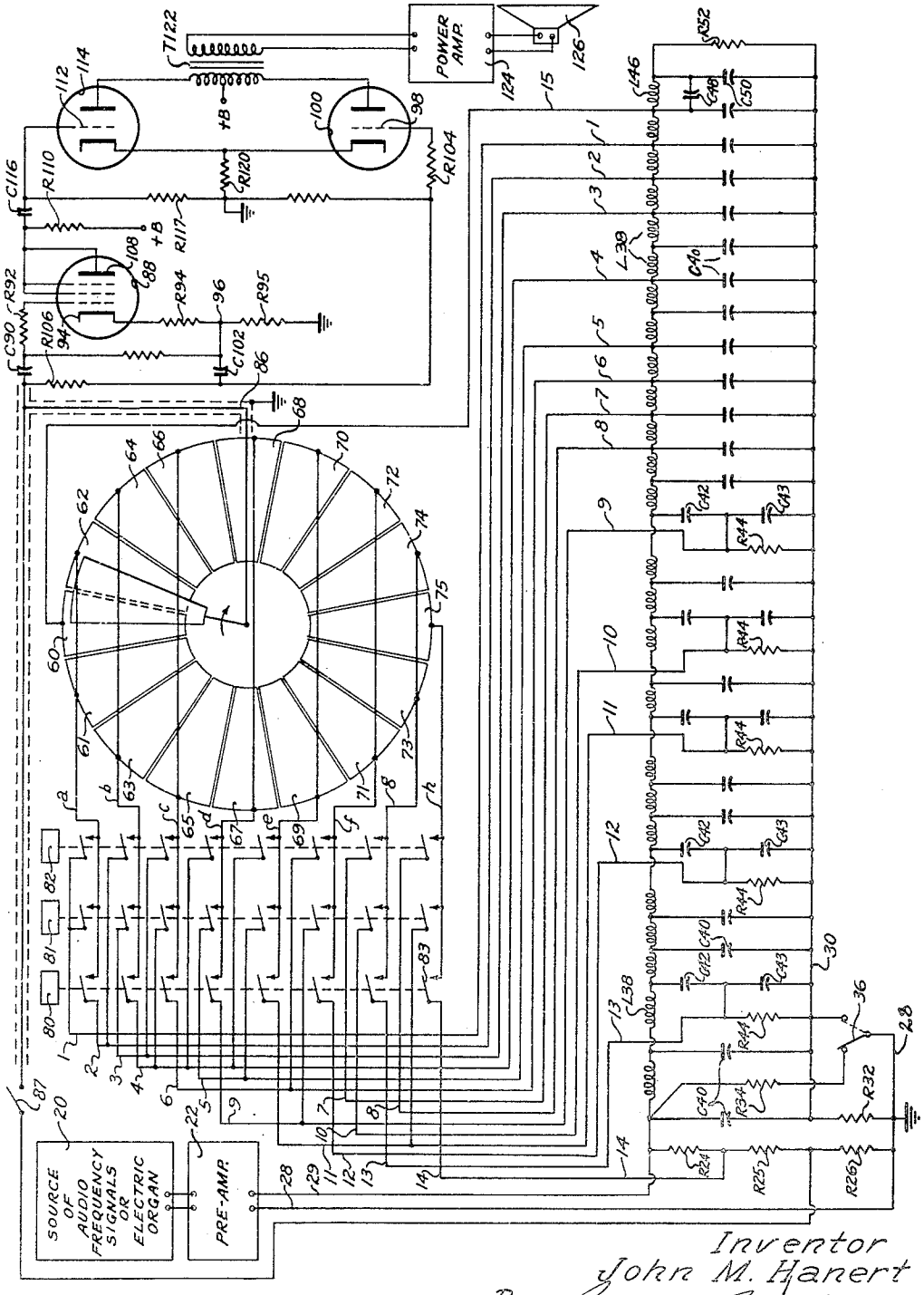
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ELECTRICAL MUSICAL APPARATUS

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ELECTRICAL MUSICAL APPARATUS

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My invention relates generally to electrical musical apparatus and more particularly to means for selectively introducing vibrato and chorus effects into electrical musical tone signals.

As more fully set forth in my prior Patent 2,382,413, a very desirable vibrato effect may be introduced into an electrical musical tone signal by transmitting the signal through an artificial line and effectively scanning the artificial line by a suitable pickup which operates to pick up the signal from spaced sections of the artificial line, in effect, in an oscillatory manner.

The effect produced is that of a true pitch vibrato in which the signal frequency is continuously being shifted either sharp or flat with respect to the original steady input signal. This vibrato effect is musically characterized as being expressive of emotion and excitement. For music of a theatrical and orchestral nature the vibrato has proved its worth, as is shown by the universal acceptance of instruments such as the violin which are nearly always played in a manner to produce a vibrato of sustantial width.

However, there are other musical instruments, particularly the organ, in which the vibrato effect may be out of character when playing certain types of music, such as ecclesiastical or church music. The effect desired under these latter circumstances is not one of wavering pitch, but is rather one of a chorus of relative stable frequencies such as the chorus effect produced by a choir of voices or organ pipes. This latter musical effect, while productive of a warmth of tone, is nevertheless of a more steady character and the listener does not perceive any particular variation in pitch, but instead, perceives the pleasant effect of several closely related frequencies sounding to make a chorus or "celeste" tone, as the effect is frequently termed in naming pipe organ stops. This chorus effect, as differentiated from the vibrato effect, can be produced by providing a plurality of sources, such as two or three alternating current generators of slightly different pitch, or by the use of several mechanical generators, such as organ pipes or reeds of slightly differing pitch. However, it is obvious that the production of the chorus effect by this means is very costly since it involves duplication or triplication of the entire generating apparatus to produce this one effect.

In the apparatus of this invention a chorus tonality is produced by the novel means and method of generating a relatively large series of side band vibrato frequencies (by which the tone is given the effect of a wavering pitch or vibrato)

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in combination with the original steady frequency. The inclusion of the original steady frequency along with the vibrato side band frequencies has the effect of removing the apparent shift in frequency which the vibrato alone produces, and the resulting effect, that of a chorus between the vibrato side band frequencies and the original frequency, is achieved. The width of the chorus thus produced is dependent upon the width of the vibrato. If the vibrato effect is wide, that is, the frequency is being modulated sharp and flat to a relatively great extent, the resulting vibrato when mixed with the unmodulated original steady frequency will simulate the effect of a chorus of tones in which the individual pitches are relatively widely separated, whereas when the vibrato deviation pitch factor is small, the chorus effect will also be small, and will correspond to a plurality of sources whose pitches are in a relatively narrow band. The inclusion of the unmodulated original signal is also very effective to mask the perception by the listener of the modulating periodicity of the vibrato effect, which usually is in the order of 5 to 7 C. P. S.

It is thus the primary object of this invention to produce a chorus effect in which but a single primary generator is employed together with a vibrato producing system, and apparatus for combining the two signals in approximately equal proportions.

A further object is to provide an improved method and apparatus capable of introducing a chorus effect in a musical signal derived from any source and in which such effect is initially absent.

Other objects will appear in the following description, reference being had to the accompanying drawing which constitutes a schematic diagram of a representative instrument.

As previously stated, the apparatus may be used selectively to introduce a combined chorus and vibrato effect or to introduce either of these effects in musical tone signals derived from any source, such as an organ, represented by the block **20** in the drawing. The signals produced by the source **20** are amplified in a preamplifier **22** and the amplified signal impressed across a voltage dividing network, comprising resistors **R24**, **R25** and **R26**, by conductors **28** and **29**. The conductor **28** is illustrated as being connected to ground and is connected to a conductor **30** by a resistor **R32**. The conductor **28** may be connected to the conductor **29** through a compensating resistor **R34** upon moving a switch **36** to its full line position. The switch **36**, when moved to its dotted line position, shunts resistor **R32** by

connecting conductor 28 directly to conductor 30 and also disconnects the compensating resistor R34.

A multi-section artificial line, comprising a plurality of series inductances L38 and shunt capacitors C40, has the signal supplied by the preamplifier 22 impressed across its input terminals. A plurality of conductors 1 to 15 are connected to spaced points along the artificial line. It will be noted that conductors 9 to 14 inclusive are connected between a pair of series voltage dividing capacitors C42 and C43 and are also connected to the conductor 30 through resistors R44 to prevent the accumulation of static charges on these conductors.

The termination of the artificial line comprises a series inductance L46 in parallel with a capacitor C48, these elements being connected to the conductor 30 through a termination capacitor C50 having a terminating resistance R52 in parallel therewith.

As more fully disclosed in my Patent No. 2,382,413, there is provided a plurality of fixed circumferentially spaced capacitor segments 60 to 75 inclusive. A pickup or scanning capacitor plate 78 is rotated at a speed in the order of 5 to 7 R. P. S. so as successively to be in capacitative pickup relation with the various segments 60 to 75.

The segment 60 is connected to conductor 15, the segments 61 and 62 to a conductor *a*, segments 63 and 64 to conductor *b*, 65 and 66 to *c*, 67 and 68 to *d*, 69 and 70 to *e*, 71 and 72 to *f*, 73 and 74 to *g*, while segment 75 has a conductor *h* connected thereto.

There are three manually operable multiple switches provided to connect conductors *a* to *h* to conductors 1 to 14 in predetermined combinations. These switches are illustrated as being manually operable by push buttons 80, 81 and 82 respectively to cause the apparatus to produce a "wide," a "medium" or a "narrow" vibrato effect. Each of the push buttons 80 to 82 upon operation closes a series of eight single pole single throw switches 83. It will be noted that operation of the push button 80 connects conductors 2, 4, 6, 9, 11, 12, 13 and 14 to conductors *a* to *h* respectively. Depression of the push button 81 connects conductors 1, 3, 4, 5, 8, 9, 10 and 11 to conductors *a* to *h* respectively, and depression of the push button 82 connects conductors 1 to 8 to conductors *a* to *h* respectively.

The signal pickup plate 78 has a shielded conductor 86 connected thereto, which, upon closure of a manually operable switch 87, is connected with the junction between resistors R25 and R26 of the voltage divider. Conductor 86 is also connected to the input of a pentode 88 which operates as a triode, the input circuit including a blocking capacitor C90, and a radio frequency eliminating resistance R92. The cathode 94 of this tube is connected to ground through self-bias resistor R94 and a load resistor R95. The junction 96 between these resistors is connected to the grid 98 of a triode 100 through a blocking capacitor C102 and a series grid resistor R104. A static charge preventing resistor R106 is connected between the conductor 86 and resistor R104. The plate 108 of pentode 88 is connected to a suitable source of plate potential, indicated as +B, through a load resistor R110, and is connected to the grid 112 of a triode 114 through a blocking capacitor C116. The grids 98 and 112 are connected to ground through resistors R117 and R118. The cathodes of the triodes 100 and 114 are connected to ground through a common self-biasing resistor R120. The plates of triodes 100 and 114 are respectively connected to the terminals of the primary winding of a transformer T122, the center tap of which is connected to a suitable source of plate current, indicated as a terminal +B. The secondary of the transformer T122 is connected to a power amplifier 124, and the output of the latter is supplied to a speaker 126.

When it is desired to introduce a wide vibrato effect into the music being rendered, without any chorus effect, the switch 80 is placed in its dotted line position and push button 80 is operated to close its switches 83, thereby connecting the conductors 2, 4, 6, 8, 11, 12, 13 and 14 to conductors *a* to *h* respectively. It will therefore be noted that as the pickup plate 78 rotates, it will successively pick up the signal commencing at one end of the artificial line, traversing the line in steps of 2, 3, 3, 4, 4, 3, 3, 2 sections of the artificial line and then retraversing the line in the reverse direction. At high frequencies the amount of phase shift between adjacent scanning positions is considerably in excess of 180° and therefore a multiple rate tremulant, or amplitude modulation effect, is produced at these very high frequencies. The periodicity of this tremulant effect is masked by making the degree of phase shift between scanning positions of unequal extent.

When it it desired to introduce the vibrato effect into the music being rendered, the switch 87 is opened, whereas when no vibrato effect whatsoever is desired this switch is closed. Under the latter conditions the signal appearing across the resistor R26 is impressed on the grid of pentode 88. Since the impedance of this circuit is low compared to that which includes the capacitor plates 60 to 75 and scanner plate 78, the signal picked up by the scanner plate 78 is comparatively negligible. In effect, the output of the preamplifier 22, as reduced in amplitude by the voltage dividers R24, R25, R26, is impressed directly upon the input of the pentode 88.

When it is desired to produce a wide vibrato effect the switch 87 is opened and the switch 36 moved to its dotted line position. Under these circumstances the resistor R32 is shunted out of the circuit and the output signal of the preamplifier 22 is connected directly to the input end of the artificial line. The apparatus thus operates in the manner of the apparatus disclosed in my aforesaid Patent No. 2,382,413 and a wide vibrato effect is obtained when the push button 80 is depressed, since the latter connects the conductors 2, 4, 6, 9, 11, 12, 13 and 14 to the conductors *a* to *h* respectively. Thus the scanner plate 78 picks up the signal from the full length of the artificial line, first in one direction and then returning in an effectively oscillator manner at the scanning periodicity of 5 to 7 C. P. S.

When a wide vibrato chorus effect is to be obtained, the switch 87 is left open, push button 80 depressed and the switch 36 moved to its full line position. Under these circumstances the vibrato effect is produced in the same manner as described in the preceding paragraph except that the resistor R32 is no longer shunted out of the circuit, but instead, is connected between conductors 28 and 30. For the signal developed across the resistor R32 the capacitors C40, C42 and C43, C50 and the terminating resistors R52,

all in parallel, constitute a negligible impedance. Thus the output signal of the preamplifier 22 which appears across the resistor R32 will also appear between the grounded conductor 28 and the conductors 1 to 15 inclusive and thus will appear upon the segmental capacitor plates 60 to 75 without substantial phase alteration, and will be picked up by the scanner plate 78 and impressed upon the input of pentode 88. The value of resistor R32 is such as to produce an unmodulated signal of substantially the same amplitude as the modulated vibrato signal which is also supplied to the input of pentode 88. The effect produced is that of the steady frequency signal plus a large number of side band frequencies, due to the vibrato signal, and this may best be characterized as a chorus effect since the listener perceives it as tones produced by a large number of instruments playing in chorus. The steady frequency component of the output signal masks the slightly wavering effect of the vibrato signal. The combined signal is thus perceived as a pure chorus effect.

When a medium width vibrato is desired the push button 80 is released and the push button 81 depressed. With the switch 87 open, the switch 36 in its dotted line position, the operation of the apparatus will be similar to that previously described for the wide vibrato except that it will be noted that conductors 1, 3, 4, 5, 8, 9, 10 and 11 will be respectively connected to conductors *a* to *h*, and that thus only a portion of the artificial line will be scanned. When a medium chorus effect is desired the switch 36 is shifted to its full line position and the operation of the apparatus will be similar to that above described with reference to the wide chorus effect, except that, due to the fact that only a portion of the artificial line is scanned, the number of side band frequencies due to the vibrato component of the signal will be reduced.

In a similar manner when only the push button 82 is depressed the conductors 1 to 8 will be connected to conductors *a* to *h* respectively, and a still smaller portion of the artificial line will be scanned. The number of side band frequencies introduced by the vibrato component of the signal will be still fewer, with the result that either a very narrow vibrato effect or a very narrow chorus effect may be produced, depending upon the position of the switch 36.

From the foregoing it will appear that by the addition of very simple circuits and controls the apparatus shown in my aforesaid Patent No. 2,382,413 is made capable of producing various degrees of chorus effects which could otherwise be obtained only by the use of multiple generating systems. For example, to obtain an effect corresponding to the wide chorus effect, without the utilization of the present invention, would require the addition of 10 or 12 complete generating systems (one generator for each note within the gamut of the instrument) while to produce an effect equivalent to the medium chorus effect it would be necessary to add about six generating systems, while to produce the narrow chorus effect it would be necessary to provide at least two additional generating systems.

The invention therefore provides an extremely simple solution for the problem of producing various degrees of chorus effect without requiring any alteration or additions to the generating system. Since the chorus effect producing apparatus is independent of the character of the tone signal generating system, it will be clear that the apparatus may be used with benefit, irrespective of the source of the musical signal supplied to the preamplifier 22. The apparatus may thus be used with any musical instrument in which the output appears as an electrical signal, such as instruments of the electric organ class, electrical instruments of the melody type, as well as any other electrical musical signal sources. It might be pointed out that among the latter the signal source might be a microphone picking up the sounds produced by mechanical musical instruments which do not produce the vibrato effect. For example, the sounds produced by a piano or trombone might be picked up by a microphone and supplied to the preamplifier 22. The result would be that the output of the speaker 26 might be made to simulate a chorus of pianos or trombones.

While I have shown and described a particular embodiment of my invention, it will be apparent to those skilled in the art that numerous modifications and variations may be made in the form and construction thereof, without departing from the more fundamental principles of the invention. I therefore desire, by the following claims, to include within the scope of my invention all such similar and modified forms of the apparatus disclosed, by which substantially the results of the invention may be obtained by substantially the same or equivalent means.

I claim:

In an electrical musical apparatus for introducing chorus effect into an electrical musical signal derived from a source incapable of producing an appreciable vibrato effect, the combination of an artificial line having its input coupled to the source, the artificial line having a plurality of terminals distributed along its length, scanning means for picking up the signal appearing at said terminals in an effectively oscillatory manner at a vibrato periodicity, means for selectively combining with the signal picked up by the scanning means a signal of substantially equal amplitude derived directly from the source, said last-named means comprising a two-position switch and an impedance mesh to cause the output signal to be of substantially the same amplitude when the signal from the source is combined with the signal from the scanning means as when only the signal from the scanning means is utilized, and means for amplifying the output signal and translating it into sound, thereby to produce a chorus effect when the switch is in one position and a vibrato effect when the switch is in the other position.

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