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METHOD AND APPARATUS FOR PREPARING MATERIALS AND APPLICATIONS THEREOF

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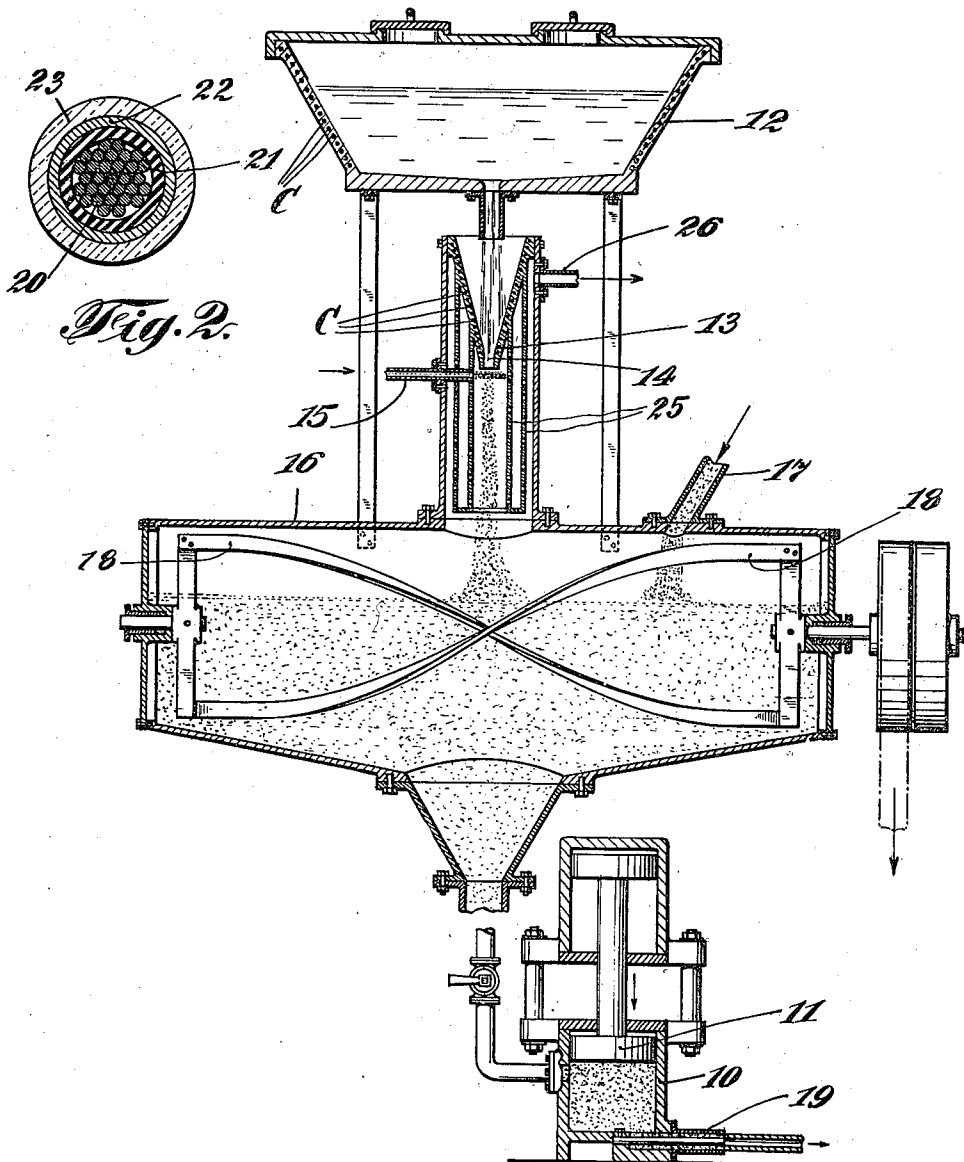


Fig. 1.

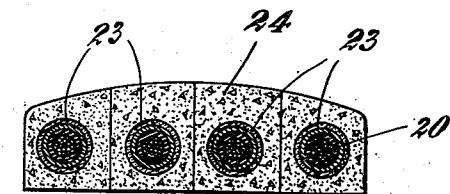


Fig. 2.

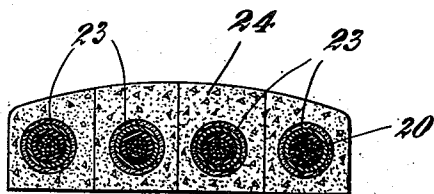


Fig. 3.

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METHOD AND APPARATUS FOR PREPARING MATERIALS AND APPLICATIONS THEREOF.

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My present invention is shown applied to eliminating distortion effects in telephone cables due to the magnetic induction of neighboring high tension alternating current transmission lines.

able operation results by increasing L and decreasing R .

As regards the decrease of R , this can be accomplished by the addition of copper wires in parallel, lengthwise of the cable. The self-inductance L may be increased, for instance, by armoring the cable with iron.

In addition to increase of the denominator of the above equation, decrease of the numerator, that is, of the mutual inductance M , renders possible the reduction of the inductive disturbances. This effect is utilized where cables are armored with iron, or enclosed in iron tubes. In the case of cable conductors, the principle has, however, not been heretofore utilized for affording protection against exterior magnetic fields, probably for the reason that the execution of this process up to now has involved considerable technical and mechanical difficulties.

According to my present invention, I have devised a new method of protecting telephone conductors from the effect of magnetic fields, induced from the exterior, which effectively utilizes the magnetic screening action of a ferro-magnetic enclosure of the cable strands.

From general theoretical considerations, it would appear that this result can be best accomplished by enclosing the cable in thick iron armor. Even the use of iron tubes as employed for many purposes would offer some advantages. The screening effect S of an iron armor whose thickness d is small in comparison to its diameter D , that is, the relation of the magnetic field strengths at the exterior and the interior of such armor, is given by the formula:

$$\frac{H_e}{H_i} = S = 1 + \frac{d}{D} (\mu - 2)$$

where (see Graetz Handbuch d. Elektrizität und des Magnetismus, Vol. IV, page 164; 1913) μ is the permeability of the ferro-magnetic medium. An iron tube of 100 m. m. diameter and 3 m. m. thickness would, assuming the initial permeability to be but 100, accordingly produce a screening effect S equal to about 4. In this case, the deleterious inductive action, assuming the cable to be centrally disposed, would be reduced by about 75 per cent.

The disturbances noted are of two kinds, the electrostatic or capacity effect, which results from grounding the cable sheaths, and the inductive electromagnetic effect.

For obviating the inductive disturbances between adjacent power lines, the same means appear to suffice, which are used for protection against reciprocal disturbances of different lines in a multiple telephone cable, that is, the same means which permits the greatest possible degree of electromagnetic symmetry of the different conductors, suitable control apparatus, etc.

Without such protection the practice of telephony in large cities, as it has developed with the transmission lines in contiguity to power lines, would hardly be possible. The protective means mentioned frequently are insufficient especially in those cases in which telephone cables necessarily extend for substantial distances in close proximity to high tension or high current conductors, as, for instance, in the train announcing telephone lines for electrical railroads. Beside the disturbances in telephony, it is noted, switching operations in the power circuit induce tensions in the telephone cables, which may break through the insulation thereof and endanger not only the installations themselves, but human life as well.

The following formula defines the electromotive force E induced by a high power line in a contiguous low power, such as a telephone line:

$$E = lpM \sqrt{l + \left(\frac{pL}{R}\right)^2}$$

Where l is the current, p the frequency of the same, M the mutual inductance between the high power conductor and the telephone line, L and R the self-inductance and resistance respectively of the cable sheath. (See G. Krause and A. Zastrow in Wissenschaftliche Veröffentlichungen des Siemens-Konzerns, Vol. II, 1922).

From this equation it appears that favor-

As many years of experience has taught, however, iron tubes lodged in the earth, particularly when traversed by induced currents, are subject to the oxidizing influence of moisture to such high degree that they are not practically utilizable for cable installations.

It is, accordingly, an object to provide a material which besides having the weather and moisture resisting qualities of the usual lead alloy of which telephone cable sheaths are made, possesses ferro-magnetic properties and is capable of being worked in the same manner as lead.

The combination, for instance, of hydraulic binding material, paper, etc. rendered ferro-magnetic and enclosing the cable strands, provides a moisture and weather resisting material of practically unlimited durability, having those magnetic properties that are necessary for the desired protection from induction. Conversely, the spread of the deleterious magnetic fields engendered by high power transmission lines lodged in the earth may be inhibited, by embedding them in ferro-magnetic concrete conduits.

According to present scientific knowledge, only the elements of the iron group, viz., iron, nickel, cobalt and Heusler's alloy (copper, manganese and aluminum bronze) have been known to present para-magnetic properties of sufficient magnitude to be practically utilizable as ferro-magnetic materials.

Other materials which in their pure state are dia-magnetic, for instance, aluminum lead or zinc, or only weakly para-magnetic, as for instance, tin, may be rendered magnetizable to a degree by the addition of iron, in so far as they may be capable of being alloyed with iron. Such alloys, however, are in general para-magnetic to a degree far less than would correspond to the proportion of iron therein. Furthermore, there is only a very limited possibility of forming alloys with iron.

My attempts to increase the number of ferro-magnetic materials have met with the result that even metals not belonging to the iron group, nor constituting a Heusler alloy, have been rendered ferro-magnetic. These new ferro-magnetic materials of my invention retain all of the typical properties of the non-magnetic constituents thereof. According to my invention, the new ferro-magnetic material may be formed in a homogeneous mass having a given weak or strong ferro-magnetic permeability. Furthermore, the same piece may be magnetic in whole or only at selected areas or volumes, at the interior or the exterior thereof.

In a preferred specific application, the telephone cable sheath or armor is formed of a special substance or alloy which has substantially the same mechanical properties as the usual lead alloy sheath having mechani-

cal strength including the capability of being readily made by extrusion, and being substantially immune to weather, moisture, and electrolytic action, all combined with high magnetic permeability.

In order to carry into execution the foregoing application and other applications, I have invented a method for imparting magnetic or magnetic screening properties to substances generally. According to my invention, this result is easily accomplished without the need for elaborate specialized apparatus. Paramagnetic material, preferably soft iron is intimately intermingled with the substance to be rendered magnetic and then congealed or allowed to congeal, the product possessing a permeability proportional to the percentage of iron therein. The comminuted iron may be combined with a base material of concrete, paper pulp, vulcanite or bakelite, metal alloys as well as metalloids and combinations of the same and in general conductors, semi-conductors and insulators, the product in every case having substantially the mechanical or physical properties of the base material with super-added magnetic permeability imparted by the iron.

The combination of metallic constituents, however, that do not form alloys by ordinary methods, for instance, lead and iron used for making telephone cable sheaths, according to my invention, presents special difficulties which I have overcome. According to my method, the iron is comminuted as is the lead or other constituent and the elements are mixed and caused to coalesce by pressure, the physical characteristics and specific gravity of the product depending on the magnitude of the pressure applied. The preferred mode of comminuting is by atomizing by a blast of air or steam applied to a stream of molten lead flowing from the hopper, thereby causing the metal to solidify in the form of an impalpable powder, similarly treating the iron, intimately mixing the powders together and then extruding the mixed powder through a die by means of a hydraulic press.

In the accompanying drawings in which I have diagrammatically exemplified my method, apparatus and product,

Fig. 1 shows diagrammatically apparatus for making my novel product.

Fig. 2 is a cross-sectional view of a telephone cable, and

Fig. 3 shows a cross-section of a telephone cable installation.

In Fig. 1 I have shown diagrammatically an apparatus for making a telephone cable sheath or other pipe by extrusion. The hydraulic press element is of conventional construction including a cylinder 10 within which the metal is confined and subjected to compression by power transmitted through plunger 11 from operating cylinder 130

(not shown) of smaller diameter. In the present embodiment, the molten lead passes from a hopper 12 by gravity flow through a nozzle 13 in a thin stream 14. The hopper and the nozzle may be heated to keep the lead molten, as by electrical heating wire C. The stream is subjected to a blast of compressed air, gas or steam admitted through pipe 15 and has the effect of atomizing and cooling the metal and causing the atomized particles of lead to form a fine or impalpable powder which drops into the mixing chamber 16. The energy of the atomized medium is dissipated in a muffler or system of baffles 25 and the de-energized medium escapes at outlet 26. Iron treated in a generally similar way is also admitted to the mixing chamber by similar apparatus (not shown) through inlet 17 and the particles are intimately intermixed by any appropriate mixing apparatus 18 and are delivered from the mixing chamber into the extrusion cylinder 10, to be forced under hydraulic pressure through die 19.

The extruded product is a pipe or sheath having the mechanical characteristics of the usual lead pipe or sheath, that is, it is impervious to acids, moisture or weather and easily bendable, but possesses magnetic permeability proportional to the percentage of iron in the product.

Referring to Fig. 2, I have shown a preferred application of the method set forth, to a generally conventional underground telephone cable. A bundle 20 of telephone conductors, each individually insulated, is enclosed in a gutta percha enclosure 21 which is covered with a paper coating 22, the latter enclosed in my preferred sheath 23 of lead alloy and iron.

It will be seen that a high tension alternating current transmission line, contiguous to the telephone cable will have no inductive effect on the conducting wires 21, since the sheath by reason of its pure iron constituent, acts as a magnetic shell intercepting magnetic flux and preventing the same from interlinking with or producing induction effects on the telephone conductors.

As shown by the foregoing formula, the screening effectiveness increases inversely with the diameter of the protective sheath. Accordingly, it is preferable to dispose the ferro-magnetic sheath as closely as possible to the strands to be protected.

In the preferred embodiment, the insulating effect is enhanced by also rendering para-magnetic the concrete cable conduit 24 shown in Fig. 3. This result is accomplished by the simple expedient of mixing

with the grout of which the conduit is made, a suitable percentage of finely divided soft iron particles.

It is preferable also to form the paper layer 22 as a magnetic screen. This may be accomplished by combining with the paper pulp of which the same is made, an appropriate proportion of fine particles of iron and thereby forming a homogeneous paper having an iron constituent. Alternatively, the paper may be rendered magnetic by impacting on the surface thereof, fine particles of iron powder which will coalesce with the surface thereof, and be intimately combined therewith.

By using a plurality of layers of ferro-magnetic material alternating with non-ferrous layers, the screening effect is increased more than by the use of solid iron armors of equivalent iron content. Accordingly, the combination of a magnetic lead sheath within an iron cement cable conduit is a satisfactory arrangement, affording particularly good protection.

It will thus be seen that there is herein described apparatus and a method in which the several features of this invention are embodied, and which attain the various objects of the invention and are well suited to meet the requirements of practical use.

As many changes could be made in the above apparatus and method, and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:—

1. The method of forming a telephone cable armor capable of excluding magnetic stray fields from the cable strands, which method consists in finely comminuting the lead alloy for said cable, intimately intermixing therewith finely comminuted iron particles and molding said mixture under high pressure to form the cable.

2. A magnetic substance including substantially homogeneously associated lead and iron combining the mechanical properties of lead with the magnetic properties of iron.

Signed at New York city in the county of New York and State of New York this 18th day of February, A. D. 1925.

ERNST BRANDUS.