Oct. 2, 1934. N. S. ANANIEW 1,975,220

ELECTROACOUSTIC MUSICAL INSTRUMENT

Filed Sept. 15, 1930

Fig. 2.

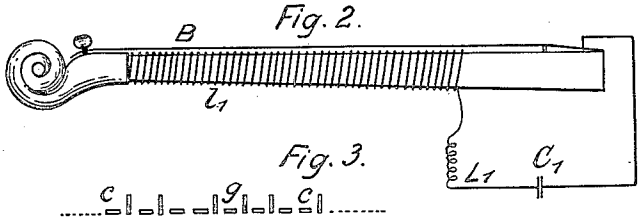


Fig. 3.

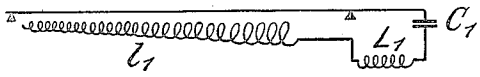


Fig. 4.

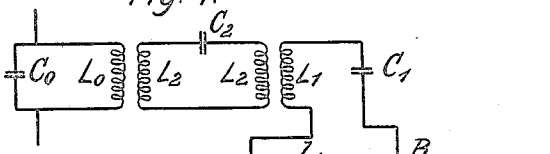
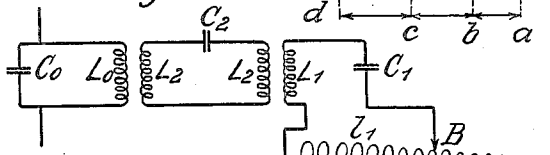


Fig. 5.



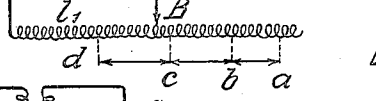
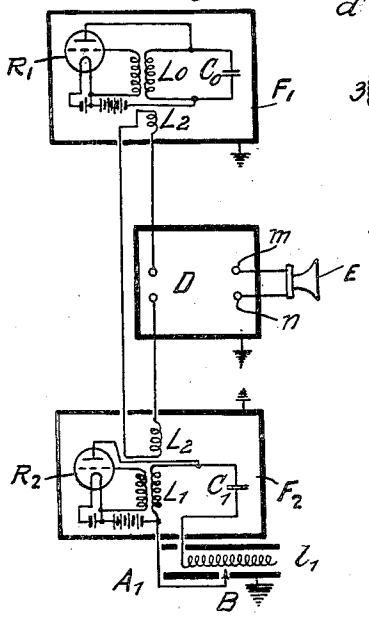
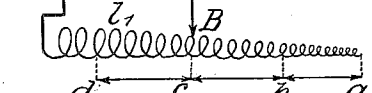


Fig. 1.





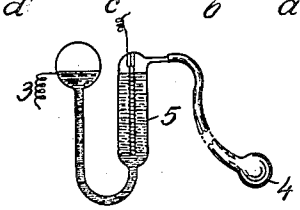


Fig. 7.

Fig. 6.

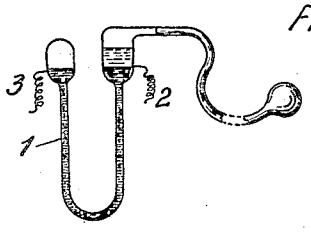


Fig. 8.



Fig. 9.

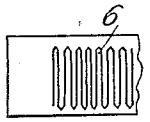


Fig. 10.

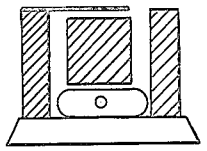
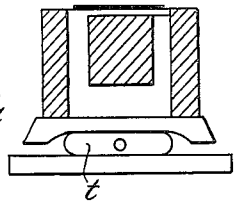


Fig. 11.



Inventor:
Nikolai Stepanowitch Ananiew,
by N. G. Chowanowne,
Attorney.

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ELECTROACOUSTIC MUSICAL INSTRUMENT

Nikolai Stepanowitch Ananiew, Leningrad, Union of Soviet Socialist Republics

Application September 15, 1930, Serial No. 482,085. In Union of Soviet Socialist Republics January 16, 1929

13 Claims. (Cl. 84—1)

It is already known that a sound whose pitch can be varied at will may be obtained by means of a heterodyne interchange of two circuits the parameters of one of said circuits remaining constant while the parameter of the other circuit is varied. This variation may be accomplished either by means of the capacity or of the self-induction of the second circuit which may be therefore called the auxiliary circuit.

The present invention relates to that group of heterodyne apparatus which have a variable self-induction. According to the invention, a variable coil is added to the auxiliary circuit besides the main coil and only partly switched into this circuit. The means of varying the parameters of the auxiliary circuit according to the present invention will be expressed by Thompson's formula:

$$\lambda = 2\pi\sqrt{(L_1 + l_1)C_1}$$

where λ is the wave length, L_1 and l_1 are the self-inductions and C_1 the capacity.

To enable the invention to be clearly understood, reference will now be had to the accompanying drawing which diagrammatically illustrates several arrangements.

Fig. 1 is a diagrammatic view of the most essential parts of a musical instrument according to the invention, i. e., the oscillation generators R_1 and R_2, the oscillatory circuits F_1 and F_2, the regulatable additional coil l_1 of the oscillatory circuit F_2, the detector and amplifier installation D with the loud speaker E, and the couplers L_2 connected to the detector and appurtenant to the two oscillatory circuits. The oscillation generators R_1 and R_2 each of which is connected to one of the oscillatory circuits F_1 and F_2 consist of electron tubes representing a connection and arrangement well-known to the art and for this reason are not described in detail in the specification.

Fig. 2 shows the arrangement of a variable additional coil in connection with a contact carrier having the form of a finger board of the kind used in violins.

Fig. 3 shows the arrangement of the keys or the marking of the notes above the contact carrier extended above the additional coil constructed as finger board.

Fig. 4 shows the spatial distribution of the octaves in case of a uniformly distributed cylindric winding of the additional coil.

Fig. 5 shows the spatial distribution of the octaves when the additional coil has a tapering form.

Figs. 6 and 7 show two constructional forms of the variable resistance for regulating the intensity of the tone.

Fig. 8 shows a part of the elastic metal comb which may replace the extended contact carrier of Fig. 2.

Fig. 9 shows a modified form of the contact carrier which is a strip of tissue with a metal conductor worked in as weft.

Figs. 10 and 11 show two constructional forms of the air ball device for regulating amplitude by changing the ohmic resistance.

In Figure 1 the letter F_1 refers to a circuit with constant parameter C_0L_0 and the letter F_2 to a circuit with parameters C_1 and L_1 l_1 of which L_1 is constant and l_1 varied by means of a sliding contact B which when connected to different points of the inductance l_1 switches a more or less turns in the circuit F_2 and thereby changes the frequency of F_2 and consequently the number of pulsations and the frequency in the detector circuit D and therefore the pitch of the sound obtained.

Both arrangements F_1 and F_2 as well as the variable coil l_1 are screened and grounded, if desired.

Owing to this fact, the pitch of the sound is not influenced by any exterior objects and even by electric generators. A preliminary graduating of the contact B at its different positions provides for finding the desired note at once, i. e., gives a stability to the hold, as is the case in ordinary string or keyboard music instruments.

The form of the proposed apparatus can be made to resemble a violoncello or a violin. A wire of conducting material l_1 is wound round a hold or neck portion (Figure 2) and a conducting string B is stretched above this winding as in the case of an ordinary violin or violoncello.

The turns of the conduct l_1 constitute a self-induction coil l_1 according to the diagram of Figure 1, and the conducting wire B provides the means for adjusting the point of contact on the coil l_1. By pressing the string B with the finger in different places a more or less number of turns of the variable coil may be included, and thereby the pitch of the sound may be varied at will, as has been described above.

The arrangement of the string according to Figures 2 and 3 is disadvantageous insofar as the fingers of the player are sensitive to a strong tension of the string. A weak tension of the string would, however, result in a simultaneous contact with the turns of the self-induction coil in several adjoining places, especially in case of deflections in the string.

Figures 8 and 9 of the drawing illustrate other constructions of the device in which this disadvantage is overcome. To this end an elastic comb-like strip S is arranged above the self-induction instead of the string B. By this means there is no longitudinal tension, and the adjoining and other teeth remain unaffected when the teeth of the comb are pressed. As is evident, the metal comb S differs from the contact B in comprising a finely subdivided metal surface which will deflect easily.

According to Figure 9 the comb is replaced by a tissue with a zigzag conducting wire 6 which is woven into it. Some parts of this wire 6 when pressed come into contact with corresponding turns of the self-induction coil, thereby producing the necessary contact. The pressure can be effected either directly or keys can be arranged above the comb or tissue.

Figure 3 illustrates a similar apparatus in which the variable inductance coil is made of a shape corresponding to the keyboard of some music instrument or to the hold of a string instrument. In this form of the invention, different points of the self-induction coil are marked by key-indications, as for example in a piano. These indications can be arranged either in front of the string, on which the pressure is to be made, or keys of usual shape can be arranged before the string. The pressure of each of these keys produces the switching in of the desired number of turns of the self-induction coil.

Self-induction coils consisting of only a single layer are generally wound round a body of similar section along all its length. Such an apparatus has the following disadvantage:

We consider, for example, a heterodyne apparatus (Figure 4) with a main circuit L_0C_0 of frequency N_0, an auxiliary circuit $(L_1+l_1)C_1$ of frequency λ and a detector circuit L_2C_2. If the adjustable contact is switched in, for instance, at the point a, the pulsations $n=N_0-N_1$ are thereby produced.

In order to obtain pulsations of $2n$ frequency (an octave higher) it is necessary to switch the contact B into the circuit at point b and to obtain pulsations of $4n$ frequency (two octaves higher) it is necessary to switch in at the point c; for the third octave at the point d and so on. The sections ab, bc and c, will not be of the same length in a coil with regularly disposed turns and an equal section of the core. In order to make the sections of the same length it is necessary to wind the coil on a conical or wedge-like core. The heterodyne scheme will then be expressed as is shown in Figure 5. Owing to this kind of winding, the intervals between the contact points which raise the pitch of the sound will be made equal and the arrangement of the hold will resemble an ordinary keyboard music instrument.

In the above-described heterodyne apparatus for obtaining sound, it was spoken of changing only the pitch of the sound.

In order that such a device might be used as a musical instrument, however, it is necessary to change not only the pitch but also the amplitude of the sound. This can be attained by means of a gradual change of the ohmic resistance with the help of a very sensitive resistance regulator as illustrated by Figure 6. Such a resistance may comprise a bent glass tube 1 having metal electrodes 2 and 3 which are disposed in it. The tube is filled with mercury so that it makes contact with both electrodes. A liquid of high ohmic resistance is poured upon the mercury at the end of the tube containing the electrode 2 and this end is connected with a rubber bulb 4 by means of a rubber pipe.

The air-pressure above the resistance liquid increases with the pressure on the rubber bulb 4 and the column of liquid causes the level of the mercury to be lowered in this branch of the tube. This increases the length of the column between the contact 2 and the mercury and consequently the amount of resistance which is in the circuit. The electrodes 2 and 3 may be connected in parallel to the terminals m, n of the loud speaker.

Figure 7 shows another arrangement for effecting the same purpose, in which the high resistance is represented by a spiral wire which is wound round a glass tube and sunk into the mercury.

When the rubber bulb is pressed, the compressed air forces mercury into the other arm of the tube, the air globe above which can be made of a considerably greater size than above the electrode 2. This allows of a greater length of the wire spiral 5 to be included in the circuit when the rubber bulb 4 is pressed and consequently a greater ohmic resistance can be obtained.

The rubber ball may be made in the form of a pedal and the governing of the force of the sound can then be conveniently produced by foot pressure.

Figures 10 and 11 illustrate another form of the apparatus in which the rubber ball is placed so that the amplitude of the sound is effected by means of a stronger or weaker pressure upon the string, comb or tissue or by a key similar to the key or string of a music instrument. For this purpose the bulb is given the shape of an oblong air-bag which is placed under the core of the winding (Figure 10) or under the whole carrier (Figure 11). The pressure produced at the suitable place of the string, comb or tissue effects not only the contact at a suitable part of the spiral of the self-induction coil but has also the required strength to compress the air-bag t, by which means (see Figures 6 and 7) the resistance of the column of liquid is varied.

Thus, the force of the sound is changed simultaneously with its pitch by means of only one manipulation. Contrary to other apparatus of this kind not only the heterodyne apparatus can be screened here but also the active part of it, i. e. the variable part of the self-induction coil.

The present invention gives very good results because the change of frequency of the auxiliary circuit is very small, expressed in percentages and compared to the frequency of the main circuit (the acoustic frequency). Owing to this fact in the formula L_1+l_1 the dimension of the variable coil corresponding to l_1 and the resistance according to Figures 6 and 7 may allow a very delicate regulation of the tone and the amplitude of the sound, such as can be scarcely attained by any other device and particularly key music instrument.

I claim:

1. An electro-acoustic musical instrument comprising a main oscillatory circuit of invariable capacity and self-induction, an auxiliary oscillatory circuit of invariable capacity and with two self-induction coils connected in series, coupling means for bringing the oscillations of the two circuits to a detector and amplifier device, the said detector and amplifier device being connected with a loud speaker, and contact means adapted

to throw in or cut out for playing different numbers of turns of one of said two self-induction coils of the auxiliary oscillatory circuit.

2. An electro-acoustic musical instrument comprising a main oscillatory circuit of invariable capacity and self-induction, an auxiliary oscillatory circuit of invariable capacity and with two self-induction coils connected in series, coupling means for bringing the oscillations of the two circuits to a detector and amplifier device, the said detector and amplifier device being connected with a loud speaker, and a contact carrier disposed above one of said two self-induction coils of the auxiliary circuit and adapted to be pressed against certain windings of said self-induction coil corresponding to the notes to be played.

3. An electro-acoustic musical instrument comprising a main oscillatory circuit of invariable capacity and self-induction, an auxiliary oscillatory circuit of invariable capacity and with two self-induction coils connected in series, coupling means for bringing the oscillations of the two circuits to a detector and amplifier device, the said detector and amplifier device being connected with a loud speaker, and contact means adapted to throw in or cut out for playing different numbers of turns of one of said self-induction coils of the auxiliary circuit, the said main and auxiliary circuits and the self-induction coil of the auxiliary circuit having a variable number of turns being provided with special screening.

4. An electro-acoustic musical instrument comprising a main oscillatory circuit of invariable capacity and self-induction, an auxiliary oscillatory circuit of invariable capacity and with two self-induction coils connected in series, coupling means for bringing the oscillations of said two circuits to a detector and amplifier device, the said detector and amplifier device being connected with a loud speaker, and contact means adapted for the purpose of playing to throw in or cut out different number of turns of one of said two self-induction coils of the auxiliary circuit, the said self-induction coil of the auxiliary circuit being arranged on a core in the form of a violin finger board, the said contact means being disposed in the form of a string above a keyboard and adapted to come into contact with different windings of said self-induction coil by being depressed at certain parts of the keyboard.

5. An electro-acoustic musical instrument according to claim 4, in which the keyboard is marked with key-indications for the various musical notes.

6. An electro-acoustic musical instrument according to claim 4, in which the keyboard is provided with keys adapted to depress the contact means having the form of a string in different places.

7. An electro-acoustic musical instrument comprising a main oscillatory circuit of invariable capacity and self-induction, an auxiliary oscillatory circuit of invariable capacity and with two self-induction coils connected in series, coupling means for bringing the oscillations of said two circuits to a detector and amplifier device, the said detector and amplifier device being connected with a loud speaker, and a contact carrier disposed above one of said two self-induction coils of the auxiliary circuit and adapted to be pressed against certain windings of said self-induction coil corresponding to the notes to be played, said self-induction coil having the form of a wedge with a gradually decreasing section of turns, so that similar tone intervals correspond to similar lengths of the contact carrier.

8. An electro-acoustic musical instrument according to claim 2, in which the contact carrier above the variable self-induction coil is constructed in the form of a comb-like metal strip.

9. An electro-acoustic musical instrument according to claim 2, in which the contact carrier above the variable self-induction coil is constructed as a tissue band with a worked in conductor.

10. An electro-acoustic musical instrument according to claim 1, comprising a variable resistance connected in parallel to the leads of the loud speaker, said resistance consisting of a U-shaped glass container filled with mercury and provided with air chambers at the end of each U-side and with electrodes in each air chamber, one of said electrodes being constructed as resistance and extended so as to be immersed more or less in the mercury, one of said air chambers being connected with a pneumatic rubber ball adapted to press more or less air into the air chamber concerned and thereby to displace the mercury in the other U-side and thus vary the resistance.

11. An electro-acoustic musical instrument according to claim 1, comprising a variable resistance connected parallel to the leads of the loud speaker, said resistance consisting of a U-shaped glass container filled with mercury and provided with air chambers at the end of each U-side and with electrodes in each air chamber, one of said electrodes being immersible in a fluid resistance provided in one of said air chambers, the said air chamber being connected with a pneumatic rubber ball adapted to press more or less air into the air chamber concerned and thus displace the mercury in the other U-side and vary the resistance.

12. An electro-acoustic musical instrument according to claim 1, comprising a variable resistance connected in parallel to the leads of the loud speaker, said resistance consisting of a U-shaped glass container filled with mercury and provided with air chambers at the end of each U-side and provided with electrodes in each air chamber, one of said electrodes being connected with a resistance disposed in one side of the U-shaped container and consisting of a high ohmic conductor wound upon a strip of glass, one of said air chambers being provided with a pneumatic rubber ball adapted to press more or less air into the air chamber concerned and thereby to displace the mercury in the other U-side and thus vary the resistance.

13. An electro-acoustic musical instrument according to claim 1, comprising a variable resistance connected in parallel to the leads of the loud speaker, said resistance consisting of a U-shaped glass container filled with mercury and provided with air chambers at the end of each U-side and with electrodes in each air chamber, one of said electrodes being constructed as resistance and extended so as to be immersed more or less in the mercury, one of said air chambers being connected with a pneumatic rubber ball adapted to press more or less air into the air chamber concerned and thus displace the mercury in the other U-side and thereby vary the resistance, said rubber ball having the form of an oblong bag and being disposed under the variable self-induction coil so that the pressure of the contact carrier on the self-induction coil will exert pressure on said rubber ball so as to change the necessary amplitude during manipulation of the instrument.

NIKOLAI STEPANOWITCH ANANIEW.