May 11, 1943. A. R. RIENSTRA 2,319,087

ELECTRIC ORGAN KEYING SYSTEM

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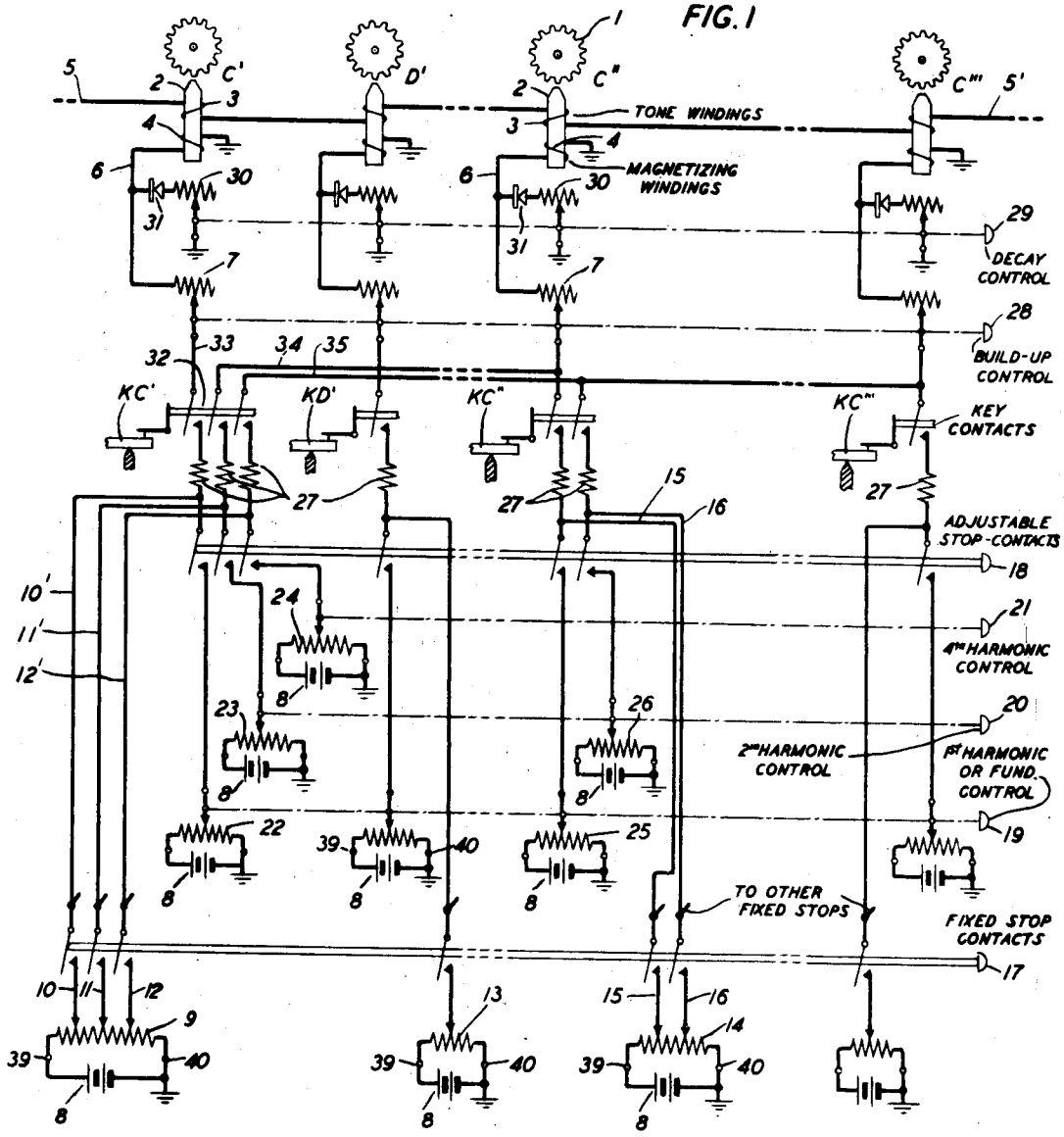
FIG. 1



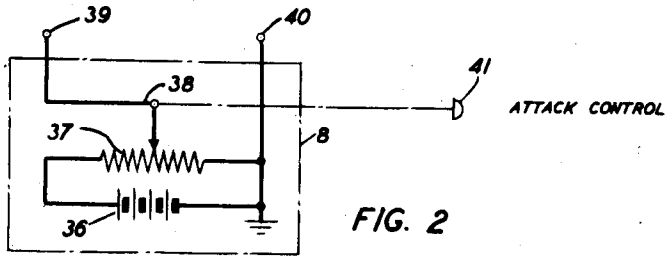


FIG. 2

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ELECTRIC ORGAN KEYING SYSTEM

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7 Claims. (Cl. 84—1.26)

This invention relates to electrical musical instruments and more particularly to a keying system therefor adapted to provide controlled rates of tone build-up and decay.

Certain electric organs, such as for example, the well-known Hammond electric organ disclosed in United States Patent 1,956,350 provides little or no control whatever over the rate of build-up or decay of the tone. In order to simulate more closely the conventional pipe organ gradual build-up and decay effects in rooms of various reverberation characteristics, it is essential that the keying circuit be supplied with some form of build-up and decay control.

It is therefore the object of this invention to provide a means for controlling the relative build-up and decay times for electric organs.

The foregoing object is attained by this invention by providing in an electric organ having a plurality of electric tone generators the combination comprising an exciting means for each generator, a resistor in series with the exciting means to control its rate of excitation build-up, and a second resistor including an asymmetric conductor connected in shunt with the exciting means effective to control the rate of excitation decay.

The invention may be better understood by referring to the accompanying drawing in which:

Fig. 1 discloses a preferred embodiment of the invention; and

Fig. 2 discloses a preferred form of power source for the control circuits.

In Fig. 1 there is disclosed a plurality of tone generators C', D', C'' and C''', respectively, the reference characters representing the similarly identified notes of a musical scale. Only four of the generators are shown the remaining generators having been deleted for the sake of simplicity. The description relating to any one of the generators applies equally to all of the others.

Each of these generators, for example, generator C'', comprises a toothed wheel 1, which may be of the general form more particularly described in the above-mentioned Hammond patent, and a field pole-piece 2. Field pole 2 is made of a magnetic material having a very low magnetic retentivity and has wound thereon two windings 3, 4. Winding 3 is serially connected with similar windings on all of the other generators and acts as the tone pick-up winding, the output whereof is delivered to the amplifiers and output system of the organ via conductors 5 and 5'. The amplifiers and output system are not shown but they may be of any convenient form well known in the art.

Winding 4 constitutes the magnetizing winding and may be energized through suitable control circuits from an electric power source 8. In Fig. 1 the electric power source 8 has been shown as a plurality of batteries. This has been done to make the drawing more easily readable. However, in actual practice these batteries may all be combined in a single battery 36 and potentiometer 37 as shown in Fig. 2, with a plurality of potentiometers such as 9, 13 and 14 connected to its terminals 39, 40.

The keyboard may be of conventional form and include keys KC', KD', KC'' and KC''' associated respectively with the generators C', D', C'' and C'''.

An adjustable stop contact control 18 and a plurality of fixed stop contact controls 17, only one of the latter being shown for the sake of clarity, are provided. Each of the fixed stop contact controls is associated with a particular predetermined tone quality, such as flute, diapason, viola or trumpet, etc. This is accomplished by having each of the fixed stop contact controls operate a plurality of switches associated with each of the keys KC', KD', etc. For example, the operation of fixed stop contact control 17 would close the circuit of adjustable contacts 10, 11 and 12 of potentiometer 9 to their associated conductors 10', 11' and 12' identified with key KC'. Only three adjustable contacts 10, 11 and 12 are shown associated with potentiometer 9. However, in the complete organ there are as many such contacts as there are harmonics under control in the entire organ system. Similarly the two adjustable contacts 15 and 16 associated with potentiometer 14 are connected to their conductors 15' and 16' identified with key KC''. It will be understood that the adjustment of contacts 10, 11, 12, 15, 16, etc., will predetermine the timbre of the organ output when fixed stop contact control 17 is operated. For other of the fixed stop contact controls 17 the adjustments will be different thereby producing different timbres.

Should the organist desire to control the harmonic content independently of the predetermined fixed stops, he may release the previously operated fixed stop contact control 17 and operate the adjustable stop contact control 18. He may, thereafter, individually adjust the several harmonics provided by the organ and thereby variably control the harmonic content to suit his own fancy. Three such controls 19, 20 and 21 for the first, second and fourth harmonics, respectively, are shown. Controls for the other

harmonics are provided in a similar manner. It will be noted that the power supply circuits are essentially the same as those for the fixed stop contact controls and further description thereof is unnecessary.

Rate of tone build-up is controlled by adjusting control knob 28 which, in turn, adjusts a plurality of rheostats 7 connected severally in series with the energizing circuit of each of the generators in the organ. Rate of tone decay is controlled by adjusting control knob 29 which is associated with a plurality of rheostats 30 connected severally in the decay circuit of each of the generators in the organ. A plurality of resistors 27 are also connected severally in series with the energizing circuit of each of the generators. These resistors provide an additive effect when a plurality of potential sources are applied to any one energizing winding 4.

The gradual tone build-up effect is achieved as follows: Assume key KC' has been pressed. This will close a plurality of contacts 32 which will supply a plurality of voltages from potentiometer 9 via conductors 10', 11' and 12' to conductors 33, 34 and 35, respectively. Conductor 33 furnishes energizing current to the magnetizing winding 4 of fundamental generator C' which is the fundamental frequency for key KC'. Since winding 4 is inductive and is being energized from a voltage source through resistors 27 and 7 it will have a definite time constant depending upon the adjustment of rheostat 7. The magnetic flux in core 2 is thereby gradually built up to produce a tone in pick-up winding 3 in a well-known manner. In a similar manner, voltage supplied from conductor 34 through resistor 7 to the magnetizing winding 4 of generator C'' provides the second harmonic for key KC' and again the voltage supplied by conductor 35 to the magnetizing winding of generator C''' provides the fourth harmonic. Other harmonics are similarly provided for each key. It will be observed that if key KC'' is pressed during the time that key KC' is pressed there will be an increase of flux in core 2 of the C'' generator in order to provide energy for the fundamental of the KC'' key in addition to that already required for the second harmonic of the KC' key. The additional flux is produced by reason of the increase in exciting current caused by the shunting effect of the two resistors 27, which have been keyed together, and the potentials applied to them. It will be understood that by adjusting build-up control knob 28 the plurality of rheostats 7 associated with the generators are simultaneously adjusted to control the build-up time of all generators.

To achieve a controlled rate of decay it is necessary that upon the release of key KC' the magnetic flux in core 2 be gradually decreased. During the build-up time asymmetric conductor 31 effectively prevents any material flow of current through resistor 30 thereby effectively insulating resistor 30 from the circuit. However, when key KC' is released, the collapsing field in core 2 generates a voltage in winding 4 in such a direction as to produce a circulating current from winding 4 to ground through rheostat 30, asymmetric conductor 31, conductor 6 and back to winding 4. Asymmetric conductor 31 is preferably of the copper oxide type although other forms of asymmetric conductors are well known and could be substituted for the copper oxide type. In effect, therefore, asymmetric conductor 31 acts as an instantaneous switch to prevent a too rapid collapsing of the magnetic field in core 2. The time constant provided by the inductance of winding 4 and resistance of rheostat 30 controls the rate of decay. Rheostat 30 may be varied so as to control the rate of decay at will and for this purpose decay control 29 is provided to adjust all of the rheostats 30 associated with all of the generators in the organ in the same manner as for the build-up control 28.

Build-up and decay control for all of the generators in the organ are provided in the same way as described above for key KC' and generator C'. By utilizing small copper oxide rectifier units for the asymmetric conductor 31 it is apparent that the above described build-up and decay controls may be made very compact and will provide a very close and uniform control over the rates of build-up and decay. Moreover, the above-described system provides a means for independently controlling both the build-up time and the decay time, so that not only can conventional pipe organ keying effects be simulated but a great variety of other build-up and decay effects can also be provided at the will of the organist.

As previously stated, all the power sources 8 of Fig. 1 may be combined into a single source 8 as shown in Fig. 2. A battery 36 provides the primary source of energy while the actual output potential is derived from a potentiometer 37 and connected to all the harmonic control potentiometers 9, 13, 14, 22, etc., by way of terminals 39 and 40, shown in both Figs. 1 and 2. Adjustable contact 38 is preferably operated by manual control 41 for special attack effects. The degree of magnetic saturation of cores 2 determine the effective inductance of magnetizing coils 4 and hence it has a control over the rate of attack. This control is of particular value in playing polyphonic music where a particular generator has been previously excited by pressing some one key and it is desired that any additional, concomitant excitation of the same generator will cause a distinctly audible transient increase of output. By adjusting the attack control 41, the initial induction in cores 2 incident upon the first keying can be made just below magnetic saturation and will result in a nearly normal build-up rate. The second, concomitant keying of the same generator, however, will be sufficient to carry the induction into the saturation range, whereby the effective inductance of the coil 4 is rapidly diminished and the rate of attack greatly increased. The second, concomitant keying, although it does not greatly increase the total energy output from the particular generator, makes that small increase of energy rapidly so the effect of the second keying is distinctive and stands out prominently. The initial increase of output energy caused by the above-described adjustment of control 41 is compensated to suit the organist's taste by suitably adjusting the main volume or swell control of the organ, not shown.

While the invention has been described by disclosing particular component instrumentalities, it is obvious that other equivalent instrumentalities may be substituted without departing from the scope of the invention as limited by the prior art and specifically defined in the appended claims.

What is claimed is:

1. In an electric organ having a plurality of electric tone generators, the combination comprising an exciter for each generator to cause it to deliver an output varying in degree in response to the degree of excitation, a resistor in series with the exciter to control the rate of excitation build-up, and a second resistor including an asymmetric conductor connected in shunt with the exciter effective to control the rate of excitation decay.

2. In an electric organ having a plurality of electromagnetic tone generators, the combination comprising a magnetizing field winding for each generator, a resistor in series with the field winding to control its rate of magnetic build-up, and a second resistor including an asymmetric conductor connected in shunt with the field winding effective to control the rate of magnetic decay.

3. In an electric organ having a plurality of electric tone generators, the combination comprising an exciter for each generator to cause it to deliver an output varying in degree in response to the degree of excitation, a variable resistor in series with the exciter to control the rate of excitation build-up, a second variable resistor including an asymmetric conductor connected in shunt with the exciter effective to control the rate of excitation decay, a build-up control mechanism coupled to all the first-named variable resistors to effect simultaneous control thereof, and a similar decay control mechanism coupled to all the second-named variable resistors to effect simultaneous control thereof whereby independent control over rate of build-up and rate of decay is achieved.

4. In an electric organ having a plurality of electromagnetic tone generators, the combination comprising a magnetizing field winding for each generator, a variable resistor in series with the field winding to control its rate of magnetic build-up, a second variable resistor including an asymmetric conductor connected in shunt with the field winding effective to control the rate of magnetic decay, a build-up control mechanism coupled to all the first-named variable resistors to effect simultaneous control thereof, and a similar decay control mechanism coupled to all the second-named variable resistors to effect simultaneous control thereof whereby independent control over rate of build-up and rate of decay is achieved.

5. In an electric organ having a plurality of electric tone generators, the combination comprising an exciter for each generator, a source of electric energy, a control key, means serially connecting the exciter with the control key and source, a resistor inserted in said series circuit to effectively control the rate at which the exciter excites the generator upon closure of the key, and a second resistor including an asymmetric conductor connected in shunt with the exciter to effectively control the rate of excitation decay upon the opening of the control key.

6. In an electric organ having a plurality of electromagnetic tone generators, the combination comprising a magnetizing field winding for each generator, a source of electric energy, a control key, means serially connecting the field winding with the control key and source, a resistor inserted in said series circuit to effectively control the rate of magnetic build-up upon closure of the key, and a second resistor including an asymmetric conductor connected in shunt with the field winding effective to control the rate of magnetic decay upon the opening of the control key.

7. In an electric organ having a plurality of electromagnetic generators, the combination comprising a magnetizing field winding for each generator, a source of electric energy of adjustable voltage, a plurality of keys each including a separate resistor in series therewith connected between the source and each field winding for either individual or concomitant excitation of the winding, and a controller for adjusting said voltage whereby the rate of attack for successive, concomitant keyings of any particular generator may be controlled.

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