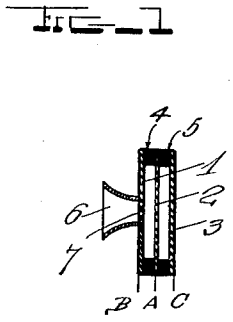
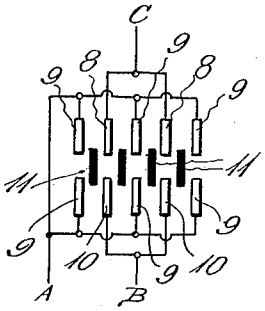
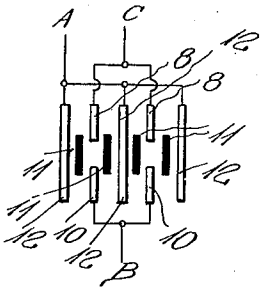
April 22, 1930. J. C. KOSITZKY 1,755,739

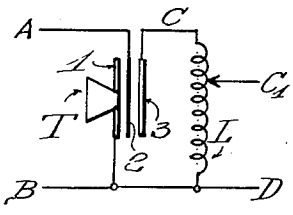
SYSTEM OF MODULATION

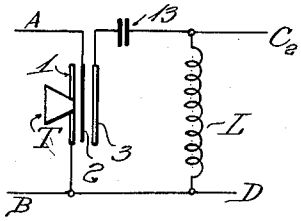
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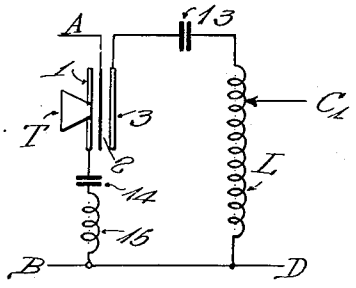


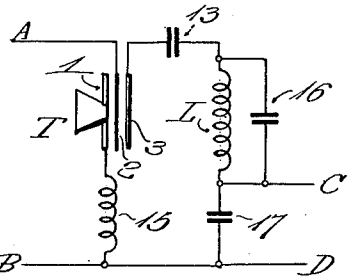


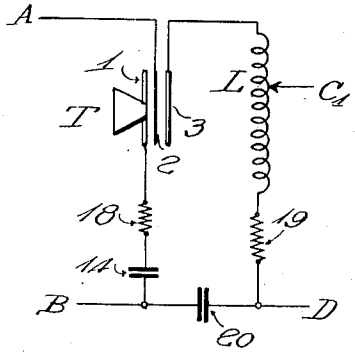


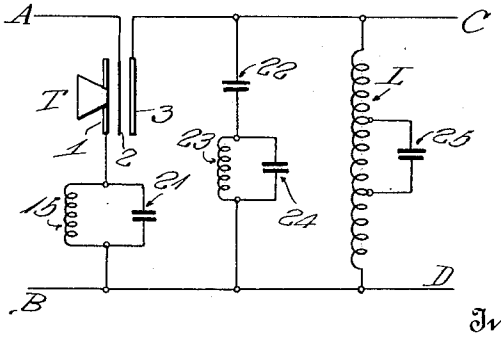












Witness

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Patented Apr. 22, 1930 1,755,739

UNITED STATES PATENT OFFICE

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SYSTEM OF MODULATION

Application filed November 8, 1926. Serial No. 146,984.

My invention relates to a new system of modulation, that is, of varying the intensity of a high frequency alternating current in conformity with some desired law, for example, in accordance with vibrations corresponding to musical sounds or the human voice. Such modulation is useful in radio transmission of speech or music, and also in other fields.

My new system depends upon varying an electrostatic capacity which is common to two electrical circuits, one of which is a tuned circuit, a second electrostatic capacity in said circuit being simultaneously varied to the same extent in the opposite sense, whereby the total capacity in said tuned circuit is left substantially unchanged, and the tuned circuit therefore is not detuned.

More specifically my new system comprises as an element an electrostatic condenser transmitter having at least three independent plates or armatures, constituting virtually two condensers connected in series, one of these condensers being in one of the circuits, while the two in series are in another.

For a more complete understanding of my invention, reference is to be had to the following description of several of the embodiments thereof, together with the accompanying drawings, wherein:—

Fig. 1 is a diagrammatic representation of the transmitter in one of its simplest forms.

Fig. 2 illustrates a more complex type having a movable dielectric.

Fig. 3 shows an embodiment similar to Fig. 2 but somewhat simplified, and

Figs. 4 to 9 inclusive illustrate various circuits in which these condenser transmitters may be used. For simplicity of illustration, in these figures, the Fig. 1 form of transmitter is indicated, although it will be understood that the types of Figs. 2 or 3 may be substituted if preferred without change of operation of these circuits.

Referring now specifically to Fig. 1, there is shown an electrostatic transmitter having three conductive plates 1, 2 and 3, spaced rather closely to each other by means of appropriate insulation, such as pieces of mica, bakelite, etc., 4 and 5. A mouth piece 6 may be secured to plate 1, said plate being perforated as shown at 7, to allow sound waves to pass to the movable or vibratory plate 2. It will be obvious that as the plate 2 moves to the right under the influence of a sound wave, the capacity of the condenser formed by plates 1 and 2 will diminish but simultaneously the capacity of the condenser comprising plates 2 and 3 will increase. If, now, we designate the area of each plate as A, the distance between plates 1 and 2 as n and that between plates 2 and 3 as m, the respective capacities of said condensers will be $\frac{A}{n}$ and $\frac{A}{m}$, and the capacity between plates 1 and 3 is obviously that of these two condensers in series. As is well known, the capacity of two condensers in series is the reciprocal of the sum of the reciprocals of the capacities of the individual condensers, or in the present case,

$$\frac{1}{\frac{n}{A}+\frac{m}{A}}$$

which reduces to

$$\frac{A}{n+m}.$$

Hence, this total capacity is constant, since whenever n is increased due to motion of the plate 2, m is decreased exactly the same amount, and their sum always remains the same. In other words, motion of the plate 2 between plates 1 and 3 does not alter the capacity between said plates, so long as plate 2 moves so as to remain parallel to the other plates, and this condition is substantially fulfilled with the comparatively slight vibrations produced in actual use.

In Fig. 2 all the conducting plates 8, 9 and 10 are stationary and the plates 11, which may be of dielectric material such as mica, glass, etc., are moved or vibrated so as to enter between plates 8 and 9 as they emerge from between plates 9 and 10, and vice versa. As they enter between plates 8 and 9, the corresponding capacity is increased, but at the same time that between plates 9 and 10 is decreased. Here again the series capacity be-

tween plates 8 and 10 remains practically unaltered when plates 11 move.

In Fig. 3 practically the same construction is used as in Fig. 2, the difference being that plates 12 which replace plates 9 of Fig. 2 are made longer, thus dispensing with the conductors necessary in the Fig. 2 form. Plates 8, 10 and 11 are the same in both types, as shown, and the operation is the same.

It will be understood that in Figs. 2 and 3, the vibrations are transmitted to plates 11 in any desired way, for instance by connecting a diaphragm directly to said plates, or by any preferred system of levers or the like, and the motion may be either of translation or rotation.

Referring now to Fig. 4, there is shown a simple tuned circuit comprising a transmitter T and an inductance L. The transmitter T corresponds to a fixed or substantially fixed capacity, and therefore the resonant frequency of the circuit TL is constant. The high frequency current to be modulated may be fed in at terminals A and B and the modulated output delivered at C_1 D, or if preferred the input may be at C_1 D and the output at AB. The conductor C_1 may be connected at any variable position along L as indicated, to control the amplitude of the currents. It is clear that as the diaphragm 2 moves to the right, the coupling between input and output increases, and vice versa, thus producing the required modulation.

As shown in Fig. 5, a fixed condenser 13 may be added to the circuit of Fig. 4, and the fixed terminal C_2 may replace the variable contact C_1 of Fig. 4. In other respects Figs. 4 and 5 are identical.

A further modification is shown in Fig. 6, wherein fixed condensers 13 and 14, and inductance 15 are added to the circuit shown in Fig. 4. These various condensers and the inductance serve to vary the characteristics of the circuits, and the condensers 13 and 14 may also serve to insulate conductor A from B, D and C_1 in case of an accidental short circuit in the transmitter T.

Fig. 7 shows another circuit which is similar to Fig. 6 but omits condenser 14 and adds condensers 16 and 17.

Fig. 8 is also similar to Fig. 6, but substitutes a non-inductive resistance 18 for the inductance 15 and inserts a non-inductive resistance 19 in series with inductance L instead of condenser 13. An additional condenser 20 may also be provided if desired.

Fig. 9 shows a still more complex circuit, having three parallel-tuned circuits formed by coils L, 23, and 15 in connection with condensers 25, 24 and 21 respectively as shown.

All these circuits are merely illustrative of forms which may be suitable for various uses and all embody the same essential idea, namely the transmitter T.

With the parallel circuits, it is possible, in fact desirable to have low losses (resistance) in the respective branches but to a source of alternating current, the circuit at resonance appears as a high resistance, with no reactance—which is desirable. The lower the losses the higher the effective resistance of the circuit as a whole. Since the losses in the condenser transmitter T are small compared to the coil losses, it is desirable that the variation in effective resistance be directed to the inductive branch.

With low losses, then, the variation of resistance with capacity is more nearly linear than with large losses. Assuming all the losses are in the coil,

$$R \text{ equiv} = \frac{1}{g} = \frac{R^2 \text{ coil} + (X_L - X_C)^2}{R \text{ coil}}$$

where:—

R equiv = the approximate effective resistance of the parallel circuit.

R coil = the effective resistance of the coil.

X_L = the reactance of the coil.

X_C = the reactance of that part of the condenser transmitter capacity which is in the same branch as the coil.

The advantages claimed by this system of modulation are as follows:

The damping factor (due to the displaced air) in the condenser transmitter is practically constant, because the air has a ready outlet, hence distortion from this source is minimized. The end effect is small, thereby giving practically a linear curve of capacity variation with displacement.

Simplicity and reliability of the circuit and operation are secured.

This system is especially well adapted for modulating at very high frequencies.

No wasteful modulating tubes or other contraptions are required.

The detuning is negligible, there is a change in the effective resistance of a parallel circuit in accordance with the motion of the movable element.

The movable system may be actuated by or from a loud speaker element, or due to the effect of light or heat, or by a bombardment of force of any kind, and the effects of these may readily be measured or recorded.

The circuit in itself has a tendency to lessen the effect of any harmonic current which the high frequency source may generate.

The condenser transmitter gives a large change in capacity, therefore a comparatively low voltage is required for its operation.

With the large initial capacity, it is unnecessary to shield the condenser transmitter; also its construction is quite rugged.

This type of condenser transmitter may readily be connected to a push-pull system of amplification.

This circuit gives a convenient method for measuring and recording motions or forces of exceedingly small magnitudes, as a slight

movement of the diaphragm or movable system results in an appreciable change in the equivalent effective resistance $\left(\frac{1}{g}\right)$ of the circuit as a whole.

The movable element may be controlled by a suitable E. M. F. impressed across the circuit, thereby producing sound waves or motion of the movable element.

Having disclosed my invention and some of the forms it may take, I claim:—

1. The method of modulating an alternating current which comprises passing the current through two electrostatic condensers arranged in series, varying the capacity of one of said condensers in accordance with the desired modulation and simultaneously varying the capacity of the other in such manner as to maintain the total capacity of the circuit substantially constant.

2. A method of modulating an alternating current which comprises passing the current through two electrostatic condensers in series, and varying the capacity of one of the condensers in accordance with the desired modulation, by varying its dielectric and simultaneously similarly varying the capacity of the other condenser in such manner as to maintain the total capacity of the circuit constant.

3. A double variable condenser comprising at least three sets of conductive plates and a set of dielectric plates cooperating therewith, said dielectric plates being movable alternatively into the field of either of the condensers, and simultaneously out of the field of the other, whereby the capacity of one is varied inversely to that of the other.

4. A double variable condenser comprising at least three sets of conductive plates and a set of dielectric plates cooperating therewith, said dielectric plates being movable alternatively into the field of either of the condensers, and simultaneously out of the field of the other, whereby the capacity of one is varied inversely to that of the other, and said dielectric plates being provided with means for moving them in response to and in correspondence with sound waves.

In testimony whereof I have hereunto affixed my signature.

JAMES C. KOSITZKY.