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J. P. TARBOX
CABLE CONSTRUCTION

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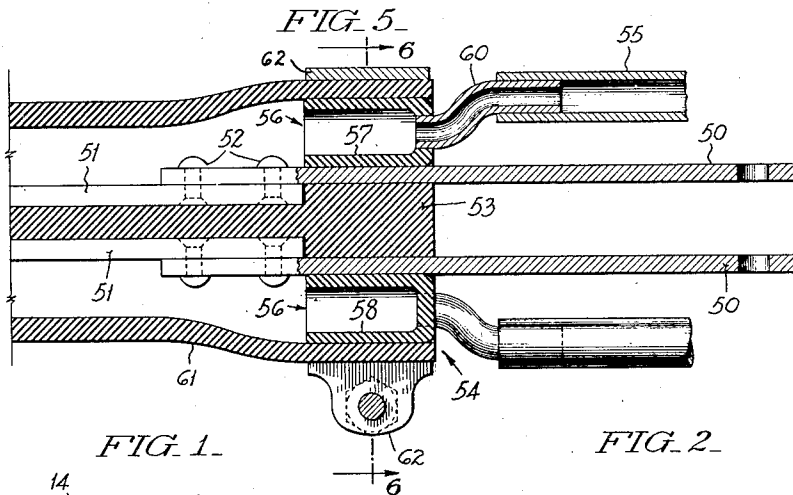


FIG. 1

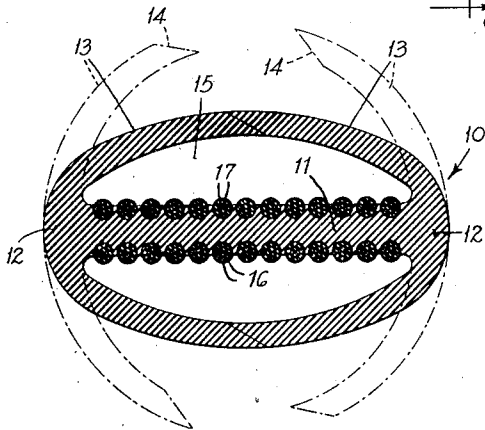


FIG. 2

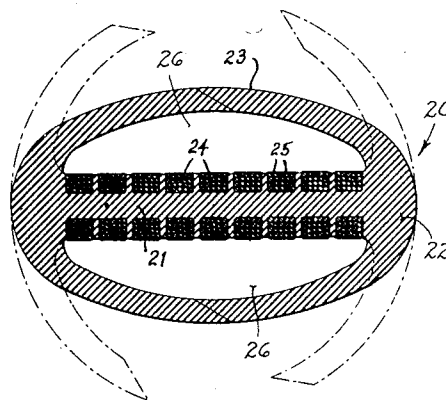


FIG. 3

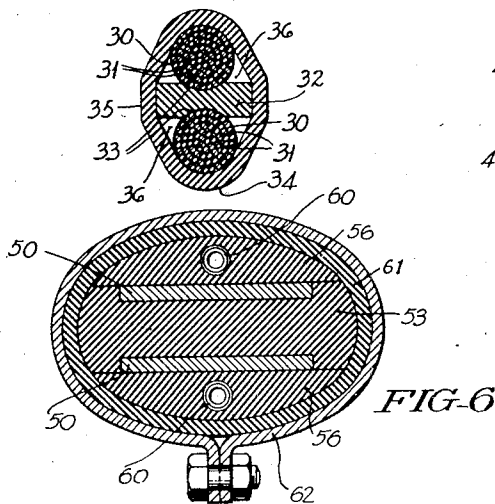


FIG. 4

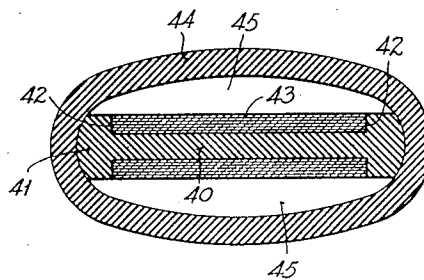
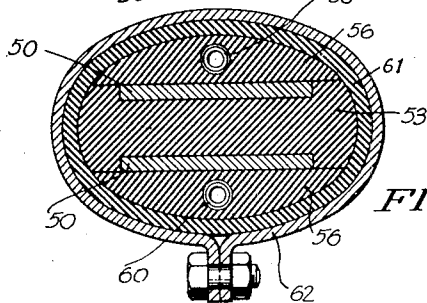


FIG. 6



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CABLE CONSTRUCTION

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This invention relates to electric bus bars, cables, and the like and has particular applicability to conductors for transfer of heavy currents.

In certain industrial fields, as in the welding art, currents are employed of values often exceeding 1000 amperes and consequently it becomes of considerable importance that the conductors are capable of carrying these currents without overheating with resulting loss in voltage and power. While numerous factors in conductor construction should be considered applicant has ascertained the following to be of outstanding importance: (a) strand formation of the conductor, (b) proximity of in and out conductors, (c) direct cooling of conductors by a coolant. Strand formation has utility in tending to confine the current in individual strands since oxidation of the strand surface develops a current resistant film. To the extent that this surface resistance develops skin effect in each strand, losses due to alternating currents are reduced. Moreover, strand formation facilitates easy flexure of the bar or cable, this feature being of particular importance in the welding art.

Proximity of in and out conductor sections is of importance primarily in reducing the reactance of the conductors, thereby permitting a larger current flow as of a given temperature and reducing lateral stress or kick. Reduction of reactance arises from the pure inductive action of one section on the other as well as the inductive interaction due to the physical connection of the two sections and known as proximity effect. The result of both inductions is to reduce the reactance on adjacent conductor surface thus increasing current flow.

Direct cooling supplements the other two factors by providing a certain means for abstracting heat from the conductor. By so doing the heat developed by the current is prevented from accumulating in the conductor and hence for a given temperature the current output may be increased.

Having the above factors under consideration the objects of the invention may be thus summarized: to provide a cable construction wherein stranded conductors are effectively employed; to provide a conductor having increased current capacity due to diminished reactance; to provide effective means for introducing and applying a

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coolant in direct relation to the conductor; to provide structure permitting ready flexure of the conductor; to provide a conductor resistant to short circuit stresses; to provide terminal connections for the conductors; and to provide in general a compact, flexible conductor construction capable of use with highest efficiency.

With these objects in mind reference is now made to the disclosure including the description of certain embodiments of the invention, which may be preferred, and the accompanying drawings in which:

Figure 1 is a sectional view of a bus bar cable illustrating one form of a conductor;

Figure 2 is a view illustrating a modified form of the bus bar construction;

Figures 3 and 4 illustrate further conductor modifications;

Figure 5 is a sectional view of a connection between general bus bars and the conductor unit of the invention; and

Figure 6 is a section taken along lines 6—6 of Figure 5.

Referring to Figure 1 there is indicated an insulation support for the cable or conductor indicated generally by the numeral 10, this support including a flattened flexible strip 11 attached to extend the full width of the conductor and beyond the same. At either edge of this strip is secured enlarged sections 12 having duplex flaps 13 with diagonal edges 14 extending from opposite sides thereof. The flap width is such that when folded with the edges 14 in engaging relationship a tubular conduit 15 is formed on either side of the central strip partition 11.

Adapted to be positioned within the tubular conduits 15 as above described are a plurality of cables 16 each of which is formed of multiple intertwined strands 17. These cables overlie and underlie the partition 11 to which they are attached as by vulcanization. The strip edge and flap material may be a homogeneous substance such as rubber or rubber containing composition possessing sufficient strength and rigidity to maintain normally the indicated form but also having sufficient elasticity to permit a degree of flexing under influence of torsional stresses. The material also preferably should be such as to permit sealing or bonding so that the cables 16 may be

welded securely in place and the juncture of the end flap offer adequate resistance to strain.

In assembling the conductor in accordance with the above described structure with the flaps 13 open, the cables 16 are placed into position on either side of the strip 11 and vulcanized or otherwise secured in place. The adjoining edges 14 of the adjacent flaps are then brought together and bonded by an appropriate means so as to be waterproof. It is pointed out that the dimensions of the flaps 13 are such that when bonded there exists a conduit 15 of cross sectional area substantially in excess of the total cross sectional area of the cables 16, this being for the purpose of providing a channel for cooling liquid such as water whereby the conductors may be subjected to a constant cooling during periods of current conduction.

Figure 2 illustrates the modification of the invention wherein the supporting unit 20, including the cross strip 21, end sections 22 and side flaps 23 are similar to corresponding parts of the support 10 of Figure 1. The change over the described modification lies in the employment of multiple cables 24, the same being in rectangular cross section and being formed of a plurality of individual strands 25 twisted together. In assembling the conductor according to this modification the cables 24 are somewhat displaced from each other so as to provide space for entry of bonding material so that when sealed or vulcanized the cables are securely fastened not only to the strip 21 but to each other thus imparting an increased rigidity to the whole structure. Conduits 26 are formed in the completed assembly.

In Figure 3 is illustrated a modification of the invention employing supporting elements frictionally related to each other instead of integral. In this modification the cables 30 are cylindrical and formed of inter-twisted strands 31, one cable being above and another below an insulating partition 32, in which grooves 33 form supporting channels. A sheath 34 forms a casing around the conductors and insulator 32, the sheath being of insulating and flexible material which is impervious to water. As shown the sheath 34 is taut, frictional contact with the squared ends 35 of the insulator strip 32 serving to hold them in place. Channels 36 above and below the strip 32 and on either side of the conductors are formed by this construction.

The modification of Figure 4 also utilizes frictional holding means between the central partition and casing. There is illustrated a central strip 40 with enlarged edge members 41 and having vertical inner surfaces 42 defining shallow channels in which the conductor is positioned. In this form of the invention the conductor is illustrated as a bus bar 43 although cables, strand or single, may also be employed. The outer surface of the edge sections are curved to form a curvilinear surface for engagement with the inner surface of the enclosing sheath or casing 44. It is observed that this sheath is oversized so that normally spaces forming conduits 45 exist for conductor of water or other coolant.

There is illustrated in Figures 5 and 6 means by which the conductors as hereinabove described may be attached to a panel bus bar for example and to the coolant source. The panel bus bars are indicated at 50, the same being attached to the cable or bus bar 51 of the conductor by any appropriate means such as the rivets 52. Interposed between the bus bars 50 is an insulation

member 53 which is of a thickness sufficient to overlie the ends of the bus bars 51 of the conductor. On the other side of the bus bars 50 are positioned the ferrule connections 54 to the water pipe lines 55. These ferrules take the form of circular segments 56 having a flat side 57 and an upper curved side 58 through the center of which a conduit 59 extends. A tube 60 connects one end of this conduit to the pipe line 55 thus establishing a pipe connection to the conductor bus bars or cables 51. The casing or sheath 61 of the conductor is extended to overlie the ferrules 54 and the insulation block 53, contact of the sheath with the ferrule and insulation being made watertight by means of the clamp 62.

In connection with the modification of the invention herein disclosed it is pointed out that the intervening partition forming part of the support within the conductor separating and supporting the conductors has a thickness of such value that the cables on one side of the partition inductively affect the cables on the other side. In order to make this action the more positive preferably the thickness of this partition should not be cut over $\frac{1}{8}$ " and desirably $\frac{1}{16}$ ". With this limited separation of the cables, the same carrying current in opposite directions, the effect of induction is made pronounced thus reducing the reactance on the adjacent surfaces of the cables and permitting a larger flow of current than would otherwise flow. This factor is of considerable importance in alternating current circuits where the cables carry large amounts of current as is the case when employed in connection with welding apparatus. It is pointed out further that the employment of strands in each cable increases the flexibility of the conductor as a whole so that the cable may be readily employed in shops and among machines. Stranding also increases the overall surface area of the cables and where the strand surface is subject to oxidation, as is generally the case, the interstrand resistance is increased thus tending to confine the skin effect current to the individual strands rather than to the cable as a whole. In this way the overall resistance of the cable may be decreased when utilized in connection with alternating currents.

In each modification as disclosed a cross section of the conduit for current is materially greater than that of the enclosed conductor so that ample passageway is maintained for the cooling liquid. The value of the coolant resides in the overall reduction of heat due to coolant flow so that for a given temperature the amount of current is considerably increased. Thus the utilization of the cooling medium combines with the reduction of reactance and the increase in effective surface area of the conductor to augment appreciably the current carrying capacity of the conductor, over conductors of the same cross section not embodying the described inventive concepts.

For illustrative purposes the invention has been described as applied to dual cable conductors. However, three or more conductors in separate coolant conduits may be employed under certain condition. Other modifications may be made, the scope of the invention being determined by the claims hereto appended.

What is claimed is:

1. A process of making electrical conductors which comprises forming a strip of insulation material with flexible, divided, strip extensions on each edge, thereof, positioning electrical con-

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ducting units on each side of said strip, folding over adjacent opposite edge extensions to form conducting unit enclosing tubes of greater cross sectional area than the enclosed conducting unit and sealing together the folded edges of said edge extensions.

2. A cable blank for electric conductors comprising a strip of insulation material having flexible reversely extended strip extensions at each edge on each side thereof, the width of each extension being greater than one-half of the strip width whereby the extensions on one side of the strip may be edge joined to form a tube adapted to receive a conductor.

3. A cable blank for electric conductors comprising a strip of insulation material adapted to be placed between said conductors and having flexible reversely extended strip extensions at each edge on each side thereof, the sum of the widths from edge to edge of the strip extensions on each side exceeding the width of said strip.

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