Jan. 14, 1941. G. WASSERMANN 2,228,797

MANUFACTURE OF TELEPHONE CABLES

Filed May 21, 1938

FIG. 1.

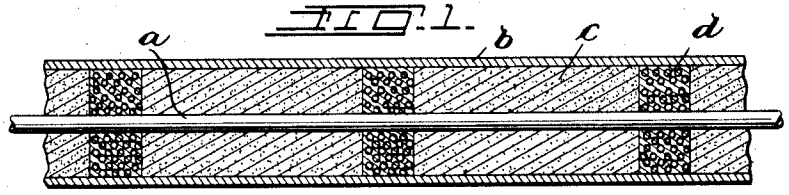


FIG. 2.

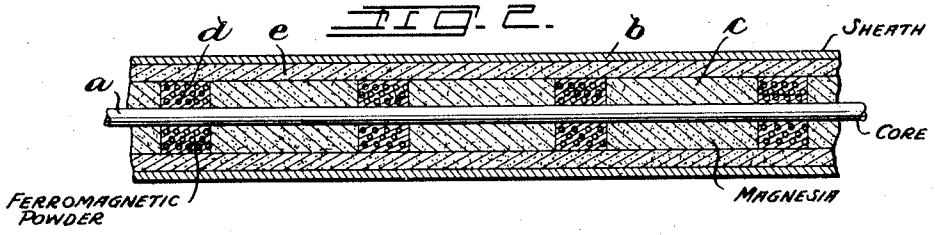


FIG. 3.

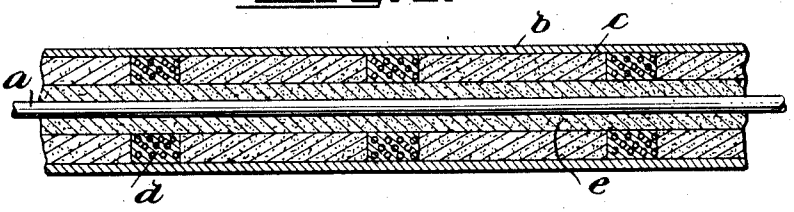


FIG. 4.

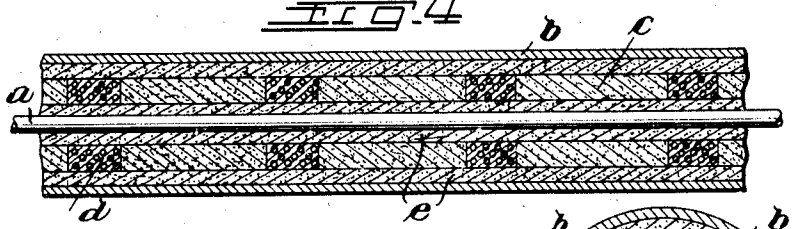


FIG. 5.

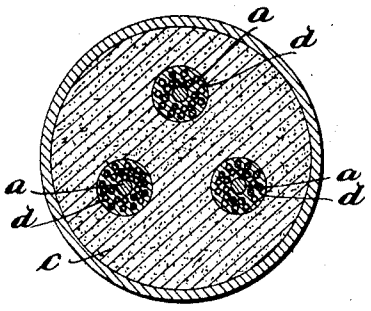
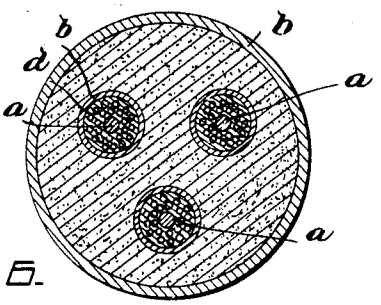


FIG. 6.



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Patented Jan. 14, 1941 2,228,797

UNITED STATES PATENT OFFICE

2,228,797

MANUFACTURE OF TELEPHONE CABLES

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Application May 21, 1938, Serial No. 209,305
In Germany May 24, 1937

8 Claims. (Cl. 178—45)

The present invention relates to a novel construction of telephone cable having a discontinuous filling and intended for the transmission of weak currents.

It has already been proposed, for the transmission of weak currents, to construct a concentric air-insulated cable, on the inner conductor of which is arranged at regular intervals a localized inductive filling which is formed by suitably insulated ferro-magnetic powder, or magnetic ribbon wound on itself so as to form a coil which occupies the whole or a part of the empty space left between the inner conductor and the outer conductor.

However, these systems have drawbacks which are inherent to their actual nature. Thus, the centering of the inner conductor relatively to the outer conductor is only ensured by the filling coils and, if necessary, by additional insulating spacing members which are arranged between the filling coils and are intended to prevent the inner conductor from touching the outer conductor during the successive winding and unwinding of the cable and the folding operations to which said cable may be subjected, and thereby making any transmission impossible. It is a well known fact that the centering thus obtained is never occurate and according to whether the inner conductor is more or less out of center relatively to the outer conductor, the characteristic impedance of the cable correspondingly varies more or less.

Furthermore, this type of construction necessarily leads, on the one hand to forming the outer conductor by two or more strips of a good conducting material which are cabled together with a relatively quick pitch, and on the other hand to providing, on said strips, grooves which are adapted to receive and secure the filling coils and the spacing members which have previously been arranged on the central conductor. This produces an increase of resistance of the outer conductor which is caused in the first place by the increase of length of the current streams due to the cabling of the strips and to the grooves created on said strips, which results in an increase of the kilometric weakening of the cable. Finally, another drawback rests in the fact that the actual formation of the outer conductor makes it difficult to prevent spaces from forming in the long run between the strips which form the outer conductor, thereby enabling outer disturbing fields to induce eddy current in the cable. It is true that said drawbacks can be overcome, and this is in general what is done, by surrounding the outer conductor with a continuous lead sheath which creates an additional obstacle to the penetration of the outer disturbing fields into the cable, but the cost of the cable is thereby considerably increased.

In the drawing various exemplary embodiments of the invention are shown in which:

Figure 1 is a longitudinal sectional view showing one form of the invention;

Figure 2 is a similar view of a modification;

Figure 3 is a similar view of a further modification;

Figure 4 is a similar view of a still further modification;

Figure 5 is a cross sectional view illustrating a plurality of cables within a single sheath; and

Figure 6 is a similar cross sectional view illustrating a modified construction with a plurality of cables within a single sheath.

The present invention enables the foregoing drawbacks to be eliminated by forming a co-axial cable *a* having a discontinuous inductive filling and in which the centering is automatically ensured and the outer conductor is formed by a continuous cylindrical sheath *b* made of a good conducting material.

According to one feature of the invention, the space between the central conductor *a* and the outer conductor *b* is filled with insulating material *c* such as magnesia and is replaced, at regular intervals, over a predetermined length of the conductor, by a ferromagnetic powder *d* the particles of which are insulated from each other.

According to another feature of the invention, the powdered insulator *c* and the ferromagnetic powder *d*, before being placed on the conductor, are compressed so as to have substantially the same or similar degree of compacity and then have the shape of cylinders provided with a central hole, the diameter of the hole being essentially that of the central conductor and the outer diameter of the cylinder being essentially the inner diameter of the outer conductor. It is of advantage that the taken compacities are limit compacities.

According to another feature of the invention, the workpiece consisting of the central conductor *a* on which the insulating cylinders *c*, the cylinders of compressed ferromagnetic powder *d*, and the outer cylindrical sheath *b* have been suitably arranged, is subjected to a drawing operation which is intended to give it the dimensions and especially the required diameter for the use it is desired to make of it (underground, submarine, aerial, telephone cable).

The filling of the central conductor of a co-axial cable decreases the cut-off frequency of the cable, that is to say the frequency beyond which transmission is no longer possible, but on the other hand it decreases the weakening produced by the non-filled co-axial in the band transmitted.

According to a known rule, the spacing of the filling points should be such that there is a fairly large number of coils per wave length corresponding to the highest frequency it is desired to trans-

mit. Nine or more filling points may be taken for example per wave length thus defined.

The highest frequency to be transmitted being fixed and the kilometric weakening at such frequency being imposed, the spacing of the filling points will then be determined, and the following parameters will furthermore be available: permeability of the ferromagnetic powder, height of the cylinder formed by the compressed powder, diameter of the inner conductor, inner diameter of the outer conductor, for giving the cable the desired kilometric weakening in the imposed transmission band.

This calculation having been made and the process according to the invention consisting in obtaining the cable by effecting successive drawing operations, from a cylindrical work-piece in which has been arranged the core suitably covered by the cylinders of compressed insulating powder and the cylinders of insulated ferromagnetic powder, it will be an easy matter to go back from the specification obtained to the determination of the dimensions of the cylinders made of ferro-magnetic powder which are to be arranged in the work-piece and to the distance which should be left between two filling points in the work-piece.

It can thus be seen that the calculation of all the starting elements is very readily effected. When this has been done, the manufacture can be started, said manufacture consisting in, after having arranged, as stated above, all the elements in the cylindrical work-piece, subjecting said work-piece to successive drawing operations alternating with intermediate annealing operations until the desired diameter is obtained. It will be observed that as the successive drawing operations may cause the ferromagnetic powder to lose its permeability, the intermediate annealing operations will be graduated so as to restore to it at the end of the operation the permeability on which the previous calculation was based.

It is now obvious that the drawbacks mentioned at the beginning of this specification for air-insulated cables are completely eliminated by the process according to the invention. In fact, the compressed insulating cylinders have a central hole which has very accurately the diameter of the central conductor and the same is the case with the cylinders made of compressed ferromagnetic powder. As, on the other hand, the outer diameter of said cylinders is equal to the inner diameter of the cylindrical work-piece from which the manufacture is started, it will be seen that the centering of the inner conductor is automatically ensured over its entire length. Finally, the process of manufacture itself gives the outer conductor the shape of a continuous cylindrical sheath which is a good conductor and performs the function of a screen for the outer disturbing fields.

Numerous modifications may be made without departing from the spirit of the invention: thus, the cylinders made of compressed ferro-magnetic powder *d* may be insulated from the inner conductor *a* and/or from the outer conductor *b* by arranging rings *e* of compressed insulating powder between the cylinders *d* made of powder and the inner and/or outer conductors *a* and *b*, respectively (see Figs. 2, 3 and 4). Another shape may also be adopted than the cylindrical shape for the outer conductor, for example a circular segmental shape, or an elliptical shape. Finally, a plurality of cables *a* according to the invention may be grouped in a single sheath *b*. (Figs. 5 and 6). All these modifications do not involve any change in the spirit of the invention.

Somewhat similar constructions are shown in applicant's co-pending application, Serial No. 209,306 filed May 21, 1938.

Having now particularly described and ascertained the nature of my invention and in what manner the same is to be performed, I declare that what I claim is:

1. A conductor for telephone cables having a high inductive filling which are obtained by drawing from a work-piece comprising at least one core, an outer metal sheath, and interposed between said core and said sheath alternate fillings longitudinally on the one hand of ferro-magnetic elements insulated from each other, and on the other hand of insulating material.

2. A conductor for telephone cables having a high inductive filling which are obtained by drawing from a work-piece comprising at least one core, an outer metal sheath, and interposed between said core and said sheath, alternate fillings on the one hand of ferro-magnetic elements insulated from each other, and on the other hand of insulating material, said fillings being in a highly compressed state.

3. A conductor for telephone cables having a high inductive filling which are obtained by drawing from a work-piece comprising at least one core, an outer metal sheath and, interposed between said core and said sheath, alternate fillings on the one hand of elements formed by particules of ferro-nickel insulated from each other, and on the other hand by an insulating material.

4. A conductor for telephone cables having a high inductive filling which are obtained by drawing from a work-piece comprising at least one core, an outer metal sheath and, interposed between said core and sheath, a filling made of a compressed powdered insulating material and interrupted at regular intervals by a filling of ferromagnetic elements which are insulated from each other.

5. Process for manufacturing the conductor according to claim 1, wherein the intermediate filling substances are compressed to the state of blocks which are introduced into the work-piece about the core, said work-piece being then subjected to a metallurgical drawing treatment.

6. Process for manufacturing the conductor according to claim 1, wherein the intermediate filling substances are compressed to the state of blocks which are introduced into the work-piece about the core, said work-piece being then subjected to a metallurgical drawing treatment by successive operations with intermediate annealing treatments until the desired elongation and diameter are obtained.

7. Process for manufacturing the conductor according to claim 1, wherein the various intermediate substances are compressed to the state of blocks of substantially equivalent capacity and are introduced into the work-piece about the core, said work-piece then being subjected to a metallurgical drawing treatment.

8. Process for manufacturing the conductor according to claim 1, wherein the various intermediate substances are compressed to blocks in the state of limited compacity and said blocks are introduced into the work-piece about the core, said work-piece then being subjected to a metallurgical drawing treatment.

GÜNTER WASSERMANN.