

March 8, 1949.

J. T. KUNZ

2,463,543

STRIKER MECHANISM FOR MUSICAL INSTRUMENTS

Filed Jan. 15, 1946

3 Sheets-Sheet 1

Fig. 1.

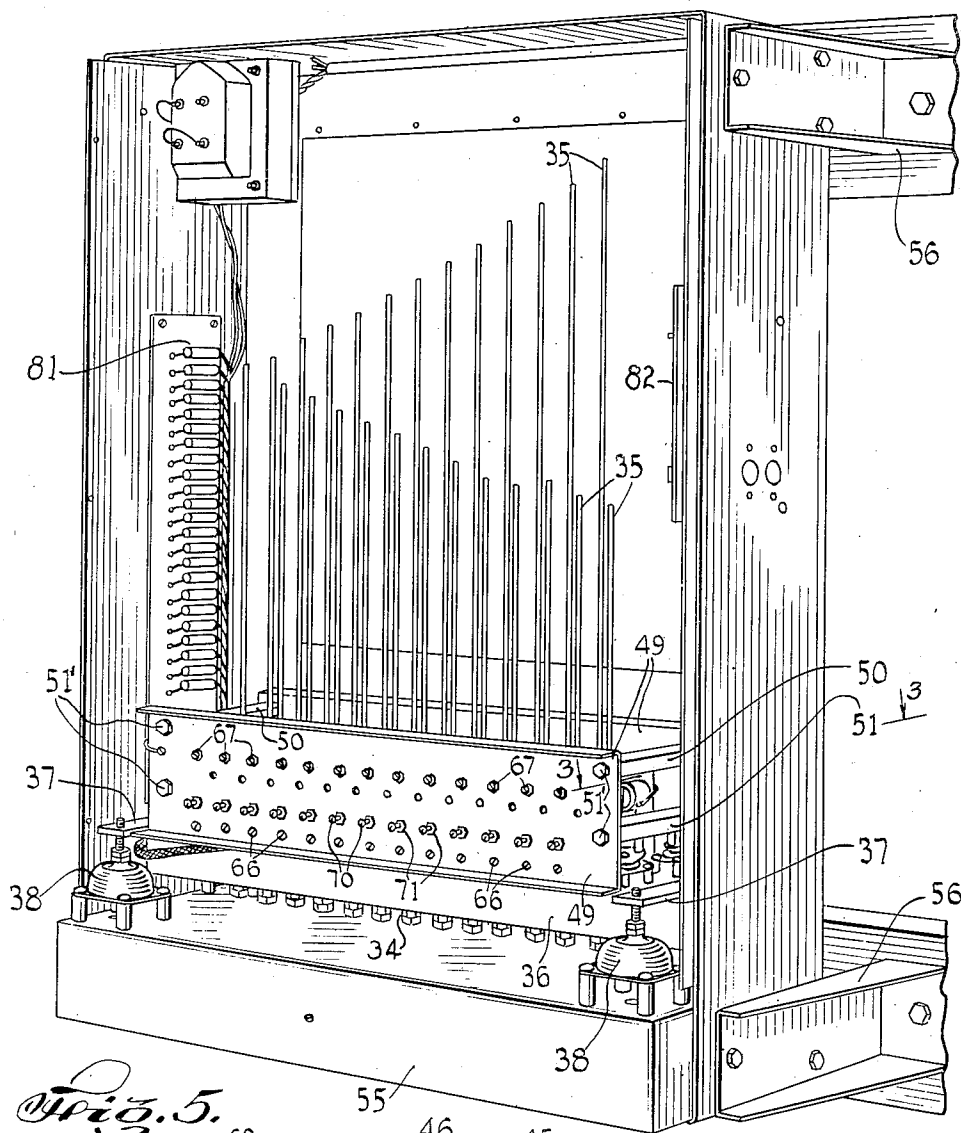


Fig. 5.

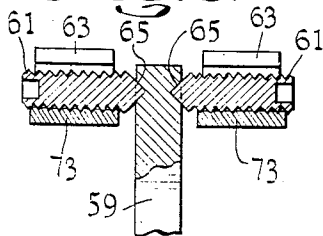
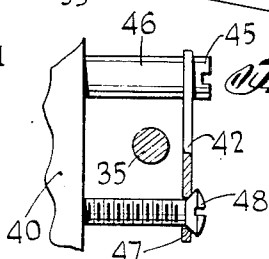


Fig. 6.



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3 Sheets-Sheet 2

Fig. 2.

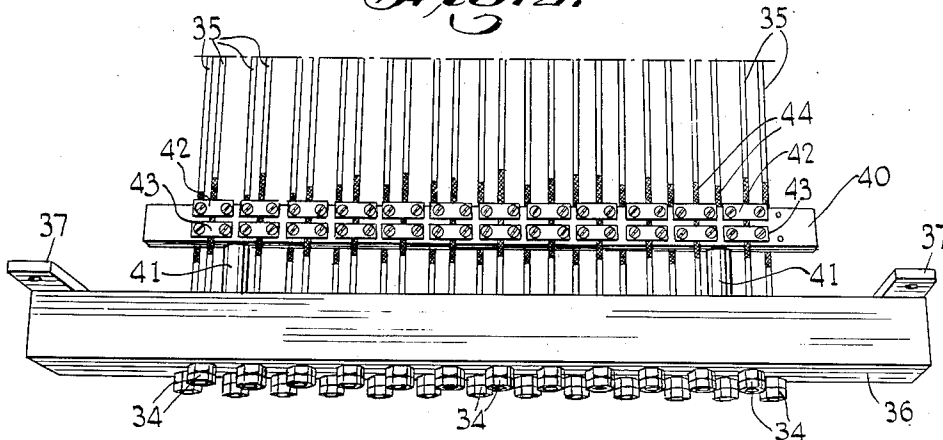


Fig. 7.

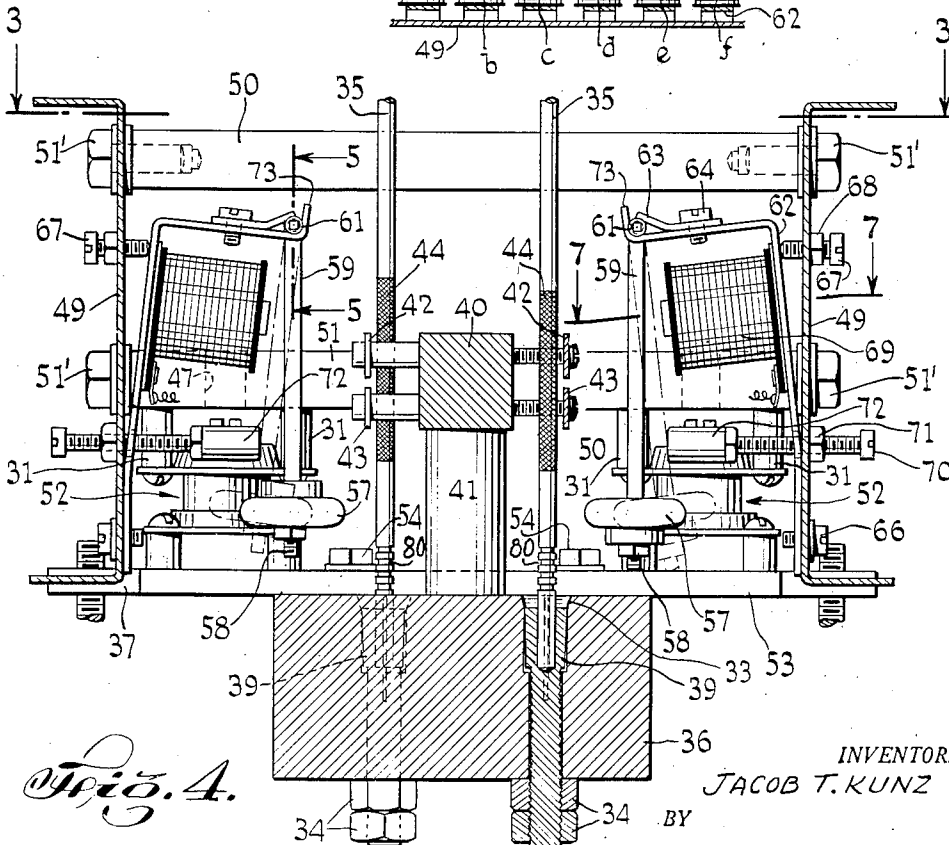
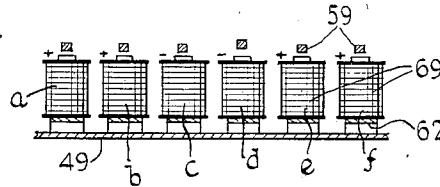


Fig. 4.

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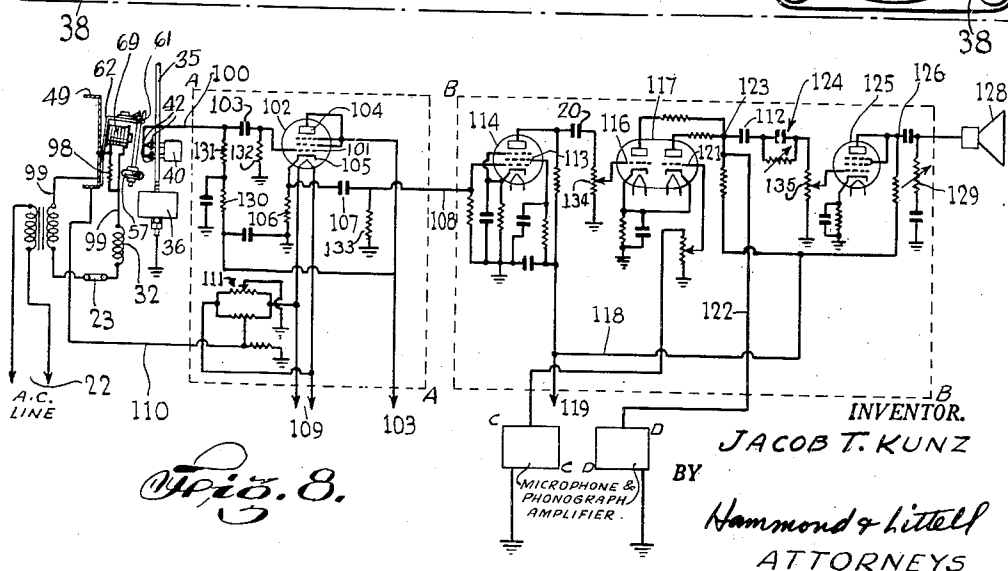
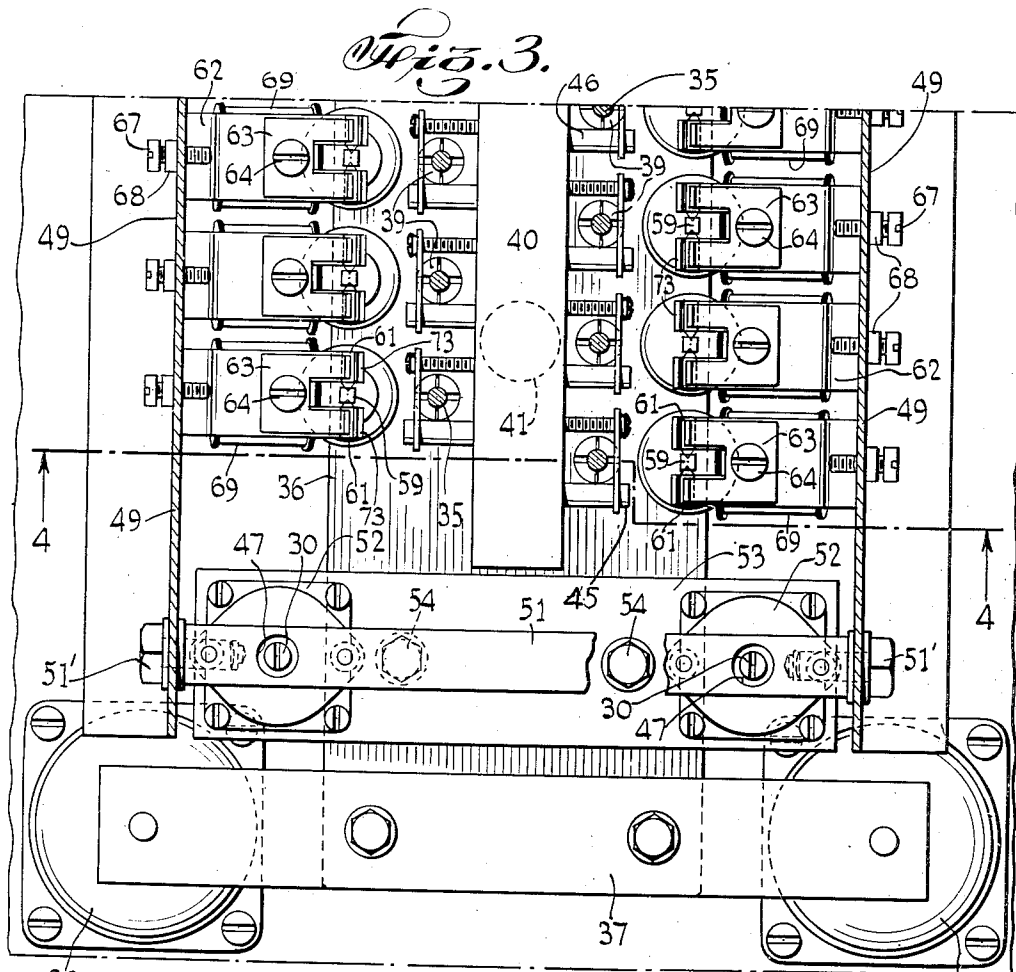
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STRIKER MECHANISM FOR MUSICAL INSTRUMENTS

Filed Jan. 15, 1946

3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,463,543

STRIKER MECHANISM FOR MUSICAL INSTRUMENTS

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Application January 15, 1946, Serial No. 641,243

14 Claims. (Cl. 84-405)

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This invention relates to a musical instrument and particularly to an instrument having a plurality of vibrators or rods which may be set in motion to produce musical tones such as in an instrument commonly referred to as an electric carillon. In such an instrument the vibrations of the tuned reeds are amplified electrically to faithfully reproduce the tones of bells or chimes. This application is especially concerned with the striking mechanism for such an instrument.

Among the advantages of an electric carillon, as compared with conventional cast bells, can be included the large saving in weight, elimination of effect due to climatic changes, volume and radiation control, and ease of playing. As an example, an electric carillon of twenty-five bells or notes weighs about 200 pounds whereas conventional cast bells weigh as much as 50,000 pounds.

In an instrument for translating the musical vibrations of a rod or the like to electrical vibrations, amplifying the vibrations, and then changing the electrical vibrations to sound vibrations with high amplification, it is necessary to carefully arrange and select the parts so as to produce the desired sound without distortion.

One of the objects of the present invention is to provide an instrument having rods properly tuned and which are struck in such a manner as to produce bell or chime tones correctly without distortion in a loudspeaker and without an objectionable clang when first struck. In previous devices, the relationship between the fundamental note and the harmonic pattern of the various rods varied with each rod so that the instruments did not produce the music of perfect bells. The rods contemplated herein are each tuned to a certain predetermined tone and then means provided for producing an even harmonic pattern in each of said rods.

It has been found that a good bell is one in which the hum tone, the fundamental tone, a minor third, a fifth, and an octave above the fundamental appear in the bell note produced thereby. The fundamental tone of the bell is the most prominent tone at the instant of striking and is taken as the basis from which the other tones are measured, it being noted that the fundamental tone in a bell is not the lowest frequency present. The tone an octave below the fundamental is called the hum note or hum tone. The minor third and the fifth are between the fundamental and the octave above the fundamental. A good bell tone having the characteristics just mentioned can be generated upon striking a rod or similar element clamped at one end by tuning

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to the third tone thereof to the desired frequency and then treating the third tone as the fundamental of the desired bell note with the second tone of the rod as the hum tone of the bell bringing the other desired partials and tones of the bell into correct relationship, and substantially decreasing the first tone of the rod so that it can not be heard. The first tone of the rod can be filtered out by means of suitable frequency filtering means in the electric circuit.

The frequency characteristics of a rod clamped at one end does not give the desired even harmonic pattern just mentioned and one object of the present invention is to cause the rod to produce said desired even harmonic pattern. The specific method of tuning is described and claimed in co-pending application Serial No. 672,820, filed May 28, 1946.

Another of the objects of the present invention is to provide a striker arrangement for the vibratory elements which can be easily adjusted so as to give the correct blow thereto each time. The striker preferably is of the pivoted and freely swingable pendulum type, said striker being held normally in an energized position or so that it is angularly located relative to its normal vertical position. Upon release of the restraining means, the striker will freely swing and give the rod a blow which will be identical each time the striker is released. This is extremely important inasmuch as the slightest difference in the blow can be detected easily by a trained ear.

A further object of the invention is to prevent or eliminate interference by the striker restraining means with the freely swinging movement of released strikers because of the effect of magnetic fields thereon. Such interference would tend to prevent identical blows being given to the vibrators each time.

These and other objects of the invention will become apparent from the following description and drawings which are merely exemplary.

In the drawings:

Fig. 1 is a perspective view showing the front and one side of the rod and striker assembly frame or mechanism.

Fig. 2 is a perspective front view of the rods and their support.

Fig. 3 is a fragmentary plan view of the striker assembly taken along the line 3-3 of Fig. 1, in a plane substantially parallel to the base of the device, the upper carrier cross bar being omitted so as to better show the carrier mounting.

Fig. 4 is a cross-section view taken along the

line 4—4 of Fig. 3, the right-hand rod being shown in full.

Fig. 5 is an enlarged fragmentary vertical section along the line 5—5 of Fig. 4 showing details of a striker pivot.

Fig. 6 is an enlarged sectional view of the collector plate mountings, an upper collector plate being shown.

Fig. 7 is a fragmentary plan view of some of the magnets and a portion of the carrier, the view being taken approximately along the line 7—7 of Fig. 4, the magnets being shown in full.

Fig. 8 is a schematic showing of one of the circuit arrangements that can be used.

In the preferred form of the invention described herein, an instrument having twenty-five notes or two octaves is employed, but it is to be understood that an instrument with any number of notes or rods may be used.

In the schematic showing in Fig. 8, striker 57 normally is held in an energized position by magnet 69, said magnet normally being energized by a source of power 22 through normally closed switch 23, said switch being opened when a key of the console or keyboard is depressed, vibrator 35 being carried in a heavy rod support 36. Condenser plates or collectors 42 are mounted on collector plate supporting bar 40, said plates being connected by wire 100 with pre-amplifier A—A, rod 35 being connected to ground through support 36. Pre-amplifier A—A in turn is connected by wire 108 with amplifier B—B, said amplifier B—B being connected to loud speaker 128. The pre-amplifier is mounted adjacent to the reed and striker mechanism assembly as indicated at 92 in Fig. 1 so as to amplify the vibrations for proper transmission to an amplifier located at some point between the reed and striker mechanism and the loudspeaker 128. Inductance 32, resistance 98, and the capacitance of the relatively long leads 99 will suppress any disturbance in the striker release mechanism which might affect the amplifier circuit, resistance 92 being shunted across the magnet to reduce the reactance of the circuit to the radio frequencies generated by an opening of switch 23. The switch suppressing elements can be mounted on the frame as seen generally at 91 in Fig. 1. It is to be understood, of course, that various combinations and arrangements of the amplifier circuits and loudspeaker may be used.

When switch 23 is opened, magnet 69 will release striker 57, allowing the striker to swing on its pivot 61 and strike rod 35, the vibrations of rod 35 causing a variation in the electrical capacity between the collector plates 42 and rod 35, plate 42 and rod 35 being given a polarizing or operating potential in a manner hereafter described.

Rod 35 (Fig. 4) can be formed from brass rod or other suitable metal and should be as symmetrical and homogeneous as possible. As explained in detail in co-pending application, Serial No. 641,242, filed January 15, 1946, the tones produced in a rod clamped at one end are not those desired for an even harmonic pattern and means such as grooves 80 may be cut into the rods to allow the rods to vibrate in a substantially even harmonic pattern. Rods 35 are held in a heavy metallic base 36 or rod support by means of suitable collets or clamps 39, the metallic base 36 being relatively massive as compared to the rods and having a high modulus of elasticity such as possessed by steel. Collet 39 is arranged to grasp rod 35 tightly at

the point it emerges from the collet, the tapered seat 33 of the socket being located adjacent this point. The tightness with which the rod is gripped is adjustable by means of nuts 34, the tighter the rod is gripped, the less the damping of the high overtones.

Base 36 has cross bars 37 at either end, said cross bars being carried by means of resilient supports 38, said resilient supports being carried by the main frame. The resilient supports 38 may be of the rubber-in-shear type or a similar kind of support.

Mounted on base 36 by insulating supports 41 is the collector plate supporting bar 40, said collector plate bar 40 carrying substantially flat upper and lower collector plates 42 and 43, respectively, for each rod, but it is to be understood that any number of collector plates may be employed. The plates are mounted on bar 40 (Figs. 2, 4 and 6) by means of studs 45 which are spaced from bar 40 by means of sleeves 46, the upper plate 42 only being shown in Fig. 3, the lower plate being supported in a similar fashion. The other end of the collector plate 42 has a cylindrical wall hole 47 with a conical head screw 48 cooperating therewith. By turning screw 48, the distance between the collector plate and its rod 35 may be varied. Rods 35 may have an insulating or fungicide coating, such as shown at 44, placed thereon although such is not essential.

By the use of a plurality of collector plates, it is easier to align the plates along a longitudinal portion of the rod than it is to align a single plate extending over the same distance, and this is particularly true when the rod is not absolutely symmetrical. As an example, it is easier to obtain a high capacity between four $\frac{1}{4}$ " plates over a 1" section of rod than it is to obtain the same capacity with one 1" plate over a 1" section of rod. In addition to this, the split collector plate arrangement enables the manufacturer to leave one or two segments of the collector plate set blank, depending on the number used, and enables the plates to be used for vernier adjustments of volume. The collectors preferably are mounted near the fixed end of the rod so that, when the rod is struck, a tone is produced that is full and rich in harmonics.

The striker assembly carrier can be constructed of two flanged plates 49 having upper and lower cross bars 50 and 51 joining each end thereof and attached to the flanges by means of bolts 51'. A rubber-in-shear or similar support 52 is mounted on bar 53, said bar being fastened by means of bolts 54 to the base 36. The lower carrier cross bars 51 may have apertures 47 therein to allow access to resilient support bolts 38, posts 31 extending between the lower bar 51 and the resilient support. The striker assembly carrier is thus resiliently supported on the heavy base 36, thereby minimizing or eliminating vibrations set up in the carrier from being transmitted to the reeds, this being especially of value when the magnets are operated by alternating current. The heavy base 36 is in turn resiliently supported on the main frame 55 of the striker and reed assembly. The main frame 55 of the striker and reed assembly mechanism can be fastened by brackets 56 to any desired support such as the structural members of the building.

Striker hammers 57 may be of any suitable material and adjustably held by means of nuts 58 on the shanks 59 of the strikers, shanks 59 being

made preferably of a magnetic material and being freely swingable and supported on pivots 61.

The preferred form of pivot comprises two conical pointed screws 61 (Fig. 5) which are held in bifurcated arms 73 of frames 62. The frames 62 have spring leaf clamps 63 mounted thereon by means of screws 64 so that the conical pointed pivot screws 61 are adjustably held between arms 73 and said spring leaf clamps. Shank 59 has mating conical depressions 65 (Fig. 5) co-operating with said pivots. By this construction, the friction on the striker pivot can be adjusted to the desired degree and the spring elements 63 will hold the same in adjusted position. Adjustment of the pivot friction provides one control of the velocity of the hammer as it hits the rod because it is possible to change the friction on the pivot and thus affect the movement of the striker. It is apparent that various other equivalent arrangements of the pivot assembly may be employed such as having the depressions in the adjustably held pivots and placing the mating conical points on the striker shank.

Frames 62 are permanently fastened by means of screws 66 to a striker assembly carrier flange 49. The upper end of each frame 62 abuts an adjusting screw 67, said adjusting screw having a lock nut 68 thereon. By means of screws 67, the position of pivots 61 readily may be adjusted so that a striker will have the desired relation to its rod 35. Thus the position of a pivot relative to a reed and the pivot points may be readily adjusted so that the swing of the striker will be correct and have the proper intensity or striking velocity upon contacting a rod.

Electromagnet 69 can be mounted on frames 62, said magnets normally being energized so that shank 69 is held against stop element 72. Upon release of a magnet, the pendent freely swingable striker will swing from the dot and dashed line position of Fig. 4 and hit its rod 35 to set the same into vibration. The energy used in striking the rod is sufficient to reduce the return period of the striker so that the striker will hit the rod and bounce clear.

A resilient adjustable stop element 72 is carried by screws 70 having lock nuts 71 thereon. Stop elements 72 preferably are made of a material which provides some cushioning action but is sufficiently hard so that it does not permit the shank to bounce when it hits the stop, one of the materials being a linen base Bakelite, although, of course, there are other similar materials that can be used. The arrangement is such that the striker will strike the reed only once when a key is depressed, the magnet again holding the striker in an energized position when the key is released. Another advantage is that when an alternating current magnet holds the striker in energized position any vibratory motion will be absorbed.

Alternating current preferably is used to energize the magnet coils. The coils have their polarity or windings arranged so that pairs of adjacent magnets have opposite polarity. The polarity is indicated by plus and minus signs in Fig. 7 for a particular instantaneous point of the alternating current wave. If magnet *d* is de-energized to release its associated striker, the fields on either side thereof caused by magnets *c* and *e* will be equal and opposite and will neutralize each other as far as striker *d* is concerned. In this way, when a striker is released, it will freely swing to hit a reed without being affected by the field of the closely adjacent restraining means. In addition to this, the magnets are operated at an extremely

low density so that the inertia of the striker provides much the same effect physically that a shading pole does electrically in an A. C. magnet operated at relatively high density. It is to be understood, of course, that other arrangements can be used such as direct current or that equivalent manners of restraining the magnets and releasing the same can be employed.

In one form of an electrical circuit, the collector plates 26 are connected through lead 100 with the pre-amplifier circuit shown in box A—A, control grid 101 of pre-amplifier tube 102 being connected through condenser 103 to wire 100.

The plate circuit of tube 102 includes a connection to plate power source 103, plate 104, cathode 105, and cathode follower 106. The polarizing or operating potential for the reed and collector plates is obtained from power source 103 through resistance 130 and resistance 131, the signal being generated across resistance 131. Power source 103 can be tied (not shown) with supply line 119.

The signal across the cathode follower 106 is taken through condenser 107 and connecting lead 108 to the amplifier circuit shown in box B—B. Normally the lead 108 is of considerable length to allow placing of the amplifier where desired. The filament of tube 102 is supplied from a suitable source through connection 109.

A humbucking network is provided at 111 connected to heater lead 109 and through wire 110 feeds an A. C. voltage similar in magnitude and 180° out of phase with the heater voltage to the carrier frame 29. When A. C. is used to energize magnet coil 21, a flux is generated thereby and the collector plate 26 and bar 34 are in said flux so that an alternating current of line frequency may be induced into the collector plate circuit. By introduction of the voltage from network 111 into the carrier 29, the undesirable induced voltage due to the magnet coils is neutralized.

Amplifier B—B is one of conventional type having its circuits arranged in combination with the other circuits to attenuate the low frequencies. Wire 108 is connected to the control grid 113 of amplifier tube 114. The signal from the plate circuit of tube 115 is carried to grid 116 of the double triode mixer tube 117 through condenser 20. Tube 117 may be of the type designated as 6SN7, but it is, of course, possible to use a single triode or other type of tube. Wire 118 may be connected at 119 to a source of B supply for the amplifier B—B.

For the particular arrangement and pitch scale, the circuits associated in amplifier B—B with condensers 20 and 112 are chosen so that the low frequency response of the amplification system will be attenuated approximately 8 to 10 decibels at a frequency of 100 cycles per second. As mentioned previously, this serves to attenuate the amplifier at low frequency so as to make the first tone of the vibrating reeds inaudible through the amplification system. It is to be understood that condensers 103 and 107 might also serve to attenuate undesirable frequencies depending on the range of the instrument and also that other attenuating circuits might be used. In addition, the bass may be cut to the extent of 15 to 20 decibels through the attenuated low frequency response of a suitably selected horn or loudspeaker.

Merely as an example, for one type of instrument, condensers 103, 107, 20, and 112 may have capacities of .01 μ f., 1 μ f., .005 μ f., and .005 f., respectively. Resistances 132, 133, 134, and 135

may have values of 10 megohms, 1000 ohms, 500,000 ohms, and 500,000 ohms, respectively.

It is to be understood, of course, that various types of tubes and high gain amplifiers can be used, the circuits shown only being one example of a suitable amplification system. The amplifier should have the attenuation characteristics mentioned above and should be of the low distortion type.

Various modifications may be made in the described device without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a striker mechanism for an electric musical instrument having a vibrator adapted to be struck, the combination comprising a pivoted freely swingable pendent striker adapted to hit said vibrator to produce vibrations therein, means restraining said striker in an angular energized position relative to the normal freely hanging vertical position thereof, means to release said means restraining the striker so that the striker will swing freely from its restrained angular position to hit said vibrator, a pivot for said striker and mounting means for said pivot adjustable to control the vibrator striking velocity of said striker by changing the distance between the pivot thereof and a vibrator.

2. In a striker mechanism for an electric musical instrument having a vibrator adapted to be struck the combination comprising a pivoted freely swingable pendent striker adapted to hit said vibrator to produce vibrations therein, means to hold said striker in an angular energized position relative to the normal freely hanging vertical position thereof, means to release said means holding the striker so that the striker will swing from its restrained angular position to strike a vibrator, and an adjustable pivot support for said pivot adjustable to vary the velocity with which the striker hits the vibrator.

3. In a striker mechanism for an electric musical instrument having a plurality of tuned vibrators adapted to be struck by striker to produce music, the combination comprising a pivoted freely swingable pendent striker for each of said vibrators adapted to hit its respective vibrator to produce vibrations therein, an electromagnet adjacent each of said strikers and holding the same when energized for normally maintaining its striker in an elevated energized position energized relative to its vibrator, means to selectively de-energize and release said strikers so that they can selectively strike vibrators, and an adjustable support means for each striker movable to vary the velocity of each of the strikers as they hit their respective vibrators whereby the instrument can be adjusted to give the desired tone.

4. In a striker mechanism for an electric musical instrument having a plurality of tuned vibrators adapted to be struck by strikers to produce music, the combination comprising a pivoted freely swingable pendent striker for each of said vibrators adapted to hit its respective vibrator to produce vibrations therein, an electromagnet for releasably holding each of said strikers in an energized position relative to its vibrator so that upon release thereof the vibrator can be struck thereby, means to selectively release said strikers, a carrier resiliently mounted on said instrument so that vibrations therefrom will not be transmitted thereto, adjustable striker supporting frames mounted on said carrier, said frames hav-

ing pivots for said strikers, and means to adjust said pivots for controlling the velocity of a striker as it hits its respective vibrator.

5. In a striker mechanism for an electric musical instrument having a plurality of tuned vibrators adapted to be struck by strikers to produce music, the combination comprising a support on which said vibrators are held, said supports being resiliently mounted on said instrument so that undesirable vibrations are not transmitted to the vibrators, a pivoted freely swingable pendent striker for each of said vibrators, an electromagnet for releasably holding each of said strikers in an energized position, means to selectively release said strikers, a resiliently mounted carrier, and adjustable electromagnet and striker support frames mounted on said carrier.

6. In a striker mechanism for an electric musical instrument having a vibrator adapted to be struck, the combination comprising a pivoted freely swingable pendent striker adapted to hit said vibrator to produce musical vibrations therein, a carrier mounted on said instrument, a frame having a striker pivot support adjacent one end thereof, fastening means for attaching the opposite end of said frame to said carrier at one point, and adjustable means spaced from said fastening means and contacting said carrier and frame adjustably movable to vary the distance between said carrier and frame at a point spaced from the point at which the frame is attached to the carrier so that the position of said pivot relative to said carrier and vibrator can be adjusted to control the blow of said striker on a vibrator.

7. In a striker mechanism for an electric musical instrument having a vibrator, the combination comprising a pivoted freely swingable pendent striker adapted to hit said vibrator, a carrier mounted on said instrument, a frame having adjustable pivot supports thereon for adjusting the friction exerted on said pivot, a semi-resilient adjustable striker stop mounted on said carrier adapted to be engaged by said striker, an electromagnet on said frame for normally restraining said striker in an energized position against said stop and releasable when the vibrator is to be struck, and means to adjustably mount said frame on said carrier movable to adjust the relative position of said striker pivot and said vibrator whereby the velocity of the striker can be controlled, the stop serving to arrest movement of the striker thereagainst without appreciable rebound.

8. In a striker mechanism for a musical instrument having a plurality of adjacently located vibrators, the combination comprising a pivoted freely swingable pendent striker for each vibrator, a pivot mounting for each striker on said instrument, an electromagnet for each striker for holding the same in an energized position, and selectively releasable so that the released striker can swing to hit its vibrator, and neutralizing means to substantially eliminate the magnetic field of adjacent electromagnets on a released striker therebetween so as to give an identical blow to a vibrator each time a striker is released irrespective of the operation of adjacent strikers.

9. In a striker mechanism for a musical instrument having a plurality of adjacently located vibrators, the combination comprising a pivoted freely swingable pendent striker for each vibrator, a pivot mounting for each striker on said instrument, said strikers having magnetic metal shanks, an electromagnet for each striker co-operating with the shank thereof for holding the same in an

energized position, and selectively release said strikers to selectively strike vibrators, and means to neutralize the magnetic field of adjacent electromagnets on a released striker irrespective of the operations of adjacent strikers.

10. In a striker mechanism for a musical instrument having a plurality of adjacent vibrators, the combination comprising a pivoted freely swingable pendent striker for each vibrator, means to pivotally support said strikers on said instrument, an electromagnet on said instrument for each striker for holding its striker in an energized position, said magnets being selectively releasable to release said strikers, a source of energy connected to said electromagnets in such a manner so that the polarity of each pair of magnets is opposite to the polarity of adjacent pairs to substantially neutralize the effect of the magnetic field of a pair of energized magnets on a released striker therebetween so that the striker will freely swing.

11. In a striker mechanism for a musical instrument having a plurality of adjacent tuned rods, the combination comprising a carrier resiliently mounted on said instrument; a pivoted freely swingable pendent striker for each vibrator pivotally mounted on said carrier; an alternating current electromagnet for each striker for holding the same in an energized position away from its rod, said electromagnets being mounted on said carrier adjacent its striker and being selectively releasable so that said strikers will selectively strike said rods; means to connect said electromagnets to a source of electricity so that the polarity of each pair of magnets is opposite to the polarity of adjacent pairs to substantially neutralize the effect of the magnetic field of adjacent magnets on a released striker therebetween.

12. In a striker mechanism for an electric musical instrument having a vibrator adapted to be struck, the combination comprising a pivoted freely swingable pendent striker for said vibrator to produce vibrations therein, a frame mounted on said instrument, and a pivot supporting said striker in said frame including adjustable conical striker pivot means mounted between said striker and frame, and pivotally carrying said striker

thereon, said conical pivot means being longitudinally movable to adjust the friction on the pivot and thereby to control the velocity of the striker as it freely swings to hit the vibrator.

13. In a striker mechanism for an electric musical instrument having a vibrator adapted to be struck, the combination comprising a pivoted freely swingable pendent striker for said vibrator to produce vibrations therein, a frame mounted on said instrument, and opposed conical striker pivot points adjustably mounted on said frame to pivotally hold the striker therebetween, said pivot points being longitudinally adjustable relative to each other so that the friction on the striker pivot can be adjusted to control the velocity of the striker as it freely swings to hit said vibrator.

14. In a striker mechanism for an electric musical instrument having a vibrator adapted to be struck, the combination comprising a pivoted freely swingable pendent striker for said vibrator to produce vibrations therein, a frame mounted on said instrument, opposed conical pivot points longitudinally adjustably mounted on said frame to swingably hold the striker therebetween so that the friction on the pivot can be adjusted to control the velocity of the striker as it freely swings to hit the vibrator, and a locking engaging said striker pivot holding said pivot points in adjusted position on the frame.

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Certificate of Correction

March 8, 1949.

Patent No. 2,463,543.

JACOB T. KUNZ

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 40, claim 2, before the word "and" insert *a pivot for said striker*, ; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of August, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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