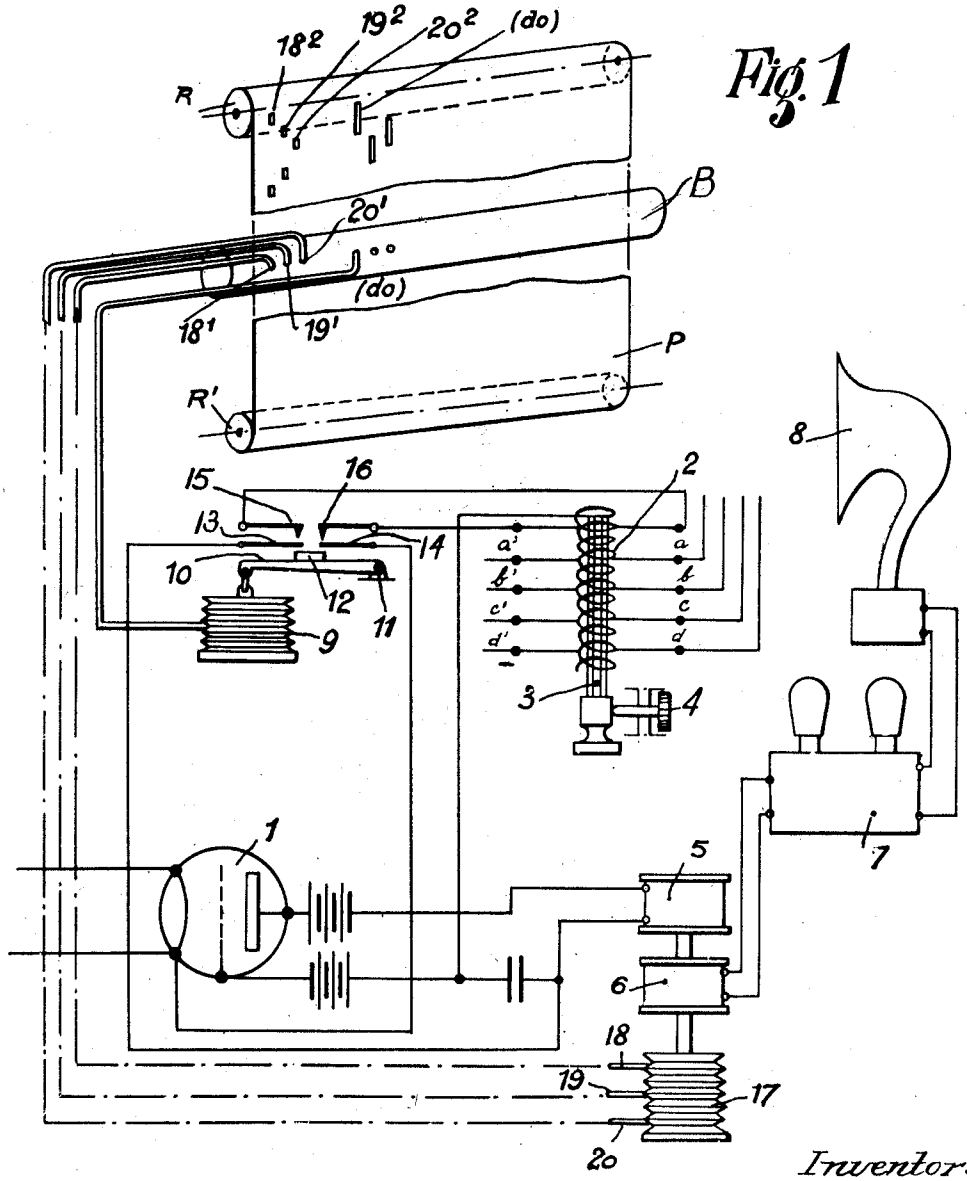
May 1, 1934. E. E. COUPLEUX ET AL 1,957,392

AUTOMATICALLY OPERATING MUSICAL INSTRUMENT OF THE ELECTRIC OSCILLATION TYPE

Filed April 24, 1930 3 Sheets-Sheet 1

Fig. 1



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AUTOMATICALLY OPERATING MUSICAL INSTRUMENT OF THE ELECTRIC OSCILLATION TYPE

Filed April 24, 1930 3 Sheets-Sheet 2

Fig. 2.

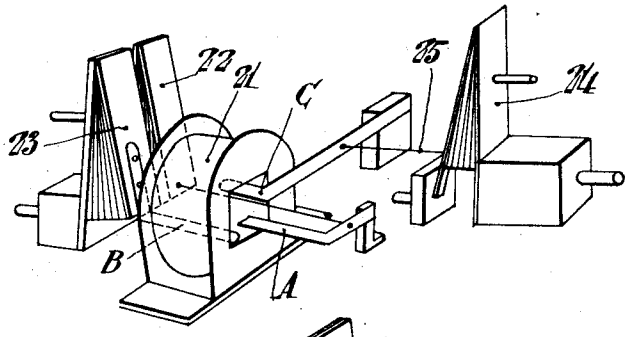


Fig. 3.

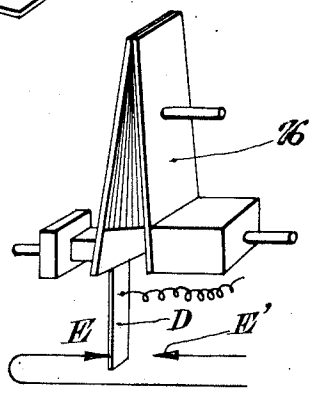
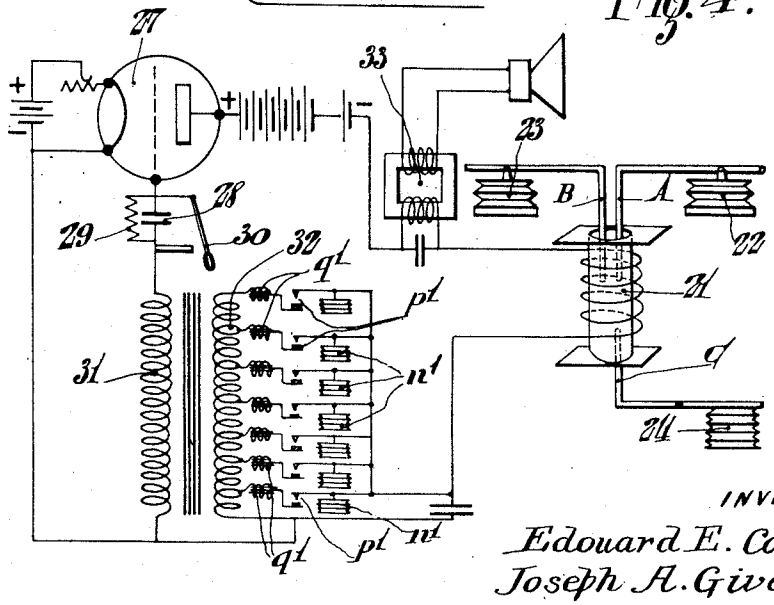


Fig. 4.



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Filed April 24, 1930 3 Sheets-Sheet 3

Fig. 5.

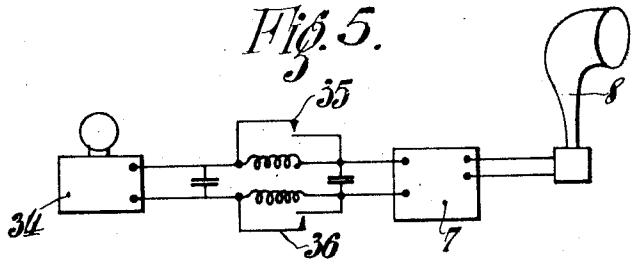


Fig. 6.

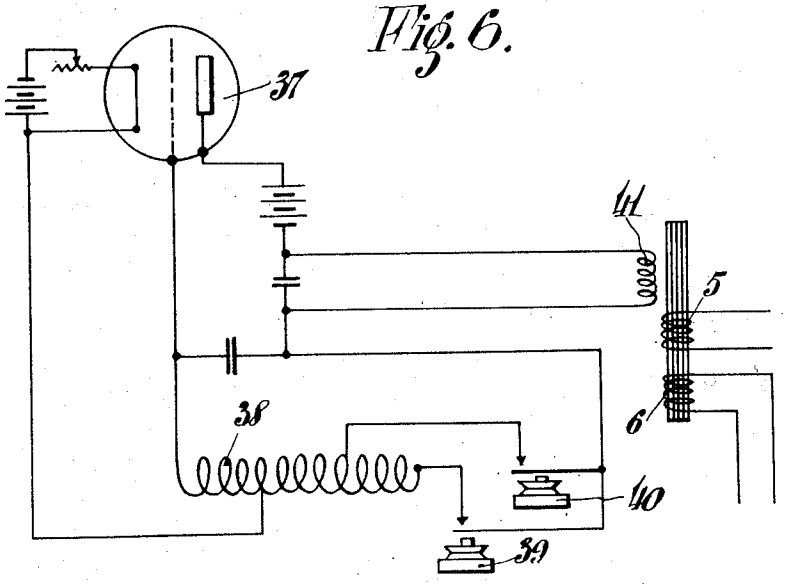
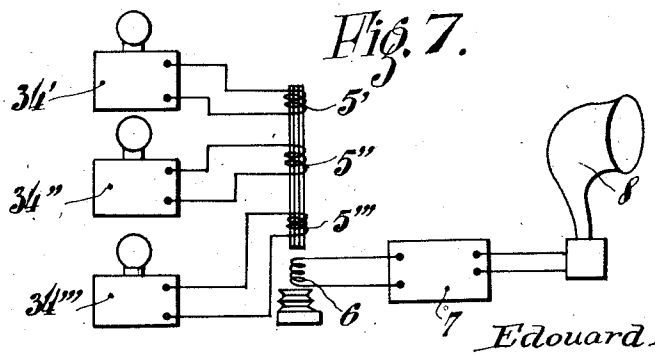


Fig. 7.



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AUTOMATICALLY OPERATING MUSICAL INSTRUMENT OF THE ELECTRIC OSCILLATION TYPE

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Application April 24, 1930, Serial No. 447,023
In France May 1, 1929

12 Claims. (Cl. 84—1)

The present invention relates to automatically operating musical instruments of the electric oscillation type.

It is well known that automatically operating musical instruments, such as pianos for example, use air suction and a perforated tube or tracker bar in such a manner as to act on the keys. It is also known that it is possible to produce oscillations of acoustic frequency by three electrode valves connected to self-induction coils and condensers, adjustment of which varies the sound emitted.

The present invention aims to provide an electric oscillation musical apparatus operated by means of a perforated band or card which acts on a perforated tube or tracker bar, thus enabling the apparatus producing the electric oscillations to be controlled automatically.

The tracker bar need only be provided as for a single instrument, but it may also be divided into a number of parts, each corresponding with a region of the bar and each region actuating a group of contacts corresponding with a determined instrument. For example, it is possible to cause the same tracker bar to operate separately or simultaneously, electric oscillation instruments producing one the effect of a violin, another the effect of a violon cello, another the effect of double bass, etc.

In order to obtain tuning of each component instrument to the normal diapason, a soft iron core may be inserted to a greater or lesser extent into a coil or coils appertaining to the said instruments and an adjustment which may be made for each of the component instruments.

In order to change the pitch of the sound at the time of the attack of the notes, that is, at the beginning of the emission of the notes, use is made of strips of magnetic metal which are caused to descend into a solenoid, or are displaced in the field by the suitable controls of the bellows.

It is also possible to vary the intensity of the sounds emitted by means of two coils which moved more or less towards or away from one another for the purpose of varying the induction effect. These variations in intensity may naturally be effected by hand or they may be effected by operation of the cooperating perforated band and tracker bar, and the variations may be different for each of the instruments.

It is also possible to adjust the sound intensity by acting on a potentiometer associated with the grid of an amplifier valve in the electric circuit of the instrument. The control of the intensity may be advantageously obtained by the operation of a lever.

As concerns the tremolo, this is obtained by pneumatic means, by the use of a bellows adapted to vibrate a strip of magnetic metal, for instance of soft iron, which will descend more or less into a solenoid mounted in the circuit of the apparatus.

To obtain the static tremolo, the apparatus includes a condenser shunted by a resistance placed in the grid circuit, having a variable resistance and capacity. With the use of several devices of the character mentioned, mounted on the valves of the apparatus, (oscillator, amplifier, etc.), which devices operate at the same time and at different speeds, varied effects may be obtained. These devices operate at different speeds because the shunted condenser (grid leak) on the oscillating valve, having a strong capacity and the resistance of the shunt being high, gives oscillations of very low frequencies on the order of $\frac{1}{10}$ per second, for example. In such cases, use may be made of an amplificating valve giving a tremolo working at ¼ per second and another valve giving a tremolo of a frequency of 1 per second. The two frequencies when superposed give characteristic varied effects. Each device can be connected in the circuit by means of bellows adapted to close a switch, or the device can be operated by hand.

Beyond a certain speed, the tremolo will be perceived by a change of tone quality.

Variations of the timbre may be obtained through operation of the tracker bar producing different effects, as for example, modifications of the constants of the output filter, variation of the polarization of the grid, bringing into action a heterodyne, etc.

This change of quality may also be obtained by employing the effects of the magnetic saturation of iron. In this connection, it will be understood, with reference to the magnetism curve obtained by carrying the intensity in abscissas and the induction in ordinated, that a curve having a substantially straight portion will be obtained. If the circuit operates at a point which is on the straight portion of the curve, the sinusoid representing the oscillations is regular and not deformed, because there exists a practically constant proportionality between the capacity and the induction. On the contrary, if the operation is made at a point next to the saturation, then the operation takes place in a point within the curved portion and pass the magnetism curve. Consequently, the propor-

tionality between the capacity and the induction is not constant and the sinusoid is deformed, which produces a certain number of harmonics, thus obtained by saturation of the core. When an iron core is saturated, such as a transformer core, the harmonics make their appearance in the currents flowing in the transformer. The same is true when the iron of the electro-magnetic loud speaker is saturated. When the core is saturated in the loud speaker, there exists no proportionality between the capacity and the induction as hereinbefore explained. The variation of the magnetic field which acts upon the diaphragm is no longer represented by a regular sinusoid, but by a deformed sinusoid so that the sound reproduced by the vibration of the diaphragm is rich in harmonics. In this manner, use can be made of a transformer having three windings, that is primary and secondary, and also a saturation winding. With an auto-transformer in which the primary coincides with the secondary, there will be only two windings, that is, the combined primary and secondary, and the saturation winding. The saturation transformer can be placed in any position in the apparatus, for instance, between two amplifying steps, at the input or the output ends, etc. If the loud speaker is acted upon, it will be provided with an electro-magnet instead of a permanent magnet, and it is saturated by a source of direct current. Whatever may be the means chosen, the saturation current is regulated by rheostats, and the aforesaid devices may be employed singly or in combination.

The apparatus also permits of obtaining a variation in the method of developing the sounds. This development may be progressive or more or less sudden according to the characteristics of operation of the oscillating valves. It is possible to act on the polarization of the grid, on the tension of the plate, on the heating of the valve filaments, or on the constants of the output filter. All these variations can be produced by hand or automatically by means of the tracker bar.

The musical apparatus formed by a number of oscillating valve circuits, each replacing an instrument, may act on a single loud speaker. In this case, the output transformer is provided with primary adjacent windings on the same armature, but it is also possible to have a loud speaker for each oscillating valve circuit.

The electric oscillations of musical frequency may be obtained by means of interference oscillations of high frequency. In this case, there are used two valve oscillating devices, one which always gives the same inaudible frequency, the other supplying frequency oscillations which are variable by modifications of the constants of its circuits (self-induction or capacity varying separately or independently). These modifications of the circuits are obtained by contacts which are closed under the action of bellows connected to the tracker bar. These contacts may also operate by placing in circuit more or less large portion of the heating resistance of one of the emitters, which modifies the frequency of its oscillations.

The contacts may be reduced to a single contact for each note herein employing an oscillating circuit on the plate with a sub-divided coil and using a coil mounted on the grid, or inversely, and a correcting coil can be used with each note, said coil having an adjustable resistance, or a solenoid with movable core. The use of such correcting core is made, because the oscillating period of the valve depends upon the characteristics of the oscillating circuit, self-induction and capacity. As the value of the self-induction of the coil cannot be changed for each note, an adjustable coil is placed in the circuit, which coil permits to regulate at will the total impedance of the system, and consequently the pitch of the sound.

To imitate instruments provided with a plectrum, such as a mandoline, use is made of a strip oscillating between two contact pieces adapted to open and close the circuit, for instance between the oscillator and the amplifier, or between this latter and the loud speaker.

In order that the invention and its mode of operation may be more readily understood by those skilled in the art, we have in the accompanying drawings set out a possible embodiment of the same.

In these drawings:—

Figure 1 is a diagrammatic showing of the device;

Figure 2 is a detail of the parts which may be provided in the apparatus for obtaining the pneumatic tremolo and change of tone quality at the time of the attack;

Figure 3 is a detail of the strip oscillating between two contacts in order to give the sound of a mandoline;

Figure 4 is a diagrammatic representation of an arrangement with static tremolo and oscillating valve, also the reduced number of contacts and the method of connecting the parts;

Figure 5 is a diagrammatic showing of the arrangement for changing the quality or timbre;

Figure 6 is likewise a diagrammatic illustration of a heterodyne arrangement for varying the quality or timbre, and,

Figure 7 illustrates the manner of mounting several instruments connected to a single loud speaker.

It will appear from Figure 1 of the drawings that the grid plate circuit of the oscillating valve 1 is provided with an induction coil 2 having a series of contacts *a*, *b*, *c*, *d*, *a'*, *b'*, *c'*, *d'*, grouped in pairs, which enables a determined length of winding to be placed in circuit. Into the center of this coil extends a soft iron core 3 for tuning the instrument to the normal diapason, this core being held in adjusted position by means of a screw 4.

An output transformer with primary coil 5 and secondary coil 6 has its two coils capable of movement for the variation of intensity. The secondary coil 6 is connected to an amplifying lamp circuit 7 adapted to actuate the loud speaker 8.

A bellow 9, which is actuated by a change in air pressure due to the action of the cooperating perforated band P supported on rollers R and R' and the tracker bar B, causes movement of a wood lever 10 pivoted as at 11. This lever carries an ebonite button 12 adapted to bear against two springs 13 and 14 for causing the same to come in contact with silver contacts 15 and 16 mounted in close proximity thereto. Thus, the coil mounted in the grid or filament circuit is controlled.

A bellow 17 controls the relative movement of the primarily coil 5 and secondary coil 6 of the output transformer. Advantageous use is made of a stepped bellows with a number of tubings 18, 19 and 20, each communicating with a corresponding hole in the tracker bar B, as indicated at 18', 19' and 20', in such a manner as to graduate the precision of variations of intensity, this being done

automatically as is known in certain pneumatic pianos.

Figure 2 shows a coil 21 operatively associated with cores or strips of magnetic metal A, B and C, respectively actuated by bellows 22, 23 and 24. The bellow 22 and strip A thus decrease the tone quantity at the attack, and the bellow 23 and strip B increase the tone quantity at the attack, and the bellow 24 and strip C interconnected by means of a wire 25 produce the pneumatic tremolo.

In Figure 3 the bellows 26 acts upon the strip D which oscillates between two contact pieces E and E' producing the vibrating effect of a mandoline, and giving the impression of a plectrum acting on the strings of the instrument.

In Figure 4, the oscillating valve 27 has in its grid circuit a condenser 28 provided with a resistance 29 and operated by hand or by a bellows through the medium of a switch 30. In the grid circuit is disposed a coil 31 coupled to a subdivided reaction coil 32 of the plate circuit. Each of the several terminals corresponds to a note comprising its regulating element q', and its contact piece p', as well as its operating bellows n', thus requiring only one contact per note. In the plate circuit is mounted the coil 21 shown in Figure 2 of the drawings with strips A, B and C actuated by corresponding bellows 22, 23 and 24, affording respectively the decrease or increase of the tone quantity, and the pneumatic tremolo. The connection with the amplifier or loud speaker is made by the transformer 33.

Figure 5 shows the circuit of an apparatus for changing the tone quality or timbre installed at the outlet of the oscillation apparatus 34. The two contacts 35 and 36 may be controlled by bellows communicating with the tracker bar in the manner hereinbefore described. The change of timbre is obtained by means of compound filters, that is, filters having a plurality of cells such as are used and well known in multiplex telephonic art. The filters may be disposed to permit the passage, for example, of an intermediate frequency and stopping the lower and higher frequencies. Thus, it is possible by this arrangement, to obtain certain harmonics. The use of a filter having a plurality of cells is necessary, if it is desired to obtain the required timbres. In this connection, it will be understood that the simple ordinary filter will act but on a restricted scale, whereas, a filter having a plurality of cells will act upon a relatively large scale, as is essential herein. The musical notes have a frequency generally inferior to 4,000, whereas the harmonics have frequencies reaching up to 10,000. For example, it is possible with a filter capable of stopping frequencies above 4,000 to eliminate all harmonics superior to such frequency and consequently change the timbre.

As shown in Figure 6, the change of timbre is effected by a heterodyne valve 37, that is, a lamp giving local oscillations which are superposed to the fundamental oscillations, by adjusting an induction coil 38 divided by the action of the bellows 39 and 40 connected to the tracker bar. The oscillations of the heterodyne act by means of a coil 41 by induction on the primary coil 5 connected to the oscillating device.

In Figure 7, there are shown three instruments 34', 34'', 34''', which may or may not be of different timbers and which may or may not be controlled by the same tracker bar, and which act on a single loud speaker 8. The output transformer is provided with three stationary primary windings 5', 5'', 5''' and a single movable secondary winding 6 which adjusts the general intensity.

Manifestly, the construction herein shown is capable of considerable modification and such modifications as come within the scope of our claims, we consider within the spirit of our invention.

We claim:—

1. In an automatic musical instrument, a perforated band, a perforated tube cooperating with said band, an electrode valve, an electric contact device in the circuit of said valve, means acted upon by operation of said cooperating perforated band and tube to control said contact device, a coil in circuit with said valve, means associated with said coil for varying the self-induction thereof, means interposed in the circuit to change the amount of current flowing to and from said valve, and amplifying means electrically connected to said valve.

2. In an automatic musical instrument, a perforated band, a perforated tube cooperating with said band, an electrode valve, an electric contact device in the circuit of said valve, a bellow actuated by the operation of said cooperating perforated band and tube to control said contact device, a self-induction coil in circuit with said valve, electric contact pieces sub-dividing said coil and disposed in pairs in the grid plate circuit of said valve, a soft iron core movable axially of said coil, means securing said coil in a given position on the axis of the latter, an output transformer for said valve, and amplifying means electrically connected to the valve through said transformer.

3. In an automatic musical instrument, a perforated band, a perforated tube cooperating with said band, an electrode valve, spring contacts in the circuit of said valve, a lever pivotally mounted adjacent said contacts and operable to move the latter to closed position, a bellow acted upon by the operation of said cooperating perforated band and tube and connected to said lever to control the same, a coil having its terminals coupled to said spring contacts, means associated with said coil for varying the self-induction thereof, means interposed in the circuit to change the amount of current flowing to and from said valve, and amplifying means electrically connected to said valve.

4. In an automatic musical instrument, a perforated band, a perforated tube cooperating with said band, an electrode valve, an electric contact device in the circuit of said valve, means acted upon by the operation of said cooperating perforated band and tube to control said contact device, a coil in circuit with said valve, means associated with said coil to vary the self-induction thereof, means interposed in the circuit to change the amount of current flowing to and from said valve, a transformer having movable coils and disposed at the output of the valve, a stepped bellow operable to displace the coils of said transformer, tubings establishing communication between said stepped bellow and the perforated tube, and amplifying means electrically connected to said valve.

5. In an automatic musical instrument, a perforated band, a perforated tube cooperating with said band, an electrode valve, an electric contact device in the circuit of said valve, a bellow acted upon by the operation of said cooperating perforated band and tube to control said contact device, a variable induction coil in circuit with said valve through the contact devices, a variable fil-

tering transformer at the output of the valve, and amplifying means operatively associated with said valve.

6. In an automatic musical instrument, a perforated band, a perforated tube cooperating with said band, an electrode valve, an electric contact device in the circuit of said valve, means acted upon by operation of said cooperating perforated band and tube to control said contact device, a coil in circuit with said valve, means associated with said coil for varying the self-induction thereof, a transformer having multiple fixed primary windings and a single movable secondary at the output of the valve, and amplifying means electrically connected to said valve.

7. In an automatic musical instrument, pneumatic means, an oscillating valve, an electric contact device in the circuit of said valve, means acted upon by operation of said pneumatic means to control said contact device, and a sound producing element electrically connected to said valve.

8. In an automatic musical instrument, pneumatic means, an oscillating valve, an electric contact device in the circuit of said valve, means acted upon by operation of said pneumatic means to control said contact device, an induction coil in circuit with said valve through said contact device, a core mounted for adjustable displacement in relation to said coil to vary the self-induction thereof, and a sound producing element electrically connected to said valve.

9. In an automatic musical instrument, pneumatic means, an oscillating valve, an electric contact device in the circuit of said valve, means acted upon by operation of said pneumatic means to control said contact device, an output transformer for said valve and capable of variable intensity under control of said pneumatic means, and a sound producing element electrically connected to said valve.

10. In an automatic electrical musical instrument, a pair of opposed and relatively spaced electrical contacts, a blade disposed to oscillate between said contacts for producing the vibrating effect of plectrum string instruments, and pneumatic means connected to said blade to impart its movement.

11. In an automatic electrical musical instrument, an electrode valve, a coil in the grid circuit of said valve, a sub-divided reaction coil mounted in the plate circuit and coupled to the coil of the grid circuit of said valve, means for regulating and controlling the circuit of each part of the reaction coil, pneumatic means connected to said last mentioned means for operating the same, and a sound producing element connected to said valve.

12. In an automatic electrical musical instrument, an electrode valve, a condenser in the grid circuit of the valve, a resistance connected to said condenser, a switch controlling the circuit of the resistance, a coil in the grid circuit of the valve, a sub-divided reaction coil mounted in the plate circuit and coupled to the coil of the grid circuit of said valve, means for regulating and controlling the circuit of each part of the reaction coil, pneumatic means connected to said last mentioned means for operating the same, and a sound producing element connected to said valve.

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