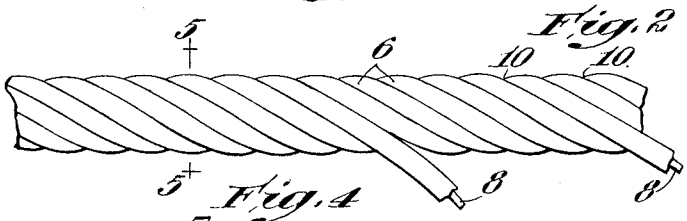

Fig. 4

Fig. 5

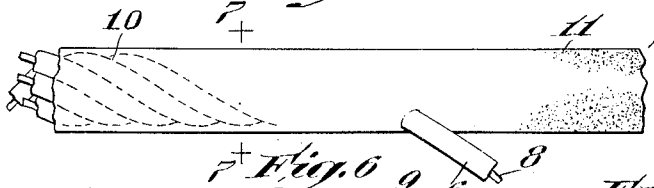

Fig. 6

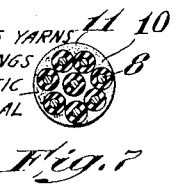

Fig. 7

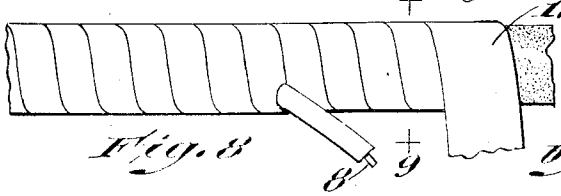

Fig. 8

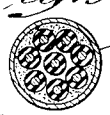

Fig. 9

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IGNITION HARNESS

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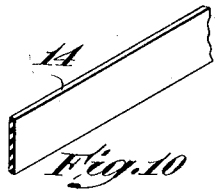

Fig. 10

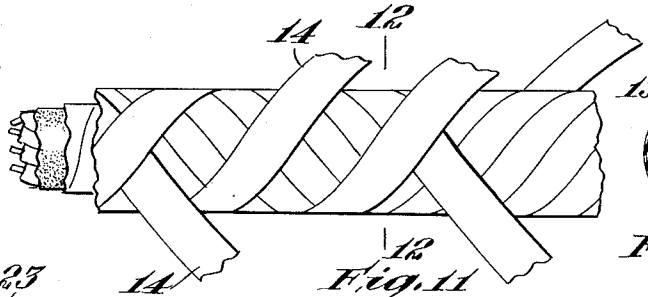

Fig. 11

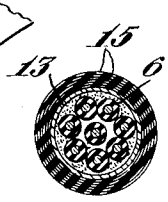

Fig. 12

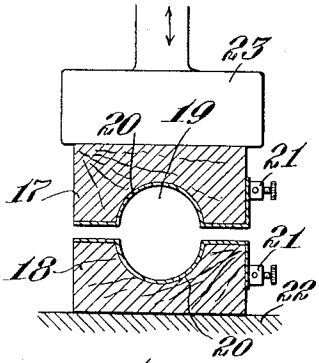

Fig. 13

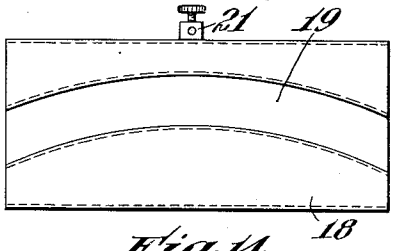

Fig. 14

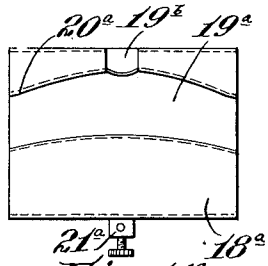

Fig. 14a

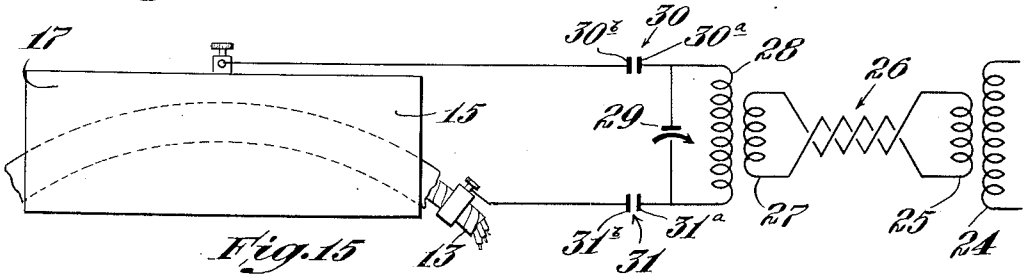

Fig. 15

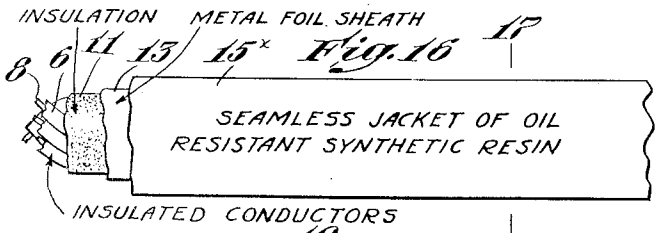

Fig. 16

Fig. 17

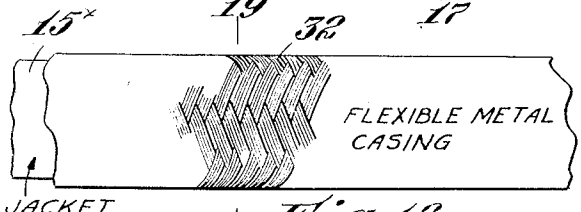

Fig. 18

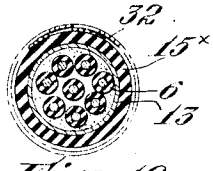

Fig. 19

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Patented June 29, 1943

2,322,903

UNITED STATES PATENT OFFICE

2,322,903

IGNITION HARNESS

Howard M. Wilkoff, Worcester, Mass.

Application December 27, 1940, Serial No. 371,927

15 Claims. (Cl. 174—71)

This invention pertains to ignition harness for internal combustion engines and to a method of making such harness.

An ignition harness is made up of the various ignition wires leading from the distributor of the internal combustion engine to the spark plugs. While the invention may be of more general utility, it is especially designed as an improvement in the harness used in airplane engines. In some of these engines the cylinders are radially disposed and some have a straight-line arrangement and the improved harness is applicable to both types of engine.

Considering the radial engine as an example, the harness usually comprises an annular tubular casing which is arranged to extend concentrically with the engine shaft and into which lead the conductors from the magneto or magnetos. These conductors extend along within the casing and at the proper intervals one after another of the conductors is led out through a lateral opening in this casing (or, as it is termed in the art, the "ignition manifold") to the spark plug of one of the respective cylinders. The conductors thus extend to different distances around the circumference of the manifold and the manifold may be of gradually decreasing transverse area, or may be of uniform cross section throughout its length according to the choice of the designer.

In certain common types of harness the manifold is made of flexible tubing and each conductor extends continuously from the magneto to its respective spark plug. In order to protect the conductors from mechanical injury and to avoid radio interference, it is necessary that each individual conductor be enclosed within metal from the time it leaves the generator until it connects with the spark plug terminal. Thus the ignition manifold is made of metal or is encased with metal and where each conductor leaves the manifold an outlet fitting is secured to the manifold to which is connected a conduit, usually flexible, which encloses the conductor and which extends to the spark plug to which it is secured by a special connection.

The conductors used for this purpose, particularly for army and navy use, are very finely constructed, being provided with insulation of the highest quality and are usually covered with a coating of lacquer. However, these finely finished conductors must be put in place in the harness by drawing them in at one end of the manifold, thence part way around the manifold and out through the particular fitting and through the conduit and then through the connection at the other end of the conduit before they can be connected to the spark plug terminal. If done carefully, this operation may be performed without injury to the conductor, but when repairs must be made by those who are not especially skilled or careful, the insulation may be scraped off or injured in pulling the conductor through the irregular channel provided for it, and not only may the particular conductor thus drawn in be injured but the operation may likewise injure the insulation of some of the other conductors already in place. Moreover, since airplane engines are ordinarily provided with double ignition systems, it may happen that if one of the conductors belonging to one of these systems should break down so as to emit sparks within the manifold, its failure may not be noticed during operation of the engine since the other ignition system provides for this emergency, and thus before the defect is discovered the sparking may have seriously injured those conductors which lie in contact with the defective conductor.

In another type of harness, intended in part to avoid the above difficulties, each conductor within the manifold terminates at the point where the corresponding outlet fitting is attached, and the fitting comprises means for mechanically securing the conduit to the manifold and also comprises means whereby the terminal of the conductor within the manifold may be electrically connected to the ignition wire which leads from the outlet fitting through the conduit to the spark plug. In this latter form of manifold it has been proposed permanently to embed the several conductors which are arranged within it in a body of insulating material which is poured into the manifold casing after the assembled conductors have been put in place. However, difficulty is experienced in filling the manifold casing with an insulating medium of appropriate type. The lacquer used at the outer surface of the several conductors may be seriously injured by any solvent which would make the insulating medium sufficiently fluid to flow at normal temperatures into the manifold. Likewise if such a solvent be employed it is difficult to provide for its evaporation from the closed interior of the manifold within any practical period of time. On the other hand, if the insulating material be thermoplastic and be heated sufficiently to soften it, the temperature requisite may be such that the heated insulating material will injure the individual conductors, for ex-

ample by causing an over-vulcanization of the rubber covering with consequent loss of insulating value. Moreover, since the insulation material which is placed in the manifold must not be brittle at arctic temperatures and must maintain its shape and insulating properties at temperatures to which it may be exposed in the tropics with the engine running, it is difficult to find such a medium which may be flowed into the manifold cavity.

It has also been proposed to encase the conductors in a jacket of rubber and, after vulcanizing the latter, to house the rubber-jacketed cables in the outer metallic casing, but the application of heat sufficient to vulcanize the mass of rubber forming the jacket is injurious to the insulation of the individual conductors and may so decrease the di-electric strength of such insulation as to result in an early breakdown and sparking under conditions of use.

A principal object of the present invention is to provide an improved ignition manifold of the kind in which the conductors are permanently fixed within the manifold casing and comprising an integral jointless jacket of oil and moisture resistant insulation of adequate thickness in which the assembled conductors are embedded. A further object of the invention is to provide an improved ignition harness comprising a manifold, and conduits leading therefrom to the several spark plugs, and wherein the individually insulated conductors within the manifold and within the respective conduits are encased in a continuous jointless insulating jacket of a highly elastic, oil, gasoline, and water resistant material capable of withstanding extremes of temperature, vibration and shock without mechanical breakdown and which is of high dielectric strength. A further object of the invention is to provide an improved ignition harness comprising a manifold and conduits leading therefrom to the several spark plugs and wherein the conductors within the manifold and within each conduit are each encased in a metal sheathing interposed between concentric bodies of insulation, such sheathing having the two-fold function of preventing radio interference from the high tension current passing through such conductors, and of permitting the heat treatment of the jacket of insulating material in which the conductors are embedded without injuriously heating the insulation of the individual conductors.

A further object of the invention is to provide a method of and novel apparatus useful in the making of such ignition harness and the constituent parts thereof and in particular to provide a method whereby an individually insulated conductor or conductors may be jacketed with an insulating substance which requires heat treatment in its application but without so heating the insulation of the individual conductor as to injure its mechanical or di-electric qualities.

A further object is to provide an improved method whereby, after wrapping an individually insulated conductor or conductors with thermoplastic insulating material to form a plurality of concentric layers, heat may be applied (or in fact generated) in such a way as to heat said layer or layers sufficiently to permit consolidation and integration thereof without injuriously heating the insulation of the conductor or conductors.

Other and further objects and advantages of the invention will be pointed out in the following more detailed description and by reference to the accompanying drawings, wherein

Fig. 1 is a diagrammatic front elevation of a harness for a radial type engine, certain of the ignition wires being broken away, only one of the spark plugs being illustrated;

Fig. 1ª is a detail section to large scale, illustrative of a preferred form of fitting at the junction of one of the ignition wires with the manifold;

Fig. 2 is a fragmentary elevation, partly in diametrical section, illustrating one of the conductors which is comprised in the ignition manifold;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary elevation illustrating a plurality of the conductors arranged to form a cable-like assembly;

Fig. 5 is a section on the line 5—5 of Fig. 4;

Fig. 6 is a fragmentary elevation showing the assembly of Fig. 4 after having its outer surface made smooth and substantially cylindrical;

Fig. 7 is a section on the line 7—7 of Fig. 6;

Fig. 8 is a fragmentary elevation illustrating the step of applying a thin, flexible metallic sheathing to the structure of Fig. 6;

Fig. 9 is a section on the line 9—9 of Fig. 8;

Fig. 10 is a fragmentary perspective view illustrating an oil and moisture resistant thermoplastic insulating tape useful in providing an insulating jacket for the assembly shown in Fig. 8;

Fig. 11 is a fragmentary elevation illustrating the step of applying the insulating jacket to the assembly of Fig. 8;

Fig. 12 is a section on the line 12—12 of Fig. 11;

Fig. 13 is a vertical section diagrammatically illustrating a multi-part mold device and showing in section fragmentary portions of a press whereby pressure is applied to the mold parts;

Fig. 14 is a plan view of the lower part of the mold of Fig. 13;

Fig. 14ª is a similar plan view of a mold part having a mold cavity of a different formation;

Fig. 15 is a diagrammatic plan view of the mold of Fig. 13 and illustrating means for supplying heat to the wrappings of insulation;

Fig. 16 is a fragmentary elevation illustrating the composite assembly resulting from the use of the apparatus of Fig. 15;

Fig. 17 is a section on the line 17—17 of Fig. 16;

Fig. 18 is a fragmentary section showing the structure of Fig. 16 provided with an outer protective casing; and

Fig. 19 is a section on the line 19—19 of Fig. 18.

Referring to the drawings, the numeral 1 designates an ignition harness of the general kind employed for engines of the radial type. This ignition harness comprises the substantially circular ignition manifold 2 which comprises an external protective casing, usually of metal, and which is provided at regularly spaced intervals with fittings 3 to each of which is connected one end of a conduit 4, through which runs an ignition wire 4ª (Fig. 1ª) extending to one of the spark plugs 5. The outer casing of the manifold houses a plurality of individually insulated conductors 6, one end of each conductor being secured to one of the terminals respectively of one of the magnetos 7. The several conductors 6 are of different lengths, one of such conductors terminating adjacent to each of the fittings 3. Each fitting 3 (Fig. 1ª) is provided with means for mechanically securing to it the outer protective conduit 4 of one of the ignition wires 4ª, and also has provision for electrically connecting the end

of the metallic core of a conductor 6 to the ignition wire 4a in the conduit 4.

As illustrated in Figs. 2 and 3, each conductor 6 comprises a metallic conducting wire or core 8 and insulation 9 which may, for example, be of rubber, braid, lacquer or resin.

In making the manifold, in accordance with the present invention, it is preferred to cable-lay the several conductors 6 so that they twine about each other in helical turns as shown in Figs. 4 and 5. The several conductors 6 making up the cable-like assembly thus provided are of different lengths as above suggested. For use as herein specifically illustrated merely by way of example, one end of each conductor may be arranged near one end of the assembly, said ends being those which are connected to the magneto terminals, while the opposite ends of the several conductors are arranged each to terminate adjacent to one of the fittings 3 of the manifold when the parts are assembled. Since the number of conductors making up the cable-like assembly thus decreases from point to point along the manifold, the outer casing of the manifold may be made correspondingly to diminish in transverse dimensions or, alternatively, it may be of uniform transverse section and the space may be filled by the use of dummy conductors which take the place in the cable of the true conductors beyond the points where the latter terminate at the several fittings.

After having thus cable-laid the conductors 6, a substantially circular transverse section is preferably then imparted to this assembly of conductors by winding insulating material, for example, a specially treated asbestos yarn or properly shaped extruded strands of plastic material into the helical grooves 10 extending around the cable. However, any other suitable method of providing a circular section and substantially smooth cylindrical outer surface 11 (Figs. 6 and 7) may be employed. Having prepared this assembly with its substantially cylindrical and smooth external surface, the next step is to encase it in a flexible metallic sheathing, for example, a wrapping of thin metal ribbon 12 (Figs. 8 and 9). This wrapping may, for example, be of Duralumin foil of approximately 0.0015 inch thick wrapped helically about the cable so as to overlap one-half its width, thus providing a complete metal sheathing 13, Fig. 9. Alternatively, the assembly might be drawn into a tubular metallic casing.

After applying this metal sheathing, the sheathed cable is wrapped with tape 14 (Fig. 10) of a thermoplastic character. Preferably this tape is made of one of the vinyl chloride or vinyl acetate resins, for instance, a polymerized vinyl chloride, such tape being, for example, 0.008 inch thick. Such a tape is a commercial product employed in the automobile industry for wrapping conductors and is of very great elasticity and toughness throughout a wide range of temperatures; it is oil and gasoline resistant (a matter of high importance when it is to be used in the vicinity of an airplane engine or the like) and has high di-electric properties. This tape is wrapped in overlapping spirals and in several concentric layers, for example, as many as twelve layers. Preferably successive layers 15 are of opposite pitch.

In preparation for the next step, suitable molding means is provided designed for the simultaneous application of heat and pressure thereby to integrate the several turns and layers of tape, the heat being so applied (or in fact generated) that the layers of tape are heated substantially uniformly and almost instantaneously, but without injuriously heating the insulating coverings of the several conductors. The molding means may comprise a mold consisting of two or more separable parts 17 and 18 and is of insulating material, for example, wood, the several parts, when operatively assembled, collectively defining a mold cavity 19 of variable dimensions and which is of proper shape to receive a portion at least of the wrapped cable already described. The interior of the mold cavity is lined with metal foil 20, for example, tin, the mold parts being provided with accessibly located binding posts 21 or the like with which the metallic lining 20 is electrically connected and to which electrical conductors as hereafter described may be attached. Provision is made whereby the assembled parts of the mold may be pressed toward each other thereby to press the wrapped cable assembly in a substantially radial direction. As illustrated in Fig. 13, the upper and lower mold members 17 and 18 are slightly separated, as they may be when the cable assembly is first introduced into the mold cavity 19 between them. The lower mold member 18 is shown resting upon a fixed support 22 while the vertically movable platen 23 of a power press rests upon the upper mold member 17 in readiness to apply downward pressure to the latter.

That section of the sheathed and wrapped cable which extends between one of the projecting ends of a conductor 6 and the next, is disposed within the mold cavity 19 and the mold parts are then placed under compressive stress so as radially to compact the layers of wrapping material. Before applying pressure, the metal lining 20 of the mold cavity is connected into a high frequency circuit so as to constitute one condenser plate while the tape covered metal sheathing 13 of the cable is made to constitute the other condenser plate.

The numeral 24 (Fig. 15) designates the tank coil of a well known type of high frequency circuit, having provision for tuning the circuit. This coil forms the primary of which the coil 25 forms a secondary, and receives high frequency current from the tuned circuit, for example, of approximately 20,000,000 cycles. This high frequency current is conducted through the high frequency cable 26 to the primary 27 of a resonant circuit whose secondary 28 has its terminals connected to a variable condenser 29 and also to auxiliary condensers 30 and 31 respectively. Each of these condensers 30 and 31 comprises a plate 30a and 31a respectively and complemental plates 30b and 31b respectively which are connected to and with the mold lining 20 and the sheathing 13 respectively, constitute condenser plates complemental to plates 30a, 31a respectively. A high frequency field is established between these condenser elements and if the material forming the wrappings be subjected to such high frequency for a period of 45 seconds while the mold parts are under pressure, the several layers 15 of the synthetic resin tape are coalesced so as to form an integrated tubular jacket 15x without crevice or seam. The jacket thus provided is waterproof, oil resistant, highly elastic, and tough and substantially unaffected by any of the temperature conditions to which the ignition manifold of an airplane engine is ever subjected. This jacket 15x (Fig. 19) also provides very effective insulation while the metallic sheathing 13 upon which this jacket is

built forms effective means to prevent radio interferences from the high tension current passing through the conductors forming the cable as well as to enable the heat treatment of the jacket as just described without heating the conductors 6.

Each of the leads 4 from the several fittings to the respective spark plugs 5 may be prepared in the same way as just described except that each of these individual leads (Fig. 1[a]) contains but a single insulated ignition wire 4[a]. This single insulated wire 4[a] is provided with a metal sheathing 13[a] and is wrapped with insulating thermoplastic tape which is consolidated by pressure and high frequency heat to form the jacket 15[a] as already described, and this jacket is then enclosed in a flexible metallic protective casing 32[a], having a connection 32[b] at one end for engagement with one of the fittings 3 of the manifold and having a rigid connection 32[c] at its opposite end (Fig. 1) for union with the spark plug 5.

After each section of the sheathed and wrapped cable has been subjected to heat and pressure in the mold 17, 18 as above described, a fitting 3 is applied at each point where the end of one of the conduits 6 projects outwardly from the jacket 15. As illustrated in Fig. 1[a], each fitting 3 comprises a screw-threaded portion 3[x] for mechanical engagement with the internally screw-threaded connection 32[b] of the ignition wire conduit, the fitting also including a flange 3[y] which is placed in contact with the outer surface of the jacket 15 and is bound down to the jacket by a plurality of wrappings of the tape 14. This portion of the jacket 15, to which the fitting is thus bound, is now placed in a mold 18[a] having a metal lined cavity 19[a], 19[b] of suitable shape, for instance as shown in Fig. 14[a], the metal lining 20[a] being connected to the binding post 21[a], and these wrappings of tape are consolidated so as to form an integral mass 15[m] permanently uniting the part 3[x] to the jacket 15, while at the same time adjoining sections of the jacket 15 are thoroughly integrated.

As already described, the manifold cable and the individual ignition wires are encased in any appropriate type of outer protective covering, for example, a helically wound metallic tape, such as that employed in electrical conduits; a braided metallic tube 32 (Fig. 18); or a sheet metal housing, but preferably such metallic casings should be so applied as to fit very snugly about the jacket and actually exert some degree of radial stress upon the enclosed material, thus to avoid any possibility of air spaces within the casing and providing against creeping of the jacket relatively to the casing. As above described, each fitting is provided with means 3[x], 32[b] for mechanically but removably attaching the jacket 32[a] of the individual ignition wires 4 to the manifold, and each fitting is also provided with suitable (preferably resilient) contact means for electrically joining the ends of wires 4[a] and 8.

While certain desirable constructions have been illustrated by way of example and certain method steps useful in the production of the structures described have also been disclosed, it is to be understood that the invention is not to be limited to these precise embodiments but is to be regarded as broadly inclusive of any and all equivalents.

I claim:

1. Ignition harness including a flexible manifold comprising a flexible, seamless insulating jacket of oil and water-resistant material having high dielectric strength and which is tough and highly elastic, the manifold having a plurality of spaced fittings, fixedly anchored to the jacket, for the attachment of ignition wires, an ignition conduit, including an ignition wire, removably attached to each fitting, a hollow, flexible metallic sheath constituting a lining for the insulating jacket, and a plurality of individually insulated conductors housed within said metallic sheath, said conductors being of different lengths and each terminating at one of the respective fittings.

2. Ignition harness including a flexible manifold comprising a flexible, seamless insulating jacket of oil and water-resistant material having high dielectric strength and which is tough and highly elastic, the manifold having a plurality of spaced fittings, fixedly anchored to the jacket, for the attachment of ignition wires, a hollow, flexible metal sheath fitting snugly within the insulating jacket, and an assembly of cable-laid, individually insulated conductors housed within said metal sheath, said conductors being of different lengths and each terminating at one of the respective fittings, a flexible protective casing tightly embracing the jacket, and an ignition conduit, including an insulated, radio-shielded ignition wire, mechanically connected to each fitting, each ignition wire being electrically connected to one of the respective conductors within the manifold, said mechanical and electrical connections being so designed and arranged as to permit each individual ignition conduit to be detached as a unit from the manifold.

3. Ignition harness including a flexible manifold comprising a flexible, seamless insulating jacket of oil and water-resistant material having high dielectric strength and which is tough and highly elastic, the manifold having a plurality of spaced fittings, fixedly anchored to the jacket, for the attachment of ignition wires, a hollow, flexible metallic sheath coaxial with and which is embraced by the insulating jacket, an assembly of individually insulated conductors within said hollow sheath, and means imparting a substantially smooth exterior surface to said assembly of conductors thereby to provide snug contact of the assembly with the interior of the sheath, the several conductors being of different lengths and each terminating at one of said fittings, respectively.

4. Ignition harness including a flexible manifold closed at its end and comprising a flexible, seamless jacket of oil, water and gasoline-resistant synthetic resin having high dielectric strength and which is tough and elastic, the manifold having a plurality of spaced fittings fixedly anchored to the jacket for the attachment of ignition wires, an assembly of cable-laid, individually insulated conductors within the jacket, said conductors being of different lengths and each terminating at one of the respective fittings, dummy conductors which take the place, in the assembly, of the true conductors beyond the ends of the latter, a hollow, flexible sheath of metal foil which snugly embraces the assembly of conductors and which is snugly embraced by the insulating jacket, and insulation filling the space within the sheath which is not occupied by the conductors, and a flexible protective outer casing tightly embracing the jacket.

5. Ignition harness including a flexible manifold comprising a flexible, seamless insulating jacket of oil-resistant synthetic resin having high

dielectric strength and which is tough and highly elastic, the manifold having a plurality of spaced fittings fixedly anchored to the jacket for the attachment of ignition wires, a hollow, flexible sheath of metal foil coaxial with and which is snugly embraced by the insulating jacket, an assembly of helically disposed individually insulated conductors within said hollow sheath, and strand-like elements filling the helical grooves in the periphery of said assembly of conductors thereby to impart a substantially smooth cylindrical peripheral surface to said assembly, said smooth surface fitting tightly against the metal sheath, the several conductors being of different lengths and each terminating at one of said fittings, respectively.

6. Ignition harness including a flexible manifold of normally arcuate contour, closed at one end and including a flexible, unitary, seamless resilient jacket of oil, water and gasoline-resistant insulating material, the manifold having a plurality of spaced fittings, each fixedly anchored to the jacket, for the attachment of ignition wires, an assembly of cable-laid, individually insulated conductors within the jacket, and a flexible layer of electrical conducting material interposed between the jacket and conductor assembly and operative to provide a radio shield and also to constitute a condenser plate for use in the heat treatment of the jacket by high frequency current, the conductors being of different lengths and terminating at the respective fittings.

7. Ignition harness including a flexible manifold of normally arcuate contour, closed at one end and including a flexible, unitary seamless resilient jacket of oil, water and gasoline-resistant insulating material, the manifold having a plurality of spaced fittings, each fixedly anchored to the jacket, for the attachment of ignition wires, an assembly of cable-laid, individually insulated conductors within the jacket, an uninterrupted flexible layer of metal foil interposed between the jacket and the conductor assembly, said layer of foil constituting means to prevent radio interference and also to act as a condenser plate useful in the high frequency heating of the jacket material, the several conductors being of different lengths and each terminating at one of the respective fittings, and a flexible protective casing tightly embracing the jacket.

8. Ignition harness including a flexible manifold closed at one end, said manifold comprising a flexible seamless insulating jacket of oil and gasoline-resistant synthetic resin having high dielectric strength and which is tough and elastic throughout a wide range of temperature variations, the jacket being provided at intervals along its length with fittings fixedly anchored thereto and designed for the attachment of ignition wires, a hollow, flexible sheath of metal foil coaxial with and fitting snugly within the jacket, a cable-laid assembly of individually insulated conductors within said hollow sheath, said conductors being of different lengths, one end of each conductor being disposed near one end of the assembly and the opposite ends of the respective conductors terminating at the several manifold fittings, dummy conductors which take the place, in the assembly, of the true conductors beyond the terminals of the latter, and insulation snugly filling the space within the sheath which is not occupied by the conductors and dummies.

9. An ignition harness of the kind including a flexible manifold comprising an assembly of individually insulated conductors housed in an elongate, flexible jacket of insulating material, the jacket having fixedly anchored thereto a plurality of spaced fittings for the attachment of ignition wires, and the several conductors being of different lengths and each terminating at one of the respective fittings, a thin flexible layer of metal interposed between the conductor assembly and the inner wall of the jacket, the jacket being of unitary, seamless construction and sufficiently flexible to permit it to be bent to arcuate contour.

10. An ignition harness of the kind including a flexible manifold comprising an assembly of individually insulated conductors housed in an elongate, flexible jacket of insulating material, the jacket having fixedly anchored thereto a plurality of spaced fittings for the attachment of ignition wires, and the several conductors being of different lengths and each terminating at one of the respective fittings, a thin flexible layer of metal foil interposed between the outer surface of the conductor assembly and the inner surface of the jacket, the jacket being a unitary, seamless mass of synthetic resin which is resistant to oil and gasoline.

11. An ignition harness comprising a manifold which is sufficiently flexible to permit it to be manually bent and straightened at will, said manifold having a plurality of fittings spaced along it and designed for the attachment of ignition wires, the manifold comprising a flexible, seamless unitary jacket of oil-resistant insulating material, and an assembly of individually insulated conductors within the jacket, the several conductors being of different lengths and terminating at the respective fittings, and a flexible tube of thin metal embracing the conductor assembly and fitting snugly within the jacket.

12. Ignition harness including a flexible manifold comprising a flexible, seamless insulating jacket of oil and water-resistant material, the manifold having a plurality of spaced fittings fixedly anchored to the jacket for the attachment of ignition leads, a hollow flexible metal sheath fitting snugly within the insulating jacket, and an assembly of individually insulated conductors housed within said metal sheath, each conductor terminating at one of the respective fittings, and a plurality of ignition leads each comprising a single insulated ignition wire provided with a metal sheathing, the metal sheathing being embraced by a jacket of oil and water-resistant insulating material, each lead having a connector at each end operative removably to unite the lead to one of the manifold fittings and to a spark plug respectively, the metal sheathing of each ignition lead extending into said connectors.

13. Ignition harness including a flexible manifold comprising a flexible, seamless insulating jacket of oil and water resistant material, a hollow, flexible metal sheathing fitting snugly within said jacket, insulated conductors within said sheathing, a plurality of ignition leads each including a flexible, seamless insulating jacket of oil and water-resistant material, a hollow, flexible metal sheathing fitting snugly within said jacket, and an insulated conductor within said sheath, each ignition lead having a connector at one end by means of which it may be removably secured to the manifold, and each of said connectors including means operative electrically to connect its respective conductor to one of the manifold conductors.

14. An ignition harness for use with internal combustion engines of the radial type, said harness comprising an annular manifold designed to

be arranged coaxially with the engine shaft and having a plurality of flexible spark plug leads, the manifold having a plurality of unitary fittings spaced circumferentially thereof and corresponding in number to the number of spark plug leads, said fittings being designed to receive the ends of the several spark plug leads, characterized in that each of the spark plug leads includes a flexible, seamless, insulating jacket of an oil- and water-resistant synthetic resin, a hollow flexible metal sheath fitting snugly within said jacket, and a single insulated conductor within said sheath, each spark plug lead having a connector at one end by means of which it may be removably connected both mechanically and electrically to one of the fittings of the manifold and each of the said spark plug leads having a connector at its opposite end for uniting it to a spark plug.

15. A normally substantially annular, flexible ignition manifold comprising a plurality of conductors encased within a unitary resilient, seamless jacket of oil-, gasoline- and moisture-resistant synthetic resin, the jacket having a plurality of circumferentially spaced openings in its outer peripheral wall, the ends of the several conductors being directed outwardly through said respective openings, and ignition lead fittings secured to the jacket at the location of each such conductor end, each fitting comprising a tubular part which is coaxial with its respective opening and a radial flange underlying a portion of the jacket-forming material bordering the opening, the fitting being firmly and permanently anchored to the jacket, each fitting also comprising a part designed for mechanical connection to the terminal of an ignition wire lead, and a thin, flexible, tubular sheathing of metal between the conductor and the jacket, said tubular sheathing constituting means to prevent radio interference and to act as a condenser plate during high frequency heating of the jacket-forming material.

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