

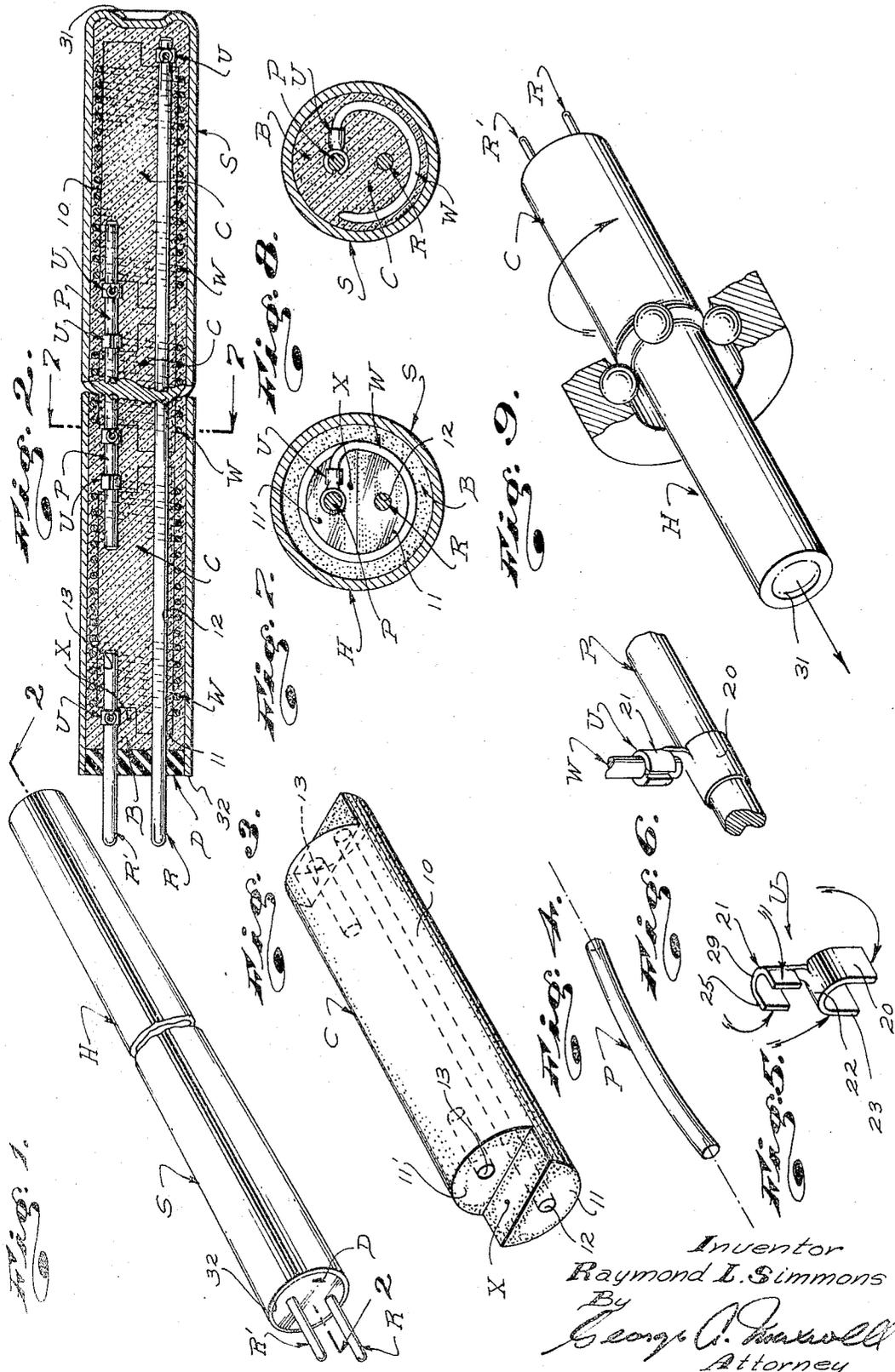
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CARTRIDGE HEATER

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CARTRIDGE HEATER

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An elongate cartridge heater construction comprising a plurality of elongate axially aligned cores of compactible dielectric material, each with a resistance wire wound helically about it from one end thereof to the other, means connecting the several wires in series and including an elongate primary contact rod substantially coextensive with and extending longitudinally through the several cores, a connector pin extending into and between the opposing end portions of adjacent cores in spaced relationship with the primary contact rod, a coupling unit fixed to each end of each wire and having a sleeve portion engaged about its related pin or contact rod, a metallic sheath coextensive with and surrounding the assembly of cores, wires, pins, coupling units and rod, a filler of granular compactible dielectric material in the sheath and about the rod assembly, an end portion on the primary contact at one end of the assembly projecting axially at one end of the assembly projecting axially outwardly from the sheath, an elongate secondary contact rod engaged in the end of the core at said one end of the assembly and projecting axially outwardly from the sheath and a coupling unit between the secondary contact rod and the adjacent end of the adjacent wire, said sheath being swaged inwardly and progressively longitudinally from one end thereof to the other to compact the cores and the filler and to urge the sleeve portions of the coupling units into tight contact about their related pins and rods, said sleeve portions initially establishing sliding engagement about their related pins and rods whereby said coupling units are free to shift axially with their related ends of the wires and relative to their related rods and pins in advance of and during swaging of the construction.

This invention relates to an electric resistance heater unit and is more particularly concerned with an improved cartridge type heater.

In the electric heater art, cartridge type heater units, that is, the type of electric heater which includes a coil of resistance wire arranged within an elongate, tubular sheath or jacket, have long been provided.

In recent years, it has been found to be advantageous and it has become common practice in the economical mass production of cartridge type heaters to wind resistance wires about a core of compressed magnesium oxide, arranging the sub-assembled wire and core centrally within a ductile metal tube, filling the annulus between the sub-assembly and the tube with powdered magnesium oxide and, finally, swaging the tube radially inwardly to compact the powdered oxide about the sub-assembly.

The core referred to above is sintered and not fired hard so that when the construction is swaged, the core will reduce to granular or powder form and will subsequently combine and compact with the powdered magnesium oxide to the end that the wire is embedded in a substantially uniform mass of compacted magnesium oxide and in spaced, insulated relationship from the surrounding tube or jacket.

The ability of the core to reduce, as above set forth, is highly important since during the swaging operation, the structure extrudes and is elongated. If the core did not reduce upon the application of the necessary swaging forces, the wire could be drawn and moved longitudinally of the core and in such a manner as to draw and break it. Further, if the core were fully fired and such that it would

not reduce, its coefficient of expansion and other characteristics would be sufficiently different from the compacted powdered oxide about it that it could, by virtue of its solid state, cause relative shifting of the various parts of the construction, when heated and cooled, which shifting and working might result in fatigue and a shortened life expectancy.

In practice, the sintered magnesium oxide cores for electric heaters are extruded parts or members and are such that the longitudinal extent to which they can be made, without warping and twisting is restricted or limited. Further, due to their soft and fragile nature, their length must be materially limited to prevent breakage and to make manufacturing and mass production practical and feasible.

As a result of the above, it is common practice to make up long cartridge type heaters by arranging and connecting a plurality of like core and coil sub-assemblies of practical length, and of known electrical capacity; and arranging the sub-assemblies in axial alignment centrally in a tube, filling the annulus between the sub-assemblies and the tube with powdered oxide and, finally, swaging the resulting assembly, as set forth above.

To facilitate the above assembly, each sub-assembly core and coil is prepared as a separate unit with its own winding of resistance wire. These separate windings are connected in parallel electrically by a pair of elongate conductor rods passing through axially aligned openings or passageways formed in the cores. The rods extend through all of the cores and connect all of the windings in parallel.

While the above-noted conventional manner of establishing long cartridge type heaters is satisfactory in many situations, it is frequently unsatisfactory, particularly where high temperatures are to be encountered. This is because the resistance of each winding must be relatively high to provide the desired power dissipation. This, together with considerations of watts density dictate, in many applications, that the winding be formed of relatively small diameter resistance wire. Heaters formed with such small diameter wire, have limited life at higher watts density.

In the construction to be described here, larger diameter resistance wires are employed to achieve the same watts density by utilizing series connections and thereby providing a superior heater with greater performance and life characteristics.

It is an object of the present invention to provide an improved cartridge type heater comprising a plurality of axially aligned, series-connected resistance coils arranged in insulated relationship in a body of compacted magnesium oxide and within a metal jacket or sheath.

Another object of this invention is to provide a method of making a heater of the general character referred to.

Still another object of this invention is to provide a novel means for coupling the related ends of adjacent coils.

It is still another object of this invention to provide a heater construction of the character referred to wherein the several coils are initially engaged about sintered cores of magnesium oxide and the means employed to couple the ends of the related coils also serves to couple and maintain the sintered cores in proper engagement and alignment during the manufacture of the construction.

It is an object of this invention to provide coupling means for the related coils which allows for relative axial movement of the parts during manufacture and which establishes dependable and positive electrical contact between the coils in the finished product.

The above objects and features and other objects and features not recited in the foregoing will be apparent

from the following detailed description of a typical preferred form and carrying out of my invention, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is an isometric view of a heater as provided by the present invention;

FIG. 2 is a longitudinal sectional view taken as indicated by line 2—2 on FIG. 1;

FIG. 3 is an isometric view of a core as employed in this invention;

FIG. 4 is an isometric view of a coupler pin that I provide;

FIG. 5 is an isometric view of a coupler unit as provided by the present invention, showing it in one position;

FIG. 6 is an isometric view of a coupler unit showing it related to a coupler pin and an end of a coil;

FIG. 7 is a sectional view taken as indicated by line 7—7 on FIG. 2 and showing the construction partially completed;

FIG. 8 is a view similar to FIG. 7 showing the construction completed; and,

FIG. 9 is an isometric view illustrating a step employed in the method of establishing my new construction.

The heater H that I provide appears as an elongate metallic cylindrical member having substantially flat ends and having a pair of contact prongs projecting from one end, as clearly illustrated in FIG. 1 of the drawings.

The heater construction includes two or more like, axially aligned cores C, a coil W of resistance wire about each core, a primary contact rod R extending longitudinally through and between the several cores, a secondary contact rod R' engaged in the outer end of the outermost core, a plurality of contact pins P engaged in and extending between the opposing ends of the related cores, a plurality of like coupler units U connected with and between the ends of the coils W and their related rods and pins, an elongate tubular metal sheath S having an open end and a closed end, freely surrounding the assembled cores, coils, rods, pins and couplers, a body or mass B of granular insulating material in the sheath and surrounding the structure arranged therein and a plug D engaged in and closing the outer open end of the sheath and through which the ends of the rod R and R' project.

The cores C are simple elongate members of sintered magnesium oxide and are characterized by cylindrical outer surfaces 10, flat ends 11, an elongate primary opening 12 extending longitudinally from one end to the other and a pair of axially aligned secondary openings 13, one entering each end of the core in lateral spaced, parallel relationship from the primary opening 12. The openings 13, preferably, are of limited longitudinal extent and terminate in the core at flat bottoms.

In practice, if desired, and as illustrated in the drawings, the end portions of the cores C can be relieved as indicated at X. That is, a portion (for example, one-half) of the stock establishing the end portions of the core can be removed so as to shift a predetermined portion of the ends 11 axially inwardly as indicated at 11'.

The relieved portions of the cores are related to those openings 12 and 13 in the cores with which the coupler units U are to be related, and serve to provide space to accommodate the said coupler units, as will hereinafter be apparent.

The cores C are sintered so as to hold the granular material of which they are established together sufficiently secure to make handling and manipulation of the cores practical and feasible and yet allow for or permit the cores to reduce to granular form when subjected to forces and pressures in excess of those forces and pressures encountered when the cores are being manually handled and manipulated. Accordingly, the cores are such that they will readily reduce to granular form when the construction is swaged in the final step of manufacturing, as will hereinafter be described.

As noted in the preceding, the sintered magnesium oxide cores are extremely fragile and, as a result, their length or longitudinal extent is restricted by obvious practical matters.

The coils W may be of any resistance wire material, such as an alloy of nickel and chromium. The coils are wound helically about their related cores to extend from one end thereof to the other. The ends of the coils are provided with extensions of sufficient longitudinal extent to allow for the establishment of suitable electrical attachment or connection of the ends of the coil, without adversely upsetting or disturbing the convolutions thereof.

The primary contact rod R is a straight length of large diameter wire stock of suitable metal. The rod is of sufficient length to extend longitudinally through the openings 12 in the several aligned cores and to further project from the inner free end of the innermost core a sufficient extent to facilitate establishing a desired electrical contact with the inner end of the innermost coil and to project from the other end of the heater through the plug D and so as to form a contact prong, as clearly illustrated in the drawings.

The secondary contact rod R' and the several contact pins P, preferably, are alike. The rod R' and the pins P are established of relatively short, predetermined lengths of the same or similar large diameter wire stock from which the contact rod R is established.

The secondary contact rod R' is engaged in the opening 13 in the outer end of the outermost core C and projects through and from the plug D, as clearly illustrated in the drawings.

The pins P are arranged between the opposing openings 13 in the cores, in alignment with the opposing openings 13 in the cores. The pins are of sufficient length to seat or bottom in the openings 13 and to serve as spacers to hold the related cores in predetermined axial spaced relationship. This spacer function is important if the ends of the cores are not relieved, as at X, but could be dispensed with in cases where the cores are relieved to provide adequate space to accommodate the coupler units U.

In practice, the pins P are initially bowed or bent slightly, longitudinally. That is, they are not straight, but are slightly curved longitudinally. The curvature or bow in the pins is provided so that when the pins are engaged in the openings 13 they are sprung or biased slightly in said openings. This biasing tends to hold each end of the pins snugly in their related openings 13 and to thereby couple and hold the related cores in snug fixed relationship.

It is to be noted that due to the fragile nature of the cores, the rods R and R' and the pins P preferably are not press-fitted in their related openings in the cores, as such could fracture the cores. Rather, the said rods and pins extend substantially freely through and into the core openings. While a free fit allows for practical assembly of the construction, it also interferes and makes assembly difficult because the cores are free to shift longitudinally relative to the rods, pins and to each other, and in such a manner as to cause detrimental displacement of the several parts of the construction, during manufacture.

By bowing or bending the contact pins P, as set forth above, the pins establish predetermined and controlled frictional engagement in their related core openings 13, which frictional engagement is sufficient to prevent the assembly from shifting and parting during assembly.

Another advantage in bowing or bending the pins in the manner set forth above is experienced during the final swaging operation. When the construction is swaged, it is elongated slightly and there is a tendency for the pins P to be urged or shifted longitudinally in advance of the swaging and in such a manner as to upset the desired relationship of parts and to break the desired connections. This tendency for the pins to be urged longitudinally in advance of the swaging would be considerable if the pins were straight and in axial alignment with the construc-

tion. However, where as here the pins are bowed, the noted tendency for the pins to be shifted longitudinally is reduced to an extent that it ceases to be a problem.

When the pins are bowed and swaging is performed, there is a tendency for the pins, when subjected to the advancing pressures and forces, to pivot or swing radially slightly and to straighten out. The forces tending to swing the pins radially and to straighten the pins are the same forces which would otherwise tend to shift the pins longitudinally and, as a result, so deplete the forces that tend to cause longitudinal shifting that such shifting is no problem.

The coupling units U are in the nature of double, split eyelets formed of soft malleable sheet metal.

Referring to FIGS. 5 and 6 of the drawings, each unit U has a vertically extending inverted, U-shaped primary portion 20 adapted to engage about a related contact rod or pin and a horizontally extending U-shaped secondary portion 21 to engage an end of a related coil W.

The primary portion 20 has a semi-circular base 22 corresponding in radius with the radius of the rods and pins and has a pair of depending deformable legs 23. In practice, the portion 20 is engaged over a related rod or pin and the legs are bent inwardly and around the rod or pin by means of a suitable tool as as to embrace the rod or pin, as clearly illustrated in the drawings.

It will be apparent from the above that the portions 21 of the couplers extend axially and surround or engage about their related pins and rods.

The portion 21 of each coupler has a semi-circular base 24 corresponding in diameter with the wire stock from which the coils W are established and has a pair of horizontally or axially extending legs 25.

The extensions at the ends of the coils W are engaged and seated in the base 24 of their related couplers and the legs 25 are bent in and about the wire as illustrated in FIG. 6 of the drawings.

It will be apparent that the secondary portions of the couplers U extend radially outwardly relative to the longitudinal axis of the construction and relative to their related primary portions.

The primary and secondary portions 20 and 21 of the couplers are integrally connected by a web 25, which web is bent and extends between the radial inner end of the base 24 of the secondary portion 21 and an end of the base 22 of the primary portion 20. While the legs 25 of the secondary portion 21 can extend axially in either direction, it is preferred that they extend axially over the base of the primary portion, so that the secondary portion occurs radially of and overlies the primary portion. With this relationship of parts, the longitudinal extent of the coupler is substantially less than it would be if the legs of the secondary portion projected in the opposite direction.

Further, with this relationship of parts, the base of the primary portion serves as a stop and as a base upon or to which the ends of the coil wire can be urged when the construction is being made up or assembled. Such a stop or base serves to aid the assembler in providing the necessary length of lead on the coils, particularly when the units U are connected with the coils first and with the rods and pin secondly.

In practice, the primary and secondary portions of the units U are engaged about their related rods, pins and wires with sufficient force to assure a snug, but sliding fit between the bases of said portions and their related rods, pins and wires.

Accordingly, the granular magnesium oxide employed will not migrate between the bases of the primary and secondary portions and their related rods and wires in such a manner as to prevent a proper electrical contact.

The establishment, initially, of a sliding fit between the couplers and their related rod, pins and wires is important since such a fit allows for limited relative shifting of the parts during the swaging operation and eliminates the

possibility of the parts being drawn or pulled apart, during swaging.

The sheath S is formed of a suitable ductile metal into a right cylinder with an end wall 31 closing the inner end of the sheath, and an open outer end 32.

In practice, the tube or sheath can be established by a suitable drawing operation and then annealed to prepare it for subsequent swaging.

The sheath is originally slightly larger in diameter and slightly less in longitudinal extent than the finished product.

The plug D is a simple cylindrical plug-like body established of a suitable compactible dielectric material, such as lava or other materials well known in the art, and is provided with a pair of openings 32 through which the outer ends of the rods R and R' project.

In manufacturing, the coupler units U are initially engaged with their related ends of the coils, which coils are engaged about their related cores C. The innermost core is first engaged about the inner end portion of the primary contact rod R and the coupler U at the inner end of said core is engaged about the inner end of the rod. The pin P related to the innermost core is inserted in the opening 13 in the outer end of said core and the coupler unit U at the outer end of said core is engaged therewith.

The next core with coil and couplers related thereto, is engaged on the rod R and is advanced longitudinally into engagement with the pin P on the first core and the coupler at the inner end of the said next core is engaged with said pin.

The above procedure is continued until all of the cores and their related parts are assembled and engaged.

The secondary contact rod R' is then engaged in the opening 13 in the outer end of the outermost core and the coupler U related thereto is engaged therewith.

The above assembly is then inserted into the sheath, in axial alignment therewith. The sheath is then arranged vertically, with its open end 35 disposed upwardly and the granular or powdered magnesium oxide is poured or introduced into the sheath. The construction, preferably, is vibrated while the oxide is being introduced into the sheath to cause the oxide to flow into and to fill all of the voids and interstices presented by the construction and to compact therein.

When the sheath is filled with oxide to a point above the upper end of the outermost core, the plug D is engaged over the rods R and R' and is advanced into engagement in the open end 35 of the sheath.

The sheath is then swaged radially inwardly and from its inner end, longitudinally outwardly as illustrated in FIG. 9 of the drawings, in the manner well known to those skilled in the art.

When the sheath is swaged as set forth above, the cores C are reduced to granular form and are compacted. At the same time, the granular or powdered filler of magnesium oxide is compacted. As a result the cores are, in effect, eliminated and the rods, pins, coils and coupler units are embedded, in insulated relationship in a uniform compacted magnesium oxide filler.

Still further, when the construction is swaged and the magnesium oxide is compacted, the forces exerted on and through the oxide are directed onto and through the coupler units U and force the coupler units into tight and positive electrical contact with their related rods, pins and coil wires.

The swaging operation also urges the sheath into tight sealing engagement about the plug D and urges the plug D into tight sealing engagement about the rods R and R'.

From the foregoing, it will be apparent that I have invented a new and novel multiple coil, series-connected, cartridge-type heater construction, which construction is easy and economical to manufacture and is highly effective and dependable in operation.

Having described only a typical preferred form and application of my invention, I do not wish to be limited to

the specific details herein set forth, but wish to reserve to myself any modifications or variations that may appear to those skilled in the art and which fall within the scope of the following claims.

Having described my invention, I claim:

1. An electric cartridge heater of the character referred to including, an elongate tubular metal sheath with a closed inner end and an open outer end, a plurality of sub-assemblies each comprising an elongate cylindrical core of granular magnesium oxide and a coil of resistance wire wound helically about the core and extending from one end thereof to the other, said sub-assemblies being arranged in axial alignment and centrally within the sheath, an elongate primary contact rod with an inner portion within the sheath, extending longitudinally through the several cores, a coupler unit securing the inner end of the coil on the innermost core to the inner end of the primary rod, a plurality of elongate connector pins extending longitudinally between and into the opposing end portions of adjacent cores, in lateral spaced parallel relationship with the primary contact rod and radially inwardly of the coils, coupling units connecting the ends of the coils at the said opposing ends of the cores to the pins, a secondary contact rod with an inner portion engaged in the outer end of the outermost core in axial alignment with the pins, a coupler unit connecting the outer end of the coil on the outermost core to the secondary contact rod, a plug dielectric material engaged in the outer end of the sheath and through which the outer portions of the rods extend and a filler of granular magnesium oxide in the sheath and about the parts arranged therein.

2. A structure as set forth in claim 1 wherein, said sheath is swaged longitudinally and radially inwardly whereby said filler and cores are compacted to establish an integral uniform supporting mass of magnesium oxide for the parts within the sheath.

3. A structure as set forth in claim 1 wherein, said coupler units are alike and each involves an axially extending semi-circular split primary sleeve engaged about its related rod or pin, a substantially radially extending, semi-circular split secondary sleeve engaged about the end of its related coil wire and a web extending between and integrally joining adjacent ends of the said primary and secondary split sleeve portions.

4. A structure as set forth in claim 1 wherein, said sheath is swaged longitudinally and radially inwardly whereby said filler and cores are compacted to establish an integral uniform supporting mass of magnesium oxide for the parts within the sheath, said coupler units being alike and each involving an axially extending semi-circular split primary sleeve engaged about its related rod or pin, a substantially radially extending, semi-circular split secondary sleeve engaged about the end of its related coil wire and a web extending between and integrally joining adjacent ends of the said primary and secondary split sleeve portions.

5. A structure as set forth in claim 1 wherein, said sheath is swaged longitudinally and radially inwardly whereby said filler and said cores are compacted to establish an integral uniform supporting mass for the parts within the sheath, said coupler units are like soft, malleable metal units each including an axially extending primary split sleeve portion engaged about its related rod or pin, a substantially radially extending secondary split sleeve portion engaged and crimped about the end of its related coil wire and a web extending between and integrally joining adjacent ends of said primary and secondary split sleeve portions.

6. A structure as set forth in claim 1 wherein, said cores have longitudinally extending primary openings and longitudinally extending secondary openings, said primary

contact rod being slidably engaged through the primary openings of the several cores, said conductor pins being slidably engaged in the ends of the secondary openings at the ends of the related core between which said pins extend.

7. A structure as set forth in claim 1 wherein, said cores have axially aligned longitudinally extending primary and secondary openings, said primary contact rod being slidably engaged through the primary openings of the several cores, opposite end portions of said conductor pins being slidably engaged in the secondary openings at the opposing ends of adjacent related cores, the ends of the cores being relieved axially inwardly and radially outwardly adjacent the ends of the openings, the coupling units occurring within the relief in the end of their related core.

8. A structure as set forth in claim 1 wherein, said cores having longitudinally extending primary openings and longitudinally extending secondary openings, said primary contact rod being slidably engaged through the primary openings of the several cores, the opposite end portions of said conductor pins being slidably engaged in the secondary openings at the opposing ends of their related cores, said connector pins being normally bowed radially throughout their longitudinal extent whereby said pins are biased radially in their related secondary openings and frictionally resist relative axial shifting of the cores and axial shifting relative to the cores.

9. An electric heater comprising an elongate outer metallic sheath with front and rear ends, a plurality of helical windings of resistance wire arranged concentrically within the sheath in axial alignment with each other, an elongate primary contact rod having an inner portion extending longitudinally through the sheath within the confines of the windings and outer portion projecting from the rear end of the sheath, coupling means connecting the inner end of the innermost winding to the innermost end of the rod, like coupling means connecting the adjacent ends of each adjacent pair of windings, a secondary elongate contact rod of limited longitudinal extent with an inner portion in the rear portion end of the sheath within the confines of the rearmost winding and in spaced relationship with the primary contact and an outer portion projecting from the rear end of the sheath, coupling means connecting the rear end of the rearmost winding to the secondary rod, and granular insulating material compacted within the sheath and about said windings, rods and coupling means to maintain said sheath windings and rods in spaced insulated relationship and to urge and maintain the coupling means in tight electrical contact with their related windings and rods, each of said coupling means connecting the adjacent ends of adjacent pairs of windings including a longitudinally extending pin arranged in spaced parallel relationship with the primary rod between and within the confines of its related windings and a pair of malleable metal coupling units each with primary sleeve portions engaging the end of a related winding and secondary sleeve portion engaged about a portion of the pin.

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