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E. R. CRIPPA

2,457,806

INDUCTANCE COIL

Filed June 11, 1946

FIG. 1

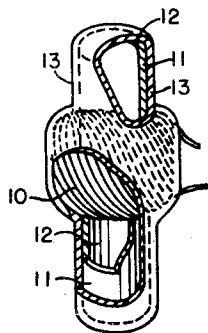


Fig 2

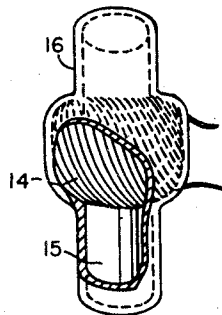


FIG. 4

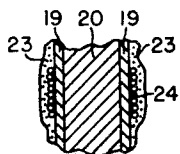


FIG. 3

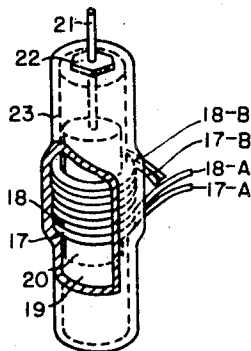
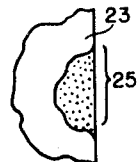


Fig. 5



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INDUCTANCE COIL

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2 Claims. (Cl. 175-359)

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This invention relates to electrical circuit components and more particularly to inductive components employing permeable material to modify the magnetic fields thereof.

In numerous applications, typically in electrical amplification systems, it is necessary to employ inductive circuit elements, whether they be of the transformer variety having a plurality of individual windings or of the choke variety having a single winding. Where several inductive elements are employed such as in a multistage high-gain amplifier, coupling between several of the inductive elements may produce harmful effects such as regeneration or a distortion of the frequency response characteristics of a tuned system. Conventional shielding methods such as placing a shielding "can" around each of the inductive elements have considerable space requirements because the shield can, unless of widely spaced construction, will produce reactive and resistive loading of the inductive element.

It is therefore an object of the present invention to provide efficient inductive circuit components which produce minimum external fields.

Another object of the present invention is to provide inductive circuit components of small mechanical size having weak external fields and high efficiency.

Other and further objects and features of the present invention will become apparent upon a careful consideration of the accompanying drawing and detailed description.

Fig. 1 shows a multi-layer inductance structure embodying the features of the present invention.

Fig. 2 shows a second multi-layer inductance structure embodying the features of the present invention.

Fig. 3 shows a third inductance structure permitting ready adjustability of inductive characteristics.

Fig. 4 is a cross sectional view of the central portion of the structure of Fig. 3.

Fig. 5 is a sectional view of a portion of the coating of the structure of Figs. 1, 2 and 3.

In accordance with the fundamental concepts of the present invention, an inductive circuit element is provided about which is placed a coating containing particles of material having high permeability. The particles contained within the coating are preferably divided to a fineness as required for efficient operation at the frequencies involved. A binder material, which may form the balance of the coating, is employed to hold the permeable particles in place. This binder, into which the particles are thoroughly mixed, is se-

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lected to exhibit properties permitting a change from a fluid to a solid state by chemical, thermal or other physical action after application. Thus, in construction, the inductance coil is wound on a suitable form which may itself contain particles of high permeability material. The entire coil and core are then covered, as by spraying or dipping with the coating material in the fluid state. Subsequent subjection of the coil to chemical, physical or time action results in a hardening of the fluid coating so that a solid structure results. An inductive element is obtained having small physical size and low external magnetic field yet retaining a desired high "Q."

With particular reference to Fig. 1, a typical inductive structure embodying the features of the present invention is shown in which a multi-layer coil 10 is wound upon an insulating and supporting coil form such as a hollow tube 11. The exact form of winding is not critical however it is preferable that conventional technique for the frequencies involved be followed. For example, in high frequency work it may be desirable in certain applications to reduce the distributed capacitance of the coil by employing universal, pie-wound sections. Within the hollow supporting form 11 is placed a core 12. The core 12 may be of conventional structure for the frequencies involved and would contain powdered iron or other material permitting relatively high permeability and low losses. Magnetic cores suitable for high frequencies consist of a compressed mass of powdered magnetic particles insulated from one another, as described for example in U. S. Patent No. 1,982,689. In Fig. 1, the core 12 is placed in a fixed position within the form 11.

Completely surrounding the outer surfaces of the coil 10 and the protruding ends of the form 11 is a coating 13 possessing a relatively high permeability yet presenting low losses at the frequencies involved. Typically, this coating comprises a binder material such as wax or resin and a plurality of particles of finely divided iron of a composition and size suited for operation at the frequencies involved. The binder serves primarily to hold the iron particles in place around the inductance presenting a magnetic path of high permeability thereabout to confine the magnetic field produced by the inductance. Confining the magnetic field reduces the energy leakage from the coil to surrounding space and raises the "Q" of the inductive circuit.

For ease of manufacture it is preferable to select an insulating binder material such as a wax, a resin or a "paint" type containing a sol-

vent and a solute or suspended material which can be applied in fluid form and then allowed to change to a solid form upon exposure to the action of temperature, time or pressure. Typical wax binders would be of the beeswax or petroleum varieties or derivatives thereof. A heat polymerizing resin such as poly-vinyl-chloride may be applied as a liquid when cool then changed to the solid state upon exposure to moderate temperatures. For use with solvents, the waxes as mentioned above or plastic compositions could be used. Polystyrene dissolved in acetone or other suitable solvents would be very satisfactory. Thus the particles of high permeability material may be thoroughly mixed into the binder while the latter is in a fluid state. The mixture is then placed on the coil and form structure by any conventional method such as spraying, dipping or brushing and allowed to change from the fluid to the solid state as mentioned above.

The coating 13 does, in general, cause a slight increase in the distributed capacitance of the coil 10 because of the dielectric properties of the coating. This increase may be minimized by employing a close-wound coil structure as shown.

Since an increase in inductance is generally realized upon application of the coating 13, allowance for this must be made. This change in inductance is in large part dependent upon the thickness of the coating 13 and may be adjusted by careful control of the thickness of the coating as applied. In certain instances it might be desirable to apply the coating 13 in several layers to facilitate manufacture to the exact inductance value desired.

Fig. 2 shows a variant embodiment of the principles of the present invention in which a coil 14 is wound upon a form 15 which may be hollow or solid. Over the entire structure is then placed a coating 16 having the properties and purpose of coating 13 in Fig. 1.

Fig. 3 shows another variant embodiment of the invention in which is provided a method of adjusting the inductance of the resulting circuit element after construction. In this embodiment a circuit element is shown possessing two separate close-wound, single layer windings 17, 18 inductively linked together. Winding 17 has ends 17-A and 17-B. Winding 18 has ends 18-A and 18-B. The windings are placed on a form 19 within which is a core 20, similar to core 12 of Fig. 1. Core 20 is attached to a lead screw 21 which threadably engages an internally threaded bushing 22 placed at one end of the structure. Thus by rotation of the lead screw 21 it is possible to vary the inductance of the circuit element. As before, the entire structure with the exception of the lead screw 21 is enclosed within a high permeability coating 23.

With reference now to Fig. 4, a cut-away view of the central portion of the inductor of Fig. 3 is shown. The core 20 is shown as the central por-

tion about which is placed the form or tube 19. On tube 19 are wound the inductance elements having winding ends typified by 24. Surrounding the windings and the ends of tube 19 is the high permeability coating 23, portions of which extend into the interstices between the windings.

Fig. 5 shows a portion of the coating 23 on the circuit element of Fig. 3 with a portion of the binder removed to disclose particles of the high permeability material indicated in general at 25.

From the foregoing discussion it is apparent that considerable modification of the features of the present invention is possible and while the devices herein described and the forms of apparatus for the operation thereof constitute preferred embodiments of the invention it is to be understood that the invention is not limited to these precise devices and forms of apparatus and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An inductive element having high inductance and low external field, comprising; a non-magnetic, insulating form, a closely wound coil positioned intermediately thereon, and a high permeability coating applied externally to the form and coil, in part impregnating interstices of the latter and extending therefrom along the form.

2. An inductive element having high inductance and low external field, comprising; a hollow non-magnetic, insulating form, a high permeability core within the form, a coil positioned intermediately of the core, and a high permeability coating applied externally to the form and coil, in part impregnating interstices of the latter and extending axially along the form to the ends thereof and overlying the ends of the form and core.

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