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VIBRATO SYSTEM FOR ELECTRONIC MUSICAL INSTRUMENTS

Filed Nov. 9, 1964

2 Sheets-Sheet 1

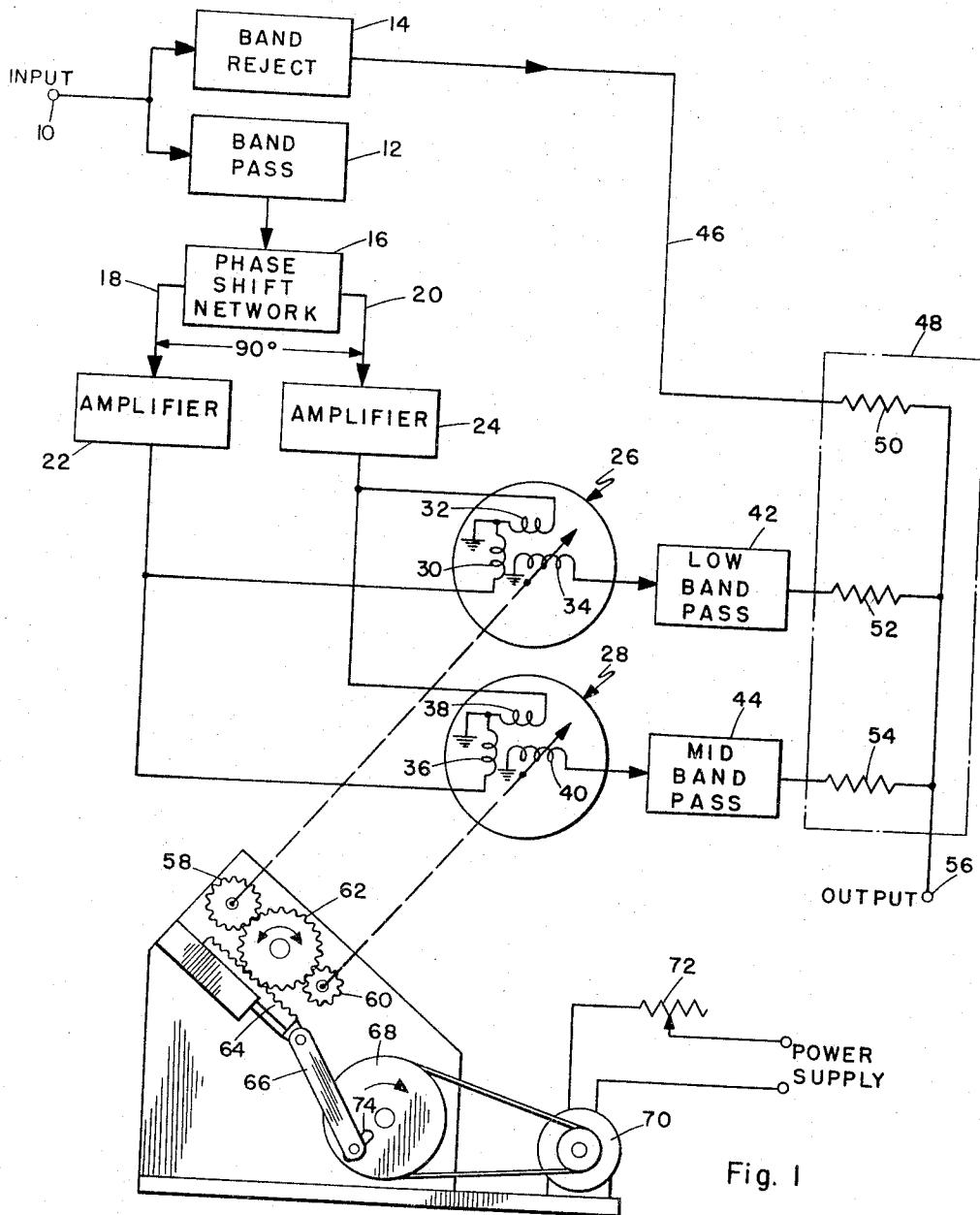


Fig. 1

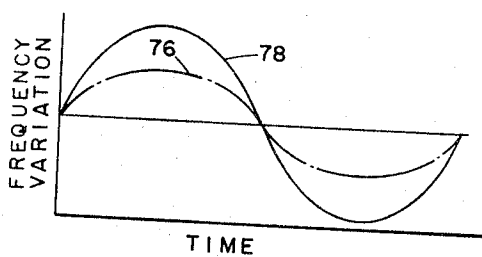


Fig. 2

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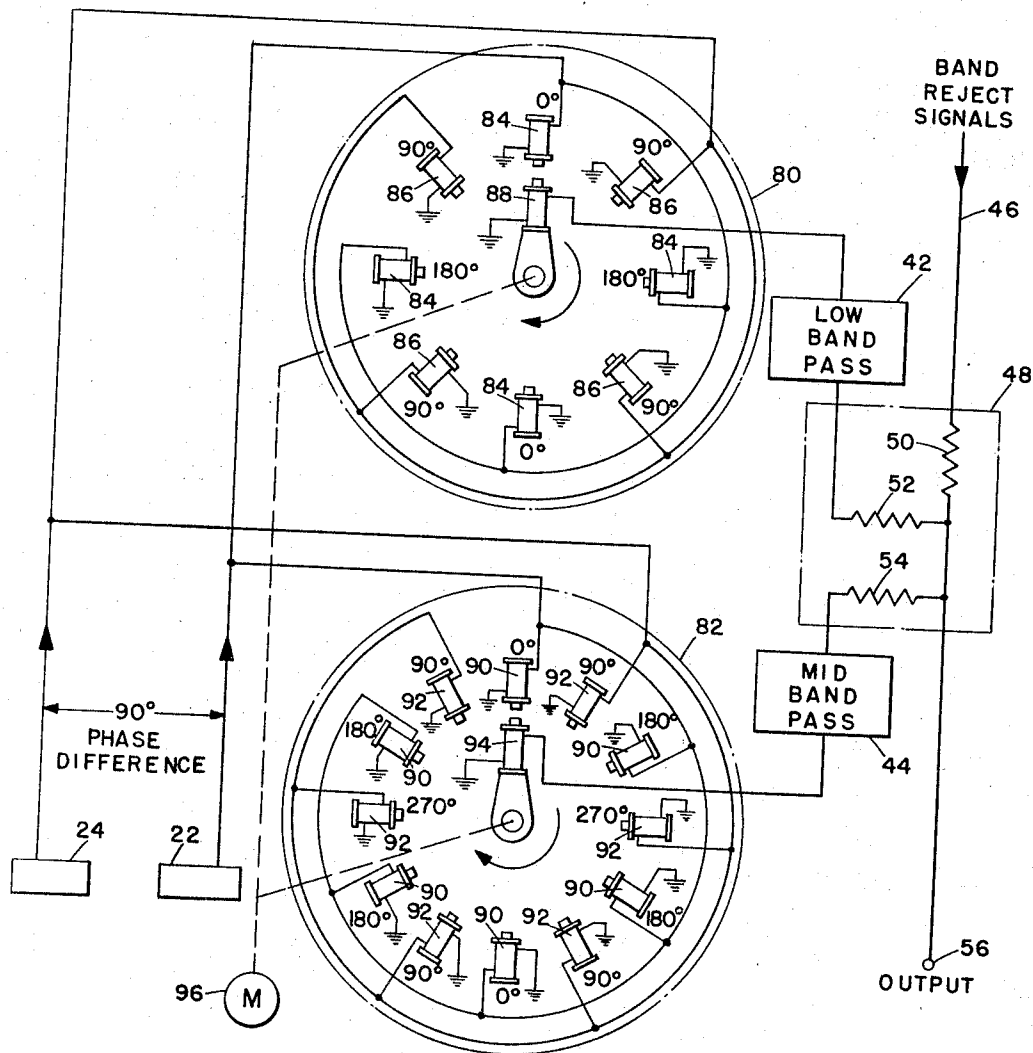


Fig. 3

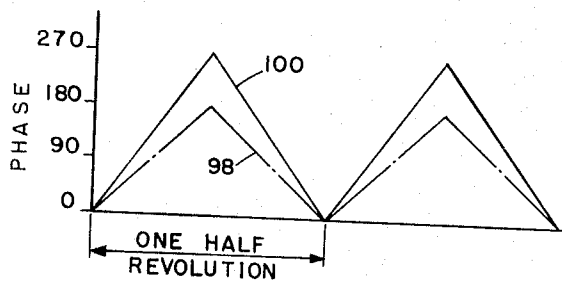


Fig. 4

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1

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VIBRATO SYSTEM FOR ELECTRONIC MUSICAL INSTRUMENTS

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The present invention relates to electro-mechanical devices and more specifically to a vibrato system for electronic musical instruments.

Various means have been developed for applying a vibrato effect to musical instruments in which music is produced electronically, or from an electro-acoustical pickup, and is then amplified for reproduction by loudspeakers. In electronic organs, one system uses an assembly of speakers which are rotated, so that the sound is continuously variable as the speakers approach and recede from the listener. This system is cumbersome and has undesirable secondary effects caused by varying echoes from surrounding walls and other surfaces. Other systems are electronic in nature and are usually incorporated into the tone generator circuits. One system uses a carrier oscillator system with a local oscillator that is frequency modulated, but it requires an expensive series of crystal filters and oscillators and provides a single vibrato depth for all frequencies. However tones in the lower register require a lesser degree of vibrato than higher frequency tones and a single rate of vibrato is not satisfactory over a wide frequency range.

The primary object of this invention is to provide a vibrato system employing an electromagnetic output element rotatably driven in a phase quadrature electromagnetic field composed of the musical signal.

Another object of this invention is to provide a vibrato system which can be built into a compact self-contained unit for connection between an electronic musical instrument and its output amplifier.

Another object of this invention is to provide a vibrato system in which the frequency range is divided and each division is given a different vibrato effect suited to its particular band of frequencies.

A further object of this invention is to provide a vibrato system which is adjustable in effect and is adaptable to a wide range of instruments.

In the drawings:

FIGURE 1 is a diagram of the vibrato system;

FIGURE 2 is a graph of the frequency variation obtained;

FIGURE 3 is a diagram of alternative frequency variation means; and

FIGURE 4 is a graph showing the phase modulation produced by the alternative frequency variation means.

Similar characters of reference indicate similar or identical elements and portions throughout the specification and throughout the views of the drawing.

Vibrato system and operation

As illustrated in FIGURE 1, the system has an input 10, for connection to an electronic musical instrument, from which input the incoming signal is fed to a band pass circuit 12 and a band reject circuit 14. It is unnecessary and, in fact, objectionable to apply vibrato to the extreme low register and vibrato is ineffective with very high tones. These very low and very high tones are thus bypassed through the band reject circuit 14, while the range of frequencies of interest pass through the band pass circuit 12 to a wide band phase shift network 16. The phase shift network has two outputs 18 and 20 which provide similar signals of the selected band of input, but separated in phase by 90 degrees, or in what

2

is commonly known as phase quadrature relation. Outputs 18 and 20 are connected to suitable amplifiers 22 and 24 to obtain sufficient signal strength to operate the vibrato portion of the circuit. The band pass, band reject, phase shift and amplifier circuits are all well known in many different forms and need not be described in detail.

Vibrato is provided by a pair of frequency varying or vibrato units 26 and 28, one for the low range of frequencies, say from 50 to 150 cycles per second, and the other for the middle frequencies, say from 150 to 1500 cycles per second. It should be understood that these frequency ranges are merely exemplary and may vary somewhat depending on the particular instrument.

Vibrato unit 26 has quadrature phased stator windings 30 and 32 with a common ground, winding 30 being connected to amplifier 22 and winding 32 to amplifier 24, so that the stator windings are energized by phase quadrature signals, which results in a rotating electromagnetic field. This is the configuration used in a special type of variable phase transformer commonly known as a resolver, the output being obtained from a rotary pick-off winding 34 which can rotate within the field of the stator windings. Vibrato unit 28 is similar, having stator windings 36 and 38 connected to amplifiers 22 and 24, respectively, and a pick-off winding 40. Resolvers of various sizes and power ratings suitable for the vibrato units are readily available.

Pick-off winding 34 is connected to a low band pass circuit 42 which will pass only the low range of frequencies in the signals. The other pick-off winding 40 is connected to a mid-range band pass circuit 44 which passes only the middle range of frequencies in the signals. The signals in the bypass circuit 46 from band reject circuit 14, together with the outputs from band pass circuits 42 and 44, are fed into a mixer 48, illustrated as containing resistors 50, 52 and 54 for the respective signal inputs, so that the signals can be balanced by suitable resistance values to provide a composite signal to the final output 56.

Pick-off winding 34 is rotated by a large drive gear 58 and pick-off winding 40 is rotated by a small drive gear 60, both drive gears being driven by a pinion 62 secured, so that by radial adjustment of the connecting coupled by a connecting rod 66 to a crank disc 68, which is rotatably driven by a motor 70 connected to a suitable power supply through a speed control 72. Crank disc 68 has a radial slot 74 in which connecting rod 66 is secured, so that by radial adjustment of the connecting rod, the throw of rack 64 can be changed. The drive mechanism is exemplary and other means may be used to provide the necessary motion of the pick-off elements.

Operation of motor 70 causes oscillatory rotation of gears 58 and 60, the gear 58 having less rotation than gear 60 due to its larger size. Pick-off winding 34 thus rotates more slowly than pick-off winding 40.

Each pick-off winding rotates in the rotating phase quadrature field of its respective stator windings, first in one direction then in the reverse direction, or first with the rotation of the stator field then against the rotation. When the pick-off winding rotates in the same direction as the stator field, the frequency induced in the pick-off winding will be decreased by the electrical Doppler effect. Similarly, when the pick-off winding rotates against the stator field, the frequency will be increased. The alternating decreases and increases of frequency in the pick-off winding produce the vibrato effect. Since the pick-off winding 34 is driven to a lesser degree than pick-off winding 40, the frequency variation 76 of vibrato unit 26 will be less than the frequency variation 78 of vibrato unit 28, as indicated in graphical form in

FIGURE 2. By this means the middle range of frequencies is subjected to a more pronounced vibrato effect than the low range, to provide the desirable balance over the entire selected range. The pulsation rate of the vibrato can be varied by means of the motor speed control 72, while the degree of vibrato or frequency change is controlled by the radial position of connecting rod 66 on crank disc 68.

Alternative vibrato units

The system illustrated in FIGURE 3 is similar to that described above except for the vibrato units themselves. In this system the vibrato units 80 and 82 are designed for continuous rotation rather than oscillatory action. Vibrato unit 80 has a plurality of stator elements illustrated as individual electromagnets, one group of stator elements 84 being connected to amplifier 22 output and the other group of stator elements 86 being coupled to amplifier 24 output. The phase quadrature signals thus generate rotating fields in the stator assembly. In addition, the stator elements of each group are connectively alternated in polarity, so that the phases of the elements are successively 0, 90, 180, 90 and 0 degrees. The vibrato unit 80 is illustrated with a total of eight stator elements which, with this particular phase relationship, provide two complete phase cycles for each revolution, but could be constructed with four stator elements to give a single cycle for each revolution. The pick-off element 88 is a further electromagnet which is connected to the low band pass circuit 42.

Vibrato unit 82 similarly has two groups of stator elements 90 and 92 connected to the respective amplifiers 22 and 24, with the elements of one group alternating with those of the other group. However, the phase shift is carried to a maximum of 270 degrees by additional stator elements, the arrangement illustrated having a total of twelve stator elements for two complete cycles in each revolution. Pick-off element 94 of vibrato unit 82 is connected to the mid band pass circuit 44. A suitable motor 96 is used to rotate both pick-off elements 88 and 94 at the same speed in a constant direction.

Since the stator field is alternately advanced and retarded in phase relation, as the fields of the stator elements are successively sampled by the rotating pick-off element, a fluctuating frequency variation will be induced in the pick-off element to produce the vibrato effect. The resultant periodic phase modulation is comparable to that of the oscillatory resolver type vibrato unit. The greater phase variation in the vibrato unit 82 will cause a correspondingly greater frequency variation compared to that of the vibrato unit 80. The comparative phase variations 98 and 100 for the vibrato units 80 and 82, respectively, are indicated in FIGURE 4, which also illustrates the phase relationships in one-half revolution of the pick-off elements.

By varying the numbers of stator elements in the two vibrato units the relative frequency changes can be varied and vibrato rate is controlled by the speed of motor 96.

The division of the signal into two bands of frequencies with individual vibrato treatment is satisfactory for most instruments. For very high quality of reproduction, additional bands of frequencies with added vibrato units of compatible effect can be used, with individual drive and speed control means. Or for instruments having a limited frequency range, it may not be necessary to divide the band of frequencies and a single vibrato unit would suffice.

The various band pass circuits and amplifiers can be very simple and, if they utilize solid state components, will be very compact and require little power to operate, while the motor for driving the pick-off elements can be very small, so that the entire system can be contained in a self-contained unit of a few cubic inches. The unit is simply connected between the electrical output of the

musical instrument and its usual amplifier, with a further connection to a suitable source of power. An on/off switch, not shown, can be provided at any convenient location for selective use of vibrato.

It is understood that minor variation from the form of the invention disclosed herein may be made without departure from the spirit and scope of the invention, and that the specification and drawings are to be considered as merely illustrative rather than limiting.

I claim:

1. A vibrato system for electronic musical instruments, comprising:
 - an input for connection to an electronic musical instrument;
 - phase shifting means connected to said input and having a pair of outputs providing similar signals separated in phase;
 - frequency changing means including at least one pair of fixed electromagnetic field elements connected each to one of said outputs, and a movable electromagnetic field element;
 - drive means coupled to said movable element to move the same cyclically in relation to said fixed elements; and an output connected to said movable element.
2. A vibrato system according to claim 1 wherein the outputs of said phase shifting means are in phase quadrature relation.
3. A vibrato system for electronic musical instruments, comprising:
 - an input for connection to an electronic musical instrument;
 - phase shifting means connected to said input and having a pair of outputs providing similar signals in phase quadrature relation;
 - a pair of vibrato units each having at least one pair of electromagnetic stator elements connected each to one of said outputs, and a movable electromagnetic pick-off element;
 - drive means coupled to said pick-off elements to move the same cyclically at different rates relative to said stator elements;
 - a pair of band pass units of different frequency ranges connected each to one of said pick-off units;
 - and a mixer connected to said band pass units to combine the signals therefrom and having an output providing a composite vibrato signal.
4. A vibrato system for electronic musical instruments, comprising:
 - an input for connection to an electronic musical instrument;
 - phase shifting means connected to said input and having a pair of outputs providing similar signals in phase quadrature relation;
 - a pair of vibrato units each having at least one pair of electromagnetic stator elements connected each to one of said outputs, and a movable electromagnetic pick-off element;
 - drive means coupled to said pick-off elements to move the same cyclically at different rates relative to said stator elements;
 - a pair of band pass units of different frequency ranges connected each to one of said pick-off units;
 - a mixer connected to said band pass units to combine the signals therefrom and having an output providing a composite vibrato signal;
 - band pass means connected between said input and said phase shifting means to pass a selected band of frequencies;
 - and a bypass circuit connected between said input and said mixer to bypass the non-selected signals around said vibrato units.
5. A vibrato system for electronic musical instruments, comprising:
 - an input for connection to an electronic musical instrument;

5

phase shifting means connected to said input and having a pair of outputs providing similar signals in phase quadrature relation;

a pair of vibrato units each having at least one pair of electromagnetic stator elements connected each to one of said outputs, and a movable electromagnetic pick-off element;

drive means coupled to said pick-off elements to drive the same cyclically at different rates with an oscillatory motion relative to said stator elements;

a pair of band pass units of different frequency ranges connected each to one of said pick-off units;

and a mixer connected to said band pass units to combine the signals therefrom and having an output providing a composite vibrato signal.

6. A vibrato system for electronic musical instruments, comprising:

an input for connection to an electronic musical instrument;

phase shifting means connected to said input and having a pair of outputs providing similar signals in phase quadrature relation;

a pair of vibrato units each having a plurality of pairs of electromagnetic stator elements connected each to one of said outputs, said stator elements being successfully phased in increments from zero to a predetermined phase shift and back to zero;

each of said vibrato units having a movable electromagnetic pick-off element;

drive means coupled to said pick-off elements to move the same at different rates with a continuous rotary motion relative to the stator elements;

6

a pair of band pass units of different frequency ranges connected each to one of said pick-off units;

and a mixer connected to said band pass units to combine the signals therefrom and having an output providing a composite vibrato signal.

7. A vibrato system for electronic musical instruments, comprising:

an input for connection to an electronic musical instrument;

a band pass circuit connected to said input to pass a selected band of frequencies from an input signal;

phase shifting means connected to said band pass circuit and having a pair of outputs providing similar signals in phase quadrature relation;

a vibrato unit having at least one pair of electromagnetic stator elements connected each to one of said outputs, and a movable electromagnetic pick-off element;

drive means coupled to said pick-off element to rotate the same relative to said stator elements;

an output connected to said pick-off element;

and a bypass circuit connected between said input and said last mentioned output to bypass non-selected frequencies of an input signal around said vibrato unit.

No references cited.

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