

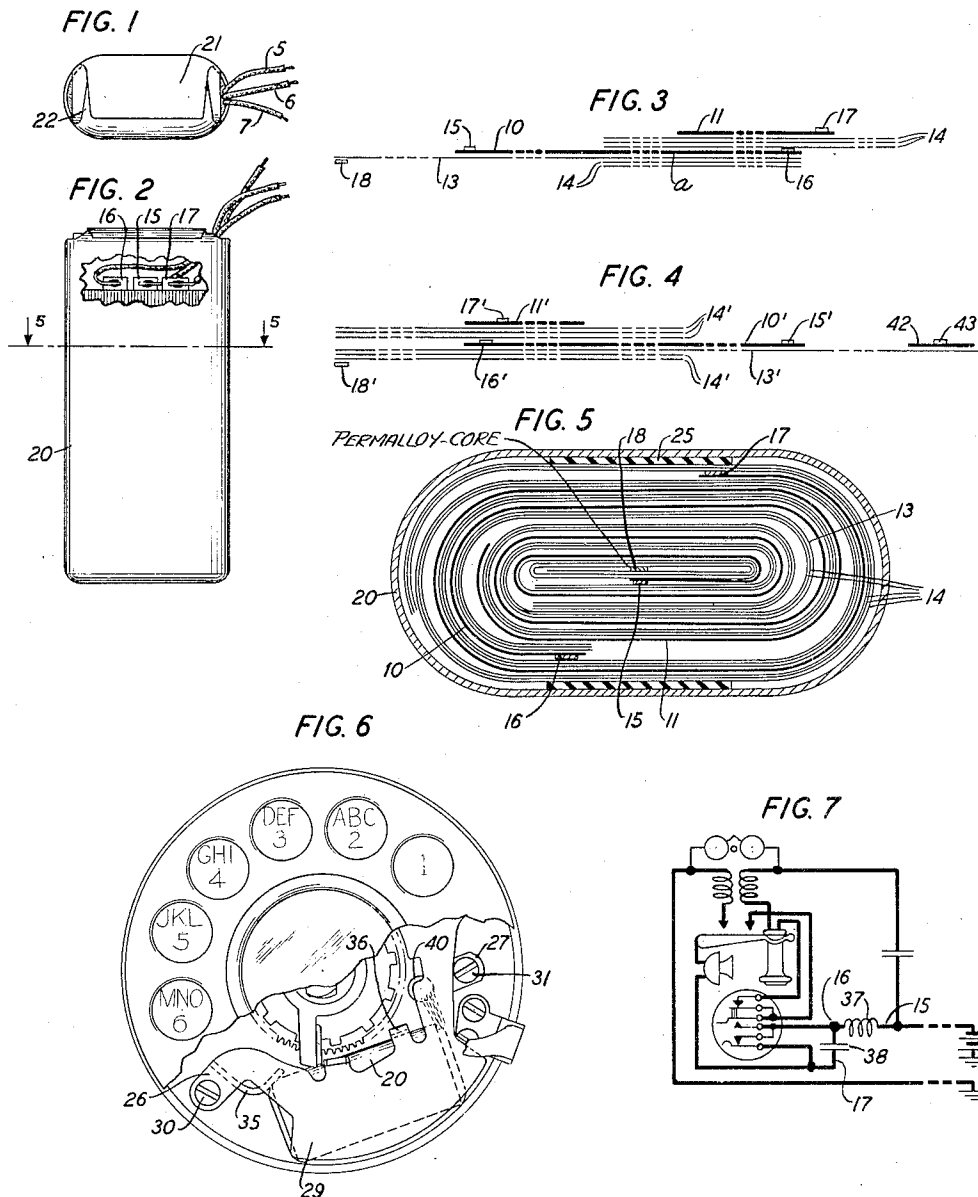
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ELECTRICAL FILTER

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ELECTRICAL FILTER

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This invention relates, in general, to filters and particularly to high frequency filters of the type used to suppress radio interference.

Since the advent of radio broadcasting and its ever increasing popularity with the radio public, there has been a demand for radio reception which is free from local controllable disturbances. It is a well-known fact that the development of radio receivers has not reached the stage of development where they, of themselves, are capable of eliminating or minimizing the objectionable effects caused by local static which is generated by neighboring electrical apparatus.

Among the types of electrical apparatus which have been found to create a condition which manifests itself in radio receivers in the form of local static is the telephone dial. In manipulating a telephone dial to transmit impulses which control the operation of automatic switches at a central office, a current carrying circuit is repeatedly interrupted. These interruptions produce high frequency electrical surges which are radiated and are picked up by neighboring radio receivers and reproduced therein as clicks or other equally objectionable noises which materially interfere with the reception of broadcast programs.

Heretofore, filters have been designed which, to a considerable extent, have been effective in suppressing radio interference caused by the telephone dial. Such filters, in general, consist of an inductance element and a capacity element and have been characterized by a construction which locates the inductance element externally of the capacity element thereby having an inherent parasitic direct capacity from the inductance element to the filter casing. In such structures it has been necessary to space the filter casing a relatively large distance from the inductance element to reduce the parasitic capacity to a satisfactorily small value, thereby resulting in a unit which had an objectionably large over-all dimension.

It is the object of this invention to provide a self-shielded filter which will efficiently suppress high frequency currents set up by the operation of contacts in an electrical circuit and which is of such dimensions as to readily adapt it for mounting in restricted areas, and close to the source of disturbance.

This object is attained in accordance with a feature of the invention by utilizing a permalloy core for the inductance element which renders it possible to obtain the same value of inductance as was obtained in previous structures of the same nature, with a smaller inductive winding.

Another feature of the invention resides in a simplified method of construction which permits the unit to be manufactured in a single winding operation and obviates the need for spacing between the filter elements and the casing. In accordance with this feature a single conductor, in the nature of a metal foil, is wound around a thin permalloy lamination to effect the inductance element of the filter and a continuation thereof is then wound in parallel with a second metal foil over the inductance element to obtain a capacity element of the desired value which is located externally of and serves to shield the inductance element. The foils and turns are separated by insulation.

These and other features of the invention will be readily understood from the following detailed description made with reference to the accompanying drawing in which:

Fig. 1 is a top view of an encased filter embodying the features of the invention;

Fig. 2 is a side elevation of the filter unit with a portion of the casing broken away to disclose the terminal connections;

Fig. 3 shows the manner in which the foils of the filter unit are arranged in constructing the filter;

Fig. 4 is a view similar to that of Fig. 3 and shows the foil arrangement in a filter unit provided with an auxiliary shield;

Fig. 5 is an enlarged section taken along the line 5-5 of Fig. 2 looking in the direction of the arrows;

Fig. 6 is a view of a telephone dial with certain parts thereof broken away to illustrate the manner in which the filter is housed within the dial structure; and

Fig. 7 is a drawing of a substation circuit showing the circuit connections of the filter to the dial.

Referring now particularly to Fig. 3, the combined filter unit consists of the conductors 10 and 11 of metal foil, such as tin foil or aluminum foil and the paper insulators or dielectrics 13 and 14. The metallic sheet 10 is of greater length than the metallic sheet 11 and is provided with terminals 15 and 16 located at each end respectively. Interposed between the metallic sheets 10 and 11 are several layers 14 of paper which extend beyond either end of the metallic sheet 11. One or more similar sheets 13 of paper of greater length than the longer metallic sheet 10 is provided, below one end of which is located a thin lamination 18 of permalloy. The metallic sheet 11 is provided with a terminal 17 near the end.

In constructing the filter, the combined elements 18, 13, 10, 14 and 11 are wound in a single operation with the winding commencing at the left in Fig. 3, so that the permalloy core 18 is first covered by the paper sheet 13 alone, then by the combined foil 10 and sheet 13, then by the combined foil 11, paper sheets 14, foil 10 and paper sheet 13 and finally by the remaining portions of the paper sheets 14 and 13. When the winding operation is carried out in the manner just described, there will be produced a single roll of alternate layers of metal foil and paper with a permalloy core center, the inner portion of the roll constituting an inductance element made up of the core 18 and several turns of the paper sheet 13 and the left-hand portion of foil 10 as far as the point *a*, and the external portion constituting the capacity element consisting of the remaining portion of foil 10, foil 11 and the interposed dielectric paper sheets 14. The sectional view shown in Fig. 5 illustrates the manner in which the various elements of the unit are positioned when the roll is completed. It is to be understood that Fig. 5 is not intended to illustrate the exact number of turns of the various elements which constitute the filter unit; such a showing would unnecessarily complicate the drawing. This figure, however, suffices to illustrate the fact that a portion of the foil 10 is used as the inductive winding and that the remaining portion of foil 10 is subsequently combined with foil 11 and the interposed paper sheets 14, to effect the capacity element. The number of turns required for the inductive winding and the capacity winding would, of course, vary with circuit requirements and the foil and paper sheet lengths would vary accordingly.

The relative lengths of the several foils and insulating paper sheets for particular values of inductance and capacity, which have been found to effectively suppress the interference caused by the manipulation of a telephone dial, are indicated in the following discussion made with particular reference to Fig. 3. The portion of the paper sheet 13 projecting beyond the left end of foil 10 is of such length as to provide six turns over a permalloy lamination having the dimensions $1'' \times \frac{1}{8}'' \times .006''$; the portion of foil 10 extending to the left of the point *a* and the corresponding portion of paper sheet 13 are of such lengths as to provide one hundred and seven turns, which constitute the inductive element of the filter; the last two of these one hundred and seven turns also include the portions of paper sheets 14 which project beyond the left end of foil 11; the next twenty-six turns are made up of the remainder of foil 10 and corresponding lengths of paper sheets 13 and 14 and of foil 11, which effect the capacity element of the filter; the next one and one-half turns are made up of the remainder of foil 11, corresponding lengths of paper sheets 14 and the remainder of paper sheet 13; and the final two turns of the roll are made up of the remaining portions of paper sheets 14.

After the several elements of the filter have been assembled in a single roll as just described, the roll is placed in a substantially U-shaped cardboard holder indicated at 25 in Fig. 5 and the entire assembly slipped into a collapsible tube 20, made of lead or other soft metal which may be provided with a cellulose acetate cap, or as illustrated in Figs. 1 and 2, the sides of the tube may be extended to provide overlapping portions 21 and 22, which, after assembly of the

filter in the tube are pressed over one another to form, with the tube, an envelope. The entire assembly may be subjected to pressure to give the unit the shape indicated in the drawing and to effect a more compact structure. The encased filter may then be dipped in a colored cellulose acetate solution which serves as a finish and gives additional protection.

As illustrated in Fig. 2, the terminals 15, 16 and 17 are extended beyond the upper edge of the rolled filter to provide means for securing the leads 5, 6 and 7 to the filter. The leads 5, 6 and 7 are brought out through an opening in an upper corner of the tube or casing 20 and are secured to the springs of the spring pile-up located on the under surface of the dial casing, in a manner such as to effect the circuit arrangement illustrated in Fig. 7. The area within the tube between the terminals and the cover or top of the tube may be filled with wax or any other suitable space filling material.

The actual size of a filter constructed as described and its location in a telephone dial are shown in Fig. 6. A substantially flat metal piece 29 is provided with two, or more, depending flanged legs 25 and 27 which are made fast to the base of the dial casing by means of screws 30 and 31 respectively. In assembling the filter in the dial, this metal piece or clamping member 29 is removed and the filter placed, as shown, on the base of the dial casing with the corner of the tube 20 from which the leads 4, 5 and 6 protrude facing the aperture 40 in the dial casing base. The clamping member 29 is then placed in position and the screws 30 and 31 made fast. The member 29 is provided with two finger-like projections 35 and 36 which serve to hold the filter unit against two points on the inner periphery of the dial casing wall, thereby securely positioning the unit and rendering it substantially fixed. The member 35 is so positioned as to abut against one corner edge of the filter unit whereas the projection 36 embraces one side of the unit near its terminal end.

In Fig. 7 the elements which constitute the filter unit are identified by the numerals 37 and 38, the inductance element being designated 37 and the capacity element 38. These two elements are connected electrically in a series circuit which is connected in shunt with the dialing contacts of the dial. The actuation of the dial finger wheel causes repeated interruptions of the dialing contacts and as these contacts are connected across the telephone line with which there is associated the usual current source, there are set up at the dial contacts, current surges. The filter unit consisting of the inductance 37 and capacity 38 acts to suppress the radio frequency components of these surges, thereby rendering them ineffective in causing disturbances to neighboring radio receivers without interference with the dial pulses which control the setting of automatic telephone switches. The terminals of the filter unit are designated by the same numerals used in Fig. 3.

While the invention thus far has been described in connection with the suppression of radio interference caused by the operation of a telephone dial, it will be understood that the filter structure described has many other varied applications and is particularly effective in instances where it is essential that the inductance element of the unit be shielded, not only from the casing in which the filter is housed, but also from neighboring electrical equipment.

The permalloy core serves not only as a means of getting the inductance element on the inside of the unit to reduce its direct capacity to outside objects without increasing the size of the filter but also obviates the necessity for including resistance in the filter circuit to increase the high frequency losses of the inductance element in order to obtain satisfactory performance. In some prior filters, the introduction of resistance in the filter circuit is effected by short-circuiting a part of the inductive winding.

In Fig. 4 there is illustrated a combination of filter elements corresponding in general to those shown in Fig. 3. The elements of Fig. 3 which correspond to those of Fig. 4 bear the same identifying numerals with a prime exponent. It is intended that the elements of this combination be wound in the same direction as described in connection with Fig. 3, that is, from left to right. This procedure obviously, would locate the capacity element effected by foils 11' and 10' and the dielectric sheets 14'' in the center of the unit with the inductance coil effected by foil 10' on the outside. To provide the shielding feature in this construction, an additional metal foil 42 is provided which encircles the capacity and inductance elements when the rolling or winding process is completed. The foil 42 is provided with a terminal 43 which in practice, would be connected together with terminal 16'.

What is claimed is:

1. A filter comprising a coiled conductor wound upon a permalloy core to form an inductance element and a second conductor coiled in parallel with a continuation of said first conductor to form a capacity element which encircles the inductance element, the conductors and turns being separated by insulation.

2. A filter comprising a pair of metallic sheets separated by sheets of dielectric and wound into the form of a coil, one of said metallic sheets being of greater length and having its inner portion wound on a permalloy core to form an inductive element and having its outer portion cooperating with the other metallic sheet to form a capacity element which encircles the inductive element.

3. A filter comprising a coiled conductor insulatively wound upon a permalloy core to form an inductance element, a second conductor insulated from and coiled in parallel with a continuation of said first conductor to form a capacity element which encircles the inductance element and a close-fitting collapsible tubing encasing the inductance and capacity elements.

4. A filter comprising a coiled conductor insulatively wound upon a permalloy core to form an inductance element and a shield for said inductance element comprising a second conductor insulated from and coiled in parallel with a continuation of said first conductor to effect a capacity element.

5. A filter comprising a pair of metallic sheets separated by sheets of dielectric and wound in the form of a coil, one of said metallic sheets being of greater length and having its inner portion wound on a permalloy core to form an inductive element and having its outer portion cooperating with the other metallic sheet to form a capacity element which shields the inductance element.

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