

Oct. 4, 1932.

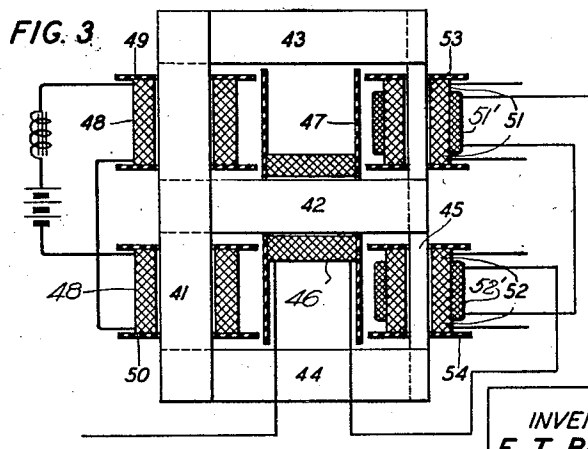
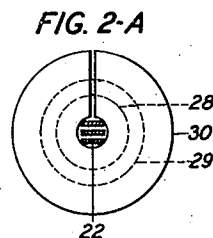
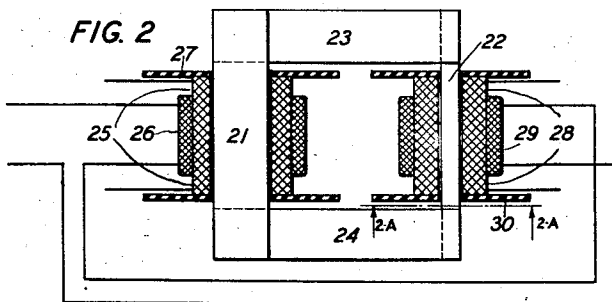
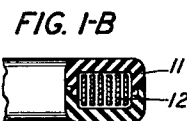
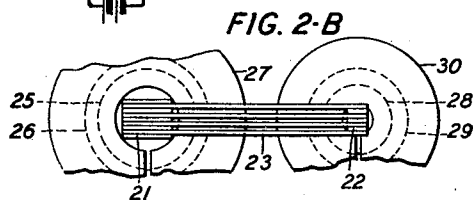
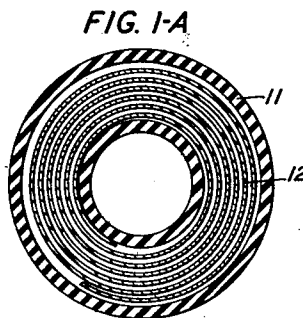
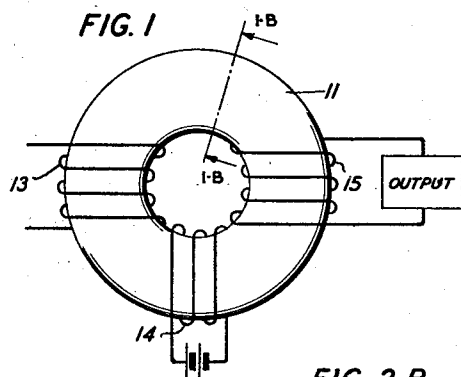
E. T. BURTON

1,880,412

TRANSFORMER

Filed June 6, 1930

2 Sheets-Sheet 1



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1,880,412

TRANSFORMER

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2 Sheets-Sheet 2

FIG. 4

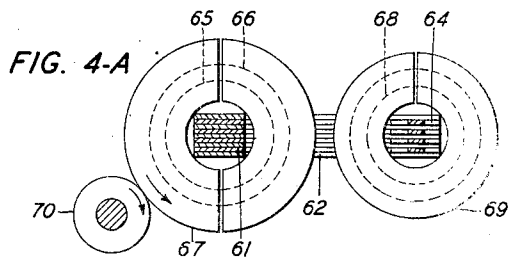
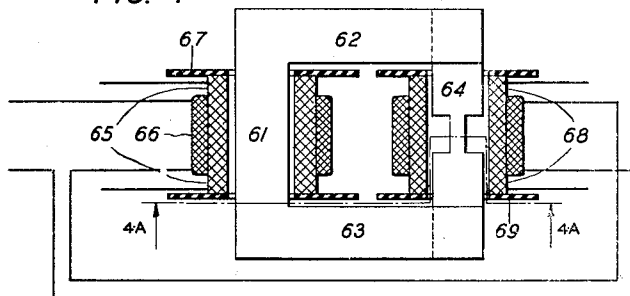
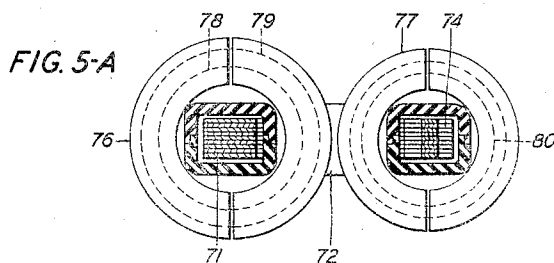
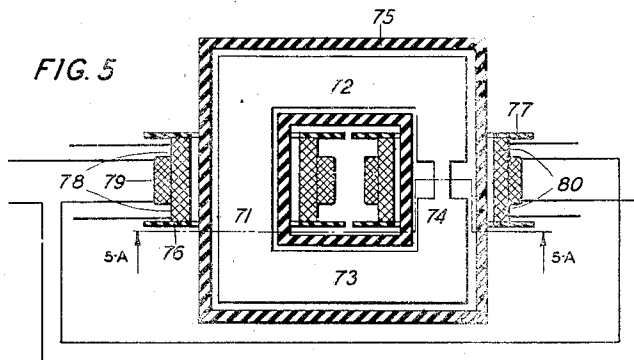


FIG. 5



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UNITED STATES PATENT OFFICE

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TRANSFORMER

Application filed June 6, 1930. Serial No. 459,546.

This invention relates to the construction of electric current transformers or induction coils, particularly those useful in signaling or other impulse transmission systems.

5 An object of the invention is to obtain an output of comparatively short, high voltage impulses from relatively long signaling impulses of low voltage.

The invention resides in the construction of transformers particularly useful in the disclosures of U. S. Patents 1,763,880 and 1,858,037 granted to E. T. Burton on June 17, 1930, and May 10, 1932, respectively, and the applicant's copending application corresponding to British Patent 340,286, the complete specification of which was accepted December 24, 1930, although it is understood that these disclosures are not limited to the types described herein.

10 According to the present invention the transformer provides a magnetic circuit which comprises a plurality of core sections having markedly different degrees of permeability or markedly different cross-sectional areas. An input current of cyclically varying intensity impressed on the transformer through primary windings on the core having a section of relatively low permeability, or large cross-section, or both causes some sections to become more quickly saturated than other sections. The more quickly saturated sections being provided with secondary windings, are effective to produce in such windings a sharp voltage impulse of short duration and of high amplitude every time the magnetic field of the latter sections becomes saturated or unsaturated by the primary current.

15 A feature of the invention is the use of an additional winding on the transformer for magnetically biasing the magnetic circuit whereby the amplitude of the cyclically varying current in the primary winding, at which the magnetic field becomes saturated or unsaturated, may be varied.

20 Another feature is the use of means upon which the primary, secondary and biasing windings of the transformers may be wound without impairing the permeability of the core material.

Still another feature resides in the adaptability of the transformers described herein to the use of a single primary winding cooperating with a plurality of secondary and a plurality of biasing windings to give the effect of a plurality of transformers.

Other objects and features will appear in the description hereinafter set forth when taken in conjunction with the accompanying drawings and appended claims.

The present invention involves several types of transformers all of which make use of core material having a high permeability at low magnetizing forces. A preferred material is permalloy, although other metals or alloys having similar electrical characteristics, may be employed. These transformers are particularly desirable for high and low frequency signaling systems. They will be described as to their structural arrangement and adaptability separately.

Several embodiments preferred in particular uses are shown in the drawings, of which:

Fig. 1 represents an annular core type of transformer suitably adapted for low frequency signaling systems;

Fig. 1—A shows a vertical cross-sectional view taken through the center of the core of Fig. 1;

Fig. 1—B shows a cross-sectional view taken along the line 1—B of Fig. 1;

Fig. 2 illustrates a square core type of transformer having cross-sectional areas of different values;

Fig. 2—A shows a cross-sectional view of Fig. 2 taken along line 2—A;

Fig. 2—B shows a fragmentary top view of Fig. 2;

Fig. 3 represents a combination of a shell type and two core type transformers to form a single transformer capable of obtaining the effect of two separate transformers;

Fig. 4 represents a core type transformer having its entire core constituted of material of high permeability and a small portion of the core reduced in area to thereby increase the reluctance of the magnetic circuit over such portion. It is particularly adaptable to systems for transmitting frequencies in the voice range;

Fig. 4—A shows a cross-sectional view taken along the line 4—A of Fig. 4;

Fig. 5 represents a modification of Fig. 4 wherein the core is encased in an insulated case;

Fig. 5—A shows a cross-sectional view taken along line 5—A of Fig. 5.

Referring to Fig. 1 a torus-shaped box 11 of insulating material, such as hard rubber, is made in two circular parts. The lower part, shown in Fig. 1—A, contains a spirally wound tape of metal of high permeability, such as permalloy, which forms the core of the transformer, and the upper part serves as a cover, both parts being arranged, when put together to interlock as shown in Fig. 1—B. Threaded around the box in the manner shown in Fig. 1, are the primary winding 13, biasing winding 14 and secondary winding 15.

This type of transformer wherein the entire core is of a high permeability material, serves best when the circumference and cross-section of its core are small. It is particularly adapted to low frequency signaling systems such as telegraph or other systems using frequencies up to approximately 500 cycles per second. It functions to produce in the secondary winding, in response to a current of slowly varying intensity impressed on the primary winding, a series of short, sharp voltage impulses, separated by relatively long intervals of zero voltage, which impulses are particularly desirable in signaling systems.

When a current is impressed on the primary winding and it rises in intensity through values slightly above and slightly below zero the magnetic field of the core becomes saturated and an inductive voltage is produced in the secondary winding, only when the primary current is rising or falling through the very low values of intensity. Therefore the intervals of unsaturation of the core are very short and the inductance during these intervals momentarily rises to a high value so as to produce during each interval a high voltage impulse of short duration in the secondary winding. The voltage impulses so produced are of polarity corresponding to the direction of the primary current at the time. By impressing a direct current of a constant voltage on the biasing winding the magnetic field of the core is maintained normally saturated and then the primary current in order to produce an interval of high inductance, will have to rise to a value equal in intensity, but opposite in polarity to that of the biasing current. When this value is reached the core momentarily becomes unsaturated for a short interval and a short, sharp voltage impulse is produced in the secondary winding during this interval. By using a biasing current the interval of high inductance may be made to

occur at any desired intensity of primary current.

The permeability of a material such as permalloy is greatly reduced by any strains to which it may be subjected when applying the windings and in order to overcome these strains the core is encased in a hard-rubber box 11 whereby the electrical character of the transformer core is preserved during manufacture and protected during shipment and installation.

In Fig. 2 is shown a core type of transformer which has one core section 21 of relatively large cross-section constituted of laminæ or stampings of a material of comparatively low permeability, and the other core section 22 of small cross-section constituted of a lesser number of laminæ or stampings of a material of high permeability. The yokes 23 and 24 interconnecting these sections on both ends are of comparatively low permeability material like that of section 21. These sections are so designed that the reluctance of the magnetic circuit through section 21 is low with respect to that of the magnetic circuit through section 22. It is preferable that core section 22 be short with respect to the remainder of the magnetic circuit. The permeability varies with the flux density and the more constricted in cross-section in section 22, the more rapidly the flux density increases and the more quickly saturated.

The biasing winding 25 and the primary winding 26 are superposed in the manner shown on a spool 27 and the secondary winding 28 and a compensating winding 29 are wound on spool 30. These spools are preferably of metallic material, for the purpose of providing electrostatic shielding, a suitable metal being German silver because of its high resistivity. The spools are split or slotted lengthwise along one side as shown in Fig. 2—A which represents a section of core 22 taken along line 2—A. They are insulatively linked with cores 21 and 22 as shown and serve as a protection to the permeability of the core material which, in a material such as permalloy, is greatly reduced by slight strains and pressures. The spools are provided in order that the windings may be machine-wound instead of being wound by hand. The bucking or compensating winding 29 which is superposed on the secondary winding, consists of a few turns, that is, a few with respect to the number of turns in the primary and the secondary windings, and serves to give a sharper cut-off to the secondary voltage impulses. The sharp cut-off is accomplished by connecting the compensating winding in series opposing with the primary winding whereby the magneto-motive force developed by the low amplitudes of the current in the primary winding is counter-acted by the magneto-motive force developed by the current in the com-

pensating winding. Fig. 2—B shows a top view of Fig. 2.

Fig. 3 is a combination of a shell type transformer and two core type transformers to form a single transformer wherein a single primary winding in conjunction with two biasing and two secondary windings, is adapted to obtain the effect of two separate transformers. The core sections 41 and 42 and the yokes 43 and 44 may be of comparatively low permeability material. The core section 45 is of high permeability material and is of a reduced cross-section like core section 22 of Fig. 2. The primary winding 46 is wound on spool 47 which is linked with core section 42 to provide two parallel magnetic circuits, one including yoke 43 and the other including yoke 44. The biasing windings 48 are respectively wound on spools 49 and 50 in opposite relation, which spools are linked with core section 41 in the manner shown. The secondary windings 51 and 52 are wound on spools 53 and 54 respectively, which are linked with core section 45 in the manner shown to form two separate output circuits. In this arrangement the two magnetic circuits are normally saturated in the opposite directions by the biasing current and a transformer so arranged may be used in place of each pair of transformers employing primary, secondary and biasing windings which are shown in the drawings of the applicant's copending applications, supra. The purpose of using a single primary winding is to reduce the primary circuit resistance. Inasmuch as the magnetic circuits are effective alternately, in response to a primary current wave of positive and negative polarities, practically the whole value of the magnetomotive force is impressed first in one of the circuits and then on the other.

Fig. 4 is a core type transformer wherein the core section 61 and yoke 62 and 63 consist of laminæ or stampings which are continuous pieces of high permeability material, and core section 64 is also composed of high permeability material but of a lesser number of laminæ than core section 61 or yoke 62 and 63. Core section 64 has a greatly reduced section at its middle as shown in the figure so as to increase the flux density at this point and to thereby provide a small part in the magnetic circuit which will become saturated more easily than the other parts. The biasing winding 65 and primary winding 66 are wound on spool 67 and the secondary winding 68 is wound on spool 69. Fig. 4—A shows a section of Fig. 4 taken along line 4—A, wherein a motor driven friction wheel 70 may be brought in contact with the edges of spool 67 for the purpose of applying the windings after the spool is in place on core section 61. This spool may be placed around core section 61 by cutting the spool into halves and then assembling the halves to fit

around the core section. This type of transformer is adapted for frequencies of the higher order such as those used in telephone transmission.

Fig. 5 is a modification of Fig. 4 wherein core sections 71 and 74 and yokes 72 and 73 consist of stampings of continuous pieces of high permeability material with the middle portion of the core section 74 greatly reduced as shown. These stampings, when assembled, are encased in a box 75 of insulating material, such as hard rubber. The box is made in the form of a hollow square, as shown, so as to allow the spools 76 and 77 to be satisfactorily mounted thereon. The biasing winding 78 and primary winding 79 are wound on spool 76 and the secondary winding 80 is wound on spool 77. These spools are mounted in the same manner as spool 67 shown in Fig. 4—A. Fig. 5—A shows a section of Fig. 5 taken along line 5—A. It is understood that the edges of the insulating box 75 are rounded on those portions upon which the spools 76 and 77 are mounted in order to provide a smooth bearing.

The functions of the transformers shown in Figs. 2 to 5 inclusive, are similar to those described above for Fig. 1. It is understood that in each of Figs. 3, 4 and 5 a bucking or compensating winding connected, in series opposing, with the primary winding, may be superposed on the secondary winding as shown and described above for Fig. 2. A better understanding of these functions may be had by referring to the applicant's copending applications, supra.

What is claimed is:

1. A transformer for impulse transmission systems having a core at least partly composed of highly permeable material, a primary winding, a source of signaling current of slowly varying intensity connected to the primary winding, a rigid element movably mounted on said core for supporting said winding on said core and adapted to protect said core from physical strain whereby the high permeability characteristic of the core material is preserved and a secondary winding mounted on said element arranged to receive from said source, a voltage wave constituted of short, sharp voltage impulses separated by relatively long intervals of zero voltage.

2. A transformer for impulse transmission systems having core material of high magnetic sensitivity, some sections of which have a smaller cross-sectional area than the remainder, a primary winding on one section of said core, a source of signaling current of slowly varying intensity connected to said primary winding, a secondary winding on the section having the smaller cross-sectional area for receiving from said source a wave of short, sharp voltage impulses separated by relatively long intervals of zero volt-

- age, said area of smaller cross-sectional area serving to increase the amplitude of the voltage impulses and to lengthen the intervals of zero voltage therebetween, and rigid electrostatic shielding elements movably mounted on said core for supporting said windings on their respective core sections, adapted to protect said core sections from physical strain whereby the highly sensitive characteristic of the core material is fully utilized for producing the desired secondary wave.
3. A transformer for impulse transmission systems comprising a magnetic circuit of core material having a high permeability characteristic and capable of passing at several points different amounts of flux simultaneously, primary windings mounted on said core material for applying at one point in said circuit a current of low voltage and low frequency, and secondary windings on said core material for receiving at other points in said circuit, in response to said current, voltage waves of high amplitude and high frequency, said wave being constituted of short, sharp impulses separated by relatively long intervals of zero voltage.
4. A transformer for impulse transmission systems comprising a plurality of windings, cores of large cross-sections for mounting some of said windings, cores of smaller cross-sections and of a magnetic character highly sensitive to slight physical pressures for mounting another of said windings, and means for mounting said windings to afford mechanical protection against physical pressures to the core material to preserve the electrical characteristics of the material of said cores.
5. A transformer for impulse transmission systems comprising a magnetic circuit of high permeability core material, a primary and a secondary winding linked with different parts of said circuit, said primary winding being arranged to impress on said circuit a current of low voltage and high frequency, and said secondary winding being arranged to receive from said circuit, in response to said primary current, a voltage wave of high amplitude and high frequency, the impulses of which wave are of short duration and are separated by relatively long intervals of zero voltage, and a compensating winding connected, in series opposing, with said primary winding and superposed on said secondary winding to give a sharper cut-off to the secondary voltage impulse.
6. A transformer for impulse transmission systems comprising a magnetic circuit of high permeability core material, a primary and a biasing winding linked with one part of said circuit, a secondary winding linked with another part of said circuit, and a compensating winding connected, in series opposing, with said primary winding and linked with said another part of said circuit.
7. A transformer for impulse transmission systems comprising a core being constituted in part at least of a material of high permeability, a plurality of magnetic circuits, a plurality of biasing windings for maintaining said circuits normally saturated in different directions, a plurality of secondary windings linked with said circuits, and a single primary winding linked with said circuits and arranged to momentarily unsaturate said circuits alternately.

In witness whereof, I hereunto subscribe my name this 29th day of May, 1930.

EVERETT T. BURTON.

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