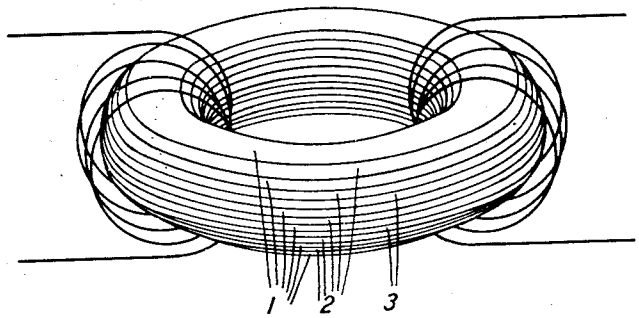
Feb. 7, 1933. H. WHITTLE 1,896,762

COIL

Filed Dec. 31, 1930



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UNITED STATES PATENT OFFICE

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COIL

Application filed December 31, 1930. Serial No. 505,798.

This invention relates to electromagnetic devices and more particularly to repeating coils for telephone systems.

An object of the invention is to increase voltage range over which a transformer is highly and uniformly effective.

A more particular object is to improve the effectiveness of loading coils, filters and transformers and other electromagnetic devices for transmitting alternating currents of the frequencies and amplitudes encountered in telephone and other signaling systems.

A repeating coil in a telephone system is required to function under a variety of conditions and over a great range of current densities. For example, such a coil must repeat effectively the minute currents due to speech, the somewhat larger but yet small currents due to ringing or signaling currents arriving over a very long line, and the relatively large ringing or signaling currents arriving over a very short line. In addition, such a coil often has impressed upon it for long or short periods of time various amplitudes of direct continuous voltage as well as of impulsive disturbances etc. When limitations of cost and size are imposed the problem of designing a coil to meet the required conditions is one of increased difficulty. Furthermore, a coil once installed must continue to function effectively over a long period of time without maintenance, although subjected numberless times to the various large and small voltages incident to its operation. It is primarily to such repeating coils that the present invention relates.

Prior to the present invention there have been proposed for use in telephone repeating coil and other cores two suitably selected magnetic materials in parallel. A transformer having such a core, when properly designed, will have the range of its effectiveness increased. Such devices attain, to a degree, the objects of the present invention.

In accordance with a feature of the present invention, further improvements are effected by the use in one core of new combinations of magnetic materials suitable for the production of coils of special properties.

In accordance with another feature, cores are made of three or more materials each different from the others and each selected with the properties of the others taken into consideration to effect an improved result.

When only two materials are used one of them is an alloy of cobalt and iron of the type having an unusually high flux density at high magnetizing forces and especially a known variety of cobalt-iron alloy composed of around 40% to 60% iron and 60% to 40% cobalt which has a high permeability in the range of magnetizing forces around 3 to 6 gauss and upward. However, other cobalt-iron alloys, especially those in the range 40 to 70% iron, may be employed. Alloys of 50% cobalt and 50% iron when heat treated in a manner suitable to develop their best magnetic properties, as previously described by another, are preferred. Within the scope of the term cobalt-iron are included certain recently developed magnetic materials which consist essentially of cobalt and iron with additional substances added to make them more readily workable.

The second magnetic material, when two are employed, may consist of silicon steel of a good commercial grade or a nickel-iron alloy of from 40 to 85% nickel, heat treated to develop high permeability in a low range of magnetizing forces. The number of rings or laminations of the second material will usually be equal to the number of the first material, but may be more or less, as preferred.

When a third magnetic material is employed it will preferably consist of one of the varieties of iron-nickel alloy having chromium, molybdenum or other equivalent material added to increase the permeability in an extremely low range of magnetizing forces near zero and to decrease the residual magnetism and coercive force. Such materials comprise, for example, 45 to 85% nickel, 2 to 10% chromium or molybdenum and the balance iron, heat treated in a manner previously described by another to develop the magnetic properties just stated. A composition of about 75% nickel, 3 to 4% chromium and the balance iron is quite suitable. Such added

materials, chromium, for example, modify both the magnetic and resistive properties of the material. For convenience they may be referred to as resistivity increasing materials.

For constructing the core of a telephone ringing transformer it is generally preferred that the number of laminations of the third magnetic material be smaller in number than of the first two materials. Thus the addition of a few laminations of 75% : 21½% : 3½% nickel-iron-chromium alloy not only serves to increase the effective permeability of the core at low flux densities approaching zero but also stabilizes the permeability of the core at magnetizing forces resulting from currents of the intensity and frequency of voice currents after being subjected to the magnetizing forces resulting from the application of heavy ringing or signaling currents to the circuit including the coil winding.

Such cores as described can perform the same variety of service as a much larger core of a single core material and although the cost of the cobalt is relatively high the savings in copper and space may be more than sufficient to offset the higher cost of the core material. They are also capable of being designed to perform more satisfactorily than other cores of two materials heretofore described.

An embodiment of the present invention is illustrated in the accompanying drawing in which:

The figure represents, in a semi-diagrammatic manner, a repeating coil having primary and secondary windings, the core of the coil consisting of alternate layers or laminations of cobalt-iron and high permeability nickel-iron alloy commonly known as permalloy with a few laminations of 75% : 21½% : 3½% nickel-iron-chromium alloy.

In this case the core consists of alternate laminations 1, cobalt-iron alloy of a composition in the neighborhood of 50% cobalt and the balance iron and laminations 2 of nickel-iron alloy of about 78½% nickel and the balance iron. The laminations 2 may consist of silicon steel instead of nickel-iron alloy with satisfactory results for some purposes. The laminations 3 are composed of the chromium-containing nickel-iron alloy.

The invention is not restricted in its application to repeating coils but may be applied usefully to other transformers and other electromagnetic devices in which it is desired to increase the range of voltage or flux density for which the devices are highly and uniformly effective. For example, a choke coil having a magnetic core composed of combinations of materials herein described, will possess high and fairly uniform impedance over a wide range of applied voltages. In coils for filters or artificial lines where special properties are desired similar combinations of two or three magnetic materials may be employed for the cores although in such cases the relative number of laminations of the several materials may be varied.

What is claimed is:

1. An inductance device having a core comprising laminations of iron-cobalt alloy of 40 to 70% iron and the balance chiefly cobalt, iron-nickel alloy of 40 to 85% nickel and the balance chiefly iron, and iron-nickel alloy of 40 to 85% nickel containing 1% to 10% of a third element.

2. An inductance device such as set forth in claim 1 in which the iron-nickel alloy containing a third element is present in smaller quantity than the other alloys of the core.

In witness whereof, I hereunto subscribe my name this 30th day of December, 1930.

HORACE WHITTLE.