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T. J. FAY

FREQUENCY TRANSFORMER

Filed June 13, 1924

Fig. 1.

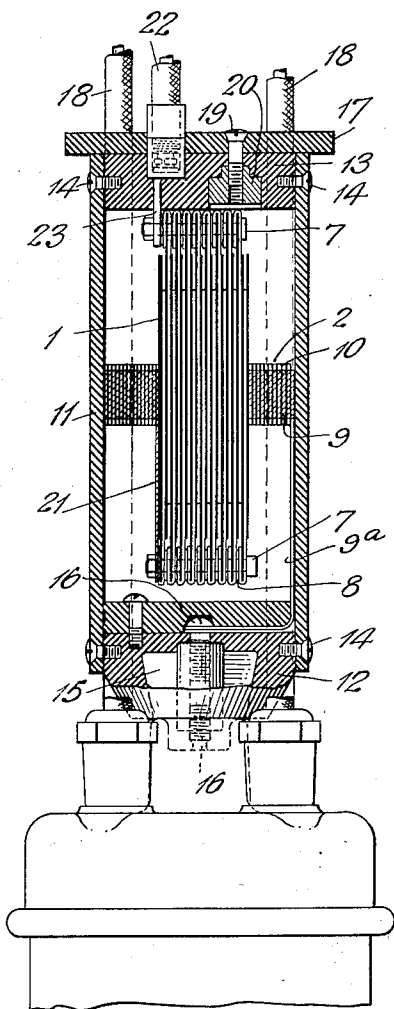


Fig. 2.

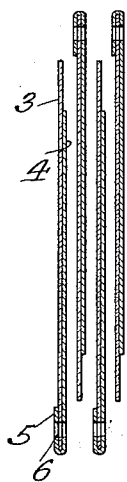


Fig. 3.

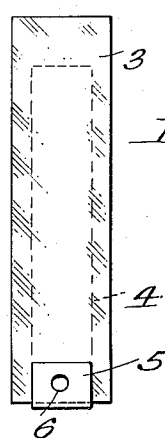


Fig. 4.

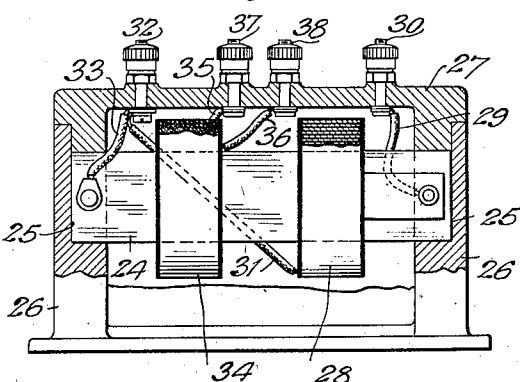


Fig. 5.

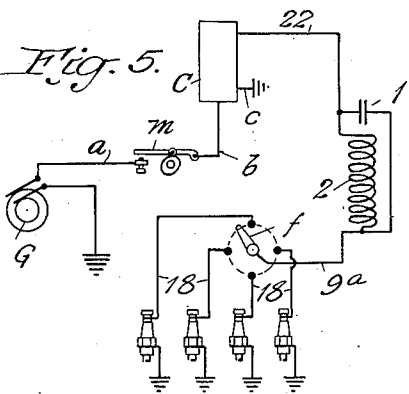
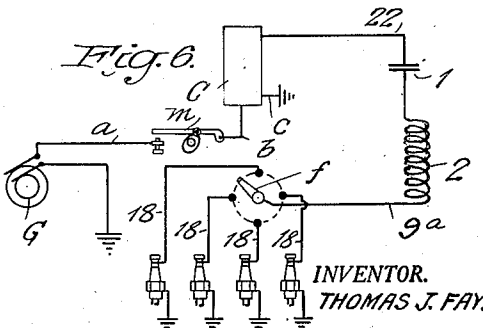


Fig. 6.



INVENTOR.
THOMAS J. FAY.

BY

Stockbridge & Borst
ATTORNEYS

UNITED STATES PATENT OFFICE.

THOMAS J. FAY, OF BROOKLYN, NEW YORK.

FREQUENCY TRANSFORMER.

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This invention relates to transformers for use in electric circuits and are particularly adapted for use in automobile ignition systems and in radio telephone and telegraph systems.

An object of the invention is to provide an improved transformer which will be compact, efficient, durable, and relatively inexpensive to manufacture. A further object is to provide an improved ignition system which will produce a more satisfactory and perfect ignition independent of the character of the gas which is burned; with which fouling of the spark plugs will be prevented; which will be reliable, efficient, and relatively inexpensive. A further object is to provide a device which may be incorporated into existing types of ignition circuits, without material modifications therein, in a simple, convenient, and practical manner for increasing the efficiency of the ignition systems and obtaining a more satisfactory detonation. Various other objects and advantages will be apparent from the following description of embodiments of the invention, and the novel features will be more particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawing:

Fig. 1 is an elevation of the distributing mechanism of an explosion engine of the type used in automobiles, to which a frequency transformer, constructed in accordance with the invention, has been applied, the transformer being shown in sectional elevation.

Fig. 2 is a sectional elevation through a number of the plates of the condenser of the transformer of the same.

Fig. 3 is a face elevation of one of the elements of the condenser.

Fig. 4 is an elevation, particularly in section, of a modification of the transformer for use in radio telephone and telegraph systems.

Fig. 5 is a wiring diagram which may be followed for the ignition systems of automobile engines; and,

Fig. 6 is a similar diagram with the connections of the transformer changed slightly from those shown in Fig. 5 and in accordance with those which are shown in Fig. 1.

Referring particularly to Figs. 1, 2, and 3 the condenser 1, having its conducting plates of magnetic material is utilized as the core of an electro-magnetic winding 2. The con-

denser is formed of a plurality of elements which are shown separately in Figs. 2 and 3, a sufficient quantity of the elements being assembled to give the desired capacity. Each element consists of a sheet 3 of insulation such as mica or any other suitable dielectric material, and a sheet or strip 4 of magnetic metal preferably not wider than the sheet of insulation and abutting against the same, as shown in Fig. 2, face to face, with one end of the metallic strip doubled over upon and embracing one end of the strip of insulation or dielectric material so as to anchor the metallic strip to the strip of dielectric material. The other end of the metallic strip stops some distance from the end of the sheet of insulation or dielectric material for a purpose which will appear hereinafter. The doubled over end of each metallic strip 4 and the interposed portion of the sheet of dielectric material are provided with aligned apertures. The condenser elements are assembled as shown in Fig. 2 so that the doubled over ends will be alternately arranged or staggered with the sheet of dielectric material, the insulating sheet of each element being face to face with the metallic strip of the next adjacent element, so that the metallic strips will be insulated from one another by the strips or sheets of dielectric material.

When the elements are assembled, the unbound edge of each dielectric sheet is disposed adjacent to, but not overlapping, with the turned over end of the metallic strip of the next adjacent elements, so that the ends of the adjacent metallic strips will not be in contact with one another. The ends with the turned-over edges, which are on alternate strips correspondingly arranged, will be brought together and bound, as will be explained presently. When the elements are assembled as shown in Fig. 2, the apertures 6 in the alternate elements will be aligned in two groups and suitable securing devices such as screws 7 may be passed through the sets of aligned apertures 6 for clamping the elements together with the turned over metallic ends of alternate metallic strips directly in contact with one another so as to form electrical connections between them. If desired, suitable washers 8 may be interposed between the turned over metallic ends at each end of the assembled condenser, so that the elements will not be drawn together in a flexed condition when the bolts 7 are

tightened. If desired, suitable clamping means may also be provided for holding the elements in assembled relation.

I may also provide adjustable clamping means for regulating the pressure upon the spaced elements when in assembled relation, so that the capacity of the condenser may be varied through an alteration of the distances between such elements. In this event, this winding would not be as tight as heretofore, and might be utilized to determine or limit the maximum possible spacing between the condenser elements. For example, with washers interposed between the elements of each group of elements, so that all of the elements would be spaced apart somewhat, flexible confining plates of insulating material may be placed upon the outer faces of the condenser and confined thereon by the screws which bind the ends of the elements together. Saddle members could be placed upon the outer faces of the confining members and connected by screws passing if desired, through the edges of the dielectric sheets so as to be positioned thereby, and suitable wing nuts or other operating members may be threaded upon the screws so as to draw the saddle members together to variable extents. The confining members and condenser elements will flex toward one another as the saddle members are brought together, the space between them will decrease, and thus the capacity of the condenser will be varied.

By doubling over one end of each metallic strip upon its corresponding sheet or strip of insulation, the metallic strip and the insulation sheet will be clamped together so that they may be handled without danger of separation. In punching the holes in the elements, the punching tools will turn in sufficient of the metal around the punched aperture to serve as an interlocking rivet which locks the sheet of insulation within the embrace of the metallic strip. The line of fold in the metallic strip abuts against the embraced edge of the insulating strip or sheet, and thus the metallic strip will be confined in proper relation to the area of the sheet of insulation; i. e., the metallic strip cannot swing laterally at its free end so as to project beyond the side edges of the insulating strip. The metal and insulating strips of each element will therefore always be properly aligned one with respect to the other. The elements may also be handled individually, without danger of the components becoming separated. The condenser may also be expanded or lessened in capacity by merely adding or taking off some of the elements.

A ribbon 9 of magnetic metal is wound into a coil winding tightly about the assembled condenser as a core, and a ribbon 10 of insulating material, such as silk ribbon, may

be wound into the coil with the metal ribbon, so as to insulate the successive turns from one another. This winding acts as an inductance with the condenser acting as a core therefor. The coil also presses and holds together in operative relation the condenser elements.

This condenser and inductance are mounted in a casing 11, closed at its ends by plugs or closures 12 and 13 of insulating material, which are secured in position in the casing in any suitable manner such as by screws 14. A metal nut 15, such as a wing nut, is suitably anchored in one end closure, such as 12, and is adapted to be threaded upon the projecting metal terminal 16 usually provided upon the upper face of a distributor cap to which the lead from the secondary of the usual inductance coil is usually connected. One end 9^a of the ribbon 9 is conducted along the casing 11 and secured to the nut 15 in any suitable manner such as by a screw 16 which passes through the end of the ribbon 9 and into the nut from the inner face, thus serving to form an electrical connection between the inductance winding and the screw circuit terminal 16 of the distributor cap. At the same time casing 11 will be supported in an upright position by the terminal screw 16 of the distributor cap.

A plate 17 of insulating material may be secured across the upper end of the casing 11 so as to project laterally or overhang the end of the casing, the flange having apertures through which the distributor leads 18 between the spark plugs and the distributor may pass so as to be supported in properly spaced relation from one another. This plate 17 may be conveniently secured to the closure 13 by a screw 19 which passes through the plate 17 into a nut 20 that is countersunk into the inner face of the closure plug 13.

In Fig. 1 the condenser is shown as in series with the inductance of which it forms the core, and therefore the inner terminal 21 of the inductance is secured to one of the screws 7 of the condenser, which, for convenience, is the lower screw. The circuit lead 22, which was formerly connected to the terminal screw 16 of the distributor cap for supplying high tension current thereto from the secondary of the high tension coil, is anchored in any suitable manner to the insulated closure plug 13 at the upper end, and has an extension 23 which is connected to the other side of the condenser, such as to the screw 7 at the upper end of the condenser. This wiring arrangement is illustrated diagrammatically in Fig. 6.

In the operation of an ignition system arranged in this manner, and referring to Figs. 1 and 6, the current from the generator G or other source of current, is conducted by a wire *a* to the usual make and break or in-

interruptor mechanism *m*, then by a wire *b* to the primary of an inductance coil *C*, and thence by a wire *c* to ground. One terminal of the secondary is usually grounded through the conductor *c* and the other terminal of the secondary of the coil is connected by the lead 22 to one side of the condenser 1. The other side of the condenser is connected to the inner terminal of the inductance 2 and the outer terminal of the inductance is connected through the terminal screw 16 to the flyer *f* (see Fig. 6) of the usual distributor mechanism, which during its rotation is electrically connected successively to the distributing leads 18 that conduct the current to the spark plugs in a particular order as usual in ignition systems.

All of the high tension current passing to the spark plugs will thus pass through the condenser and the inductance, in series with one another, and I have found that the condenser and inductance included in the circuit in this manner will very materially increase the efficiency of the ignition circuit. In Fig. 5 a similar arrangement is diagrammatically illustrated except that the condenser and inductance are connected in parallel with one another, instead of in series as shown in Figs. 1 and 6.

I have found that the insertion of the condenser in the circuit apparently serves to ionize the gas between the electrodes of the spark plugs, and this ionized gas is more susceptible to detonation than unionized gas, and is more unstable chemically. The turbulence of the fluid in the explosion chamber tends to remove the ions from the vicinity of the spark plug, but with the condenser in the ignition circuit the ionization appears to take place more rapidly than it can be dissipated by the turbulence of the surrounding fluid. As a result, a more perfect ignition is obtained, independent of the character of the gas, and with this more perfect ignition there will be less fouling of the spark plugs and less carbon deposited in the cylinder and on the electrodes of the spark plugs. In fact, it has been found by actual demonstration, that with this transformer in an ignition circuit, there have been no noticeable deposits of carbon in the cylinders or upon the spark plugs and electrodes.

It has been found that by making the condenser plates of magnetic material, and utilizing the condenser as the core of the coil or inductance, the core will demagnetize rapidly to respond to and keep up with the current which is produced, the amount of magnetic metal required for handling the total flux being a minimum for this purpose. The winding furnishes sufficient magnetic flux to snuff out any arcs which may for any reason be formed in the condenser. Therefore there will be no danger of the high tension current puncturing the dielectric mate-

rial of the condenser. The condenser plates form the laminations of the core so that there will be no difficulty in the condenser by reason of the formation of Foucault currents therein. The flat ribbon winding supplemented by the magnetic material of the condenser forms its own core with a short magnetic circuit, and, as a result, it will demagnetize rapidly.

In case there are any Foucault currents developed in the winding, they will be harmless because the only direction in which they can flow will be in the direction of the winding and thus in the direction of the current which is passing therethrough. Since the conductor of the coil or inductance is of magnetic material it forms the equivalent of a magnetic enclosing shell, so there will be no material loss from stray flux. The inductance coil may be wound upon the condenser sufficiently tight to bind the condenser elements together, or additional securing means may be provided. Also any desired number of the coils may be mounted upon the condenser for furnishing the desired inductance. While any form of conductor may be used for the inductance, the flat ribbon of magnetic metal is preferable for the reasons explained.

In Fig. 4 I have illustrated a transformer constructed in accordance with this invention, and adapted for use in radio telephone and telegraph circuits in substitution for the usual audio frequency transformer. In this embodiment the condenser 24, made up as explained in Figs. 1 to 3, is supported at its ends in sockets or recesses 25 provided in the ends 26 of a suitable frame or casing, the condenser being confined therein by a cap 27 which also serves as a terminal board or member. Both the cap member and ends 26 of the frame are preferably of insulating material, such as hard rubber or bakelite, and an inductance 28 similar to the inductance 2 of the embodiment shown in Fig. 1 is mounted upon the condenser with the condenser serving as the core thereof, one terminal of the inductance 28 being connected to one end of the condenser and also by a wire 29 to a terminal post 30 on the cap member. The other end of the inductance 28 may be connected by a conductor 31 to a terminal post 32 upon the cap member, and the latter by a wire 33 to the other end of the condenser, so that the inductance and the condenser will be in parallel between the terminal posts 30 and 32, this forming the primary of an audio frequency transformer.

A second inductance 34 may be mounted upon the condenser as a core, with its ends connected by conductors 35 and 36 to secondary terminal posts 37 and 38 upon the cap member. A pulsating or alternating current passing through the primary circuit of the transformer will produce an induced

current in the secondary winding 34. If desired, the condenser in many instances, may be advantageously connected in series with the inductance, in the primary circuit, but the usual arrangement for radio work will be as shown in Fig. 4. This transformer will respond without distortion to very rapid fluctuations since the field will damp out rapidly. Such a transformer has been found to be particularly efficient. If desired, the pressure between the condenser elements may be regulated to some extent to vary the capacity of the condenser.

While the transformer has been described in connection with ignition circuits and radio circuits it will be obvious that various other uses, both in the ignition circuits and radio circuits, may be found for the same, and that it may advantageously be utilized in other electrical circuits where a variation in the frequency of currents is desired. It will also be understood that various changes in the details and arrangements of parts, herein described and illustrated for the purpose of explaining the nature of invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim:

1. A transformer comprising a condenser having its conductor parts of magnetic material, and an electromagnetic winding about the condenser, the winding and said condenser being connected together for inclusion in a common circuit.

2. A transformer comprising a condenser having its conductor parts of magnetic

material, and an electromagnetic winding of magnetic material about the condenser, the winding and said condenser being connected together for inclusion in a common circuit.

3. A transformer comprising a condenser having its conductor parts of magnetic material, an electromagnetic winding about the condenser, the winding and said condenser being connected together for inclusion in a common circuit, and a secondary electromagnetic winding about the condenser.

4. A transformer including a magnetic circuit comprising a condenser formed partially of magnetic material and an electric circuit electrically connected to said condenser.

5. A transformer including an inductance unit and a magnetic circuit comprising a condenser, the inductance unit being wound upon said condenser.

6. A transformer including an inductance unit and a magnetic circuit comprising a condenser, the inductance unit being wound upon said condenser and electrically connected thereto.

7. A transformer having a magnetic core and an inductance unit wound thereupon, said core comprising a condenser.

8. A transformer having a magnetic core and an inductance unit wound thereupon, said core comprising a condenser, said condenser being electrically connected to said inductance unit.

In testimony whereof, I hereunto subscribe my signature.

THOMAS J. FAY.