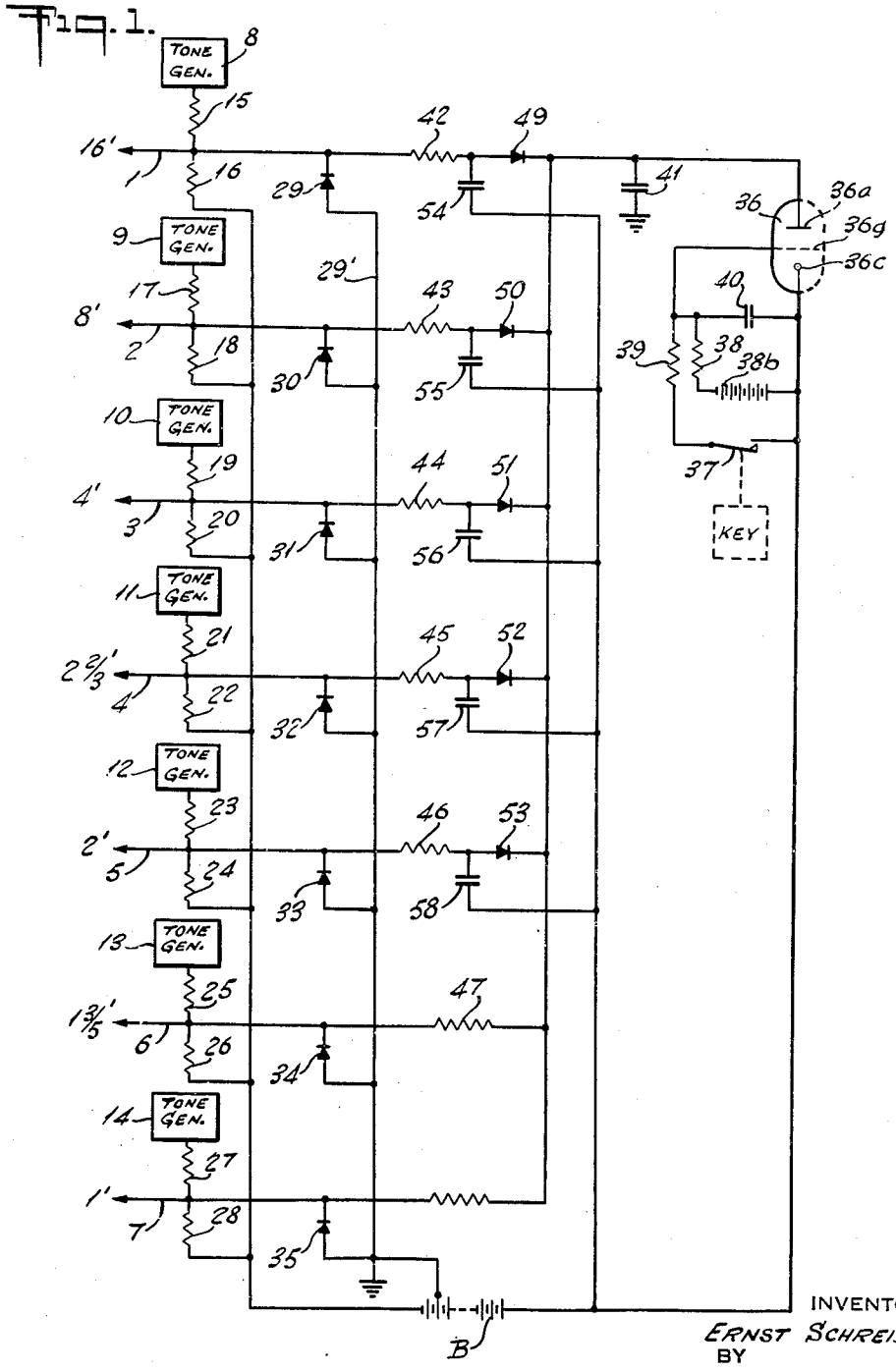
July 1, 1958 E. SCHREIBER 2,841,043

ELECTRIC ORGAN

Filed Jan. 31, 1956 3 Sheets-Sheet 1

Fig. 1.



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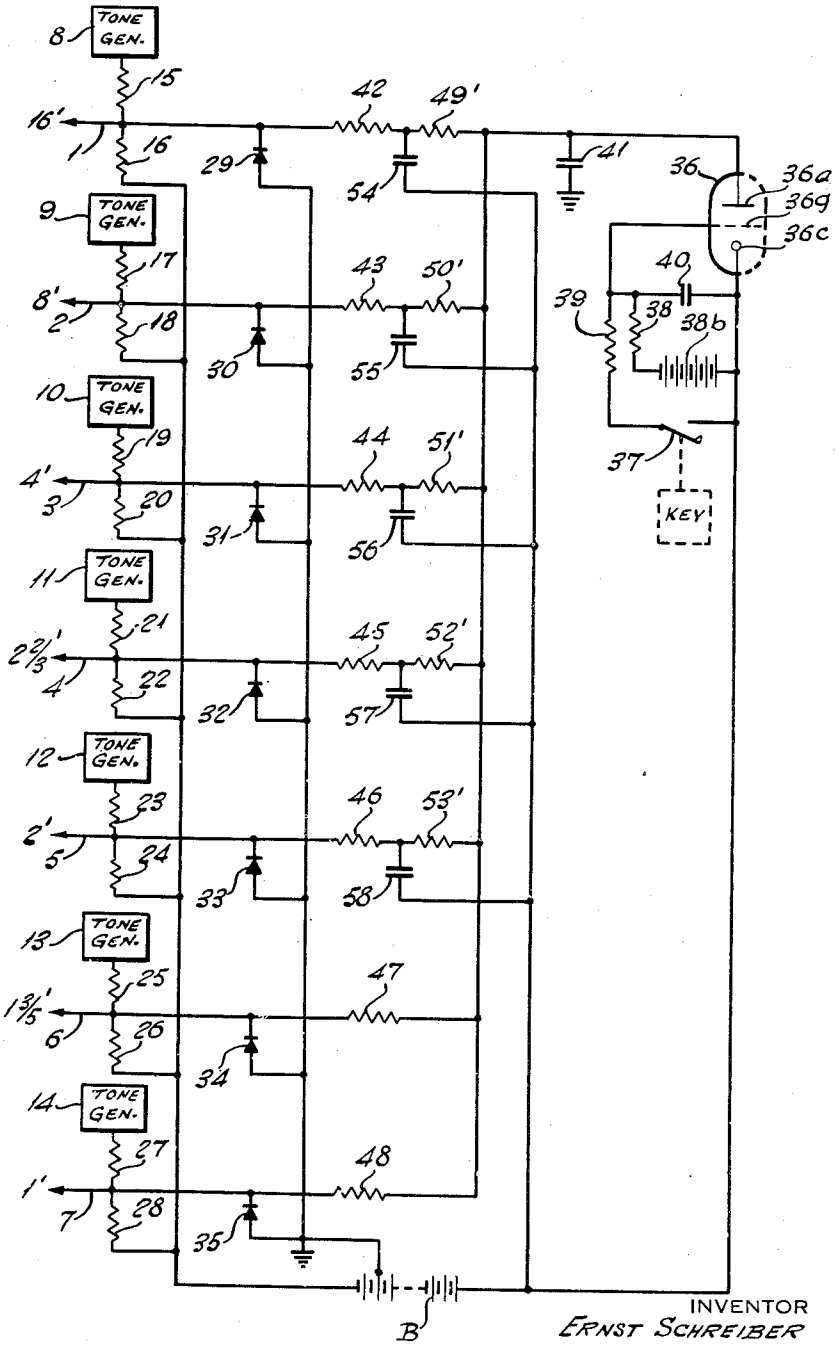
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Fig. 1a.



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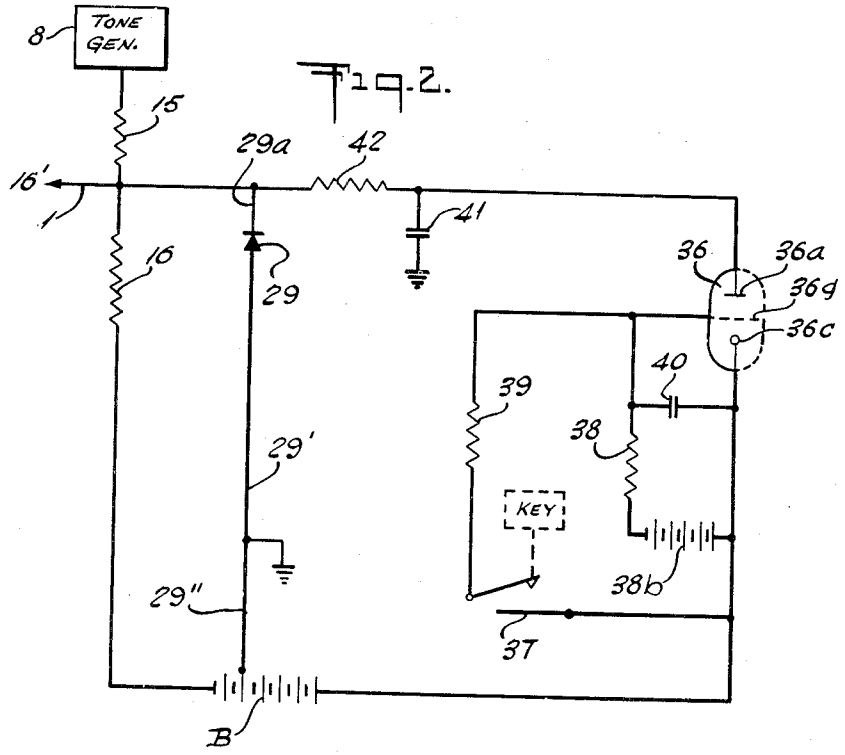


Fig. 2.

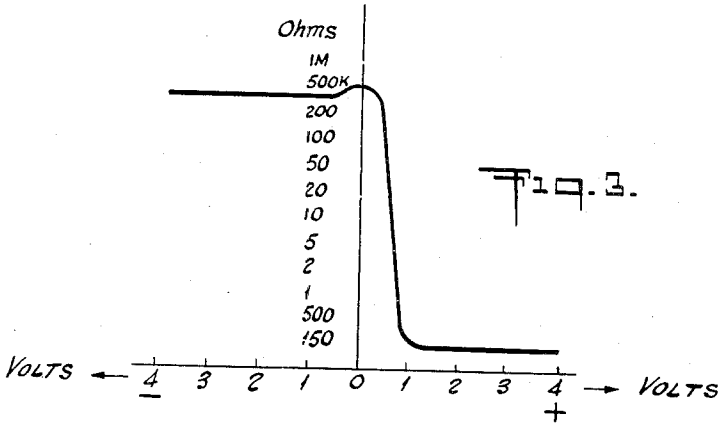


Fig. 3.

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ELECTRIC ORGAN

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Application January 31, 1956, Serial No. 562,528

5 Claims. (Cl. 84—1.13)

The present invention relates to electric musical instruments having a keyboard, and more particularly to electric organs having several stops.

It is an object of the present invention to reduce the number of tubes used in the controlling members of the organ.

It is another object of the present invention to improve the organs from an economical point of view.

It is a further object of the present invention to improve an organ in the operation thereof.

It is still another object of the present invention to reduce the floor space required by the tubes and/or the switching elements of an electric organ.

Other objects and advantages of the present invention will become apparent from the following detailed description thereof in connection with the accompanying drawings showing, by way of example, an embodiment of an organ according to the present invention.

In the drawings:

Fig. 1 is a wiring diagram of an electric organ according to the present invention,

Fig. 1*a* is a wiring diagram of a modification of Fig. 1,

Fig. 2 is a simplified diagram of one stage shown in Fig. 1, and 1*a* and

Fig. 3 is a diagram for the explanation of the operation of the electric organ shown in Figs. 1 and 2.

Referring now to the drawings and first to Fig. 1 a key system is shown comprising a plurality of, for instance seven, stop positions, and more especially for the 16′, the 8′, the 4′, the 2⅔′, the 2′, the 1⅗′ and the 1′ positions. The key system includes seven bus bars **1**—**7** associated, respectively, with the seven register positions 16′ to 1′. Each of the bus bars **1**—**7** is associated with sixty-one tone generators corresponding to the number of keys of the manual and thirty tone generators corresponding to the number of keys of the pedal. In Fig. 1 single tone generators **8**—**14** are shown for each bus bar **1**—**7**, respectively. The voltages supplied by the tone generators **8**—**14** are reduced to predetermined voltages by the voltage dividers or potentiometers **15/16**, **17/18**, **19/20**, **21/22**, **23/24**, **25/26**, and **27/28**, respectively.

The bus bars **1**—**7** are connected, respectively, with diode rectifying elements **29**—**35** for the control of the tones. These seven rectifiers **29**—**35** are arranged in the circuit of a control tube **36** having a grid **36***g* to which is imparted a high negative bias over a resistor **38** so that the tube **36** is blocked. The resistor **38** is connected in series with a voltage source or battery **38***b* connected with the cathode **36***c* of the tube **36**. A second resistor **39** and a switch **37** connected in series thereto are connected in parallel to the resistor **38** and the battery **38***b* and reduce the grid bias upon closing the switch **37** so far that the normal working point of the characteristic of the tube **36** is shifted. A capacitor **40** is connected in parallel with the resistor **38** and the battery **38***b* so that the same has also the potential of the grid bias. The capacitor **40** has the effect that the grid bias is not reduced suddenly but in a period of time corresponding to the time constant of the transient circuit formed by the resistor **39** and the capacitor **40**. A capacitor **41** connected with the anode **36***a* of the tube **36** short-circuits the seven tone frequencies against the tube **36**.

The direct current output of the diode rectifiers **29**—**35** is controlled over decoupling resistors **42**—**48** by the tube **36** according to the position of the switch **37**. Furthermore, second diode rectifying elements **49**—**53** are inserted, for instance, in the bus bars **1**—**5**. Capacitors **54**—**58** are connected, respectively, between the junctions of the resistors **42**—**46** and the rectifiers **49**—**53** and the cathode **36***c* of the tube **36**, their purpose being a prolongation of the onset of sound or an additional delaying of the onset impulse as more fully described hereinafter.

The operation of this device is as follows, reference being made to Figs. 2 and 3 of the drawings, Fig. 2 showing only the bus bar **1** for the 16′ stop position, the circuit elements **49** and **54** being omitted. In Fig. 3 the resistance values of the rectifier element **29** are plotted against the voltage; this figure shows the resistance characteristic K of the rectifying element **29** in dependence on the voltage applied to the rectifying element, and more particularly in the low resistance direction corresponding to positive values of the voltage, and in the negative direction corresponding to negative values of the voltage.

The operation of the circuit shown in Fig. 2 is based on the resistance characteristic shown in Fig. 3. The resistor **16** of the voltage divider **15**, **16** should have a value of, for instance 1 megohm. The rectifier element **29** connected in parallel to the resistor **16** is controlled by means of the tube **36**.

When the contact **37** is closed so that the tube **36** reaches the normal working point of its characteristic at a reduced grid bias, an anode current will flow through the tube **36** over the correspondingly poled rectifier **29** and the decoupling resistor **42**. As shown in Fig. 3, the rectifier element **29** has in the current carrying direction only a relatively low resistance value amounting to, for instance, 150 ohms which is connected in parallel with the resistor **16** having an assumed value of 1 megohm. Thus it will be seen that the resulting resistance value of the circuit elements **16** and **29** is below 150 ohms so that the voltage divider ratio between the high ohmic resistor **15** and the resultant resistance is shifted so as to reduce by short circuiting the voltage of the tone generator **8** on the bus bar **1** practically to zero. If now the contact **37** is opened by depressing a key of the manual or pedal (not shown), the full negative grid bias is imparted to the grid **36***g* of the tube **36**. In consequence thereof the tube **36** is absolutely blocked so that no anode current flows through this tube. Thus the rectifier element **29** is not current carrying in this position of the circuit elements.

As will be seen from the resistance characteristic K shown in Fig. 3 of the drawings the rectifying element **29** has in this case a resistance value amounting to about 500 kiloohms. This value is connected in parallel to the resistor **16** and yields a resultant resistance of approximately 333 kiloohms. This voltage divider ratio between the resistor **15** and the resultant resistance of 333 kiloohms has the effect that the desired alternating voltage of the tone generator **8** appears on the bus bar **1**. The tube **36** is now connected in parallel with the parallel combination of the resistor **16** and the rectifying element **29**. In order to prevent a short circuit by this parallel connection the decoupling resistor **42** is inserted in the line to the anode **36***a* of the tube **36** and is sufficiently high-ohmic to prevent a short circuit.

In order to prevent at the keying of a tone the sound potential from suddenly increasing to its final value or

conversely decreasing from its final value to zero, the time constant members 38—40 including the resistors 38, 39 and the capacitor 40 are provided so that the opening and closing of the tube 36 is effected in predetermined intervals of time.

The switching contact 37 is a rest contact which is in closing position when no key of the manual or pedal (not shown) is depressed. When the contact 37 is opened at the depressing of a key, the tube 36 is blocked as described hereinabove and thus the anode current thereof is interrupted. At the same time the rectifying element 29 attains the blocking resistance thereof of about 500 kiloohms. When the sound voltage at the bus bar 1 amounts to, for instance, 1 volt the positive half wave of the sound voltage curve falls in the range of the decreasing branch of the resistance characteristic K shown in Fig. 3. Thus a voltage loss and an unbearable distortion of the sound voltage curve occurs. In order to prevent this, one end 16′ of the resistor 16 is connected to the full potential of the anode battery B whereas the voltage connection 29′ of the rectifying element 29 is connected to an intermediate terminal 29″ having a somewhat lower potential. The operation of this arrangement is as follows:

When the tube 36 is open, that is carrying a current, a circuit is established over the rectifier 29 including the cathode 36*c* of the tube 36, the anode 36*a* of the same, the resistor 42, the rectifier 29, the intermediate terminal 29″, the battery B and back to the cathode 36*c*. Although the resistor 16 being connected in parallel to the rectifier 29 has a somewhat higher D. C. potential, practically no current will flow through the resistor 16 because at the assumed resistance value of 1 megohm the voltage drop across the resistor 16 will be very high in comparison to the voltage drop across the rectifier 29 having a resistance value of 150 ohms in current carrying condition.

However, conditions are changed when the tube 36 is shifted into the blocking condition thereof by depressing a key of the manual or pedal (not shown). In this condition no current will flow through the rectifier 29 so that the increased direct potential across the resistor 16 is applied to the end 29*a* of the rectifying element 29 turning toward the bus bar 1. This is practically equivalent to a further shifting of the resistance characteristic K of the rectifying element 29 into the blocking range, that is into the negative range of the resistance characteristic. In other words, the tone voltage present on the bus bar 1 cannot shift operation of the rectifier 29 into the falling range of the characteristic. Thereby a distortion of the tone voltage and thus an undefined change of the timbre thereof is avoided.

Since in the circuit according to the present invention a single control tube 36 serves for the control of the rectifying elements 29—35 of a plurality of stop positions, all the stop positions are associated with the same onset and decay times. However, this does not correspond to the requirements of a synthetic imitation of transients since the deeper stop positions have a longer onset time than the higher stop positions. In order to satisfy these conditions also in an arrangement according to the invention the deeper stop positions, for instance those associated with the bus bars 1—5, are provided with capacitors 54—58, respectively, which are connected to the bus bars 1—5. If the contact switch 37 is in closed position an anode current will flow through the control tube 36 over the rectifier element 29 and the resistor 42 across which a considerable voltage drop will develop which has the effect that the potential of the capacitor 54 is considerably smaller than the potential applied to the rectifying element 29. When by a depression of the key the switch contact 37 is opened, the tube 36 is blocked within a period of time depending on the time constant of the RC-members 38, 40. This time constant is chosen so that it corresponds to the period of the onset transient of the highest stop positions, that is to the 1′ and 1⅗′ stop. In order to obtain a longer onset period in the deeper stop positions, that is in the 16′ to 2′ stops, care should be taken that after the blocking of the control tube 36 a certain rectified current may flow in the rectifier elements 29—33. This is accomplished by the capacitors 54—58 in connection with the decoupling resistors 42—46. As mentioned hereinabove, a considerable voltage drop is encountered across the decoupling resistors 42—46. If now the control tube 36 is blocked, a current will flow through the resistor 42 for a certain period of time so as to charge the capacitor 54 with the potential prevailing across the rectifier 29. The period of time taken by this charging depends on the time constant characterizing the resistor 42 and the capacitor 54.

In order to maintain these conditions at the anode 36*a* of the tube 36 when the seven stop positions are switched on together, rectifying elements 49—53 are provided in the lines of the corresponding bus bars 1—5. In this way it is accomplished that the individual time constant members do not influence one another.

Figure 1*a* shows an arrangement which is the same as that of Figure 1, except that instead of the rectifier elements 49—53 decoupling resistors 49′ to 53′ are used.

While I have described hereinabove a preferred embodiment of an electric organ, it will be understood that many changes and modifications thereof, and substitutions of equivalents are to be considered as falling within the scope of the appended claims.

I claim:

1. In an electric musical instrument having a plurality of keys each associated with a respective multi-position stop; a plurality of tone control arrangements for said keys, respectively, each control arrangement comprising a single electronic vacuum tube for all associated stop positions, a resistance-capacitance transient circuit for applying a bias voltage to said tube, switch means in said circuit and operable when closed to reduce the resistance of said circuit and thus the bias on said tube to a value rendering said tube conductive, and operable when open to increase the resistance of said circuit and thus the bias on said tube to a value rendering said tube nonconductive, said switch means being normally closed when the respective key is inoperative and being arranged to be opened by said respective key when the same is operative, and a plurality of grounded diode rectifiers, one for each stop position, arranged in parallel with one another and connected across said tube, whereby when said switch means is closed and said tube is rendered conductive said rectifiers are operated in their voltage-transmission ranges and tone voltages applied to said rectifiers are shorted to ground via said rectifiers, while when said tube is rendered nonconductive due to opening of said switch means by said respective key said rectifiers are operated in their voltage-blocking ranges and said tone voltages are not shorted to ground and may be taken off across said rectifiers for subsequent amplification and transformation into sounds.

2. In an instrument according to claim 1; each control arrangement further comprising a plurality of decoupling resistors each connected between the output terminal of a respective one of said rectifiers and the plate of said tube, a plurality of bus bars connected, respectively, to the junctions between said decoupling resistors and said output terminals of said rectifiers, a plurality of voltage dividers arranged in parallel with said rectifiers and each having first and second terminals, said first terminals being connected, respectively, to said bus bars, and a source of D.-C. potential connected to said second terminals and to the cathode of said tube, the input terminals of said rectifiers being connected to said source of potential in such a manner as to be subjected to a lesser potential than said voltage dividers.

3. In an instrument according to claim 2; the resistance and capacitance values of said transient circuit being

so chosen as to impart to the latter a predetermined time constant corresponding to the attack rate of the tones in the highest stop positions, each control arrangement further comprising a plurality of capacitors connected to said cathode of said tube and to the junctions between said plate of said tube and those of said decoupling resistors associated with the lower stop positions, said capacitors and decoupling resistors constituting additional transient circuits for retarding the attack rate of the tones in said lower stop positions.

4. In an instrument according to claim 3; each control arrangement further comprising a plurality of additional diode rectifiers having their output terminals connected to said plate of said tube and their input terminals connected to the junctions between said capacitors and said decoupling resistors associated with said lower stop positions.

5. In an electric organ having tone voltage generator means and a plurality of keys each associated with some of said tone genrator means and with a respective multi-position stop; a plurality of tone control arrangements for said keys, respectively, each control arrangement comprising a vacuum tube provided with a plate, a grid and a cathode, first resistance means and bias voltage means connected in series with one another between said grid and cathode for biasing said tube to cut-off, capacitance means connected in parallel with said first resistance means and said bias voltage means, second resistance means arranged in parallel with said first resistance means and said bias voltage means, switch means for connecting said second resistance means to and for disconnecting the same from said first resistance means, said switch means being normally closed so as to reduce the bias voltage applied to said grid to a value rendering said tube conductive, said switch means being arranged to be opened by the respective key to maximize said bias

voltage applied to said grid so as to render said tube nonconductive, a plurality of bus bars for conducting tone voltages, a plurality of decoupling resistors connecting said bus bars, respectively, with said plate, a plurality of resistive voltage dividers arranged in parallel, a first end point of each voltage divider being connected to said cathode, a second end point of each voltage divider being connected to corresponding tone voltage generator means, an intermediate point of each voltage divider being connected to the junction between the associated bus bar and the corresponding decoupling resistor, and a plurality of diode rectifiers arranged in parallel with one another and connected with their output terminals to said junctions between said bus bars and said decoupling resistors, and connected with their input terminals to ground and to the junction between said second end points of said voltage dividers and said cathode, whereby when said tube is rendered conductive upon closing of said switch means said rectifiers are operated in their voltage-transmission ranges and said tone voltages are shorted to ground via said rectifiers, while when said tube is rendered nonconductive due to opening of said switch means by said respective key said rectifiers are operated in their voltage-blocking ranges and said tone voltages are not shorted to ground and are conducted away by said bus bars for subsequent amplification and transformation into sounds.

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