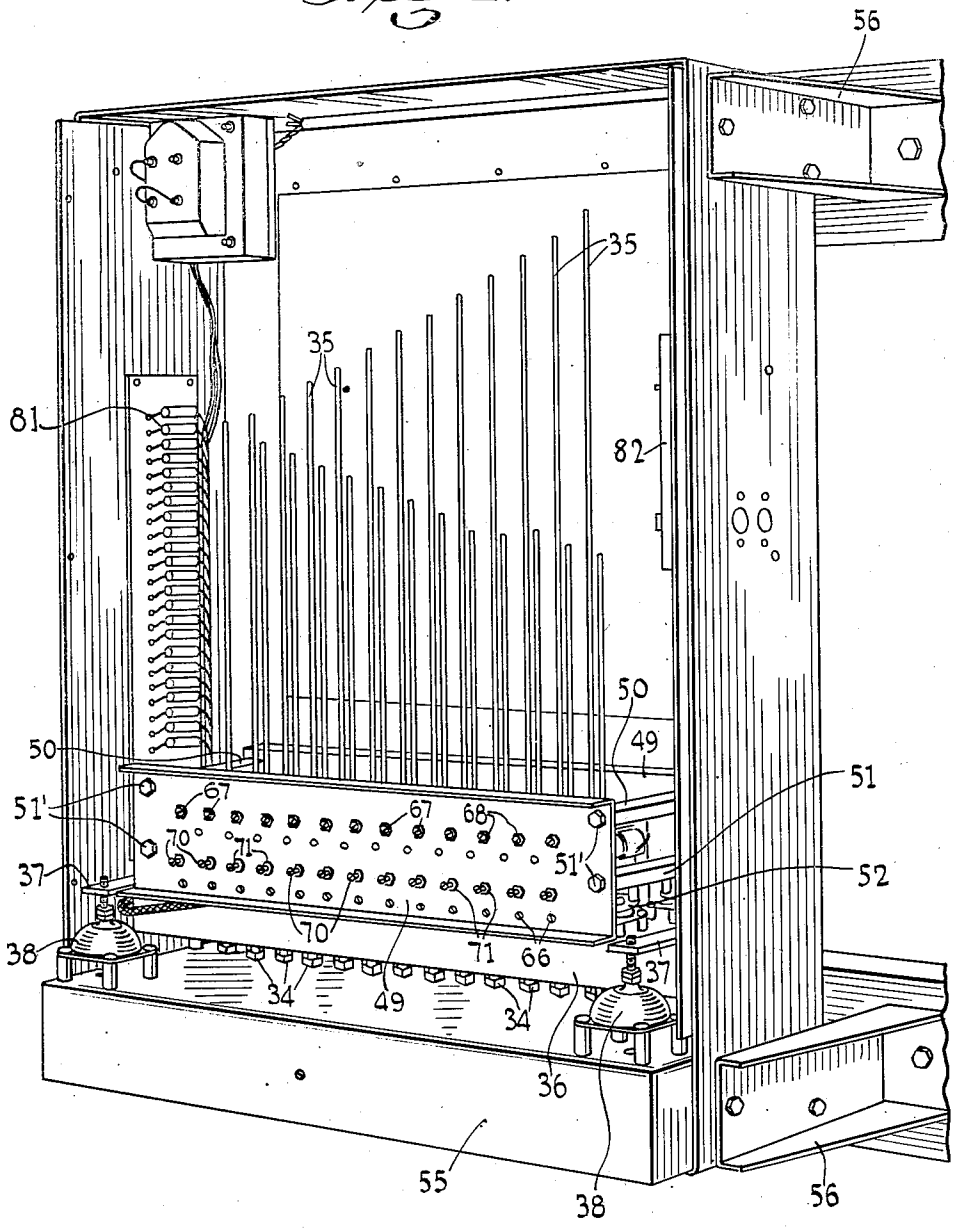
June 7, 1949. J. T. KUNZ 2,472,595

MUSICAL INSTRUMENT

Filed Jan. 15, 1946 4 Sheets-Sheet 1

Fig. 1.



INVENTOR.
JACOB T. KUNZ
BY
Hammond & Littell
ATTORNEYS

June 7, 1949. J. T. KUNZ 2,472,595

MUSICAL INSTRUMENT

Filed Jan. 15, 1946 4 Sheets-Sheet 2

Fig. 2.

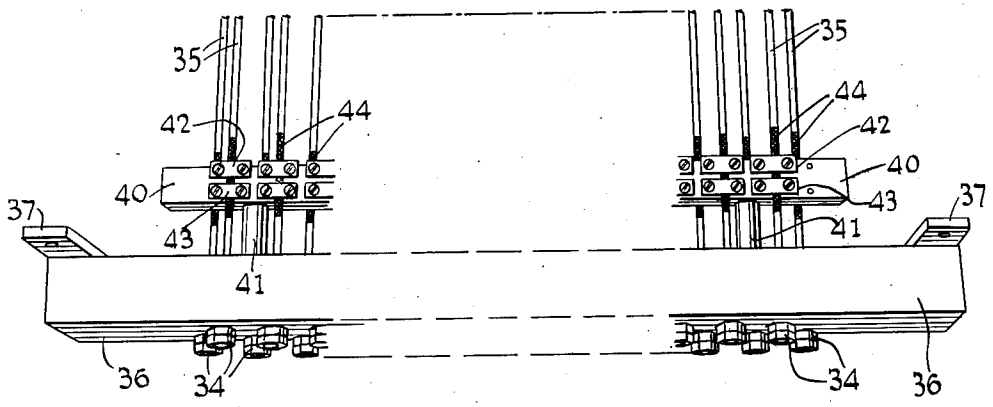
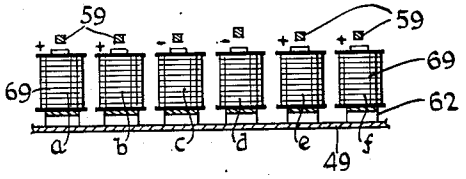


Fig. 7.



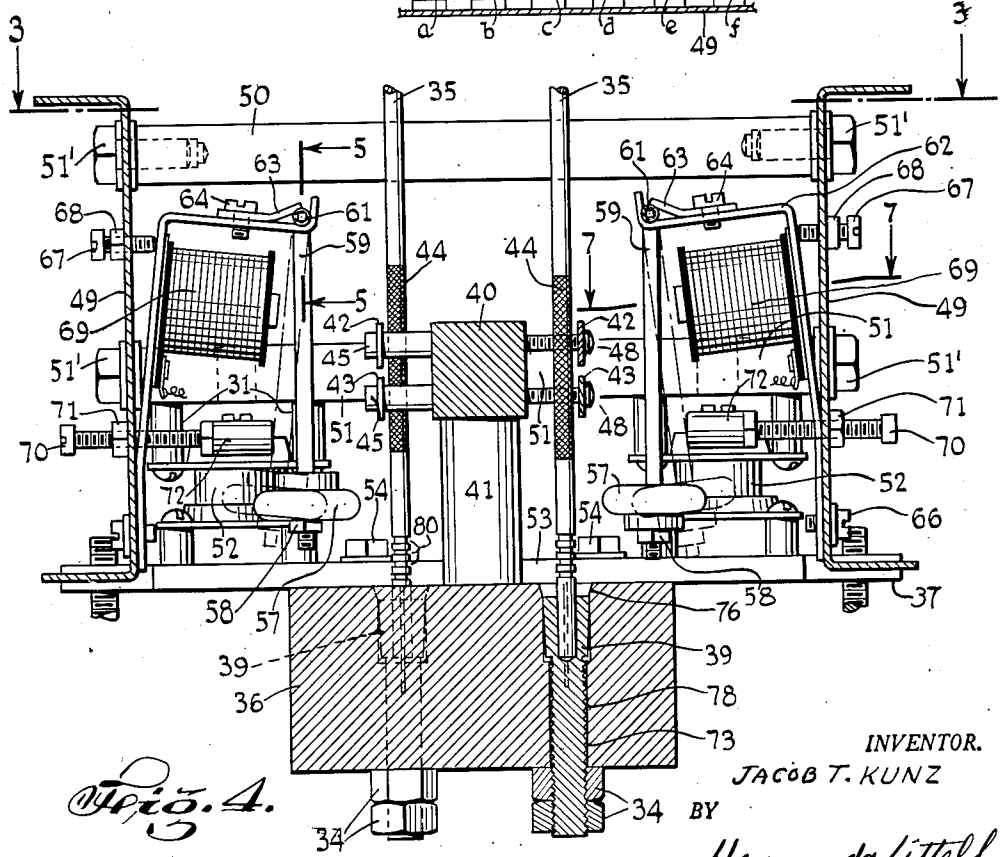


Fig. 4.

INVENTOR.
JACOB T. KUNZ
BY
Hammond & Littell
ATTORNEYS

June 7, 1949. J. T. KUNZ 2,472,595

MUSICAL INSTRUMENT

Filed Jan. 15, 1946 4 Sheets-Sheet 3

Fig. 3.

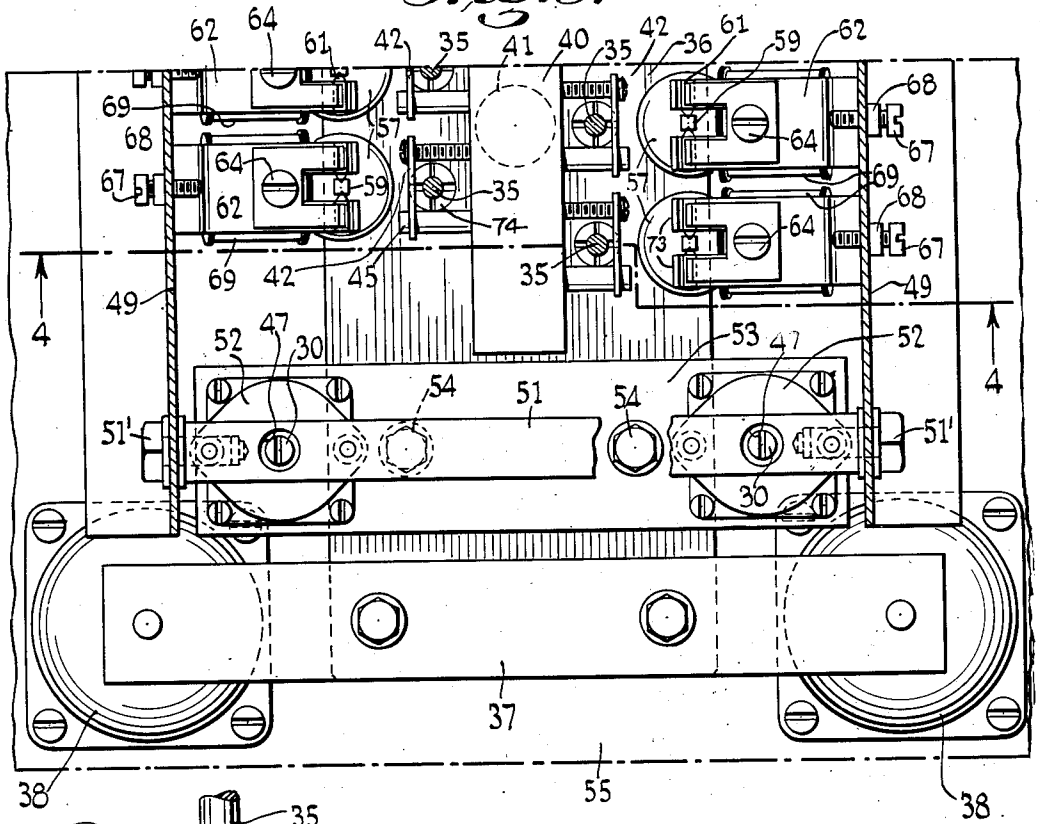


Fig. 8.

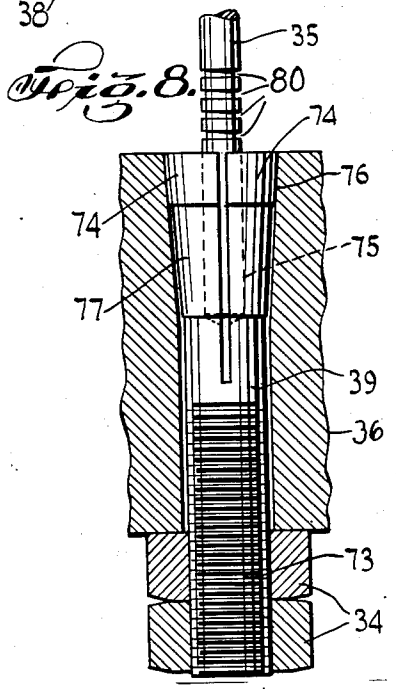


Fig. 5.

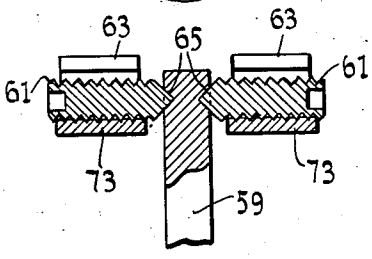
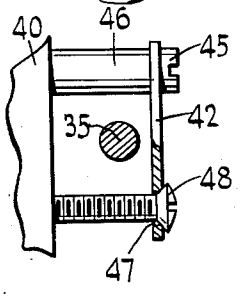


Fig. 6.



INVENTOR.
JACOB T. KUNZ
BY
Hammond & Littell
ATTORNEYS

June 7, 1949. J. T. KUNZ 2,472,595

MUSICAL INSTRUMENT

Filed Jan. 15, 1946 4 Sheets-Sheet 4

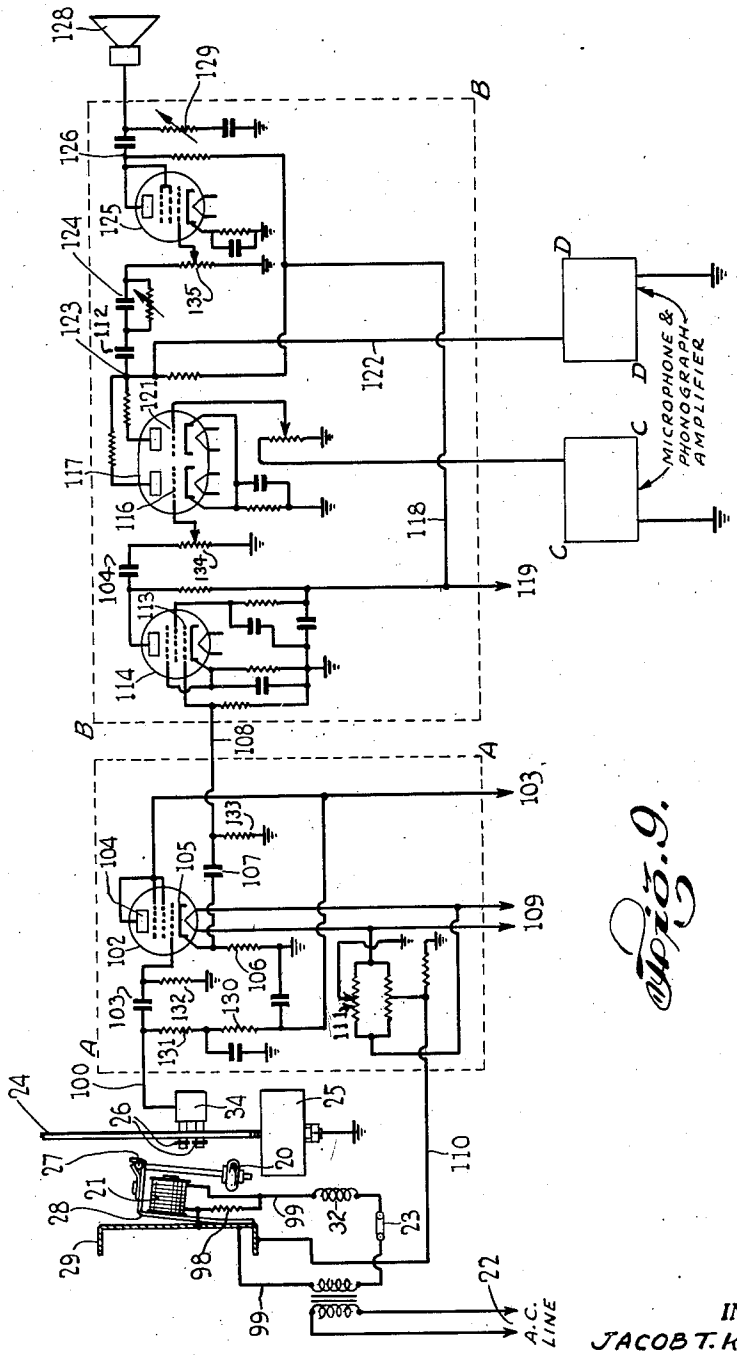


Fig. 9.

INVENTOR.
JACOB T. KUNZ
BY
Hammond & Littell
ATTORNEYS

Patented June 7, 1949

2,472,595

UNITED STATES PATENT OFFICE

2,472,595

MUSICAL INSTRUMENT

Jacob T. Kunz, North Hills, Pa., assignor to Schulmerich Electronics, Incorporated, Sellersville, Pa., a corporation of Pennsylvania

Application January 15, 1946, Serial No. 641,242

10 Claims. (Cl. 84—1.14)

1

This invention relates to a musical instrument and particularly to one having a plurality of vibrators which may be set in motion to produce musical tones such as an instrument commonly referred to as an electric carillon. In such an instrument, the vibrations of tuned rods are amplified electrically to faithfully reproduce the tones of bells or chimes.

One of the many advantages of an electric carillon over conventional cast bells is the large saving in weight which eliminates the necessity of special structural provisions for housing the carillon. For example, when a carillon of twenty-five bells or notes is used, the weight of an electric carillon made in accordance with the present invention will be about 200 pounds as compared with a weight of possibly 50,000 pounds for conventional cast metal bells.

Other advantages are that the electric carillon is not affected by temperature changes and that the volume and sound radiation pattern can be controlled with ease. In addition, a console or keyboard similar to an organ or piano can be furnished so that no special skill is required in playing.

One of the objects of the present invention is to provide an instrument having rods tuned in such a manner as to produce bell or chime tones correctly and without distortion. 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 giving an even harmonic pattern for 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. 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 or other interval 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 bell tone can be generated by a rod or similar element clamped at one end by tuning the same to the third tone, treating the third tone as the fundamental with the second tone as the hum tone, and bringing the other desired partials and

2

tones into correct relationship. The first tone of the rod is not used directly but is filtered out of the amplified sound in the electric circuits by means of suitable frequency filtering means. One of the results is the elimination of the objectionable clang sometimes heard in bells and particularly in electrical bell tone reproducing means.

The frequency characteristics of a rod clamped at one end does not give the desired even harmonic pattern which has just been mentioned and one object of the present invention is to provide means to cause the rod to produce the 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.

In an instrument for translating musical vibrations of a rod 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 all of the mechanical and electrical elements in order to produce the desired tones without distortion. When electric carillon bell notes are to be reproduced in a sound system, the rod must be properly tuned and the striker means arranged to give the desired and correct vibratory motion of the rod.

Another of the objects of the present invention is to provide a striker which can be adjusted with ease to give the correct blow to a rod, this being important inasmuch as the slightest difference in the blow can be detected easily by the trained ear. The striker preferably is of the pivoted and freely swingable pendulum type held normally in an energized position or so that it is angularly located relative to a vertical line through the striker support. Upon release of a restraining means for a striker, the selected striker will freely swing and give its associated rod a blow.

Another object of the invention is to provide a restraining and releasing means for the strikers which can be selectively operated to allow the desired striker or strikers to freely swing and impart vibrations to the selected rods, and at the same time not to interfere in any manner with the freely swinging movement of a released striker and thereby possibly change the force with which the striker hits a rod. The striker and restraining means are the subject matter of and are claimed in co-pending application, Serial No. 641,243, filed January 15, 1946, now Patent No. 2,463,543, issued March 8, 1949.

Another object of the invention is to provide an electrical pick-up or collector plate arrangement which can be adjusted easily to give the desired volume and tone for its associated rod. The collector plate for a rod is divided into a plurality of individually adjustable elements, such an arrangement providing for easy adjustment, allowing any number of plates for a rod to be used, and making possible adjustments to compensate for irregularities in the homogeneity or shape of a particular rod.

The clamping means for each rod is arranged to provide a positive grip or solid clamp at the point where the rod leaves the collet, said grip being adjustable so as to give the desired tones for a particular rod. For example, a tight grip will allow a note to be generated in a rod with high overtones, the high overtones being easily damped by a partial contact of a clamp with the rod caused by a poor grip.

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 frame assembly or mechanism.

Fig. 2 is a broken perspective vertical front view of the rods and supporting bar.

Fig. 3 is a fragmentary plan view of the striker assembly taken along the line 3—3 of Fig. 4.

Fig. 4 is a cross-sectional view taken along the line 4—4 of Fig. 3, the right-hand rod being shown in full lines.

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 showing the mounting for one of the collector plates.

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, the magnets being shown in full.

Fig. 8 is an enlarged detail view partially in section of a collet with a portion of a rod therein.

Fig. 9 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 rods may be used.

In the schematic showing in Fig. 9, striker 20 normally is held in an energized position by magnet 21, 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. Rod or vibrator 24 is carried in heavy rod support 25. Condenser or collector plates 26 are mounted on collector plate support bar 34, said plates being connected by wire 100 with a pre-amplifier A—A, rod 24 being connected to the ground through support 25. Pre-amplifier A—A in turn is connected by wire 108 with amplifier B—B, said amplifier B—B being connected to loudspeaker 128. The pre-amplifier is mounted adjacent to the rod and striker mechanism assembly as indicated at 32 in Fig. 1 so as to amplify the vibrations for proper transmission to an amplifier located at some point between the rod 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 98 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 31 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 21 will release striker 29 allowing the striker to swing on its pivot 27 and strike rod 24, the vibrations of rod 24 causing a variation in the electrical capacity between the collector plate 26 and rod 24, plate 26 and rod 24 being given a polarizing or operating potential in a manner hereafter described.

As explained previously, in tuning the various rods of the carillon, it is desirable to obtain the tone appearing in a good bell, namely, a hum tone, a fundamental, a minor third, a fifth, and an octave. When a rod or bar is clamped rigidly at one end and with an unsupported free end, there will be certain predetermined frequency ratios between the overtones and the fundamental, these ratios having been established by physicists such as Rayleigh in "Theory of Sound." As indicated in Table I, the frequency ratios of the first 4 tones being given, these ratios in a rod clamped at one end not being even multiples of the fundamental.

Table I

No. of Tone	Frequency Ratio	Freq. of Specific Note	Desired Frequency	Resultant Tone (3 as Fundamental)
1 (Basic)	f	10		
2	6.26f	62	87.5 (Hum Tone)	1+2—72 or 3—2—113
3	17.55f	175	175 (Fund.)	3—175
Minor Third				2+3—237
Fifth				2+3+2—299
4	34.34f	343	350	4—343

Assuming that the first or basic tone has a frequency of 10, the frequency of the second, third, and fourth tones will be 62, 175, and 343, respectively. If the third tone be taken as the fundamental, it will be noticed that the fourth tone is slightly under the octave above or twice the frequency of the fundamental. The second or hum tone, is not ½ of the frequency of the fundamental. The desired frequency of the various partials with the third tone as the fundamental including the minor third and fifth is indicated in the fourth column of the table. The hum tone is produced as a result of the combination of tone 3 minus tone 2 or 113 vibrations per second, this being accomplished through the phenomenon of beats as is well known. The minor third is arrived at by a combination or beat note between tones two and three and the fifth is a combination between the minor third and the hum tone. The resultant tones are not as close as is desired to the tones set forth in the desired frequency column.

It has been ascertained that the tones are brought closer to an even harmonic pattern by cutting a groove or grooves 30 (Figs. 4 and 8) near the point where the rod is clamped in the collet and exteriorly thereof. There may be more or less grooves than the number shown. The exact reason for this phenomenon is not precisely known although it may have some analogy in the

fact that when circuits or vibrating members are made unstable or are given the opportunity to vibrate with even harmonics they will so do.

By grooving the rod **35** near the clamped end, opportunity is given for the rod to vibrate in an even harmonic pattern. The base frequency is determined by the strongest tone present in the rod or which is being picked off the rod, this being 175 cycles per second in the example of Table I. Grooving of the rod permits tone **4** to vibrate substantially at 350 cycles instead of 343 and also permits the rod to vibrate or produce a hum tone of 87.5 cycles per second instead of 62 or 113 cycles per second. Thus the grooving causes the relationship between the fundamental tone and the octave to fall into an even relationship.

Actual tests have shown that the partials in an unnotched rod can be off as much as 30 or 40 cents in a rod, a cent being defined as an interval between any two tones whose frequency ratio is the twelve hundredth root of two, whereas the rods can be tuned to show a deviation of only 5 or 6 cents by grooving. When a deviation of about 12 cents is present, dissonance usually becomes noticeable between the rods and tones in the rods.

In addition to the grooving of the rod, a weight in the form of a ring around the rod will help in the case of the hum tone and fundamental, said ring preferably being placed near a tonal node. The weight will shorten or lengthen, as the case may be, the frequency of the vibration of the particular section. A similar effect can be secured by notching the rod in the correct place but the sliding rings are preferable because they may be more easily adjusted and placed on the rod.

As an example of the tuning of the lowest and highest pitch rods of one form of twenty-five note or 2 octave electric carillon reference is made to Table II.

Table II

Name of Tone	Freq. Ratio	Low G—196~			High G—784~		
		Desired Tones	Resultant Tones		Desired Tones	Resultant Tones	
1 (Basic Tone)	f	----------	11.1	----------	----------	44.6	----------
2 Hum Tone	6.26f	98	69.5	80.5 1+2	392	279.5	324.1 1+2
3 Fund	17.55f	196	196	196 3	784	784	784 3
Third (Minor)	--------	251	-------	265.5 2+3	1045	-------	1063 2+3
Fifth	--------	326	-------	335.0 (2+3)+2	1306	-------	1332 (2+3)+2
4 Octave	34.34f	392	381.7	381.7 4	1568	1540	1540

Rods or vibrators **35** can be formed from brass or other suitable metal and should be as symmetrical and homogeneous as possible, circular rods being shown herein. Rods **35** are held in the heavy metallic base **36** or rod support by means of suitable collets or clamps **39**. The metallic base **36** should be relatively massive as compared to the reeds and should have a high modulus of elasticity such as possessed by steel.

A collet or clamp **39** (Fig. 4 and Fig. 8) may be composed of a single piece of metal having a screw threaded extension **73** and four spring fingers **74**. A socket **75** is provided in the collet for holding one end of the rod **35**. A tapered

shoulder **76** is located at one end of the collet with a greater diameter than the reduced portion **77** thereof, aperture **78** having a tapered wall **79** cooperable with the tapered shoulder **76** of the collet. When the nuts **43** are tightened with the collet in place and a rod is in socket **75**, the tapered shoulder **76** will cooperate with the tapered socket **79** to cause the spring fingers to grip the rod tightly at the point where the rod emerges from the collet. In this way, the tightness with which the rod is gripped can be adjusted by means of nuts **34**. The tighter the rod is gripped, the less the damping of the high overtones. A loosening of the grip on the rod will result in the higher overtones being damped more quickly. Such a construction assures that the gripping action positively takes place at the outer end of the collet so that a positive grip will be made at the point where the rod leaves the collet. A tight grip will thus permit the high overtones to develop and permit them to travel up the rod whereas with a loose grip, the vibrations will be absorbed by the collet fingers.

As previously mentioned, the metallic base is relatively massive as compared to the rods so as to keep the base from entering into the generated vibrations of the rods. Base **36** has cross bars **37** at either end thereof, said cross bars being carried by means of resilient supports **38**. The resilient support **38** may be of the rubber-in-shear type such as sold on the market under the name "Lord Bonded Rubber Mounting" or a similar support.

Mounted on base **36** by insulating columns **41** is the collector plate supporting bar **40**, said collector plate bar **40** carrying two substantially flat collector plates **42** and **43** for each rod, but it is to be understood that any number of collector plates may be employed for each rod. The plates are mounted on bar **40** (Fig. 3 and Fig. 6) by means of a screw threaded stud **45** which is spaced from bar **40** by means of sleeve **46**, the upper plate **42** being shown in Fig. 6, the other plates being supported in a similar fashion. The other end of the collector plate **42** has a straight wall aperture **47** with a conical head screw **48** therethrough. By turning screw **48**, the distance between the collector plate and its rod may be varied. Rods **35** may have an insulating or fungicide coating, such as shown at **45**, placed thereon if desired, although such is not required.

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 abso-

lutely symmetrical. As an example, it is easier to obtain a high capacity between four ¼" plates over a 1" section of rod than it is to obtain the same capacity with one 1" plate over a 1" section or rod. In addition thereto, the multiple collector plate arrangement enables the manufacturer to leave some of the segments of the collector plate assembly blank so that they can be connected thereafter in case it is so desired. A multiplate collector also enables vernier adjustments of volume. The collectors preferably are mounted near the gripped 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 carried by bar 53 mounted by means of bolts 54 to the heavy metallic base 36. Lower carrier cross bars 51 may have apertures 47 therein to allow access to adjusting bolts 30 of the resilient mounts 52. The striker assembly carrier thus is resiliently supported on base 36 thereby minimizing or eliminating vibrations set up in the carrier from being transmitted to the rods, this being especially of value when the magnets are operated by alternating current. Base 36, in turn, is resiliently supported on the main frame 55 of the rod assembly. The main frame 55 can be mounted on brackets 56 which are connected to structural members of the building or any suitable supporting means.

Striker hammers 57 may be of any suitable material and adjustably held by means of nuts 58 on shanks 59 of the striker, shanks 59 preferably being made of a magnetic material and freely swingable and supported on pivots 61. The preferred form of pivot comprises two conical point screws 61 (Fig. 5) which are held in bifurcated arms 73 of frames 62. Frames 62 have spring clamps 63 mounted thereon by means of screws 64 so that the conical point pivot screws 61 can be adjustably held on said frames. Shank 59 has mating conical depressions 65 (Fig. 5) co-operating with the conical pointed screws.

The pivot friction can be adjusted to the desired degree and spring clamps 63 will serve to hold the pivots in said adjusted position. Various other equivalent arrangements of the pivot assembly, of course, may be employed.

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

Electromagnet 69 can be mounted on frames 62, said magnets normally being energized so that shanks 59 will be held against stop elements 72. Upon release of a magnet, the pendent freely swingable striker will swing from the position indicated in broken lines in Fig. 4 and hit rod 35 setting 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 and lock nuts 71, stop elements 72 preferably being 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 top. One of the materials that may be used is a linen base "Bakelite," but there are, of course, other similar suitable materials. The arrangement is such that the striker will strike the rod only once when the key is depressed, the magnet again holding the striker in an energized position when the key is released. A semi-resilient stop also will serve to absorb any vibratory motion of the shank due to the alternating current of the mechanism as explained in detail in the aforementioned co-pending application, Serial No. 641,243.

The magnet coils have their polarity or windings arranged so that pairs of adjacent magnets have opposite polarity as indicated by the plus and minus signs in Fig. 7. For example, when magnet *d* is de-energized to release its associated striker, the magnetic fields on either side thereof caused by magnet *c* and *e* will be equal and opposite and will neutralize each other as far as the striker *d* is concerned. 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.

In one form of an electric circuit that may be used, collector plates 26 are connected through lead 100 with the pre-amplifier circuit shown in box A—A of Fig. 9, control grid 101 of the 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, resistance 130, and resistance 131, the signal being generated across resistance 131. Power source 103 can be tied (not shown) in some suitable manner 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 or heater element of tube 102 is supplied from a suitable source through connection 109 and a humbucking network is provided at 111. The network is connected to heater leads 109 and through wire 110 feeds an alternating current voltage similar in magnitude and 180° out of phase with the heater voltage to the carrier frame 29. When alternating current is used to energize the 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 in the collector place circuit. By introduction of the out of phase voltage from network 111 into carrier 29 the undesirable induced voltage due to the magnet coils is neutralized. The network may have an adjustable ground on one resistance and a center tap resistance in parallel so that the desired voltage and phase relationships are obtained.

Amplifier B—B is one of conventional type having its circuits arranged in combination with the other circuits to attenuate the low frequency as explained hereafter. Wire 108 is connected to the control grid 113 of amplifier tube 114. The signal from the plate circuit of tube 114 is carried to grid 116 of the duplex triode mixer tube

117 through condenser 104. 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 to power lead 119 to supply plate voltage to the mixer tube 117 and amplifier tube 125.

For the particular pitch scale of the carillon chosen, the circuits associated in amplifier B—B with condensers 104 and 112 are arranged 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 explained previously, this serves to attenuate low frequency in the amplifier circuit so as to make the first tone of the vibrating rod inaudible through the system. It is to be understood that condensers 103 and 107 together with their associated circuits might also serve to attenuate undesirable frequencies depending upon the pitch range of the instrument. 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 128.

Merely as an example for one type of instrument, condensers 103, 107, 104, and 112 may have capacities of .01 μf., 1 μf., .005 μf., respectively. Resistances 132, 133, 134, and 135 may have values of 10 megohms, 1000 ohms, 500,000 ohms, and 500,000 ohms, respectively.

A microphone and amplifier combination C—C may be provided and connected to grid 121 of mixer tube 117 and a phonograph D—D may be connected through wire 122 to the plate circuit of tube 117. The signal from the plate circuit and phonograph, if used, is taken from point 123 through condensers 112 and the bass control network 124 to amplifier tube 125. The plate circuit of amplifier tube 125 is connected by means of wire 126 to the loudspeaker or to other amplifiers if necessary, a treble control 129 being provided if desired. Amplifier tubes 102, 114, and 125 may be pentodes of the type designated as 6SJ7. Tubes 102 and 126 have the screen and supressor grids connected together to the plate thereof so that the tubes operate as triodes.

It is to be understood, of course, that the microphone and phonograph may be omitted and that various types of tubes and high grade amplifiers can be used, the circuits shown being only 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 an electric musical instrument, a plurality of rods, each of said rods being tuned to the third tone thereof and each rod having means thereon to produce an even harmonic pattern relative to said third tone; normally restrained pendent freely swingable strikers selectively releasable for striking rods; an electrical pick-up for each of said rods; an electric circuit connected to said pick-ups attentuating the first tone of each of said rods; and a loudspeaker connected to said circuit to produce tones when said rods are struck having substantially the same relationship between the fundamental tone of a rod and the harmonic pattern therof for all of said rods, said third tone serving as the characteristic tone and the second tone as the hum tone.

2. In an electric musical instrument a plurality of fixed-free rods, each of said rods being tuned to the third tone thereof and each rod having an even harmonic pattern producing means thereon; selectively operable strikers for said rods; an electrical pick-up for said rods; an electric circuit connected to said pick-up, said circuit attenuating between about a minimum of 8–10 decibels the first tone of said rods; and a loudspeaker connected to said circuit, said loudspeaker attenuating the bass of said circuit between about a minimum of 15–20 decibels and producing tones when said rods are struck having substantially the same relationship between the fundamental tone of a rod and the harmonic pattern thereof for all of said rods.

3. In an electric musical instrument, a plurality of fixed-free rods, each of said rods being tuned to a predetermined tone and having grooves cut therein adjacent the fixed end thereof to produce an even harmonic pattern; selectively operable strikers for said rods; translating means for changing mechanical vibrations of said rods to electrical vibrations; an electric circuit attenuating predetermined tones of said rods; and an electro-acoustic means for translating said electric vibrations into tones when said rods are struck having substantially the same relationship between the fundamental tone of a rod and the harmonic pattern thereof for all of said rods, said electro-acoustic means having means to attenuate the bass.

4. In an electric musical instrument, a relatively heavy resiliently mounted base; a plurality of tuned rods carried on said base; a pivoted freely swingable pendent striker for each of said rods; an electromagnet for releasably holding each of said strikers in an energized position; means to selectively release said strikers; a resiliently mounted carrier; an adjustable electromagnet and striker support frame for each of said strikers mounted on said carrier; a multiplate collector with closely adjacent plates for each of said rods, said plates being carried by said base and located longitudinally of a rod and with plates individually adjustable relative thereto; and electrical means to translate mechanical vibrations of said rod to electrical vibrations including said rod and collector plates in a capacitative relationship.

5. In an electric musical instrument, a plurality of fixed-free rods, each of said rods being tuned to a predetermined tone thereof and having even harmonic pattern producing means therefor including a grooved portion adjacent the fixed end thereof; a base; rod holders adjustably mounted on said base and having means adjacent the outer end thereof for adjustably gripping said rods substantially circumferentially at their point of emergence from said holders; selectively operable strikers for said rods; translating means for changing mechanical vibrations of said rods to electrical vibrations; and an electro-acoustical translating means producing tones when said rods are struck having substantially the same relationship between the fundamental tone of a rod and the harmonic pattern thereof for all of said rods.

6. In an electric musical instrument, a vibrator, a normally energized striker for said vibrator, an alternating current operated restraining means for said striker, an electrical pick-up for said vibrator, and electrical means connected relative to said restraining means and pick-up to substantially eliminate undesirable induced alternating current from said restraining means in the output of said pick-up.

7. In an electric musical instrument having a vibrator, a striker for said vibrator, alternating current operated releasable restraining means for normally holding said striker in an energized position, a restraining means support, an electrical pick-up for said vibrator, and means to connect said support to an alternating current out of phase with that of said restraining means alternating current to substantially eliminate undesirable alternating current in the output of said pick-up.

8. In an electric musical instrument a plurality of rods, selectively operable strikers for said rods, alternating current electromagnets for normally holding said strikers in an energized position; a support for said electromagnet; electric pick-up means for said rods; and electro-acoustical means connected to said pick-ups; and a phase shifting network connected in phase with said electromagnet alternating current and having an output 180° out of phase with said electromagnet alternating current and similar in magnitude thereto connected to said support for substantially eliminating undesirable alternating current hum in the output of said electrical pick-ups.

9. In an electric musical instrument, a plurality of rods, each of said rods being tuned to a predetermined tone and having even harmonic pattern producing means therefor, selectively operable strikers for said rods, alternating current magnet restraining means for said strikers, supports for said magnets, a multiplate collector having individually adjustable closely adjacent plates for each of said rods, an electric circuit connected to said collectors and having attenuating means for one of the tones of each of said rods, means to introduce an alternating current out of phase with said magnet current into said support to prevent undesirable induced alternating current from said magnets in said collectors, and a loudspeaker connected to said electric circuit producing tones when said rods are struck having the same relationship between the fundamental of a rod and the harmonic pattern thereof for each of said rods.

10. In an electric musical instrument, a plurality of fixed-free rods, each of said rods being tuned to a predetermined tone and each rod having means thereon to produce an even harmonic pattern, selectively operable strikers for said rods, translating means for changing mechanical vibrations of said rods to electrical vibrations, an electric circuit including attenuating means attenuating predetermined tones of said rods, a bass attenuating means connected to the instrument for additionally attenuating the bass to a total minimum of about 23–30 decibels, and an electro-acoustic means translating said electric vibrations into tones when said rods are struck having substantially the same relationship between the fundamental tone of a rod and the harmonic pattern thereof for all of said rods.

JACOB T. KUNZ.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,269,511	Roberge	June 11, 1918
1,935,215	Severy	Nov. 14, 1933
1,994,560	Brewer et al.	Mar. 19, 1935
2,187,251	Severy	Jan. 16, 1940
2,223,206	Dome	Nov. 26, 1940
2,273,333	Schluter	Feb. 17, 1942
2,286,587	Sundt	June 16, 1942
2,330,261	Beyer	Sept. 28, 1943
2,321,366	Demuth	June 8, 1943
2,352,438	Hruby	June 27, 1944
2,413,062	Miessner	Dec. 24, 1946

FOREIGN PATENTS

Number	Country	Date
44,708	Norway	Jan. 2, 1928

Certificate of Correction

Patent No. 2,472,595. June 7, 1949.

JACOB T. KUNZ

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

Column 5, line 48, for "reeds" read *rods*;

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 1st day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Certificate of Correction

Patent No. 2,472,595. June 7, 1949.

JACOB T. KUNZ

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

Column 5, line 48, for "reeds" read *rods*;

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 1st day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.