

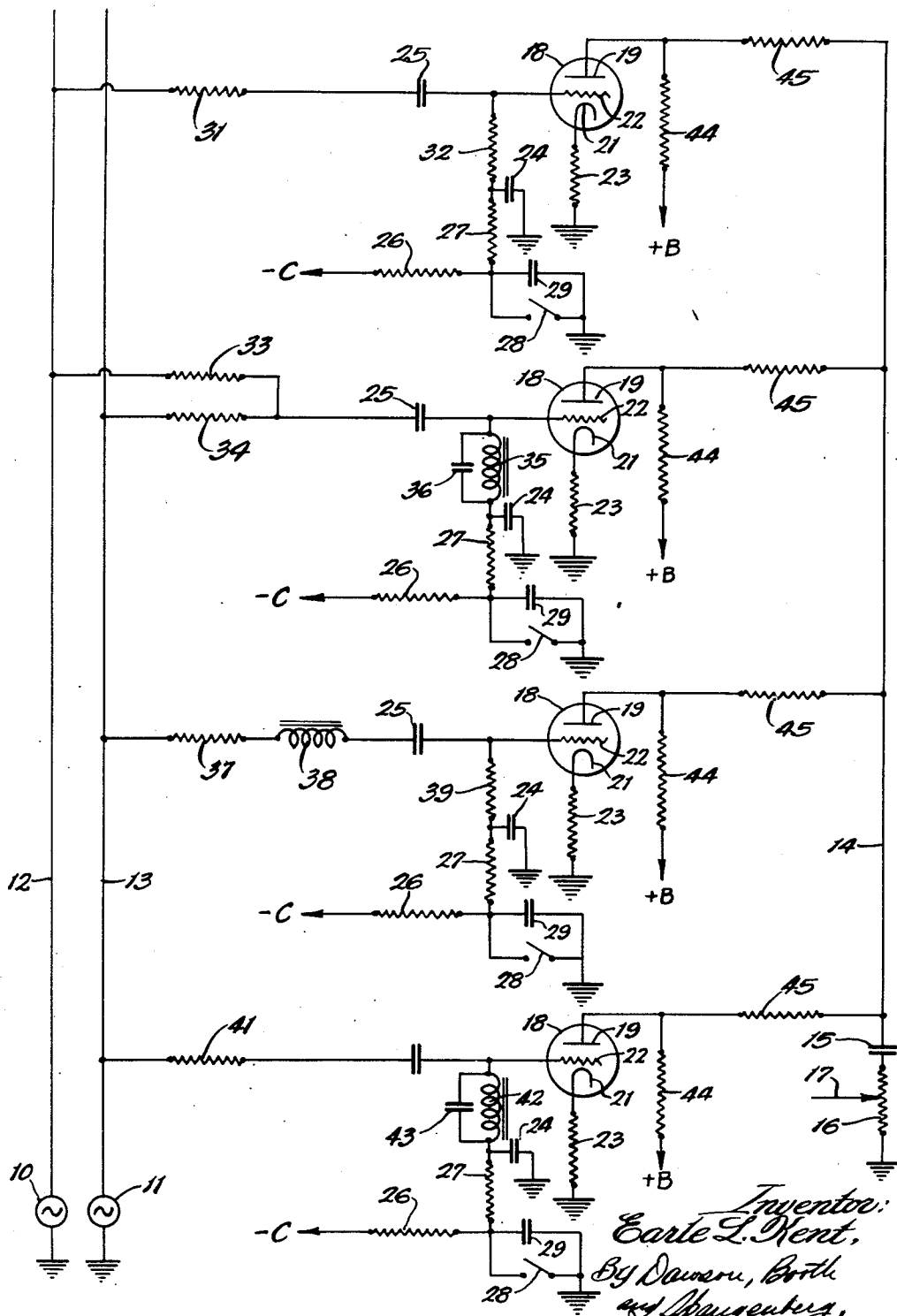
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SIGNAL MIXING APPARATUS

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SIGNAL MIXING APPARATUS

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This invention relates to signal mixing apparatus and more particularly to apparatus for selectively mixing and transmitting a plurality of electrical signals.

The invention is particularly applicable to electrical musical instruments of the organ type and will be specifically described in connection therewith. It will be understood, however, that the principles of the invention and the apparatus can be used to mix various other types of signals such as a plurality of microphone signals from different sources as, for example, from microphones located at different places throughout an orchestra or in a public address system.

In an electric organ as in other systems having a plurality of input or mixer channels, it is desirable that the volume produced through any one channel shall be greater when that channel is used alone than when it is used in conjunction with other channels. This effect is generally called compression. If no compression is used in an electric organ, the volume of a given stop alone will be limited by the total level producible with the full organ. On the other hand if some compression is present, the stops may produce an additive effect but each time a new stop is added the mixing loss is automatically increased so that the overall volume control can be turned higher for a full organ than would otherwise be possible without overloading. This makes any individual stop playable at a higher volume level when used alone than would otherwise be possible.

It is one of the objects of the present invention to provide signal mixing apparatus in which any desired amount of compression can be produced with a minimum number of parts.

Another object is to provide signal mixing apparatus in which compression is produced electrically.

Still another object is to provide signal mixing apparatus in which each of a plurality of mixers arranged in parallel includes a tube which is cut-off when the mixer is not in use and in which compression is produced by resistors in the mixer circuits.

The above and other objects and advantages of the invention will be more readily apparent from the following description when read in connection with the accompanying drawing in which the single figure is a wiring diagram of a signal mixing apparatus embodying the invention.

The apparatus as shown is adapted particularly for use with an electric organ of the type having a plurality of tone frequency currents of different tonal qualities. In the drawing the sources are indicated as oscillators 10 and 11 each of which may be a series of oscillators of different fundamental frequencies with each series producing tone frequency currents of different harmonic content. For example, the os-

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cillators 10 may produce substantially pure sine waves representative of flute tones and the oscillators 11 may produce complex waves of high harmonic content representative of string tones.

The oscillators 10 may supply a bus 12 and the oscillators 11 a bus 13. The outputs of the several mixers are adapted to be supplied to a common output circuit 14 connected through a blocking condenser 15 to an output resistor 16. An adjustable contact 17 connects the resistor through an amplifier to a loudspeaker in the usual manner.

The buses 12 and 13 are adapted to be connected to the output circuit 14 selectively through one or more of a plurality of parallel channels or mixer circuits. As shown, there are four such channels designed to produce different tonal effects each of which includes an electron discharge tube 18 having an anode 19, a cathode 21 and a control grid 22. The control grids of the several tubes are adapted to be supplied with tone signal currents from one or both of the buses 12 and 13 through different types of filtering circuits to modify or selectively attenuate the applied signals.

In the circuits shown each of the cathodes is connected to ground through a resistor 23 and each of the grids is connected to ground through a circuit including a smoothing condenser 24. The grids are also connected to one or both of the buses 12 and 13 through blocking condensers 25 to keep direct voltages out of the buses without interfering with transmission of the signals from the buses to the grids. A bias voltage is supplied to each of the grids from a -C source as indicated through resistors 26 and 27 in series. For keying the tubes the mid point between the resistors 26 and 27 is adapted to be connected to ground through a keying switch 28 having a condenser 29 in shunt therewith. When the switch 28 is open, a bias voltage will be supplied to the grid sufficient to bias the tube to cut-off so that it will not conduct. When the switch 28 is closed, at least a part of the bias voltage will be shunted so that the tubes will become conducting and will supply an anode current similar to the signal voltage applied to the grid.

To vary the tone quality of the signal current transmitted by each of the mixer circuits additional circuit elements are associated with each circuit to modify or to variably attenuate the tone signals. As shown, the upper most mixer circuit is connected solely to the bus 12 through a series resistor 31 and includes a series resistor 32 between the grid and the condenser 24. With this circuit the form of the substantially pure sine wave supplied by the bus 12 will not be materially altered so that the mixer will supply a flute tone. The next lower mixer is connected to both of the buses 12 and 13 through resistors 33 and 34 and has its grid connected to the condenser 24.

through a tuning circuit including an inductance 35 and a condenser 36 in parallel. In this mixer both flute and string tones will be mixed and attenuated by the tuned circuit to produce a chorale effect. The next lower most mixer has its grid connected solely to the bus 13 through a resistor 37 and inductance 38 in series and has its grid connected to the condenser 24 through a resistor 39. In this circuit the string tone supplied by the bus 13 will be modified to produce a string diapason effect. The lower most circuit has its grid connected to the bus 13 through a resistor 41 and to the condenser 24 through a tuned circuit including an inductance 42 and a condenser 43 in parallel. In this circuit the string tone supplied by the bus 13 will be attenuated and modified to produce a reed effect. It will be understood that any desired number of additional mixer circuits to produce different organ effects could be used and that where no filtering or attenuation is desired the several mixer circuits could be connected directly to a plurality of different input sources such as microphones.

The anodes of the several mixer tubes are supplied with B voltage from a common source through individual resistors 44 in series between the anodes and the sources. The anodes are additionally connected to the output circuit 14 at a point between the anodes and resistors 44. Preferably series resistors 45 are employed in the connections to the output circuit.

When only one of the mixers is conducting, each of the remaining mixer tubes is biased to cut-off so that it does not conduct and does not draw plate current. Its load is, therefore, not added to the circuit to produce a mixing loss. However, the plate feed resistors 44 are all in circuit at all times so that there will be a constant mixing loss proportional to the number of mixers employed. When a mixer is conducting the plate resistance of its tube is in shunt with its plate feed resistor 44 so that the change in loading due to the plate resistance being removed when the tube is biased to cut-off and being added when the tube is conducting depends upon the ratio of the plate feed resistor 44 to the plate resistance of the tube. The amount of compression obtained can, therefore, be controlled by controlling the value of the plate feed resistor 44 with respect to the plate resistance of the tube employed. The compression is also dependent upon the relative values of the plate feed resistors 44 and the resistors 45. If the resistors 44 are large and the resistors 45 are small relative to the plate resistances of the tubes, more compression will be obtained. Thus by varying the relationship of the resistors 44 and 45 in the several mixer circuits substantially any desired compression effect can be produced. It will be understood that the resistance of the resistor 16 is of a sufficiently high value compared to the plate resistance of the various tubes as to insure that the foregoing additive mixing losses will occur as described.

It will be seen that the apparatus of the present invention is extremely simple and involves a minimum number of parts to produce compression. Furthermore it eliminates signal expansion due to changing signal load on the input bus and minimizes bus isolation since the grid is not short circuited. It further minimizes the possibility of hum pick-up in the switching leads so that the switches 23 can be conveniently mounted on an organ console at a substantial distance from the mixer circuits. The resistors 44 and 45 in addition to their function of producing com-

pression and in conjunction with the keying circuits as shown eliminate switch pops or clicks and may contribute to control of attack and release of the tones.

While one embodiment of the invention has been shown and described in detail herein, it will be understood that this is illustrative only and is not intended to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. In an electrical musical instrument, a plurality of sources of tone frequency currents of different tone qualities, a common output circuit, a plurality of mixer circuits connected in parallel between the sources and the output circuit, each of the mixer circuits including an electron discharge tube having an anode and a control grid, means connecting the grid to at least one of the sources to supply a signal thereto, means to supply a bias voltage to the grid to bias the tube to cut-off, a switch connected to the last named means to remove the bias voltage from the grid so that the tube will conduct, and means for providing a mixing loss for each tube which is additive for the conducting tubes to produce compression of the signal transmitted thereby comprising, a resistor in series with the anode connecting it to a voltage source, and a connection from the output circuit to a point between the anode and the resistor, said output circuit having a relatively high impedance of the order of the anode impedance of the tube when the latter is conducting.

2. The apparatus defined in claim 1 in which the last named connection includes a resistor in series.

3. In an electric musical instrument, the combination of a plurality of sources of tone frequency current of different tone qualities, a common output circuit, a plurality of mixer circuits, one for each of said sources, connected in parallel between said sources and said output circuit, each of said mixer circuits including an electron discharge tube having an anode and a control grid, means connecting the grid to at least one of the sources to supply a signal thereto, means including a switch for applying a biasing voltage to the grid of the tube to make the tube conducting or non-conducting, and means for providing a mixing loss for each tube which is additive for the conducting tubes to produce compression of the signal transmitted thereby comprising, a resistor connecting said anode to a voltage source, and a connection from the output circuit to a point between the resistor and the anode, said output circuit having a relatively high impedance of the order of the anode impedance of the tube when the latter is conducting.

4. The construction defined in claim 3 in which the last named connection includes a resistance in series.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,298,987	Thomsen	Oct. 13, 1942
2,369,081	Shook et al.	Feb. 6, 1945