Sept. 20, 1960 S. HEYTOW ET AL 2,953,054

VIBRATO PRODUCING CIRCUIT FOR ELECTRONIC MUSICAL INSTRUMENT

Filed Aug. 14, 1953 3 Sheets-Sheet 1

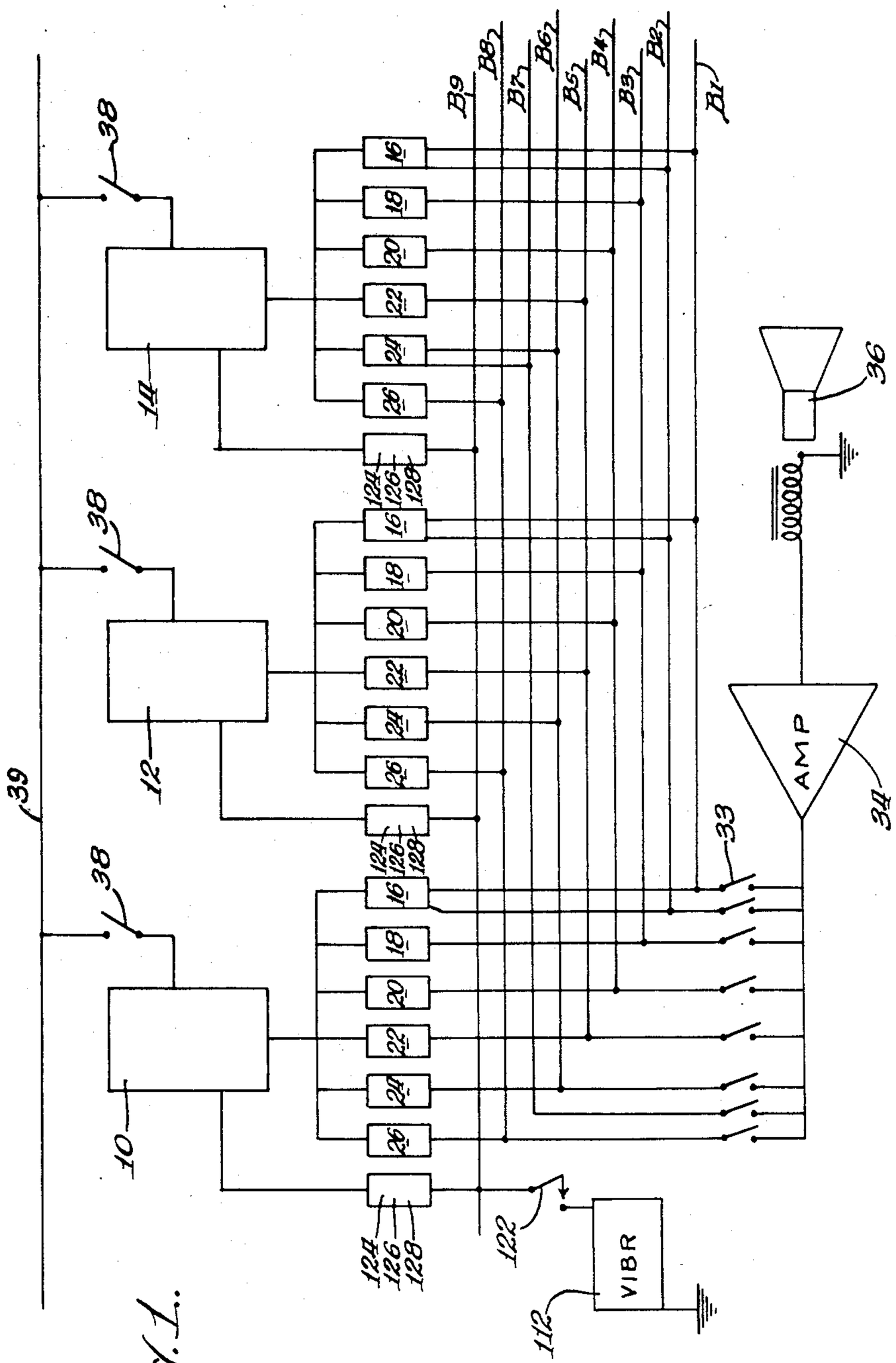

Fig. 1.

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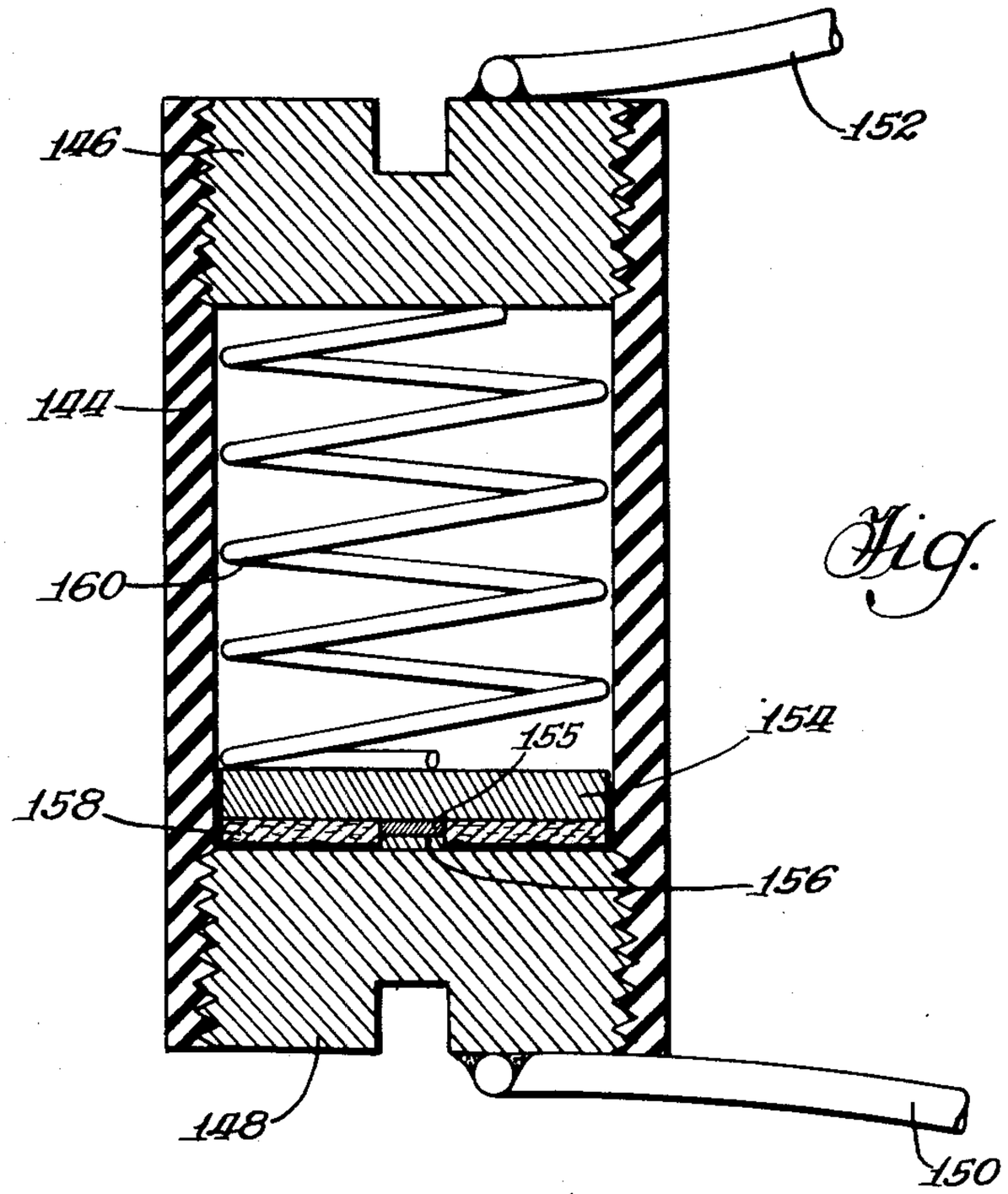

Fig. 2.

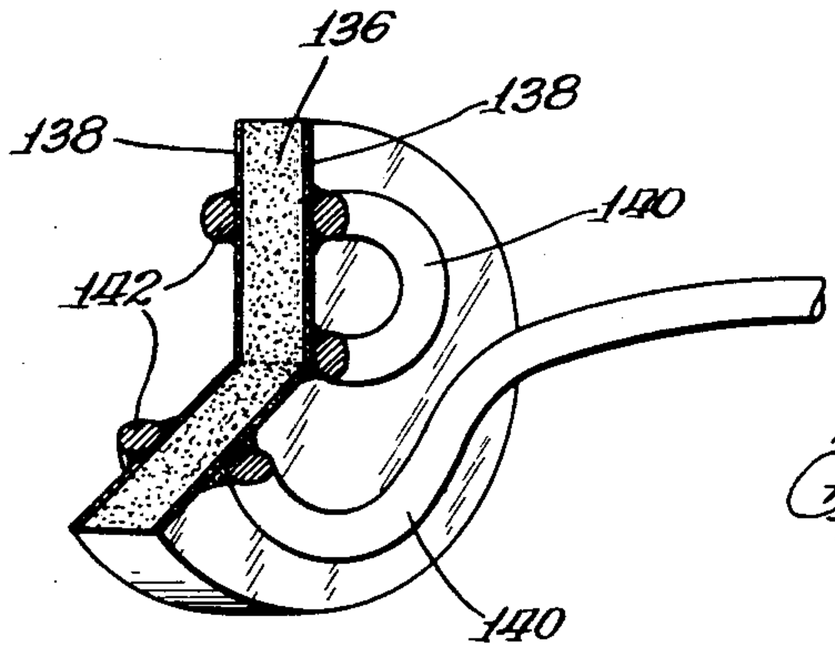

Fig. 3.

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Fig. 4.

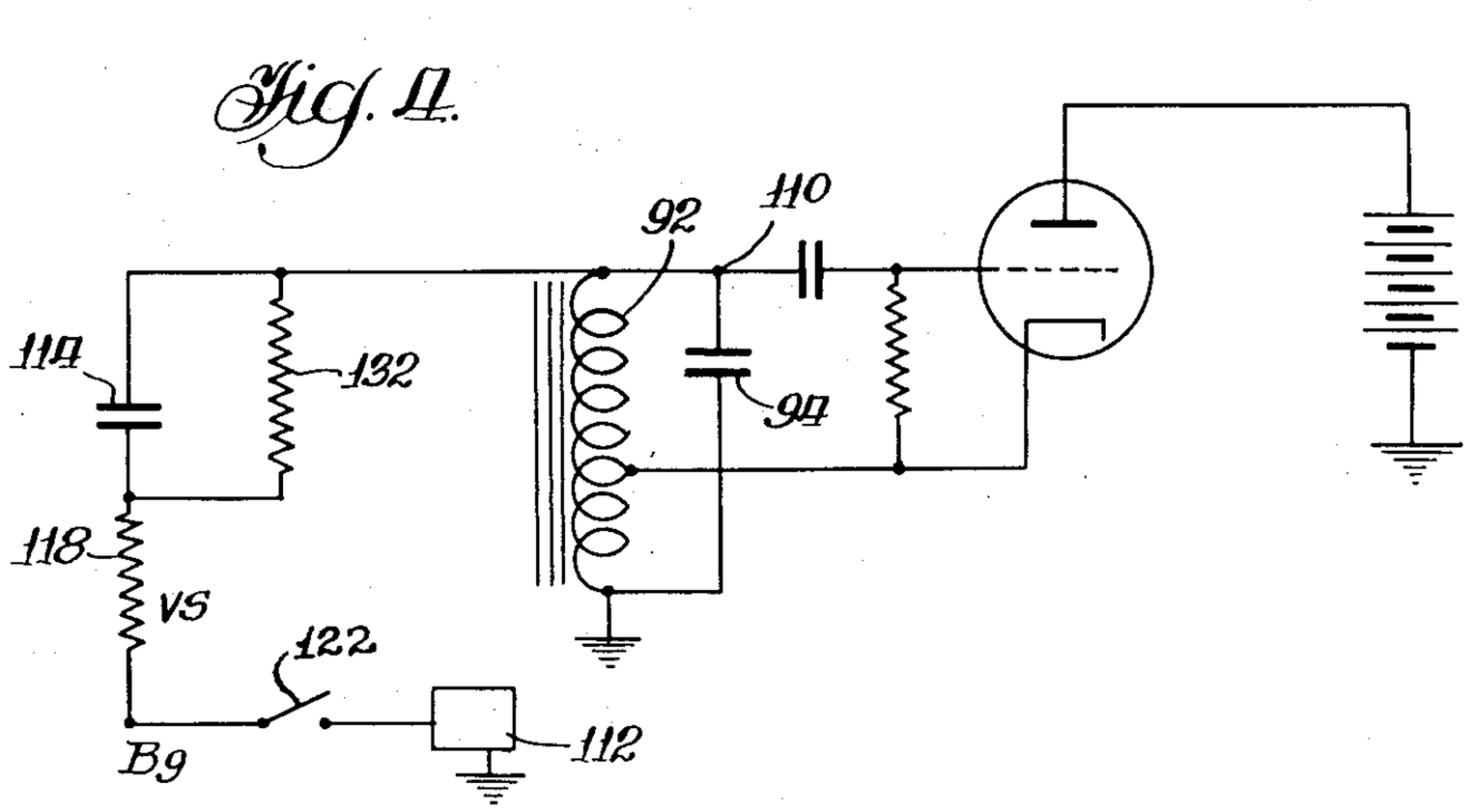
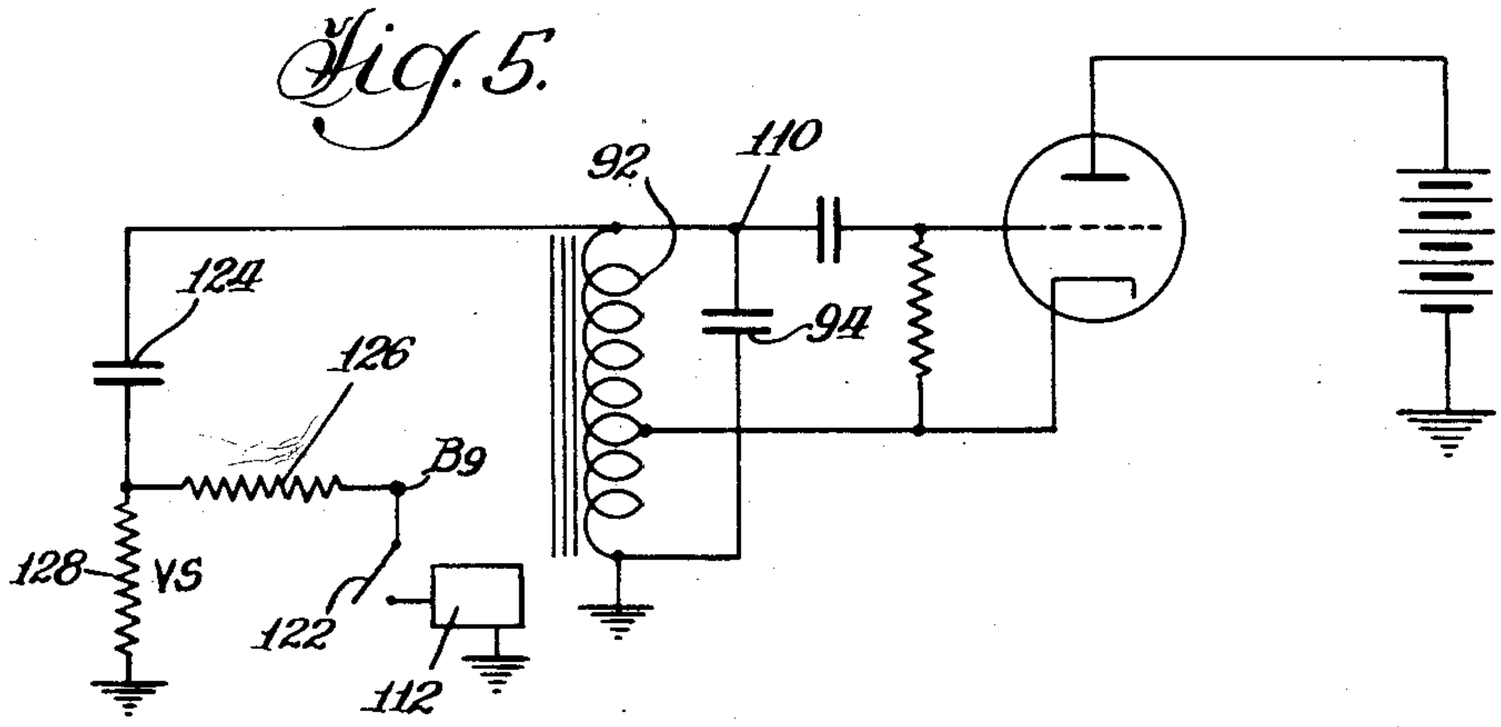


Fig. 5.



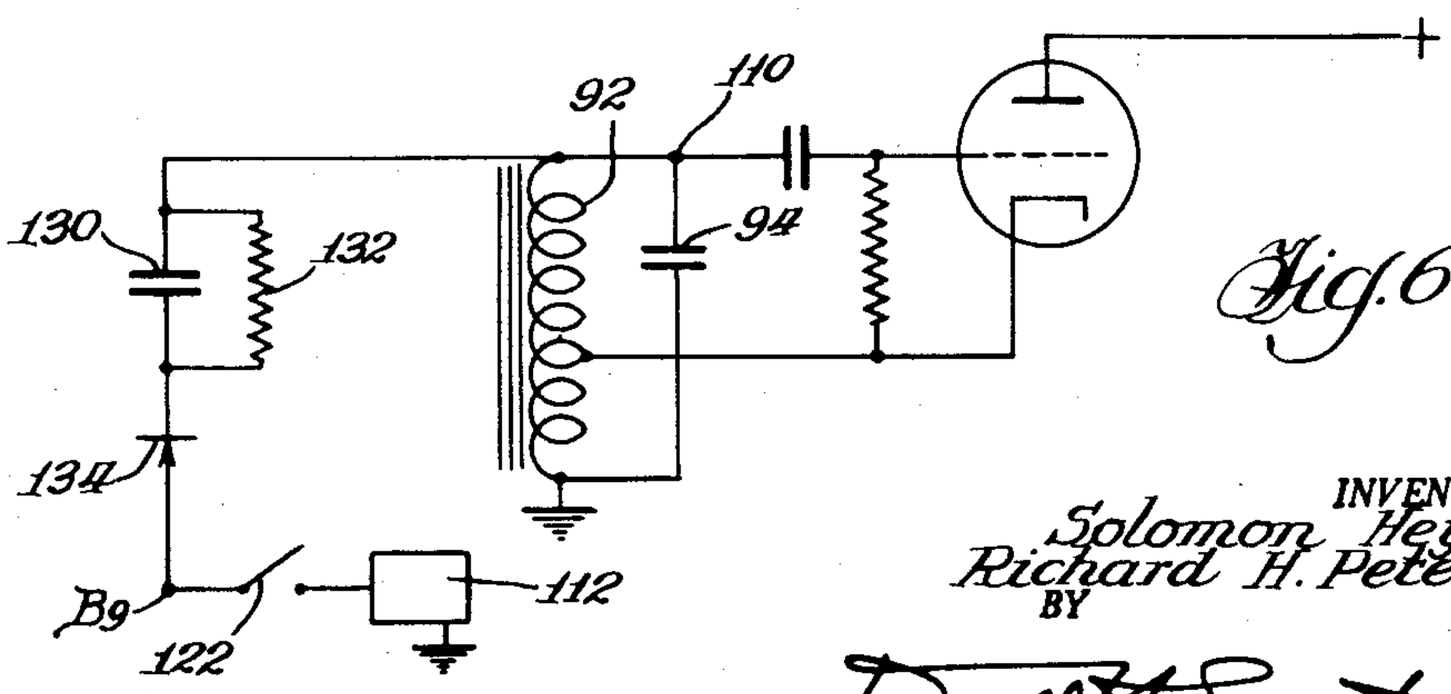


Fig. 6.

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VIBRATO PRODUCING CIRCUIT FOR ELECTRONIC MUSICAL INSTRUMENT

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6 Claims. (Cl. 84—1.25)

Our invention relates to electronic musical instruments and includes among its objects and advantages improved means for developing a vibrato effect in an electronic musical instrument.

In the accompanying drawings:

Figure 1 is an assembled block diagram of a portion of a musical instrument according to the invention;

Figure 2 is a section of a selenium rectifier;

Figure 3 is a perspective, partly in section, of a voltage-sensitive resistor;

Figure 4 is a wiring diagram of an oscillator provided with means for producing a vibrato;

Figure 5 is a wiring diagram of the same oscillator with a different vibrato means; and

Figure 6 is a wiring diagram of the same oscillator with a third vibrato means.

In the embodiment of the invention selected for illustration, and referring first to Figure 1, there are indicated three tone-generating units **10**, **12**, and **14**. Each of these units may be a conventional Hartley oscillator, which is a type well known to those skilled in the art. Each oscillator delivers a wave of dependably constant frequency and substantially sine curve shape. A complete organ bank would call for sixty one, or seventy three, or eighty five such oscillators, one for the pitch corresponding to each note to be produced.

Each of the entire series of oscillators is selectively controlled by the player by its selective key switch **38**, which receives activating potential from the bus **39**.

The output from each of the oscillators **10**, **12**, and **14** is connected to each of six wave-shaping units **16**, **18**, **20**, **22**, **24**, and **26**.

For convenience in discussing thet functioning of the parts involved, rectifying means, considered in connection with the specific functions described in this invention, may conveniently be referred to as of two sorts, substantial and absolute. The well-known selenium rectifying plate has a very low resistance in one direction it still conducts current, with a resistance that may be from fifty to five thousand times as great as in the low-resistance direction. However, a diode or triode vacuum tube can be made to conduct current easily in one direction and not at all in the opposite direction. Such a rectifier is an absolute rectifier, and the characteristics with respect to which it differs from a substantial rectifier are advantageous in some combinations and disadvantageous in others.

Referring now to Figure 4, it will be obvious that the frequency characteristics of the circuit containing the inductor **92** and capacitor **94** may be varied by changing the constants of the circuit with respect to either the capacitance or the inductance, and most conveniently by changing the capacitance. In Figure 4 we have indicated a capacitor **114** connected to point **110**, and through a voltage-sensitive resistor **118**, to bus bar B_9. The variable D.C. potential source **112** may be connected with bus bar B_9 by selective switch **122**. With bus bar B_9 unbiased,

the frequency of the oscillation may be tuned to the exact pitch desired. Subsequently, if the operator connects B_9 to the variable potential source **112**, by means of selective stop switch **122**, bus bar B_9 assumes a voltage which fluctuates at the desired low frequency. This renders the capacitor **114** effective whenever the potential of the bus bar rises to the point where resistor **118** becomes a low resistance. The ordinary resistance **132** is needed to carry the D.C. current that controls the voltage-sensitive resistor **118**. This arrangement can produce an excellent vibrato.

In Figure 5 we have illustrated a capacitor **124** corresponding to capacitor **114** and connected to bus bar B_9 through a resistor **126**. But the ground connection is through a voltage-sensitive resistor **128**. This arrangement gives a very pleasing and smooth vibrato.

A different arrangement is indicated in Figure 6. The potential of the bus B_9, of course, oscillates with respect to ground, and the point **110** is connected to bus B_9 through a capacitor **130** shunted by resistor **132**, and with loop in series with a selenium rectifier **134** arranged in the direction to permit current to flow when the bus has a positive potential. This arrangement produces a smooth, pleasant vibrato. Furthermore, the selenium rectifier can be replaced with one of copper oxide or with a voltage-sensitive resistance of fairly high value.

One form of voltage-sensitive resistor with which good results have been secured, is illustrated in Figure 3. It comprises a disk **136** of granular silicon carbide mixed with ceramic binder and fired at high temperature, with metal conducting plates **138** affixed to both sides. We have illustrated the plates **138** plated on the silicon carbide disk and soldered to wire connectors **140** and **142**. The voltage-sensitive resistor is non-polar, i.e., its resistance characteristics are identical regardless of the direction of the applied voltage.

Referring now to Figure 2, one form of rectifier with which satisfactory results have been obtained is a simple tube **144** of insulating fiber threaded at both ends to receive a metal top plug **146** and bottom plug **148**. For convenience in assembly, both plugs may be slotted to receive a screw driver. External leads **150** and **152** are convenient for connecting the device into a circuit. Inside the tube **144** we provide a thin metallic plate **154** having a small central boss or tit abutting the plug **148**. The annular space around the boss is filled in with an insulating washer **158**.

The boss consists of a layer **155** of selenium, and a layer **146** of Woods metal. A light compression coil spring **160** bears at its upper end against the plug **146** and at its lower end against the plate **154**. This keeps the boss **156** in effective contact with the plug **148** and establishes an electrical connection through the device. A convenient size for such a device is about a quarter of an inch in diameter and three-fourths of an inch long. In such small sizes it is convenient to form the plate **154** by stamping it out of a large plate, one side of which has previously been coated with selenium and then with Woods metal. Then the disk is placed in a small lathe and turned down to final shape. This leaves a contact area ample for the extremely small currents involved, and at the same time reduces the condensor action at the contact surface to a very minor fraction of what it would be if the contact surface were the entire area of the plate **154**.

Such a device has a low conductivity when the terminal **150** is negative and relatively high conductivity when that terminal is positive. In the wiring diagrams the arrow points in the direction of low resistance conductivity.

Others may readily adapt the invention for various

conditions of service by employing one or more of the novel features disclosed or equivalents thereof. As at present advised with respect to the apparent scope of our invention, we desire to claim the following subject matter.

This application is a continuation in part of our co-pending application Serial Number 195,222, filed November 13, 1950.

We claim:

1. An electronic musical instrument comprising, in combination: a series of independent audio frequency oscillators, one for each semitone of the musical scale throughout the range of the instrument; each oscillator having a tank circuit of constant frequency; each tank circuit comprising inductance and capacitance connected in parallel; detuning means for each oscillator comprising a supplemental capacitance adapted to lower the normal tank circuit frequency; an electrical connection for rendering said ancillary detuning means operative; said electrical connection including a resistor of the silicon carbide type, sensitive to impress voltage at constant temperature; a separate D.C. circuit for passing direct current through said voltage-sensitive resistor to change its resistance; automatic means for varying the direct current potential on said resistor smoothly from maximum to minimum with vibrato frequency; and player-operated switch means for rendering said automatic means continuously operative or continuously inoperative.

2. An instrument according to claim 1 in which said automatic means includes a continuously operative source of varying D.C. potential, and said player-operative switch means is constructed and arranged to connect and disconnect said source and said D.C. circuit.

3. An instrument according to claim 1 in which said D.C. circuit includes a protective resistor in series with said voltage-sensitive resistor.

4. An instrument according to claim 3 in which said protective resistor is shunted across said supplemental capacitance.

5. An electronic musical instrument comprising, in combination: a series of audio-frequency oscillators for the semi-tones of the musical scale; each oscillator having a tank circuit of stable frequency; each tank circuit comprising inductance and capacitance connected to store and exchange energy at a predetermined frequency; frequency-changing means operatively associated with each oscillator comprising a series-connected diode sensitive to variations in impressed potential; a circuit connected to

said diode for selectively impressing potential on said diode to control its impedance; automatic repetitive vibrato producing means operatively associated with said circuit for intermittently varying the impressed potential in said separate circuit to change the frequency of said oscillator in vibrato fashion; and player-operated means operatively associated with said automatic means for rendering said automatic means continuously operative or continuously inoperative; said automatic means operating at vibrato frequency.

6. An electrical musical instrument comprising, in combination: a series of audio-frequency oscillators, one for each semi-tone of the musical scale; each oscillator having a tank circuit of constant frequency; each tank circuit comprising an inductor and a main capacitor; detuning means operatively associated with each oscillator comprising a supplemental capacitor for lowering the normal tank frequency; an electrical connection for rendering said supplemental capacitor operative by connecting it in parallel with said main capacitor; said electrical connection including a diode sensitive to variations in impressed potential; a separate D.C. circuit operatively associated with said diode for impressing D.C. potential on said diode to change its resistance; automatic vibrato producing means operatively associated with said circuit for varying the impressed potential on said diode to change its resistance intermittently for producing a vibrato effect; and player-operated switch means operatively associated with said automatic means for rendering said automatic means continuously operative or continuously inoperative.

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CERTIFICATE OF CORRECTION

Patent No. 2,953,054 September 20, 1960

Solomon Heytow et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 47, for "thet" read -- the --; line 53, for "tion it still" read -- tion, but in the other direction it still --; column 2, line 21, for "with loop" read -- with this loop --; line 49, for "146" read -- 156 --.

Signed and sealed this 4th day of April 1961.

(SEAL)
Attest: ERNEST W. SWIDER
XXXXXXXXXX
Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents