Dec. 23, 1952 J. T. KUNZ 2,622,467

MUSICAL INSTRUMENT

Filed Nov. 17, 1948

2 SHEETS—SHEET 1

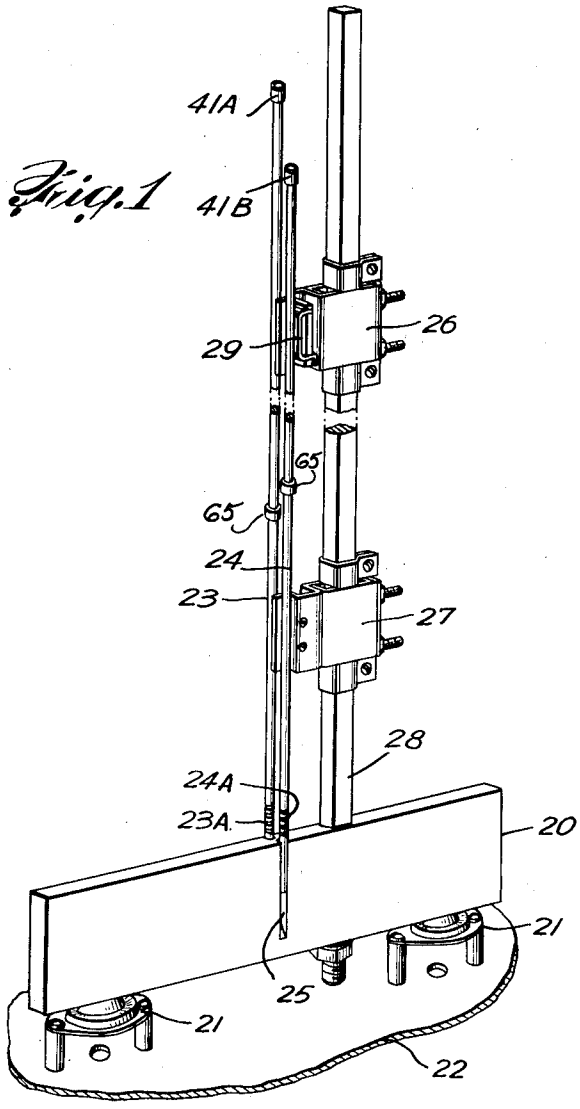


Fig. 1

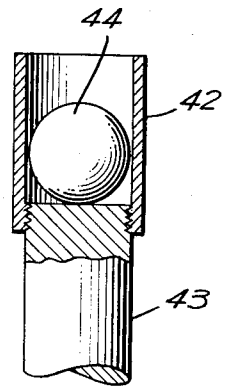


Fig. 2

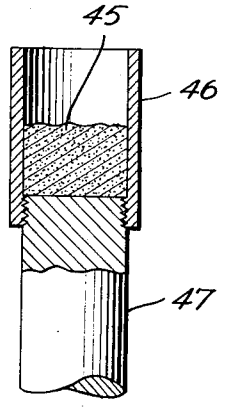


Fig. 3

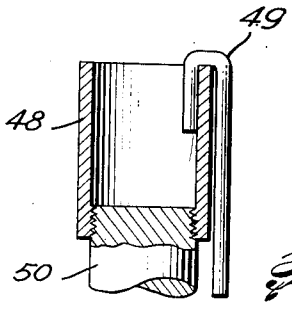


Fig. 4

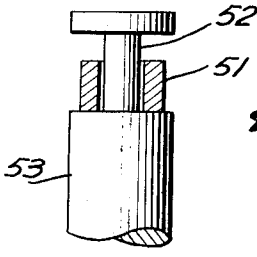


Fig. 5

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Dec. 23, 1952 J. T. KUNZ 2,622,467

MUSICAL INSTRUMENT

Filed Nov. 17, 1948 2 SHEETS—SHEET 2

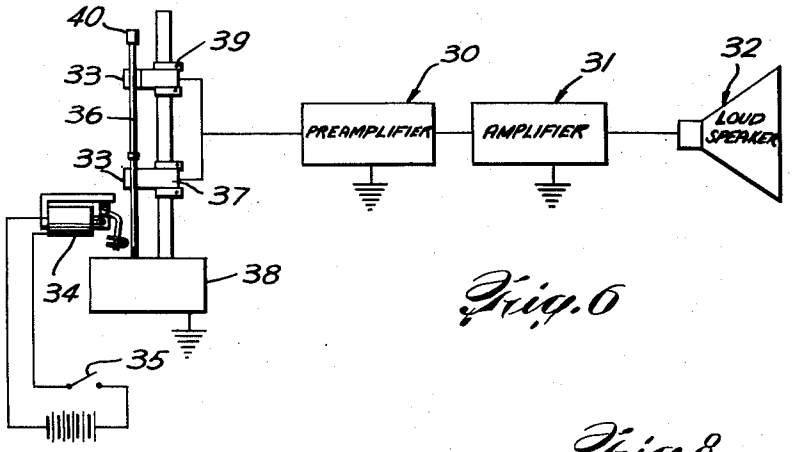


Fig. 6

Fig. 8

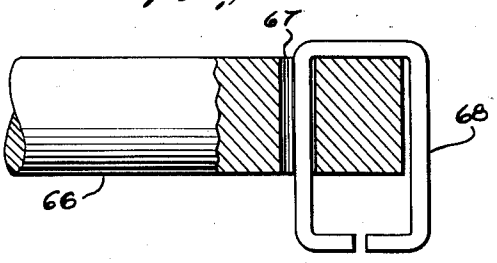


Fig. 7

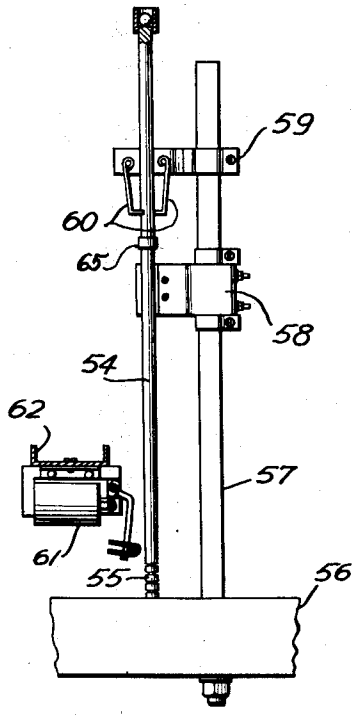
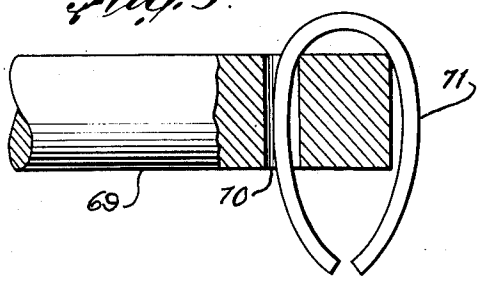


Fig. 9



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UNITED STATES PATENT OFFICE

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MUSICAL INSTRUMENT

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Application November 17, 1948, Serial No. 60,469

14 Claims. (Cl. 84—404)

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This invention relates to music instruments and particularly to vibrator damping arrangements for electric music instruments, the vibrator involved especially being adapted for use in the production of true bell or chime tones and the like.

Various vibrators have been used in music instruments for producing bell or chime tones. The vibrating elements of said instruments have comprised bars or rods, both solid and hollow, as well as innumerable other shapes of elements. The mechanical vibrations produced thereby have been translated or picked-up electrically, amplified, and then translated into sound by an electro-acoustic transducer or loud speaker to produce bell tones. The location of the electric pick-ups or collectors, the characteristics of the amplifier circuits, and the characteristics of the electro-acoustic transducer normally have been arranged so as to modify the vibrations and thus produce the desired bell tones at the loud speaker from the particular vibrator or vibrators used.

Prior instruments have employed bars or rods arranged in a fixed-free manner wherein the vibrator has one end thereof fixed and the other end free to vibrate. Free-free vibrators also have been used wherein both ends of the vibrator are unrestrained and therefore free to move, the vibrator being suitably supported.

In the case of an instrument employed to reproduce bell tones, particular care must be used in the arrangement of the vibrators to obtain the desired characteristic tone, the correct relationship of partials, and the correct relationship of damping or decay of the partials relative to each other. This requires that the vibrators function in such a way as to permit the electrical pick-up and electrical circuits and arrangements to finally produce a correct bell tone at the loud speaker.

One of the objects of the present invention is to provide a vibrator or tone generator in an electric music instrument which will produce a bell tone or other desired tone having the correct relationship between the partials and tones therein during the period of vibration of a vibrator thereof.

When a fixed weight is placed on a rod or bar vibrator for purposes of altering the partial structure of a tone produced by the rod, the weight will be frequency selective according to its position on the rod. For this reason, the use of a fixed weight on the rod does not give the desired damping relationship for the partials in the rod to produce correctly a bell tone.

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Another of the objects of the invention is to provide a damping arrangement for a vibrating rod which is only intermittently effective during vibration of the rod, and which will retain the desired partial structure.

The invention contemplates a damping means placed on a rod or vibrator in such a manner that the damping means will be activated upon energization of the rod and will not substantially affect the partial structure relationship during vibration of the rod.

The energy at the end of a rod will be made up of the total energy of all of the partials in the rod, especially in a rod having a free end. The damping can be accomplished by the use of a damping device which is effective intermittently during the vibration period of the rod, the damping device being activated or rendered intermittently effective upon energization of the vibrating bar arrangement.

In one aspect of the invention, reference being made especially to a fixed-free rod arrangement, a receptacle or holding means can be fastened to the free end of the rod and a ball or other shaped solid element placed therein, said ball normally resting on top of the rod. When the rod is set into vibration, the ball will bounce or move relative to the top of the rod and away from contact with the top thereof and thus will intermittently serve to damp all of the vibrations. The damping device thus will not substantially affect the partial structure so that the electrical vibrations produced in the amplifier circuit will have the proper relationship between the various partials from the time the rod is struck until the rod comes to rest. This is not true of a weight permanently fastened at some point along the rod because such a weight will only affect one or some of the partials and will affect these during the entire vibration and not intermittently.

In another aspect of the invention, a finely divided solid material can be placed in the receptacle or holder located on the end of the rod. The finely divided material will be effective intermittently to absorb energy from all of the partials. Also, some type of loosely mounted element can be placed on the end of the rod. In the case of a loosely mounted element, such as a wire or collar, the wire or collar will jump free from the rod intermittently as the rod is vibrated, and thus serve to intermittently damp the various partials. A plurality of spheres may be used at the end of the rod instead of one sphere. Also, a piece of plastic or other energy

absorbing solid material may be loosely threaded through an aperture adjacent the end of the rod so as to intermittently contact the rod upon vibration thereof. The rod may be in the horizontal position as well as vertical, the damping arrangement being suitably positioned on the rod or vibrator. The aforementioned divided material, wire, collar, sphere, or plastic are to be considered solid materials.

The rod and damping device of the present invention can be used for various purposes such as for example, the vibrators in the musical instrument described in the copending application, Serial No. 60,470, filed November 17, 1948, now Patent No. 2,606,474, issued August 12, 1952, or for the type described in copending application, Serial No. 641,243, filed January 15, 1946, now Patent No. 2,463,543, issued March 8, 1949. In each of the aforementioned instruments, a plurality of vibrating rods of the fixed-free variety are mounted on a block or a plurality of blocks, the rods being selected to give the various desired notes of a carillon. Selectively operated strikers are located adjacent said rods so that the various notes of the bell instrument can be sounded. Electric pick-ups or collectors are arranged adjacent the rods and connected to amplifiers for energizing a loud speaker. The amplifiers and loud speaker are selected and arranged to modify or eliminate the partials as desired to produce a good bell tone.

In one of the instruments described, a pair of vibrators is used for each note, said vibrators being tuned a predetermined musical interval apart. In one of said rods, the pick-up is located at a node of one of the partials used to form the synthesized characteristic tone thereof so that the characteristic tone of said rod is changed as described in said copending application, Serial No. 60,470, filed November 17, 1948. The musical interval of the rods is chosen so that the new characteristic tone of one rod will bear the proper relationship to the partials or the characteristic tone of the other rod. The partials of the two rods then can be chosen so that they will be those desired in a bell of the Flemish or harmony type. Damping devices made in accordance with the present invention if placed on such rods will cause the partials to persist the correct length of time and relationship in each rod to produce a good bell tone.

In a rod having free ends, each of the partials will have an anti-node at the free end thereof so that energy will be absorbed from all of the partials intermittently. In the case of a vibrator fixed at both ends, the intermittent damping device of the invention must be placed very close to a fixed end so as to only disproportionately affect a few of the partials. The damping means must be located at a point where there are no nodes of any of the significant partials to be used in producing the desired tone.

The invention may be employed on various types of vibrators and may take various forms other than those described herein. These and other objects, features and advantages of the invention will become apparent from the following description and drawings.

Figure 1 is a perspective view of a pair of rods with the invention in use thereon.

Figure 2 is an enlarged fragmentary view of the top of one of the rods of Figure 1 in section showing one form of the invention.

Figure 3 is similar to Figure 2 except that it shows a modification of the invention.

Figure 4 is similar to Figure 2 with the exception that it shows still another modification.

Figure 5 is similar to Figure 2 except that it shows a further modification.

Figure 6 is a schematic showing of the invention and a wiring diagram therefor.

Figure 7 is a fragmentary view of one form of the invention showing a stabilizer arrangement added thereto.

Figure 8 is a fragmentary view of another form of the invention.

Figure 9 is a fragmentary view of a modification of the form of the invention shown in Figure 8.

In Figure 1 will be found a rod assembly such as described in copending application, Serial No. 60,470, filed November 17, 1948. In this form of the invention, two rods are mounted on a single base, the rods being tuned a predetermined musical interval apart. When only one rod is used per note, all of the rods may be mounted on a single base. Base **20** may be mounted on resilient supports **21**, **21** carried on a bed plate **22**. Rods **23**, **24** are solidly fixed in grooves **25** of base or rod support **20**. The rods preferably are grooved at **23A**, **24A** near their point of emergence from the block or rod support **20**. When a groove, or a plurality of grooves of even depths and widths are placed on a rod, the rod when struck will produce partials falling into a substantially even harmonic pattern.

The collector may take various forms such as seen at **26** and **27** (Fig. 1), said collector plates being mounted on collector plate bar **28**, each collector plate having an electrode **29** closely adjacent its rod. When collector plates are used as seen in Figure 1, the vibrations therefrom are collected and fed to a preamplifier **30** (Fig. 6), said preamplifier being connected to amplifier **31** which in turn is connected to an electro-acoustic transducer or loud speaker **32**. The collector plates **33** in this form are located at desired positions so as to pick up the desired partials from the rods and to eliminate others. Referring to Figure 6, strikers **34** can be selectively operated by a suitable keyboard mechanism **35**. In the case where two rods are employed for producing a single note, one striker is used to strike both rods simultaneously. A rod is seen at **36** and a collector plate at **37** for said rod. A second rod (not seen) also may be on base **38** with a collector plate **39** therefore.

A damping device made in accordance with the invention is indicated at **40** on the end of each rod **36** of Figure 6 and at **41A**, **41B** in Figure 1.

As mentioned previously, the damping device contemplated in the present invention is one which is of solid material and is intermittently effective upon the partials of the rod and which is activated upon energization of the rod. The term "solid material" includes flexible elements such as thread.

In the preferred form of the invention, collar or receptacle **42** (Fig. 2) is screw-threadedly mounted on the end of rod **43**. It is of course obvious that the collar may be fastened on the rod by other means than by threads. A ball **44** is located inside of said collar, said ball normally resting upon the top of rod **43**. The ball **44** preferably has a diameter very close to the external diameter of the rod, there being, for example, a clearance of about 0.002 to 0.003 inch between the ball and the interior wall of the collar or receptacle. It is desirable that the end of the rod be

substantially at right angles relative to the longitudinal axis of the rod so as to obtain consistent damping action when the rod is vibrated.

Also a soft material or paint may be placed on the inside of the collar 42 or cup so that the ball will not set the rod into vibration due to ambient vibrations. The ball may be made of any suitable material such as brass, stainless steel, or other material having the desired resilient and hardness properties.

When the rod is at rest, the ball will be in place on top of rod 43. Upon vibration of the rod, the ball will jump upwardly and return into contact with the end of the rod intermittently so that the rod will be vibrating free of the ball at intervals and thus the ball will not be damping the vibrations continuously as is the case with a weight solidly mounted on a vibrator. The energy from all of the partials in the rod is thus absorbed in pulses as compared to a weight which is permanently located on the rod.

Merely by way of example, in a rod which is 1.7 ozs. in weight, and tuned to middle C, the undamped period will be about 15 seconds as compared to a damped period of about 5 seconds when 2 steel balls of about $\frac{1}{32}$'' diameter are used.

In another form of the invention, the ball may be replaced by a finely divided material 45 (Fig. 3) located in the collar or cup 46, said bushing or cup being firmly fastened to the end of rod 47. It is apparent that as the rod is vibrated, the sand or other finely divided material will change position relative to the end of the rod so that the mass of material will vary and will be effective to damp the vibrations intermittently, similar to the use of the ball.

In still another form of the invention, the holder or collar 48 (Fig. 4) located on rod 50 may have a wire or rod 49 of suitable weight connected over the end thereof, said wire being held in place in some suitable manner. The wire 49 is free to vibrate upwardly and clear of the collar 48 as the rod is struck and thus the mass of the wire 49 will serve intermittently to damp the vibrations in the rod.

In still another form of the invention, a collar 51 (Fig. 5), which may be split, may be placed in the groove 52 cut in the end of rod 53. It is apparent in this form that as the rod is vibrated, the collar will intermittently jump clear from contact with the rod and thus intermittently damp the vibrations in the rod in a manner similar to the previously described arrangement.

In Figure 7 will be seen the use of the invention of the form shown in detail in Figure 2 in conjunction with another arrangement for modifying the vibrations. The stabilizer illustrated will serve to laterally restrict free motion of the rod and thus tend to restrict the fundamental or lowest tone of the rod. This is desirable in a bell instrument wherein the lowest partial tones employed in the electrical system are higher than the fundamental tone or lowest partial existent in the rod.

Rod 54 having grooves 55 may be suitably rigidly mounted in base 56. A collector plate support bar 57 also is firmly held in base 56 so as to vibrate therewith. Collector plate 58 is mounted along rod 54 so that the partial tone or tones desired can be removed. A stabilizer 59 having spring fingers 60 is mounted on collector plate bar 57. The springs are located at the correct place along rod 54 so as not to alter or interfere with any of the desired partials in the rod. The stabilizers can be placed at any desired point along the rods such as near the centers thereof.

A striker mechanism 61 can be carried on a resiliently supported channel 62. In the form shown in Figure 7, two rods for each tone can be carried on a single base, or there may be a single rod for each tone as desired. Preferably, the base 56 is resiliently mounted (not shown) and the weight of the base properly related to the other elements of the vibrating system.

Suitable weights 65 (Figs. 1, 7) may be placed along the rod or rods as desired so as to control the partials in the rods as necessary.

In Figure 8 is seen another form of intermittently acting damping device wherein rod 66 can have an aperture 67 therein loosely holding one leg of the damping element or loop 68. The damping element 68 may be made of wire, plastic, thread, or other suitable material for intermittently absorbing the energy of the partials. The element 68 may be round or flat, or any suitable cross sectional shape. Figure 9 is similar to Figure 8, rod 69 having an aperture 70 loosely holding loop 71. Loop 71 can have a cross section similar to element 68 of Figure 8 and be of similar material.

The forms shown in Figure 8 and 9 are especially suitable for rods mounted in a horizontal position. The other types of damping devices also can be used on horizontal rods by suitably mounted said devices on the ends of the rods.

In accordance with the present invention, the partial tones in a vibrator or vibrators, useful in an electric instrument producing bell tones, can be damped so that the proper relationship between the various partial tones will be present throughout the time of vibration of each vibrator in producing the bell tone, the damping means affecting all of the desired partials in substantially the same manner so as to retain the partial structure produced.

Various modifications may be made in the details of construction described herein, and the invention can be applied to various types of vibrators and musical instruments without departing from the spirit of the invention except as defined in the appended claims.

What is claimed:

1. In a vibrator damping device adapted for use in an electric music instrument or the like, a vibrator element, a solid intermittently acting inertia damping means loosely mounted on and operatively connected with said vibrator, and means normally loosely holding said damping means on said vibrator when said vibrator is at rest, said damping means being activated by vibration of the vibrator to move into and out of damping relationship therewith and thus intermittently damp the partial tones generated in said vibrator.

2. In a vibrator damping device adapted for use in an electric music instrument or the like, a vibrator element, a solid intermittently acting inertia damping device loosely mounted on and operatively connected with said vibrator adjacent one end thereof, and means normally loosely holding said device on said vibrator when said vibrator is at rest, said damping device being activated by vibration of the vibrator to move into and out of damping relationship therewith and thus intermittently damp the partial tones generated in said vibrator.

3. In an electric music instrument vibrator damping device, an elongated rod, a solid intermittently acting inertia damping device loosely mounted on said vibrator, and means normally loosely holding said device on said rod when said rod is at rest, said device being movable intermittently out of damping position relative to said rod upon energization of said rod.

4. In an electric music instrument vibrator damping device, an elongated rod fixed at one end and free at the other, a solid intermittently acting inertia damping device loosely operatively connected to said rod, and means normally loosely holding said device on said rod when said rod is at rest, said device being movable relative thereto intermittently out of damping condition relative thereto, so that the partials in said rod have energy absorbed by said damping device in pulses.

5. In an electric music instrument vibrator damping device, an elongated rod fixed at one end and free at the other, a solid intermittently acting inertia damping device loosely operatively connected to said rod adjacent one end thereof, and means normally loosely holding said device on said rod when said rod is at rest, said device being movable relative thereto intermittently out of damping condition relative thereto, so that the partials in said rod have energy absorbed by said damping device in pulses.

6. In an electric music instrument vibrator damping device, an elongated fixed-free rod vibrator, a solid inertia element, and restraining means loosely connecting said inertia element to said rod, said means normally loosely holding said element on said vibrator when said vibrator is at rest, said inertia member being intermittently contactable with portions of said restraining means as the rod is vibrated so as to intermittently damp the partial tones generated in said rod, and substantially retain the partial structure thereof.

7. In an electric music instrument vibrator damping device, an elongated rod, a restraining means mounted on said rod, a solid inertia means loosely mounted on and carried by said restraining means, and means normally loosely holding said inertia means on said rod when said rod is at rest, said inertia means intermittently contacting said restraining means upon vibration of said rod so as to intermittently damp the partial tones generated in said rod.

8. In an electric music instrument vibrator damping device, an elongated rod, a receptacle mounted on one end of said rod, and a solid ball inertia member held thereby against the end of said rod when the rod is at rest, and intermittently movable away from damping contact with said rod upon energization of said rod so as to intermittently damp partial tones generated by said rod.

9. In an electric music instrument vibrator damping device, an elongated rod, a receptacle mounted on one end of said rod, and a mass of finely divided solid material loosely held in said receptacle in damping relationship relative to said rod when the rod is at rest, the relative position of the mass of said finely divided material at the end of said rod being intermittently variable upon energization of said rod, so as to intermittently damp the partial tones generated by said rod.

10. In an electric music instrument vibrator damping device, an elongated rod, a holder means mounted on said rod, and a solid inertia rod loosely mounted on said holder means and movable relative thereto in and out of damping contact intermittently in relation to said rod when said rod is vibrated, so as to intermittently damp the partial tones generated in said rod.

11. In an electric music instrument vibrator damping device, an elongated rod having a groove therein, and a solid collar loosely mounted in said groove and intermittently movable in and out of damping contact with said rod upon energization thereof so as to retain the partial structure of said rod as it is vibrated.

12. In an electric music instrument vibrator damping device, an elongated rod having an aperture therein adjacent one end thereof, and a solid energy absorbing loop member loosely mounted in said aperture for intermittently absorbing energy upon vibration of said rod, said energy absorbing loop being activated by vibration of the rod to move into and out of damping relationship therewith and thus intermittently damp tones generated in said rod.

13. In a vibrator damping device adapted for use in an electric music instrument and the like, a vibrator element, said vibrator element having an aperture therein, and a solid intermittently acting elongated inertia damping element loosely threaded in said aperture, said element being activated by vibration of the vibrator to move into and out of damping relationship therewith and thus intermittently damp tones generated in said vibrator.

14. In an electric music instrument vibrator damping device, an elongated rod, a solid inertia rod loosely mounted and held on said rod, and means normally loosely holding said inertia rod on said elongated rod when said elongated rod is at rest, said inertia rod being movable relative thereto in and out of damping contact intermittently in relation to said rod when said rod is vibrated, so as to intermittently damp the partial tones generated on said rod.

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