July 17, 1923. 1,462,035

W. FONDILLER

TREATMENT OF MAGNETIC MATERIAL

Filed Aug. 10, 1920

Fig. 1.

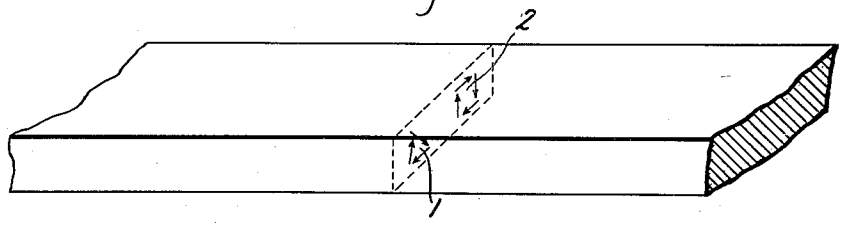


Fig. 2.

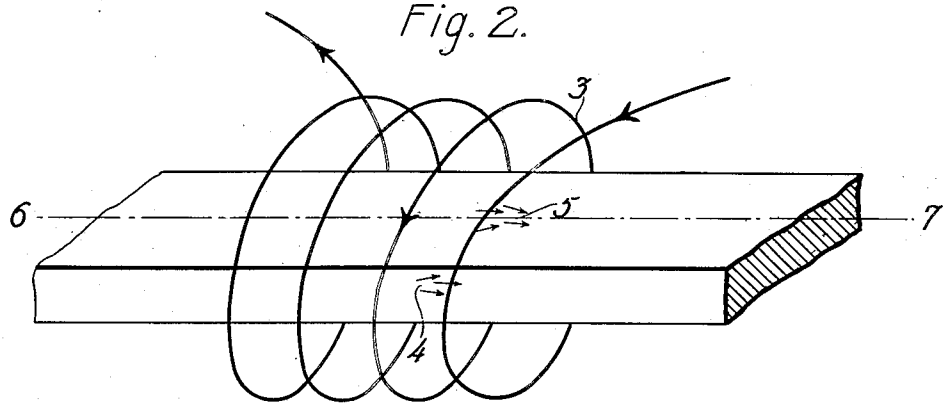
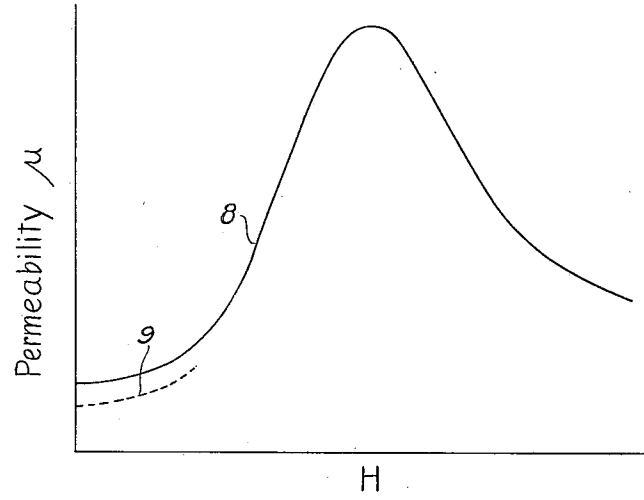


Fig. 3.



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UNITED STATES PATENT OFFICE.

WILLIAM FONDILLER, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TREATMENT OF MAGNETIC MATERIAL.

Application filed August 10, 1920. Serial No. 402,872.

To all whom it may concern:

Be it known that I, WILLIAM FONDILLER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in the Treatment of Magnetic Material, of which the following is a full, clear, concise, and exact description.

This invention relates to a method of securing uniformity in the permeability to signaling currents of magnetic materials.

In using magnetic materials in conjunction with electrical circuits and apparatus when it is desirable to have uniformity of permeability therein toward signaling currents, it has been the practice heretofore, to subject such materials to mechanical and heat treatments. This method, however, is not productive of very uniform results and the permeability of the several parts of the circuit or apparatus is liable to vary in most cases as much as ten per cent or more.

It is an object of the invention to provide a means whereby a much closer balancing of the permeabilities to signaling currents may be realized.

The magnetic state of any particular material is commonly defined as the ratio of the magnetic induction B to the magnetizing force H, i. e., the permeability μ. In air the magnetic induction is equal to the magnetizing force and hence the permeability is unity. For all paramagnetic substances the permeability is greater than this value. For any particular material, measurements may be made of the values of H and B to show their relation during the change in the magnetic state from a neutral magnetic condition to complete magnetic saturation. By mechanical and heat treatments the physical state of the magnetic material may be so altered that it exhibits different B-H relations, the precise values depending upon the nature of the treatment given. The electrical treatment which is the subject of this invention makes possible the alteration and adjustment of the permeability of a given magnetic material for magnetizing forces of the order of those produced by telephone and telegraph currents and thus provides a means whereby two or more specimens of magnetic material may be made substantially identical in this respect.

In the drawings, Figure 1 shows a piece of magnetic material after having been worked into a bar shape; Figure 2 shows the same material after being subjected to the influence of an electric current, as hereinafter described and Figure 3 shows the characteristic μ–H diagram for this material before and after the electrical treatment.

In explaining the phenomena which take place in magnetic material when acted upon by magnetizing forces, it is often convenient to resort to assumptions in regard to its internal structure. For the purpose of illustration, the magnetic material might be considered as being composed of magnetons which are in effect molecular magnets. In a material such as that shown in Figure 1, the magnetons are assumed to be grouped together such as in groups 1 and 2, the groups lying in planes transverse to the plane of the material as shown. If the permeability of the material while in this condition, that is, after being mechanically and heat treated, is measured, a curve such as that shown by 8 in Figure 3 might be obtained. The relative positions of these magnetons, however, may be permanently altered by subjecting the material to a cyclic demagnetization, such as is well-known in the art. This treatment consists in passing through the coiled conductor 3 in Figure 2 a pulsating current of large amplitude and then reducing the current gradually to zero. Thus an alterating current may be used, or a direct current whose direction of flow during application is continuously reversed. The effect of this treatment is thought to cause the magnetons to change their position as shown by Figure 2. As will be apparent from the drawing, the magnetons now reside in a longitudinal plane, and cannot be changed back to their original position by subsequent electrical treatment. The magnetons are, of course, free to move, and do, under the influence of further electric currents. But these changes are merely in the longitudinal plane, the angle which such magnetons make with the axis depending upon the magnitude of the magnetizing force. Thus, under heavy magnetization, the magnetons take up a position parallel to 6—7, while under a weak force they are not deflected to such a large degree. No general rule can

be formulated in this respect since investigation has shown that the magnetons present in dissimilar materials do not under like circumstances possess the same tendency to respond to a given magnetizing force.

It is generally believed that when a magnetic material had been subjected to a thorough demagnetization, its μ–H curve is, throughout its entire range, substantially the same as that of the virgin material, or curve 8 in Fig. 3. In accordance with the above explanation, it has been found, however, that when virgin magnetic material—magnetic material which has not been subjected to previous magnetic forces—is subjected to a demagnetization process, its initial permeability is reduced from five to ten per cent of its original value. As the magnetizing forces of signaling currents, such as used in telephone and telegraph operation, are small; only the initial part of the curve need be considered. Curve 9 in Fig. 3 represents the permeability to small magnetizing forces of a magnetic material which has been subjected to cyclic demagnetization. This invention contemplates making use of these experimentally observed facts in the loading of conductors for telephone and telegraph currents.

In continuously loading signaling conductors which are to be used for example in connection with amplifiers, or as the constituent parts of phantom circuits, it is essential that the loading material be of a substantially uniform permeability to signaling currents, in order that a well balanced system may be realized. The present invention may be availed of to produce such a balance. It must be understood, however, that although the loading of signaling conductors is mentioned herein in explaining the application of the invention, the invention is not restricted to such use. The selection of lengths of loading material which would give the balance desired, from the material commercially obtainable, would result in the rejection of a large percentage of such material. Moreover, due to the strains and stresses which the loading material is subjected to during the serving processes, the initial variation in the several lengths of permeability to signaling currents would be greatly accentuated. The facts brought out above provide a way to decrease the variations in permeability of such material and to more nearly balance the various conductors of a signaling circuit after they have been loaded. By means of demagnetizing treatment those pieces of magnetic material having a higher permeability than the desired value may be reduced in permeability so that a substantial uniformity in permeability of the pieces of magnetic material or of the loaded conductors results. A maximum utilization of continuously loaded signaling conductors is realized when this treatment is employed. Thus, if four signaling conductors are loaded with material which has been subjected to this method of treatment, a maximum of four telephonic communications, and four telegraphic communications, may be obtained.

What is claimed is:

1. The method of obtaining a substantially uniform initial permeability in a plurality of pieces of magnetic material which consists in adjusting the permeability of these pieces by magnetizing some of the pieces to their saturation point and then thoroughly demagnetizing them.

2. The method of obtaining a substantially uniform permeability to currents such as used in telephone or telegraph operation in a plurality of continuously loaded conductors comprising a telephone or telegraph circuit which consists in reducing the permeability of the loading material in those conductors where this material has a high permeability by means of a magnetizing treatment followed by a demagnetizing treatment.

In witness whereof I hereunto subscribe my name this 5th day of August, A. D., 1920.

WILLIAM FONDILLER.