

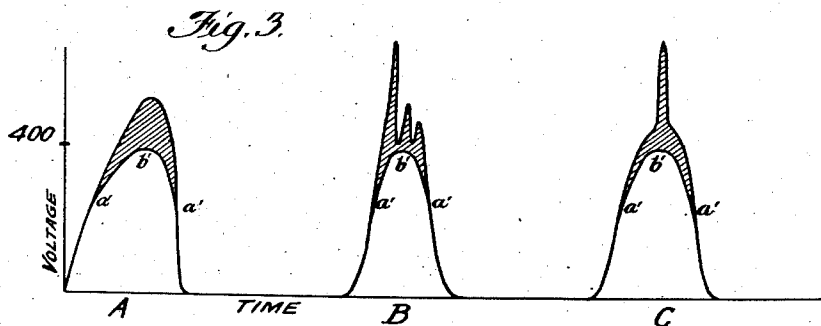
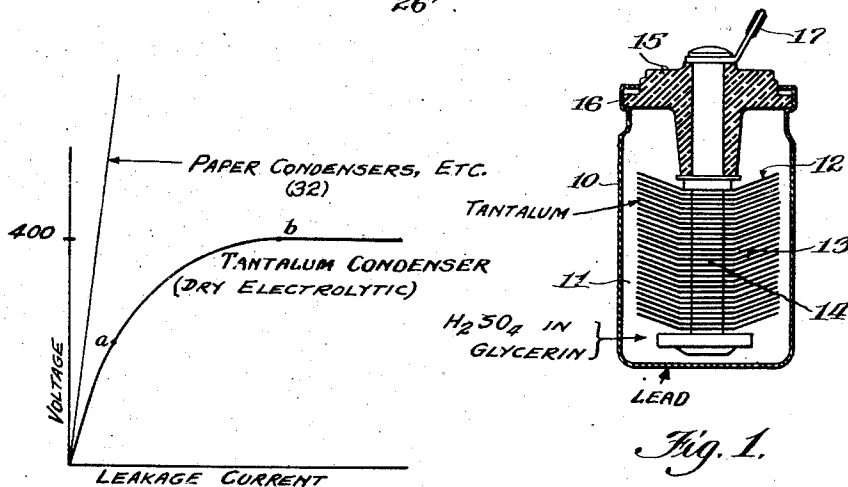
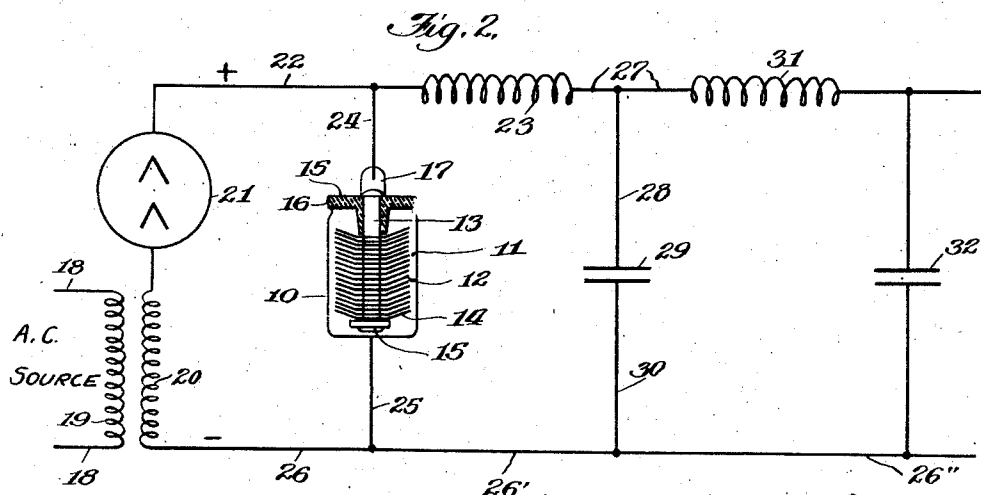
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ELECTROLYTIC FILTER CONDENSER

Filed March 22, 1928



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UNITED STATES PATENT OFFICE

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ELECTROLYTIC FILTER CONDENSER

Application filed March 22, 1928. Serial No. 283,772.

This invention relates to electrolytic condensers and pertains particularly to the type in which a filmed electrode is inserted in a dry (non-aqueous) solution of an acid, base and/or salt dissolved in substantially dry glycerin.

The object of this invention is to provide an electrolytic condenser which will have low leakage at low voltages, which will have high leakage when a certain voltage limit is exceeded, and which will have a leakage characteristic between these limits which is geometric as distinguished from the ordinary arithmetic characteristic of the leakage of a paper condenser. Due to these characteristics the cell will act as an electrolytic safety valve for taking care of surges and peak voltages.

A further object is to provide an electrolytic condenser with an improved conducting fluid.

A further object is to provide an electrolytic condenser which requires substantially no reforming after periods of idleness and which will not deteriorate with age.

Other objects will be apparent as the detail description of my invention proceeds.

My invention may be briefly characterized as a filmed tantalum plate inserted in a substantially dry (non-aqueous) glycerin solution of sulphuric acid, the tantalum electrode being supported by an insulator holding it out of contact with the casing which may form the other terminal of the condenser. The peculiar characteristics of the film on the electrode causes this cell to act as a safety valve when it is subjected to extremely high voltages and as a compound condenser and variable resistance at intermediate voltages as will be more particularly pointed out in the detail description of my preferred embodiment which follows.

In the accompanying drawings which represent the preferred embodiment of my invention and in which like parts are represented by similar reference characters throughout the various figures,

Fig. 1 is a vertical section of my improved condenser;

Fig. 2 is a filter circuit incorporating this condenser;

Fig. 3 is a graph showing the difference between the characteristics of paper condensers and my improved electrolytic condenser; and

Fig. 4 is a diagrammatic representation of characteristic wave forms upon which my condenser is adapted to operate.

The condenser casing 10 is preferably non-film forming metal such as lead, although any suitable conductor may be used for this purpose. This casing contains a substantially dry (non-aqueous) solution prepared by mixing 1% of sulphuric acid with 99% of substantially dry glycerin. By increasing the amount of sulphuric acid in the solution, the voltage break-down characteristic of the film is lowered. It is apparent therefore that varying amounts of sulphuric acid may be added, depending on the desired voltage limit, the 1% solution having under certain conditions a break-down at approximately two hundred fifty volts. While sulphuric acid dissolved in glycerin is my preferred electrolyte, it is understood that I may use any suitable acid, base or salt instead of sulphuric acid without departing from the spirit of my invention.

Into this electrolyte is inserted a filmed electrode 12 preferably of tantalum, and prepared by securing a plurality of tantalum plates 13 on a film-forming rod 14. This electrode may be held in place by an insulating cover 15 held in place by the crimped edges 16 of the casing 11. The upper portion of the rod is preferably provided with a terminal lug 17.

When this condenser is connected in the filter circuit shown in Fig. 2, it acts as a condenser, as an electrolytic safety valve and as a compound condenser and variable resistance. In this figure an A. C. source is connected by wires 18 to the primary 19 of a transformer, secondary 20 of which is connected in series with a rectifier 21. A wire 22 connects the positive side of the rectifier with an inductance 23 and a wire 24 connects wire 22 with terminal lug 17 of the improved condenser. The casing of the condenser serves as the negative electrode and it is connected by wire 25 to a wire 26 which forms the negative side of the rectified circuit.

The other end of inductance 23 is connected by wires 27 and 28 to one side of condenser 29, the other side of which is connected by wire 30 to conductor 26'. Wire 27 is also connected to inductance 31 which is bridged by a condenser 32 connected in a manner similar to condenser 29.

It is well known that in ordinary paper condensers the leakage current is directly proportional to the applied voltage, that is, the graph is a straight line as shown in Figure 3. However, in my improved electrolytic condenser the film permits current to flow above a certain voltage and the voltage is prevented from rising above a certain limit. From O to *a* in the graph there is relatively low leakage (about .05 mills at 250 volts). As the voltage increases, however, it will be noted that the curve bends and that the leakage current flows through the condenser. When the voltage reaches *b* the leakage current is a maximum. Between *a* and *b* this curve is not a straight line; the ratio of current to voltage is not constant but increases, i. e., the condenser has in effect a resistance in parallel therewith which decreases as the voltage goes up. I take advantage of this phenomenon by using my improved condenser bridged across the rectifier and/or acting as the first element of my filter circuit.

As the voltage builds up a conductor 22, a charge is built up on the electrode 12 of the condenser. When this voltage goes higher than point *a*, current will flow through the condenser and back to the transformer (the normal charge remaining on the condenser). Since the current has a low resistance path back to the source the voltage will increase less rapidly and the wave form will approximate *a' b' a'* in Figure 4.

Since the time during which the condenser is subjected to this high voltage is very short, there will not be sufficient leakage to impair the film, consequently there will be no gasing or electrolytic decomposition of the film or electrodes.

The wave form of rectified current varies markedly under different operating conditions with different electrodes, electrolytes, loads, temperatures, concentrations, etc. An ideal wave form is represented at A where it will be noted that the area at the top of the curve for a given voltage variation is smaller than the area at any other portion of the curve for the same variation. Curves B and C represent rectified waves in which the peak voltage is accentuated due to transformer or load characteristics. In actual operating conditions this peak voltage may be two or three times normal value.

When paper condensers are used between 22 and 26, these peak voltages and surges will be detrimental to and cause disturbances in the choke coil 23 unless a very high inductance is used,—likewise, the discharge of the

condenser subjects the rectifier to high voltages that tend to break down its insulation and cause short circuiting. My improved condenser not only overcomes these difficulties and makes it possible to use smaller inductance units and less expensive rectifiers, but it gives a markedly superior filter effect and gives a very smooth current.

In effect, therefore, I provide a condenser which has a low leakage at normal voltages which has a geometrically increasing leakage, and which has a high leakage at normal voltages and I make particular use of these leakage characteristics to overcome the peak voltage effect on the first filter condenser.

It should be noted that subsequent condensers 29 and 32 are not subjected to such severe operating conditions. The current has passed through inductance 23 before it reaches these condensers and the current is already smooth to a considerable extent. While my improved condenser may be used in any part of the circuit, its principal benefits, so far as the above characteristics are concerned, are obtained when it is used as the first condenser in a filter circuit wherein the pulsations are characterized by surges or peak voltages.

It should also be noted that all wave forms are relatively broad at the base line and narrow at the peak. In effect my condenser "lops off" the top of these waves. When the voltage reaches *a'* the condenser by-passes current around the load and the effective voltage is represented by *a' b' a'* in Figure 4. This has a marked smoothing effect on the rectified current, and since it only affects the wave at its peak, the area under the curve is not noticeably diminished, i. e. the efficiency is not impaired.

While I have described my invention as applied to tantalum in a sulphuric acid electrolyte, it is obvious that other filmed electrodes such as aluminum may be used if the electrolyte is varied accordingly. In the latter case the electrolytic solution may, for example, be a salt such as sodium bicarbonate dissolved in a polyhydric alcohol such as glycerin. The term electrolyte as used in this specification and claims, refers to acids, bases and/or salts or any other substances which ionize in the fluid state or in solution to conduct an electric current, the ionizing medium in my condenser being substantially dry glycerin.

While I have described a preferred embodiment of my invention, it is understood that I am not limited to the details therein set forth except as defined by the following claims. The expression substantially dry, non-aqueous, etc. as used in the following claims refers to glycerin whose specific gravity is about 1.252 at 20° C., i. e., the ordinary C. P. glycerin as defined by pharmaceutical tables.

I claim:

1. In a filter circuit, a rectifier, an induc-

5 tance unit, an electrolytic condenser bridged across the circuit between the inductance and the rectifier characterized by a filmed electrode immersed in substantially dry glycerin solution of an electrolyte and adapted to act as a safety valve at high voltages whereby the rectifier and inductance unit are protected.

10 2. An electrolytic filter condenser comprising a tantalum electrode and a substantially anhydrous glycerin solution of sulphuric acid.

3. An electrolytic filter condenser comprising a non-aqueous glycerine solution of a fluid electrolyte, and a tantalum electrode.

15 4. An electrolytic filter condenser comprising a substantially dry glycerine solution of an acid electrolyte, and a tantalum electrode.

5. An electrolytic filter condenser comprising a tantalum electrode and a non-aqueous electrolytic solution including substantially 99 per cent of glycerine and an acid in the fluid state.

20 6. An electrolytic filter condenser comprising a filmed electrode and an anhydrous electrolyte including glycerine, and more than 1 per cent of an ionizing fluid.

25 7. A filter circuit comprising in combination a rectifier, an inductance unit and an electrolytic condenser connected across the circuit between said inductance unit and said rectifier and including an anhydrous solution of a fluid electrolyte and dry glycerine, and a tantalum electrode immersed therein, said condenser serving as a combined filter condenser and variable resistance, and as an electrolytic safety valve to protect the said inductance unit and the said rectifier.

30 8. In a filter circuit, a rectifier, an inductance unit, and a combined filter condenser and variable resistance connected across the circuit between the inductance unit and the rectifier to filter the rectified current, and including a non-aqueous electrolyte and dry glycerine mixed therewith.

35 In witness whereof, I hereunto subscribe my name this 10th day of March, 1928.

EDGAR W. ENGLE.

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