May 10, 1966 G. JENNY 3,250,843

ELECTRONIC MUSICAL INSTRUMENT WITH FLUID PRESSURE ACTUATED VOLUME CONTROL

Filed Aug. 19, 1964 3 Sheets-Sheet 1

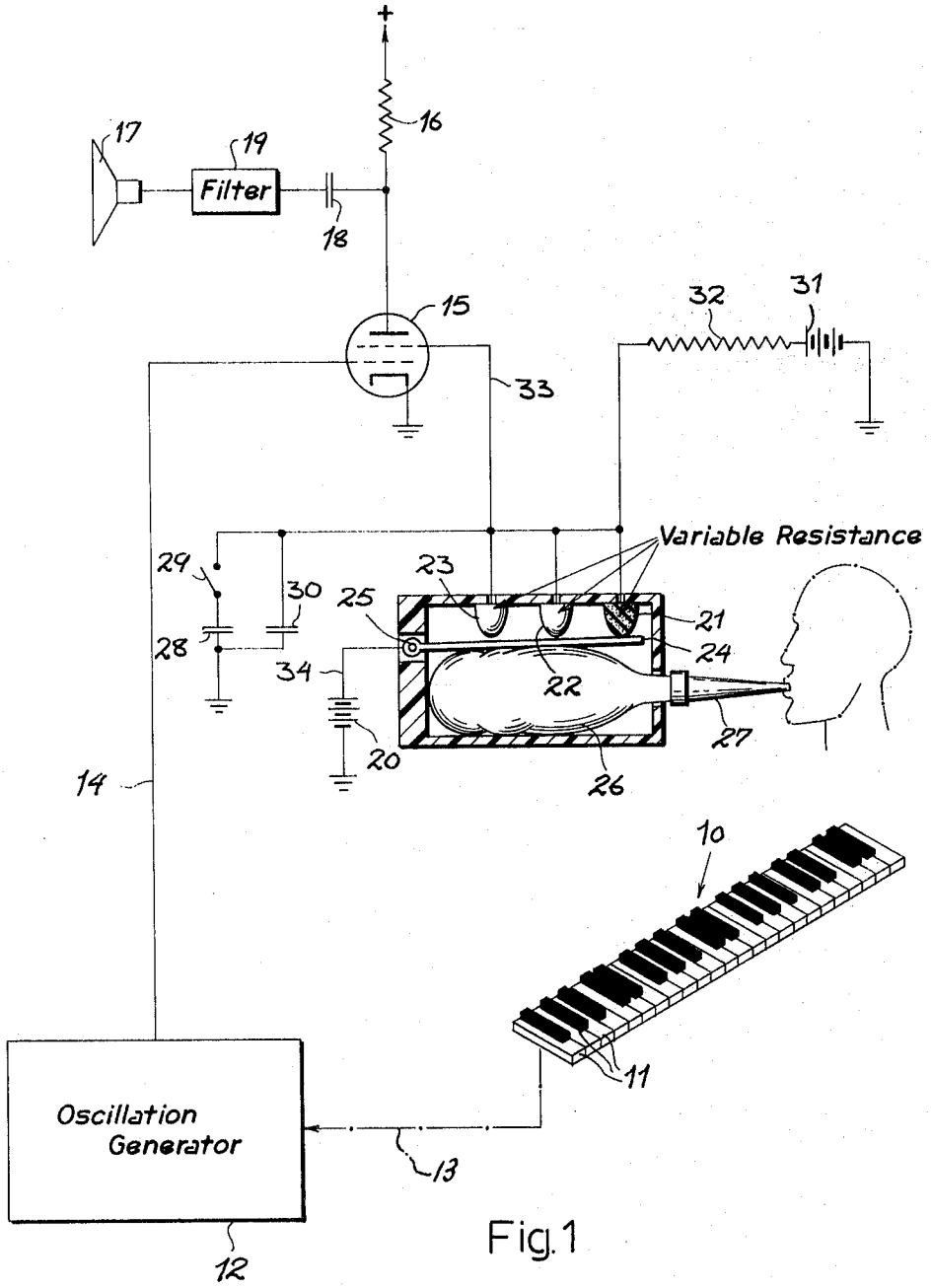

Fig. 1

Georges Jenny
INVENTOR.

BY Karl F. Ross
AGENT

May 10, 1966 G. JENNY 3,250,843

ELECTRONIC MUSICAL INSTRUMENT WITH FLUID PRESSURE ACTUATED VOLUME CONTROL

Filed Aug. 19, 1964 3 Sheets-Sheet 2

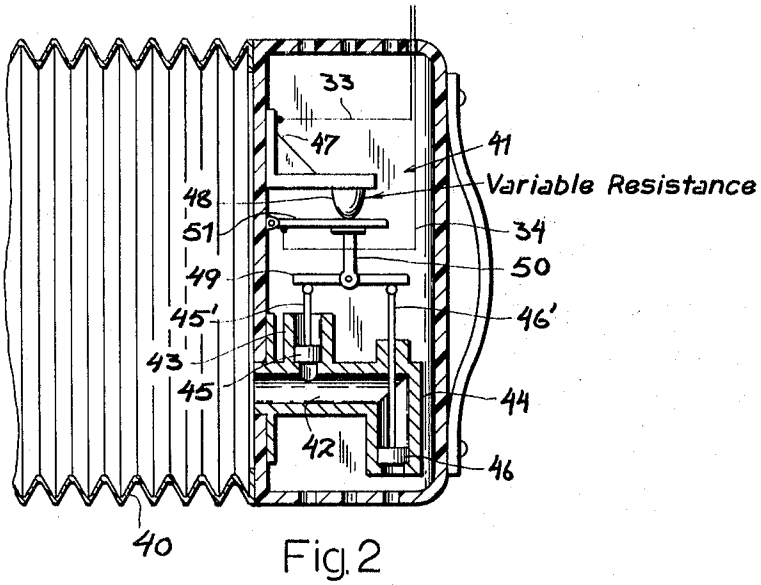

Fig. 2

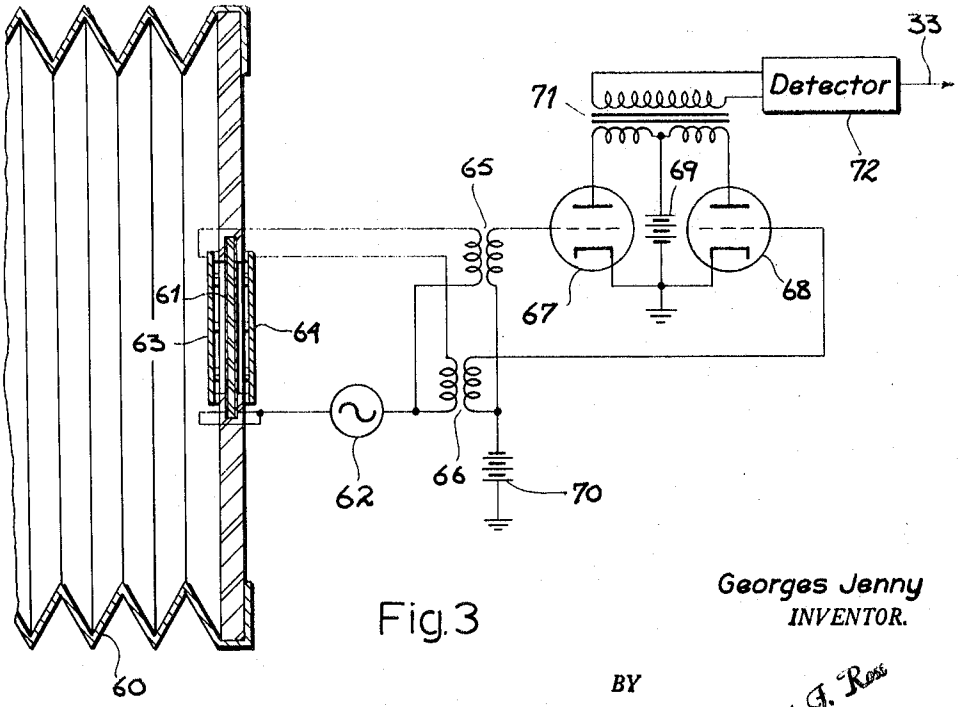

Fig. 3

Georges Jenny
INVENTOR.

BY

Karl F. Ross
AGENT

May 10, 1966 G. JENNY 3,250,843

ELECTRONIC MUSICAL INSTRUMENT WITH FLUID PRESSURE ACTUATED VOLUME CONTROL

Filed Aug. 19, 1964 3 Sheets Sheet 3

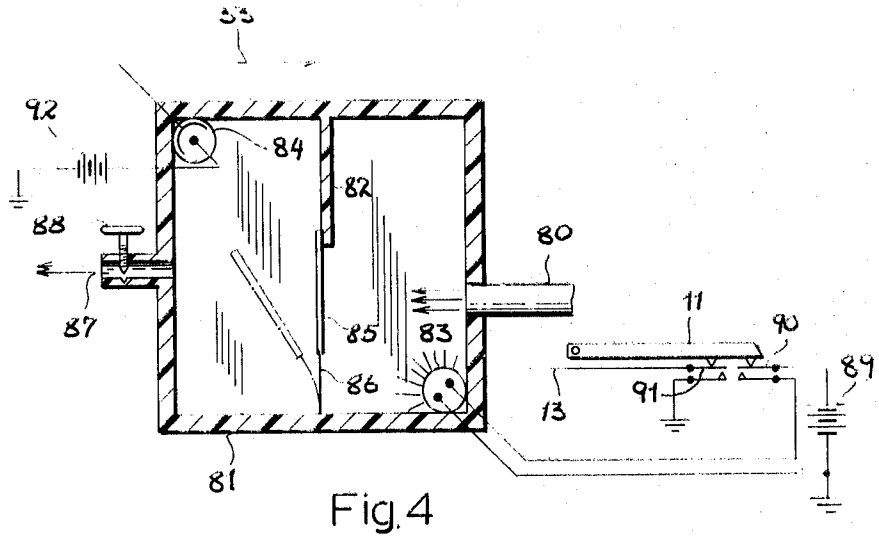

Fig. 4

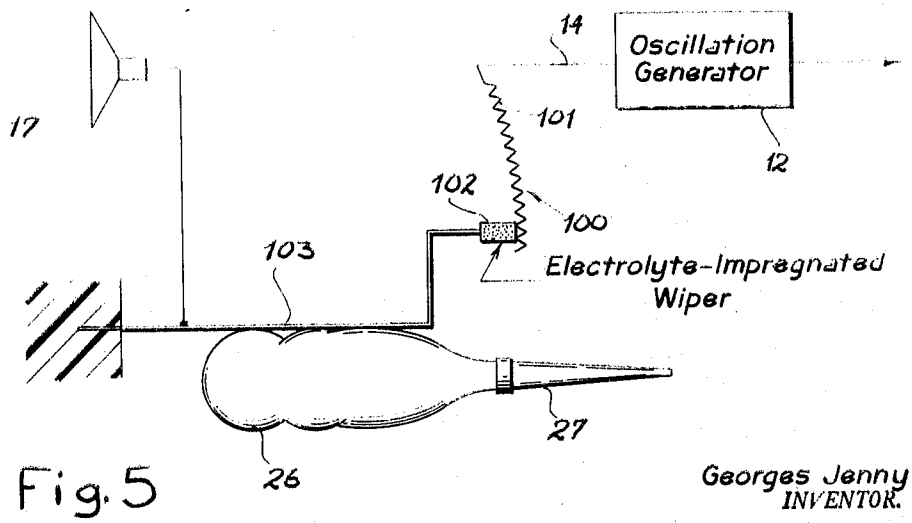

Fig. 5

Georges Jenny
INVENTOR.

BY Karl F. Ross

AGENT

United States Patent Office 3,250,843 Patented May 10, 1966

3,250,843

ELECTRONIC MUSICAL INSTRUMENT WITH FLUID PRESSURE ACTUATED VOLUME CONTROL

Georges Jenny, Quessigny (Eure), France

Filed Aug. 19, 1964, Ser. No. 390,694
8 Claims. (Cl. 84—1.09)

This application is a continuation-in-part of my application Ser. No. 123,818, filed July 13, 1961.

My present invention relates to a musical instrument of the type wherein notes of different audible frequencies are produced with the aid of an electronic oscillation generator under the control of individually operable tone selectors, such as a set of buttons or keys of a key board.

Although the operation and control of such electronic tone generators is well known per se, it has not yet been possible to operate them in such a way that their acoustic performance resembles that of conventional body-operated musical instruments, particularly wind instruments. Thus, notes produced by wind instruments (a term here intended to include not only instruments actuated by the mouth of the player, such as flutes, harmonicas and the like, but also instruments such as accordions in which the "wind" is generated by manual compression and expansion of a bellows) have a distinct intensity characteristic which is due to the fact that the medium which excites the individual sound generators, e.g. reeds, is an intermittent air stream which varies in intensity, and sometimes (as in a harmonica or accordion) in direction, at a subaudible rate so that there occurs a distinct amplitude modulation of each note. The general object of my invention is to provide, in an electronic musical instrument, means for simulating the performance of such wind instruments.

This object is realized, in accordance with my present invention, by the provision of a body-actuated source of air flow, such as a mouthpiece or a bellows operable by hand or foot, in combination with flow-backing means oscillatable at subaudible frequencies or otherwise displaceable at a relatively slow rate in response to variations or reversals of the air flow, the flow-blocking means electrically controlling an amplitude-modulating network in the output circuit of an associated electronic tone generator.

The flow-blocking means, positioned, to intercept the air current from the mouthpiece or bellows, may be a closed or substantially closed elastic bag, a spring loaded piston, or some other element resiliently obstructing or impeding the flow. Resilient biasing, however, is not absolutely essential in the case of a reversible air flow, e.g. as produced by an accordion, in which, for example, an elastic or inelastic membrane may be used as the flow-blocking and pressure-responsive element. Such a membrane, which can be regarded as a double-acting piston, may also be replaced by a pair of oppositely biased pistons disposed side by side and interconnected by a mechanical linkage which in turn acts upon a variable impedance element constituting part of the amplitude-modulating network. This network may also include other selectively adjustable impedances, e.g. capacitors, for varying its time constant and therefore the response characteristics of the modulator. Mechanical variation of this response characteristic is possible, alternatively or supplementally, with the aid of devices for selectively throttling the flow of air into or past the flow-blocking means.

The amplitude of the generator may also be modulated more directly by passing its oscillating output current through a potentiometer or other variable impedance element controlled by a device which responds to the pressure of the air flow. I have found, in accordance

with a further feature of my invention, that a particularly suitable potentiometer for this purpose comprises a wiper with a porous body permeated by an electrolytic liquid so that the resistance element of the potentiometer is contacted by liquid film rather than by a solid conductor, with the result that friction and backlash are minimized. A very effective electrolytic liquid for this purpose is a solution of magnesium chloride in a nonvolatile alcohol, preferably glycerol.

The above and other features of my invention will become more readily apparent in the following detailed description of certain embodiments, reference being made to the accompanying drawing in which:

FIG. 1 is a partly diagrammatical view of a mouth-operated modulating system according to the invention, as originally disclosed in my above-mentioned copending application;

FIG. 2 is a cross-sectional view of an accordion embodying the invention in modified form;

FIG. 3 illustrates, again partly diagrammatically, a further modification of the invention as applied to an accordion;

FIG. 4, in still another partly diagrammatical view, illustrates a further embodiment; and

FIG. 5 diagrammatically shows yet another embodiment.

In FIG. 1 I have illustrated a keyboard **10** whose keys **11** individually control, in a manner known per se, an oscillation generator **12** via a set of conductors symbolized by a connection **13**. An output lead **14** of generator **12** terminates at the control grid of an amplifier tube **15**, here shown as a tetrode, whose plate is connected to a high positive voltage via a resistor **16** and is further coupled to a loudspeaker **17** by way of a blocking condenser **18** and a filter **19**. The screen grid of tetrode **15** is connected via leads **33, 34** to positive voltage at a battery **20** by way of a set of variable resistances **21, 22, 23** all connected in parallel, these resistances consisting for example of blocks of electrically conductive foam rubber whose conductivity increases as the blocks are compressed. A metal plate **24**, pivotally mounted at **25**, bears upon the blocks **21–23** under pressure of an inflatable bag **26** of resilient material, e.g. rubber, having a mouthpiece **27** into which the user may blow. A shunt circuit of manually adjustable impedance, including a first condenser **28** in series with a switch **29** and a second condenser **30** in parallel therewith, is connected across the variable-impedance unit **21–27** to permit selective altering of the time constant of the RC network **20–30** connected to the screen grid of amplifier tube **15**.

In operation, a skilled musician will be able to produce a variety of artistic expressions in modulating the output of tone generator **12**, as selected with the aid of keyboard **10**, under the control of his own breath as he blows more lightly or more strongly into the mouthpiece **27**; in the absence of any air pressure applied to the bag **26**, the conductive plate **24** may be disconnected from the resistances **21–23** so that the screen grid of tube **15** receives negative bias from a battery **31** through a large resistance **32** and the tube **15** is effectively cut off. Naturally, the resistances **21–23** may also be so arranged that the tube **15** retains some conductivity in the no-pressure condition whereby a note of minimum intensity can be heard when one of the keys **11** is depressed without concurrent blowing.

In FIG. 2, I have shown at **40** the bellows of an otherwise conventional accordion provided with an attachment **41** which forms a passage **42** communicating with the interior of the bellows. Passage **42** has a pair of lateral ports **43, 44** in which two pistons **45, 46** are movable in response to pressure differentials between the interior of the bellows and the surrounding atmosphere; piston **45** is

displaceable when this pressure differential is positive, i.e. when the bellows **40** is compressed whereas piston **46** leaves its normal position when suction is created by an extension of the bellows. The keyboard of the accordion (not shown) is connected, in the manner illustrated for keyboard **10** of FIG. 1, to an oscillation generator whose output is amplitude-modulated by an amplifier such as the tube **15** of FIG. 1, having an input lead **33**, connected to a conductive bracket **47** carrying a block **48** of variable electrical resistance similar to the blocks **21–23** of FIG. 1. The rods **45'**, **46'** of pistons **45** and **46** bear upon opposite extremities of a lever **49** whose center is fulcrumed to a bar **50** depending from a conductive plate **51** which in turn is connected to the conductor **34** leading to a source of bias voltage as shown in FIG. 1.

It will be apparent that the differential linkage **45'**, **46'**, **49–51** in the system of FIG. 2 applies pressure to the variable resistance **48** upon both compression and expansion of the accordion bellows **40**, thereby modulating the amplitude of the notes produced by the associated tone generator. This instrument, therefore, can be worked essentially in the same manner as the one shown in FIG. 1, except that the air pressure is now applied manually rather than by mouth. Naturally, the performance of the tone generator may be further controlled by adjustable impedances, e.g. as illustrated at **28–30** in FIG. 1.

In FIG. 3, I have shown an accordion bellows **60** having a flexible membrane **61** inserted in an end wall thereof. Membrane **61** is conductively coated and electrically connected to a source **62** of alternating current whose other terminal is connected to a pair of rigid plates **63**, **64**, spaced from the membrane on opposite sides thereof, via the primary windings of respective transformers **65**, **66**. The secondary windings of these transformers are connected to the grids of a pair of triodes **67**, **68** connected in push-pull across a source of operating voltage here shown as a battery **69**, the two grids being biased by another battery **70**; tubes **67** and **68** work into an output transformer **71** connected to a detector **72** which applies their rectified output to the lead **33** of the amplitude modulator (not shown in this figure).

In operation, deflection of the membrane **61** in either direction by the operation of bellows **60** will unbalance the push-pull in connected tubes **67**, **68** by making the capacitance of one input condenser **61**, **63** different from that of the other input condenser **61**, **64** so that a control voltage will appear on the lead **33** in the output of detector **72**. The magnitude of this control voltage will again be determined by the pressure differential existing between the interior of the bellows and the surrounding atmosphere but will be substantially independent of the sign of this differential. The bias of battery **70** may also be made sufficiently negative to cut off both tubes **67**, **68** until the deflection of membrane **61** is substantial enough to lower the impedance of either condenser **61**, **63**, or **61**, **64** to less than a predetermined cutoff value whereby only one or the other of the tubes **67** and **68** will conduct at any time.

In FIG. 4, I have shown an inlet tube **80** through which a flow of air, originating for example from a mouthpiece as shown at **27** in FIG. 1, enters an enclosure **81** provided with an internal partition **82**. On one side of this partition there is disposed a light source **83** whose rays are directed toward a photoelectric cell **84** on the opposite side of the partition, the path of the rays being normally cut off by a light gate represented by a swingable baffle **85** which is urged under pressure of a spring **86** against the partition **82**. The oncoming air stream opens the light gate to a greater or lesser extent, depending on its intensity, by deflecting the baffle **85** against the force of its biasing spring **86** so that the air may escape through an outlet **87**; this outlet carries a throttle valve **88** for regulating the flow resistance of the passage **80**, **81**, **87**.

Light source **83** is a glow tube energizable by a battery **89** via a pair of normally open contacts **90** which are closed upon depression of any key **11** of the keyboard **10** (see FIG. 1), the contacts **90** of all the keys **11** being connected in parallel. FIG. 4 also illustrates another set of contacts **91** individual to the particular key **11**, which connect ground potential to the associated conductor **13** leading to the oscillation generator. Photocell **84** is energized by a battery **92** and has its output electrically connected to the control lead **33** of the amplitude modulator.

In operation, battery **92** applies a control voltage to lead **33** only upon illumination of photocell **84** when the light gate **85** is partly or fully opened, the magnitude of this voltage thus depending upon the intensity of the air stream flowing through tube **80** and exiting via outlet **87**. This air stream is again under direct body control of the operator, whether produced by blowing, manual compression of a bellows or stepping upon a pedal, so that the acoustic output of the tone generator will reflect the artistic performance of the operator.

In FIG. 5, finally, there is illustrated a potentiometer **100** connected in the output lead **14** of the oscillation generator **12**, this potentiometer including a resistance **101** contacted by a wiper **102** on the free end of a conductive spring **103** which in turn is connected to the loudspeaker **17**. Spring **103** is acted upon by the bag **26** of FIG. 1 so as to make the wiper **102** slide along the resistance element **101** as the bag is inflated by blowing into the mouthpiece **27**. Wiper **102** has a porous body e.g. of felt, permeated by a conductive liquid, preferably a source of magnesium chloride in glycerol; a proportion of three parts glycerol (by volume) to one part of $MgCl_2$ has been found extremely suitable. It should be noted that this solution, like any other electrolyte, would tend to polarize if direct current were applied to the potentiometer; with the arrangement illustrated, in which the alternating output of oscillator **12** passes through the potentiometer, this is not the case.

The potentiometer **100** shown in FIG. 5 operates substantially without inertia and quickly responds to the expansions and contractions of the bag **26** at subaudible frequencies. Naturally, a potentiometer of this kind could also be used with, for example, a piston type controller of the construction shown in FIG. 2 or other control device responsive to air pressure. Other compatible features shown in different embodiments may be similarly combined, these and further modifications readily apparent to persons skilled in the art being intended to be embraced within the spirit and scope of my invention as defined in the appended claims.

I claim:

1. In a musical instrument having an electronic tone generator provided with a control circuit, electro-acoustic transducer means connected to the output of said generator, and a multiplicity of individually operable tone selectors connected to said generator for energizing the latter to produce electrical oscillations with a variety of audible frequencies translatable by said transducer means into sound waves, the combination therewith of a body-actuated source of air flow, flow-blocking means displaceable in response to variations of said air flow, and amplitude-modulating means for said oscillations controlled by said flow-blocking means, said amplitude-modulating means including a pressure-sensitive impedance element of compressible resistance material connected in said control circuit and a physical connection from said flow-blocking means to said element.

2. The combination defined in claim **1** wherein said source comprises a mouthpiece.

3. The combination defined in claim **1** wherein said source comprises a manually operable bellows.

4. The combination defined in claim **2** wherein said flow-blocking means comprises an inflatable bag.

5. In a musical instrument having an electronic tone generator provided with a control circuit, electro-acoustic transducer means connected to the output of said generator, and a multiplicity of individually operable tone selectors connected to said generator for energizing the latter to produce electrical oscillations with a variety of

audible frequencies translatable by said transducer means into sound waves, the combination therewith of a body-actuated source of reversible air flow, means forming a pair of interconnected passages for said air flow, first and second flow-blocking means respectively displaceable in said passages in response to air flow in either of two directions, and amplitude-modulating means for said oscillations controlled by said first and second flow-blocking means, said amplitude modulating means including a variable impedance element connected in said control circuit and a physical connection from each of said flow-blocking means to said element.

6. The combination defined in claim 5 wherein said physical connection comprises a differential linkage.

7. The combination defined in claim 5 wherein said impedance element comprises a pressure-sensitive body of compressible resistance material.

8. In a musical instrument having an electronic tone generator provided with a control circuit, electro-acoustic transducer means connected to the output circuit of said generator, and a multiplicity of individually operable tone selectors connected to said generator for energizing the latter to produce electrical oscillations with a variety of

audible frequencies translatable by said transducer means into sound waves, the combination therewith of a body-actuated source of reversible air flow, flow-blocking means oscillatable at subaudible frequencies in response to reversals of said air flow, and amplitude-modulating means for said oscillations controlled by said flow-blocking means, said flow-blocking means comprising a pair of oppositely biased pistons disposed side by side and interconnected by a mechanical linkage, said amplitude-modulating means comprising variable impedance means connected in said output circuit and physically coupled with said linkage.

References Cited by the Examiner

UNITED STATES PATENTS

1,975,220	10/1934	Ananiew	84—1.27
2,301,184	11/1942	Arnold	84—1.27 X
2,475,168	7/1949	Workman	84—1.01

FOREIGN PATENTS

424,892	2/1935	Great Britain.

GEORGE N. WESTBY, *Primary Examiner.*