Oct. 13, 1953 F. H. SLAYMAKER ET AL 2,655,070

DAMPING MEANS FOR TONE GENERATORS

Filed Dec. 4, 1950

2 Sheets-Sheet 1

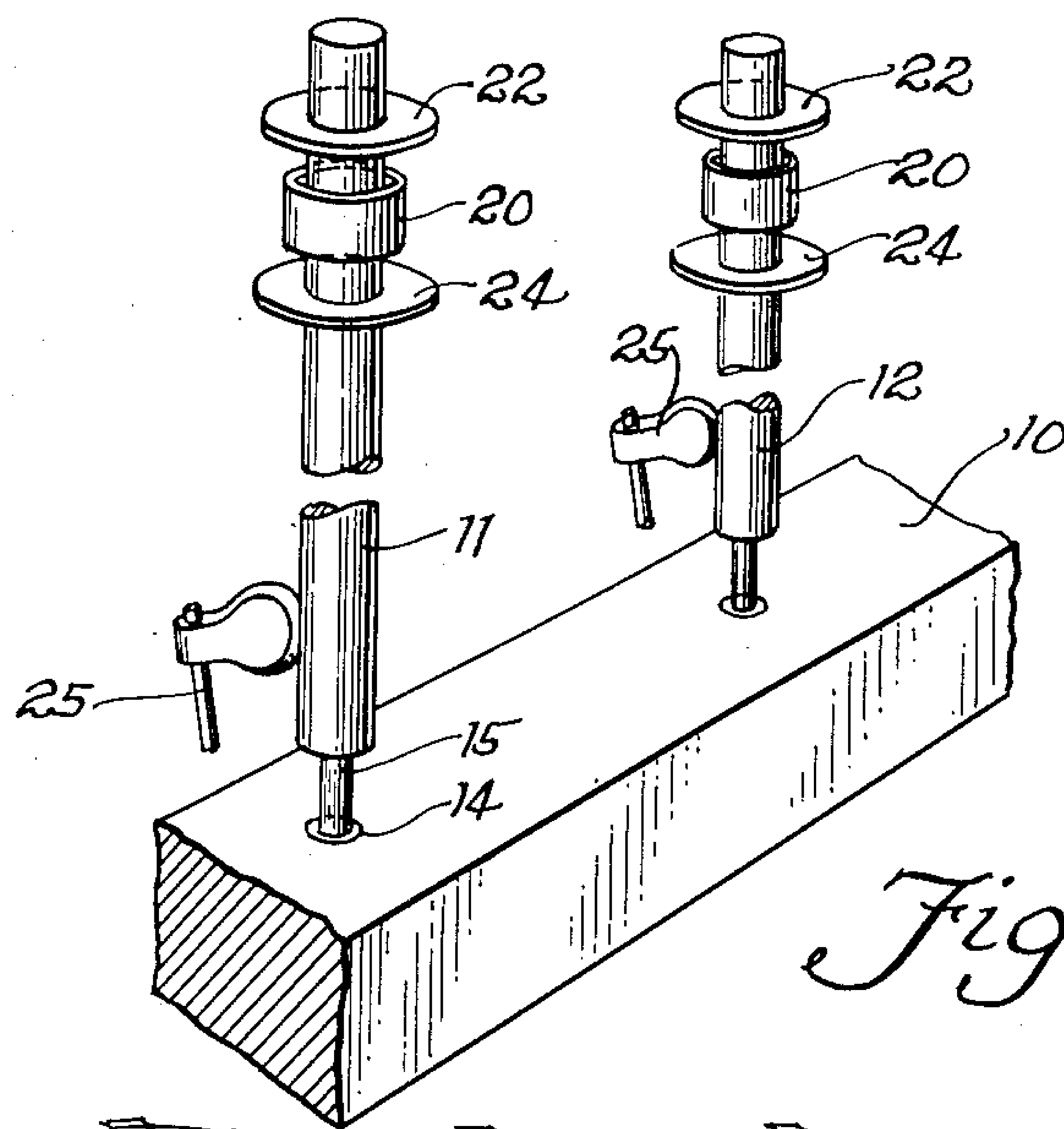

Fig. 1

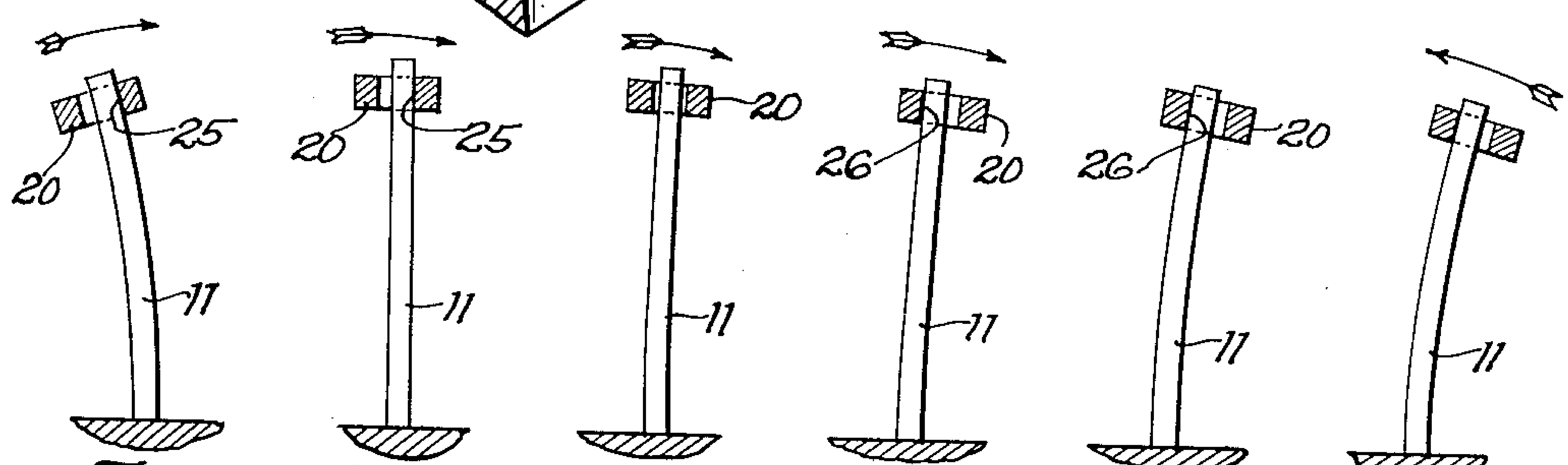

Fig. 2a Fig. 2b Fig. 2c Fig. 2d Fig. 2e Fig. 2f

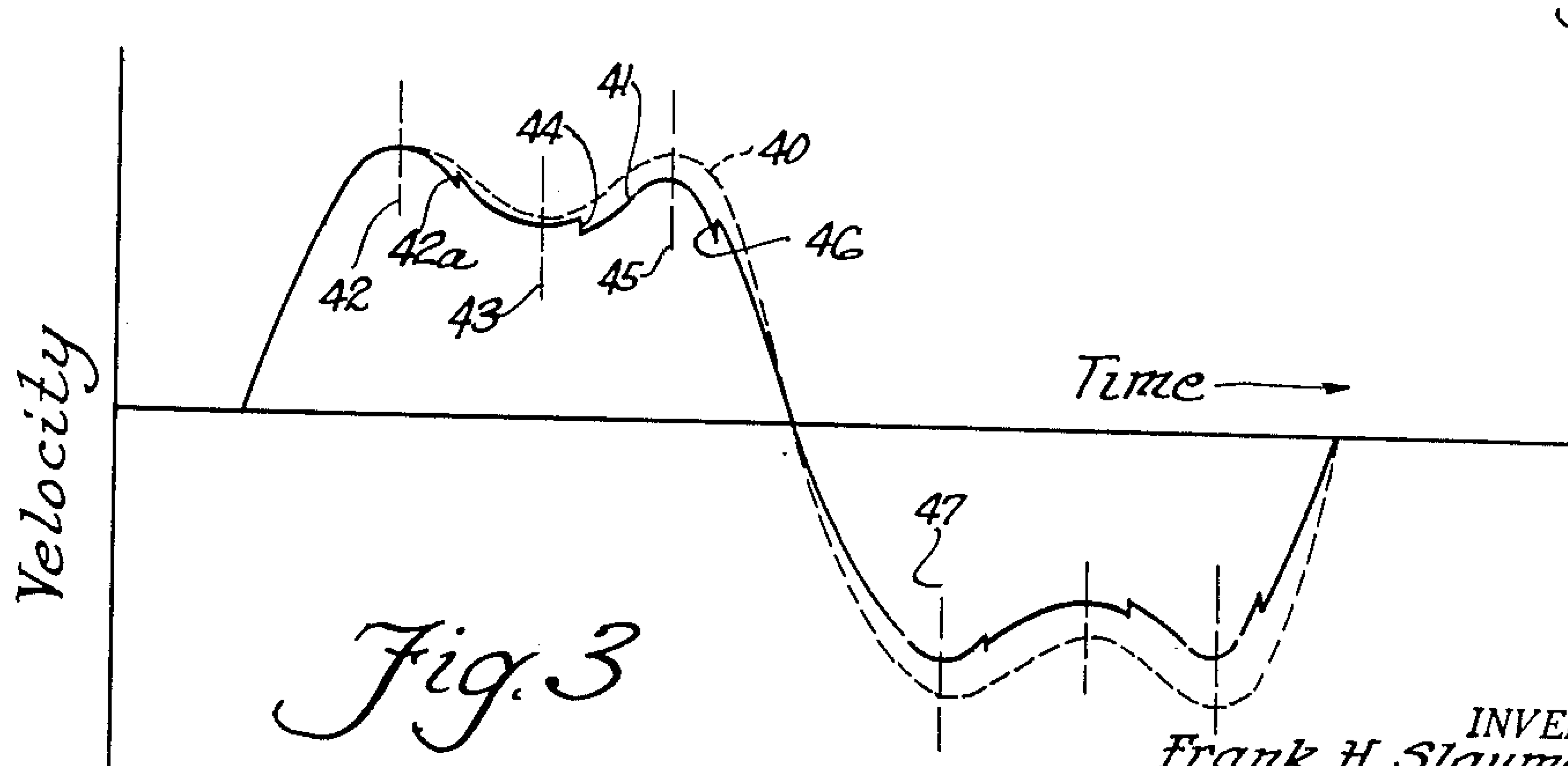

Fig. 3

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DAMPING MEANS FOR TONE GENERATORS

Filed Dec. 4, 1950 2 Sheets-Sheet 2

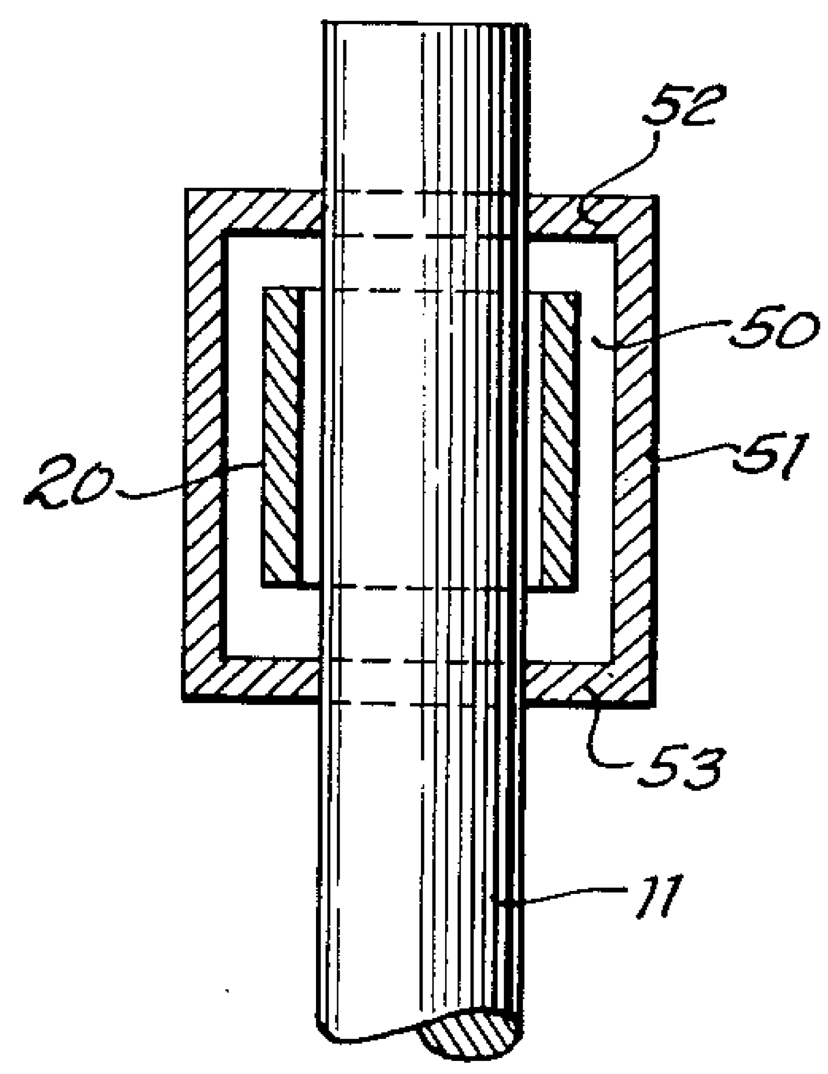

Fig. 4

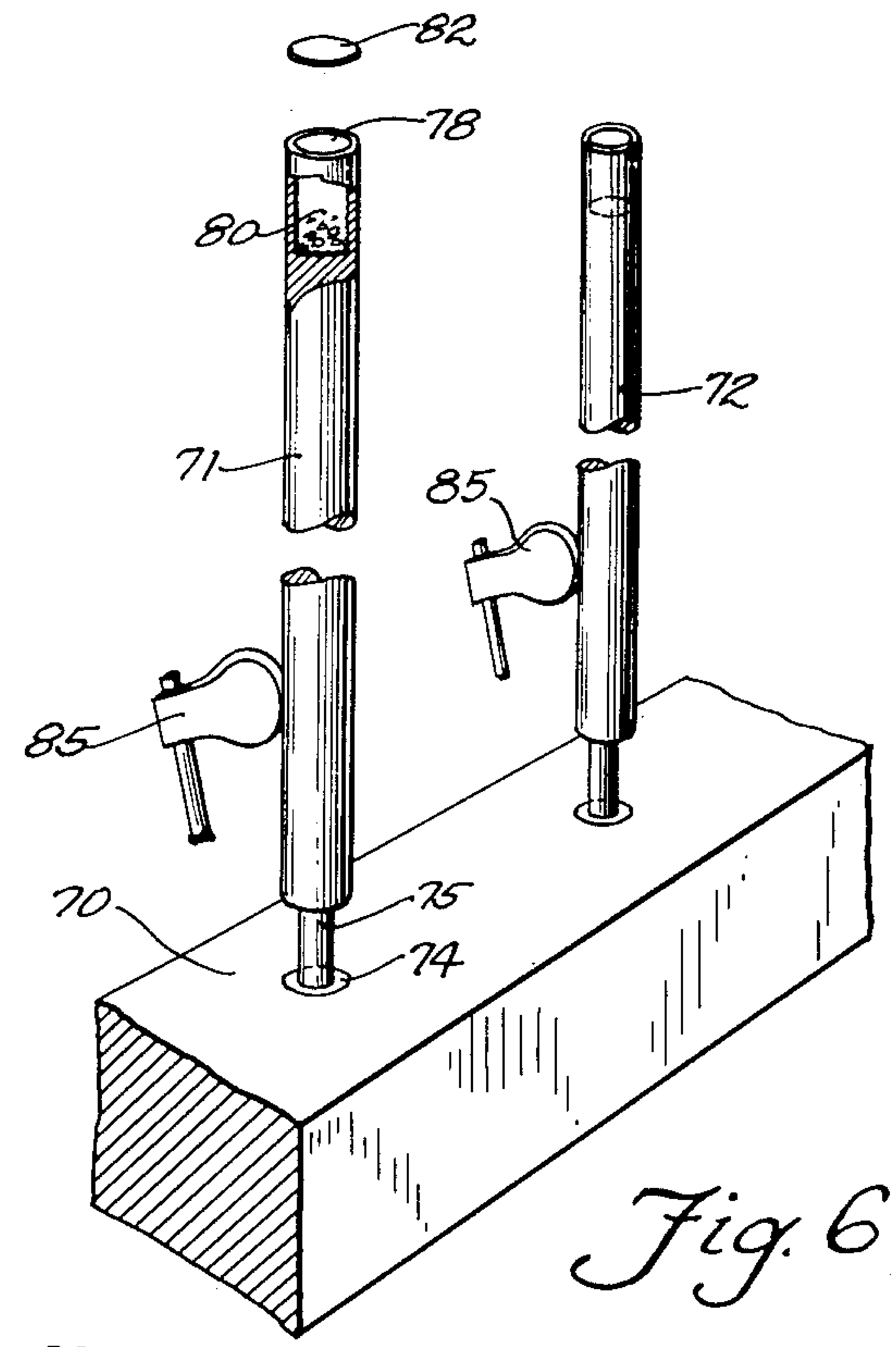

Fig. 6

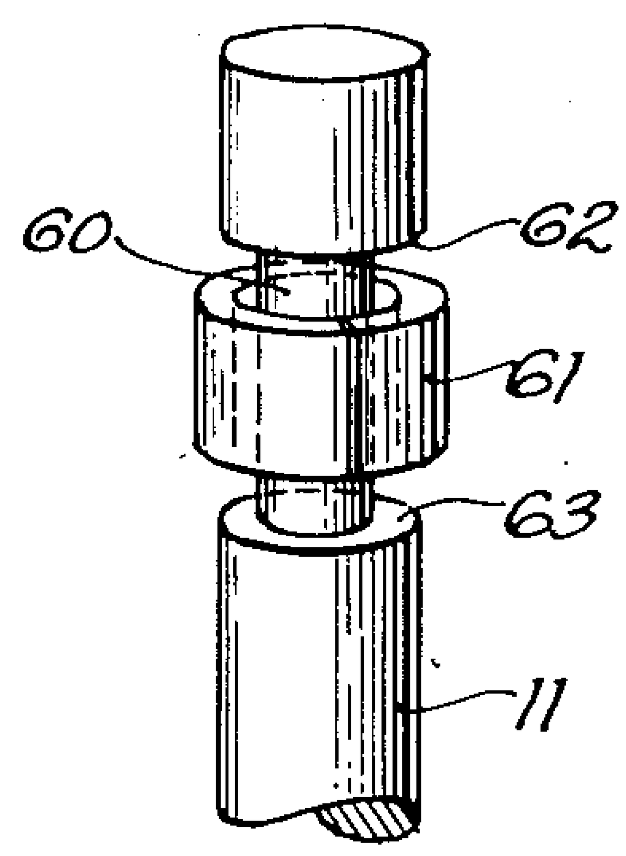

Fig. 5

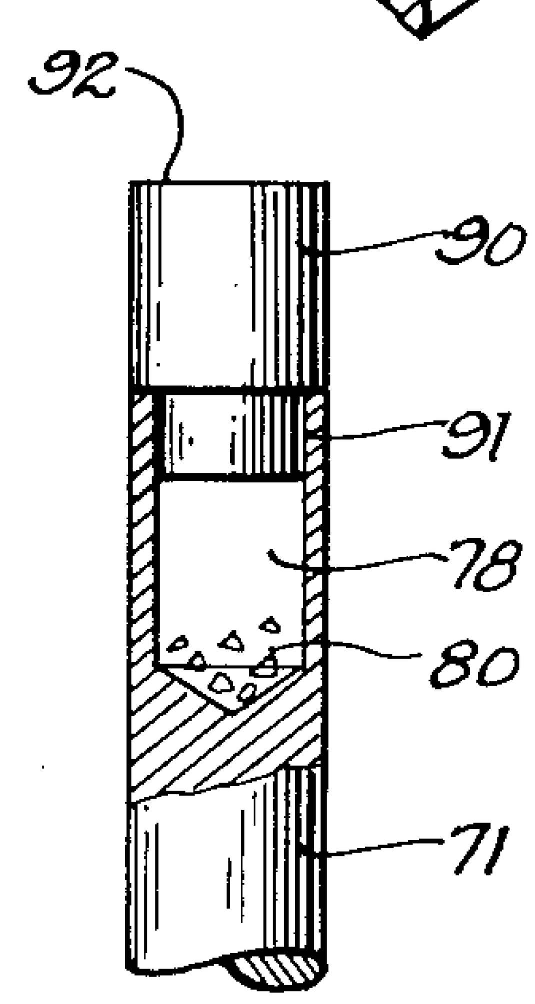

Fig. 7

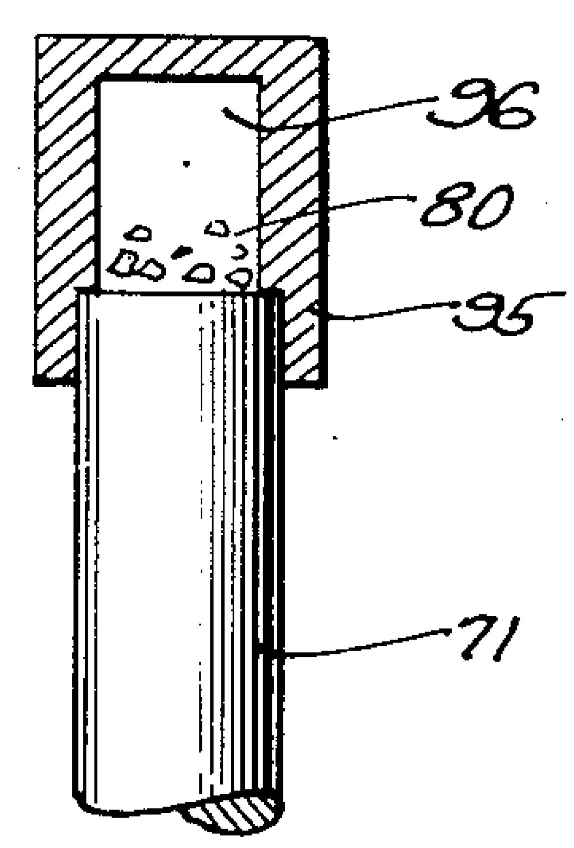

Fig. 8

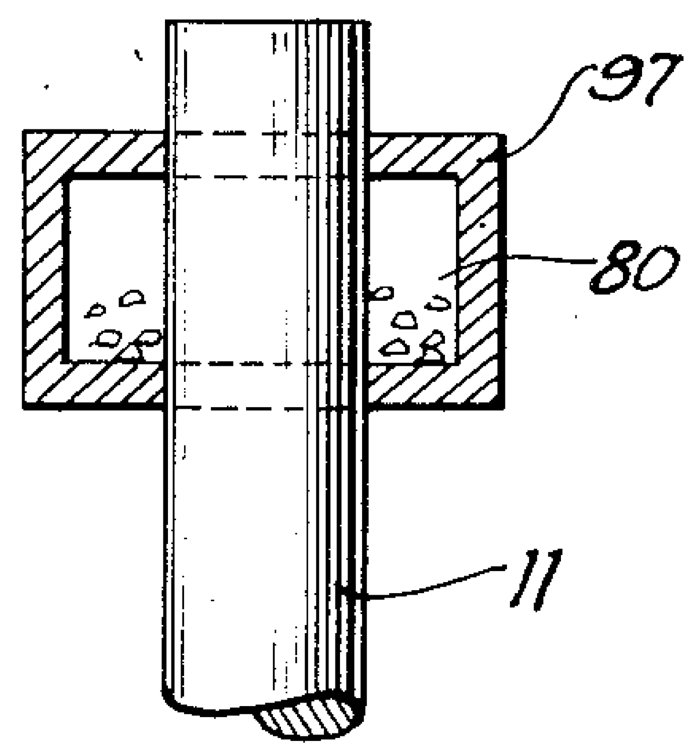

Fig. 9

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DAMPING MEANS FOR TONE GENERATORS

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Application December 4, 1950, Serial No. 199,056

4 Claims. (Cl. 84—404)

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The present invention relates to damping means for tone generators and, more particularly, to damping means for tone generators of the type employing an elongated metallic bar which is struck to produce tone vibrations therein.

In certain musical instruments, such as the electronic carillon, which employ a plurality of tone bars of different lengths and striker means for striking individually or in groups various ones of the bars, it often happens that the vibrations set up in a particular tone bar are sustained so long that an annoying accumulation of after-ring builds up. This after-ring may reach such a volume that it "muddies up" all the music played on the carillon. This tendency toward muddiness is particularly troublesome when notes are played in rapid succession, even though single note passages may sound very pleasing with the long after-ring.

To eliminate the above-described carry-over of the vibrations, or muddiness of the musical passage, it is necessary to reduce the decay time of each tone bar by reducing the amplitude of the vibrations therein by a predetermined small amount during each cycle thereof so that one tone will have died out sufficiently before the next tone is struck to prevent after-ring build up.

While it is possible to damp the tone bar by employing a damping material which has a rather high internal mechanical loss, this type of damping reduces the amplitude of the higher frequency partials much more than the lower frequency components of the tone. Moreover, when the tone generator is in the form of an elongated cylindrical rod clamped at one end, the extremely high damping of the high frequency partials produces an unpleasant "clunky" sound, and it is much more desirable from an esthetic point of view to damp the higher frequency partials less severely than the lower partials.

While certain arrangements heretofore proposed have been employed to damp out completely the vibrations in certain mechanical elements such as relay contact springs or long electrical transmission lines or other mechanical systems in which it is desirable completely to suppress vibrations, these arrangements are entirely unsatisfactory for use as a damping means in connection with a tone generator of the above-described type wherein an extremely small percentage of the total energy of the system is to be reduced during each cycle of the tone generator. Thus, with a conventional tone generator of the above-described type it is

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necessary only to reduce the amount of energy loss per cycle by about .2 per cent for the high frequency partials and by about one per cent per cycle for the low frequency partials.

Accordingly, it is a primary object of the present invention to provide new and improved damping means for a tone generator.

It is another object of the present invention to provide new and improved tone generator damping means whereby the free and clear ringing of a bell is simulated yet the tone does not ring on so long that interference between notes is excessive.

It is a further object of the present invention to provide new and improved damping means for a tone generator of the above-described type wherein a predetermined small percentage of the vibratory energy of the generator is removed during each cycle of vibration thereof.

It is a still further object of the present invention to provide new and improved damping means for a tone generator wherein the percentage change in the rate of decay of the low frequency partials is greater than the percentage change of the high frequency partials.

It is another object of the present invention to provide new and improved damping means which may be employed with the tone generators of an electronic carillon to damp the generators by a sufficient amount to prevent after-ring build up.

It is still another object of the present invention to provide new and improved damping means for a tone generator of the above-described type which may be readily adjusted to permit tuning of the generator without interfering with the damping action thereof.

It is a further object of the present invention to provide new and improved damping means for a tone generator of the above-described type wherein substantially uniform damping of all the frequency components of the tone is achieved, i. e., the decay rates of all components are increased by the same number of db per second.

It is another object of the present invention to provide new and improved damping means for a tone generator wherein damping of a particular frequency component of the tone is substantially eliminated.

It is still another object of the present invention to provide new and improved damping means for the tone generators of an electronic carillon which can be added to existing instruments having undamped tone generators without substantial change thereto.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view of a plurality of carillon-type tone generators which are provided with damping means constructed in accordance with one form of the present invention;

Figs 2*a*–2*f* are diagrams useful to an understanding of the operation of the device of Fig. 1;

Fig. 3 is a timing diagram which further illustrates the mode of operation of the device of Fig. 1;

Fig. 4 shows an alternative embodiment of the invention;

Fig. 5 shows a further alternative embodiment of the invention;

Fig. 6 is a perspective view of a plurality of tone generators which are provided with damping means constructed in accordance with another form of the invention;

Fig. 7 shows an alternative form of the invention;

Fig. 8 shows still another form of the invention; and

Fig. 9 shows an additional form of the invention.

Referring now to the drawings and more particularly to Fig. 1 thereof, one embodiment of the improved damping means of the present invention is there illustrated as employed in a tone generator of the elongated cylindrical rod type having one end thereof securely clamped and the other end free to vibrate. Thus, a carillon base member 10 is used as a support for a plurality of elongated cylindrical tone bars 11 and 12, each of which is securely clamped at one end thereof in the base member 10 by any suitable means such as the socket 14, which is positioned in the base member 10 and receives the end section 15 of the bar 11. Each tone bar is struck at a point somewhat removed from the clamped end thereof by any suitable means such as a hammer 25.

In order to damp the tone bar 11 there is provided a small lightweight damping body 20 in the form of a ring which encircles the free end of the tone bar 11. The damping ring 20 may be made of either an elastic or an inelastic material and has an inside diameter slightly larger than the outside diameter of the bar 11. If an inelastic damping action is required the ring 20 may be made of an inelastic material such as lead. For example, the ring 20 may comprise one or two turns of fine wire solder which is wrapped around the tone bar and twisted. In such an arrangement the clearance between the solder and the tone bar is very small and just that which normally occurs by virtue of the fact that the solder cannot be tightly twisted about the bar. If an elastic damping action is desired, the damping ring 20 is preferably made of an elastic material. For example, the ring 20 may comprise a short length of metal tubing or a plurality of Phosphor bronze or beryllium copper retaining rings. Moreover, we have successfully used materials of the type known as "plastics." For example, a vinylidene-vinyl chloride copolymer such as known under the trade name "Saran" has been found satisfactory. For reasons to be discussed in more detail hereinafter, the clearance between the damping ring 20 and the tone bar 11 is very small. For example, with a tone bar of one eighth inch outside diameter

it has been found that a damping ring of Phosphor bronze or other elastic material should have an inside diameter of 0.140 inch, i. e., a clearance between the ring and tone bar of 0.015 inch.

To prevent the damping ring 20 from moving longitudinally along the tone bar 11, a pair of restraining washers 22 and 24 are provided which are spaced apart so as to retain the damping ring therebetween while permitting limited longitudinal movement thereof. The washers 22 and 24 are preferably constructed of fibrous material and may be secured on the tone bar by first soaking the washers in water and then pushing them over the end of the tone bar. When the washers dry they shrink to a very tight fit. However, it will be obvious that other suitable means may be employed for securing the washers 22 and 24 to the tone bar.

In considering the action of the damping ring 20 upon the vibrations of the tone bar 11 it will be understood that irrespective of whether an elastic or inelastic material is employed, the mass of the damping ring 20 is extremely small as compared to the mass of the tone bar 11. As the tone bar vibrates it carries the ring with it. However, due to the clearance between the ring and the tone bar which permits limited relative movement therebetween, impacts occur between the ring and the tone bar and some energy is lost from the vibratory system at each impact. While I prefer to employ an elastic damping body for reasons to be pointed out in more detail hereinafter, a qualitative discussion of the simpler damping action provided by an inelastic damping ring will be given before considering the action which obtains when an elastic ring is used.

When an inelastic impact occurs between the ring 20 and the bar 11, the two members remain together after the impact until the bar begins to slow down. The tone bar slows down after it passes the middle equilibrium position due to the increasing restraining force produced by flexion of the bar. As the bar slows down, the ring continues to move in its original direction and with the maximum velocity obtained. If the clearance between the ring and the tone bar is small as compared to the amplitude of vibration of the bar, the ring overtakes the bar almost immediately after the bar passes through its maximum velocity point and before the bar reaches its maximum displacement point. Thus, the collision occurs while the damping ring 20 and the free end of the tone bar 11 are traveling in the same direction but at different velocities. Accordingly, the impact of such a collision is much smaller than if the tone bar and damping member were traveling in opposite directions.

If the clearance between the damping ring and the bar is so large that the bar can reverse directions between the instant that the bar and the ring separate and the instant that they collide again, the damping is violent and completely destroys the vibrations of the tone bar in one or two cycles. Such a damping action is entirely unsuited for the control of musical tones. However, in accordance with the present invention and when an inelastic ring is used, the clearance between the ring and the tone bar is very small as compared to the amplitude of vibration of the tone bar. In this connection it will be understood that as the vibrations die out in the tone bar, a situation will occur at which the amplitude of vibration is so small that the bar can change direction before the collision with the damping ring takes place and a violent collision occurs due to the fact that the ring and bar are traveling in opposite directions. However, in accordance with the present invention, the clearance between the damping ring and the tone bar is made small enough that a reversal of direction of the tone bar without collision does not take place throughout the audible portion of the tone. Thus, throughout the audible range of the tone bar vibrations the impacts between the tone bar and damping ring occur while these members are traveling in the same direction, although at different velocities, so that a very light damping action is produced and the pleasing qualities of the tone, particularly the high frequency partials thereof, are preserved although the overall decay time of the tone is substantially reduced to prevent after-ring build up. It will also be understood that when the frictional forces between the restraining washers and the damping ring become larger than the acceleration forces, a situation which obtains with low amplitude vibrations, no more impacts between the tone bar and the damping member will occur.

In order to illustrate more clearly the action of the damping ring 20 in providing a predetermined small amount of damping for the tone bar 11, reference is now made to Figs. 2a to 2f, inclusive, wherein the relative movement between these members is shown. Thus, referring to Fig. 2a, the bar 11 is shown at the instant just after its reversal of direction and in its position of maximum displacement. In this position, one side of the tone bar 11 is in contact with the inner surface 25 of the damping ring 20 and the ring and bar are moving together at the same speed. In the position shown in Fig. 2b the bar has just reached its center or equilibrium position. It will be noted that the damping ring 20, at this point in the travel of the bar 11, is still so positioned that the inner surface 25 of the ring is in contact with the bar. In the position shown in Fig. 2c, which occurs just slightly after the bar has passed through the center equilibrium position of Fig. 2b, the free end of the bar has slowed down slightly although the damping ring has continued to move at its previous velocity so that the damping ring is now separated from the bar.

In the position shown in Fig. 2d the damping ring, which has been moving at a greater velocity than the free end of the tone bar, has overtaken the bar and moved to such a position that the rear inner surface 26 of the ring collides with the other side of the bar. Thus, the ring 20, during the interval from Fig. 2b to Fig. 2d, frees itself from one side of the bar and then catches up with and impinges upon the opposite side of the bar. The rear surface 26 of the damping ring 20 remains in contact with the bar 11 while the bar swings to the point of maximum displacement, as shown in Fig. 2e, at which point the bar is stationary. The damping ring and tone bar further remain in contact after the bar reverses direction as shown in Fig. 2f. However, after the tone bar passes through the equilibrium position in the opposite direction, the damping ring again separates and catches up with the bar so that the inner surface 25 of the ring again contacts the first side of the bar as shown in Fig 2a.

In the inelastic collision illustrated in Figs. 2a–2f, momentum is conserved, but energy, insofar as the motion of the members is concerned, is not. Accordingly, at each impact between the damping body and the tone bar some energy is lost from the total system. To further illustrate the inelastic damping action described above, Fig. 3 shows a graph of the velocity of the free end of a tone bar in which there are two frequency components present. In Fig. 3 the undamped velocity of the free end of the tone bar 11 is illustrated by the dotted line 40, whereas the solid line 41 shows the velocity when an inelastic damping ring 20 is positioned in the manner described above about the free end of the tone bar. Considering the damped characteristic 41, it is evident that just after the tone bar passes the first equilibrium position with maximum velocity, as illustrated by the dotted line 42, the tone bar begins to slow down while the ring continues to travel at the same speed so that the ring collides with a first side of the bar at the point 42a, and remains in contact with the bar until the next equilibrium position occurs as indicated at the dotted line 43. Just after the position 43 is reached, the tone bar speeds up so that it frees itself from the damping ring and continues to speed up until the other side of the bar contacts the damping ring at the point 44. The damping ring and tone bar then remain in contact from the point 44 through the next equilibrium position 45, after which point the tone bar slows down while the damping ring continues to travel at the same velocity so that the damping ring contacts the first side of the tone bar at the point 46. The damping ring and tone bar then remain in contact from the point 46 through the next equilibrium position indicated by the dotted line 47, after which point the same cycle of collisions between the tone bar and the damping ring occurs. In this connection it will be understood that the damping action of the ring 20 is greatly exaggerated in Fig. 3 to facilitate analysis thereof. In action practice the ring 20 extracts a maximum of about 1% of the energy of the bar during each cycle of vibration thereof.

It will be noted from the foregoing description that the inelastic damping action which obtains with a complex tone in which the damping ring first overtakes the tone bar and then the tone bar overtakes the ring. However, all of the impacts between the tone bar and damping ring occur while these members are traveling in the same direction. The diagram of Fig. 3 is based upon the assumption that the clearance between the inelastic damping ring and the tone bar is small as compared with the amplitude of vibrations of the bar. It will be evident that such a requirement is necessary in order to practice the present invention for if the clearance between the tone bar and ring is large the bar can reverse direction in the interval between the instant that the bar and ring separate and the instant that they again collide.

If an elastic damping ring is employed in the arrangement shown in Fig. 1, the damping action between the tone bar and the damping ring is more complex than if an inelastic damping ring is used. If the ring is very small in mass as compared with the mass of the tone bar and if the ring is struck by the bar when the bar is traveling at a given velocity, the ring will bounce away from the bar at almost twice the velocity of the bar. Traveling at this rate, the ring soon overtakes the bar and bounces back again even though the clearance between the bar and ring is substantial. This bouncing back and forth can take place may times in the course of one cycle of vibration of the bar. However, with smaller clearances the collisions take place more often and a heavier damping action is produced. When the tone bar overtakes the ring and collides with it, or when the ring and tone bar collide when traveling in opposite directions, the damping ring takes energy from the bar. Due to the elasticity of both the tone bar and the elastic ring 20 the amount of energy consumed during these impacts is very small. When the damping ring overtakes the tone bar and collides with it, some energy is restored to the tone bar from the damping ring. However, due to internal losses in the damping ring, and losses due to air viscosity, and the like, each collision results in a small loss of energy from the system. Also, it has been observed that the elastic damping rings spin violently and climb up and down the tone bar within the limits imposed by the restraining washers so that energy is also lost from the orderly state of vibrations within the bar to sustain this very random motion of the damping ring. Additionally, a certain amount of the energy is lost in friction between the damping ring and the tone bar as the ring spins and climbs up and down the bar.

The random character of the motion of the elastic damping ring is markedly different from the action of an inelastic ring. Due to the random motion of the elastic ring there is little frequency discrimination in the damping effected by the ring and approximately the same number of decibels per second is added to the decay rates of all of the frequency components which go to make up the composite vibration of the tone bar. Accordingly, when an elastic damping ring is employed the damping means of the present invention provides substantially uniform damping for all of the frequency components of the tone.

In considering the damping action achieved with either an elastic or an inelastic damping ring, it will be understood that the damping ring provides a subtle type of damping in which a very small amount of energy is extracted from the vibratory system during each cycle of oscillation thereof. Thus, the lightweight damping body produces a gradual decrement of the tone vibration during each cycle and the high frequency partials are not excessively damped so that a very pleasing bell-like tone is provided although the overall decay rate of the tone is substantially decreased to avoid after-ring. Another advantage of the tone generator damping described above is that the damping bodies are of such small mass that the tuning of the tone bar is not noticeably altered thereby and the bars may be tuned independently of the action of the damping body thereon. Additionally, the damping means described above can be added to existing tone bar instruments, such as carillons, in a simple and economical manner without making other changes in the instrument, an advantage which is particularly desirable in eliminating after-ring in presently existing carillons.

The above-described damping means has the further advantage of permitting a particular tone partial to be accentuated. Thus, if the position of the damping ring corresponds to the node of a particular frequency component of the tone, the tone vibrations at that point will not include that particular frequency component. Accordingly, the damping ring will not affect this frequency component but will damp the remaining components in the manner described above so that the frequency component in question is accentuated.

While the damping ring has been illustrated as positioned at the free end of the bar, it will be evident that effective damping control can also be obtained when the damping ring is positioned nearer the clamped end of the bar. Also, it will be evident that the damping body may comprise several rings in the event that a heavier damping action is desired.

In the alternative embodiment of the invention shown in Fig. 4, the damping ring 20 is positioned within a chamber 50 defined by a cylindrical enclosing member 51 which fits snugly over the free end of the tone bar 11. The end walls 52 and 53 of the chamber 51 act as retaining washers to restrain the longitudinal movement of the damping ring. With this arrangement, the chamber 50 is sealed against dirt, and damage during use thereof is substantially prevented.

In the alternative embodiment shown in Fig. 5 the use of retaining washers is eliminated and the tone bar 11 is provided with a section 60 of reduced diameter. A split damping ring 61, which is of small mass and of just slightly larger inside diameter than the reduced section 60 is then slipped over the reduced section and vibrates between the shoulders 62 and 63 which restrain the longitudinal movement of the damping ring. The damping ring 61 is preferably of elastic material so that it may be opened to permit insertion over the tone bar 11 and the damping action thereof is identical to that described above in connection with Fig. 1.

In Fig. 6 there is illustrated another alternative embodiment of the invention in which the tone bars 71 and 72, each of which is securely clamped in the base member 70, are provided with cavities 78 in the upper ends thereof. The tone bars 71 and 72 may be secured to the base 70 by any suitable means such as the socket 74, which receives the reduced neck 75 of the tone bar 71. In the embodiment of Fig. 6, the damping body comprises a plurality of particles 80 which are loosely positioned within the cavity 78. The cavity 78 is sealed by any suitable means such as by the cover 82 which may be of cellophane tape or the like. The tone bar may be struck at a point somewhat removed from the clamped end thereof by any suitable means, such as the hammer 85, to produce fundamental and overtone vibrations thereof.

For reasons to be discussed in more detail hereinafter, the particles 80 are preferably of a highly elastic material such as sand, and the number of particles positioned within the cavity 78 is extremely small. For example, in a tone bar having a cavity 78 approximately one-fourth inch deep and $\frac{3}{32}$ inch in diameter, it has been found that approximately fifty grains of sand having an average diameter of .5 millimeter will provide a suitable damping characteristic for an elongated cylindrical tone bar having an outside diameter of one-eighth inch and a length of seventeen and one-fourth inches.

When the tone bar 71 is struck by the hammer 85, vibrations are set up in the bar so as to produce a fundamental tone and certain overtones as determined by the physical dimensions of the bar. Without considering the effect of the particles 80 which are positioned within the cavity 78, it will be evident that the vibrations set up in the tone bar 71 continue for a substantial period of time, the decay rate of these vibrations being determined by the internal, or inherent damping of the vibratory system. While it is possible to decrease the decay time of the tone bar 71 by using a damping material having a rather high internal mechanical loss, which is attached to the free end of the tone bar, this type of damping reduces the high frequency components, or partials, much more than the low frequency overtones, and accordingly, damping of this type produces an unpleasant "clunky" sound and is not suitable for use in carillons or other similar musical instruments.

In considering the action of the particles 80 in providing a suitable damping of the tone bar, it will be understood that if the particles 80 are packed within the cavity 78 and occupy a substantial part of the cavity, the particles will slide over one another as the tone bar vibrates so as to produce an energy loss due to friction between the particles. The forces which cause the particles to slide over one another must be sufficient to accelerate the particles from their rest position, and due to the fact that the acceleration is proportional to the square of the frequency, the higher frequency components of the tone are much more rapidly damped than the low frequency components thereof. While this type of damping is suitable for complete destruction of the vibrations, such as is required in certain mechanical systems, it does not produce a subtle damping of the tone bar and does not preserve the brilliance and esthetic qualities of the tone.

In accordance with the present invention, the particles 80 are preferably of a highly elastic material and an extremely small number of particles is positioned within the cavity 78 so that in the main the particles do not slide over one another but instead collide directly with each other and with the walls of the cavity 78 to decrease the total energy of the vibratory system. Thus, part of the energy of the vibrating tone bar is lost at each collision of a sand particle with the walls of the cavity 78 and with each collision of one particle with another. Since both the silica particles and the steel tone bar are highly elastic the energy actually lost at each collision is extremely small. Other sources of energy loss include the viscosity loss as the sand travels through the air at a high velocity and the friction between sand particles that happen to graze by each other. However, due to the fact that an extremely small number of particles is employed, the energy loss due to friction between the particles is a small portion of the total energy and accordingly, the energy loss is not predominately in the high frequency region. Another energy loss which occurs is the conversion of the highly ordered energy, which is stored in the vibrating bar at very definite high frequency overtones, into the random, and hence useless, energy of the dancing sand particles.

While other finely divided materials can be used instead of sand for the damping particles 80, these materials are preferably elastic to reduce the frictional losses to a minimum. Large particles, such as steel shot, have been found unsatisfactory since they produce a rattling sound which detracts from the over-all tone brilliance and clarity.

While the provision of a plurality of elastic particles in a cavity located in the end of the tone bar is entirely satisfactory to produce a tone damping characteristic which is pleasing to the ear, it is also necessary in the mass production of tone bars for electronic carillons and the like to provide means for varying the length of the tone bars so that they emit a tone of a particular fundamental frequency. To meet both of these requirements, the alternative embodiment shown in Fig. 7 may be employed. Thus, referring to this figure, the tone bar 71 is again provided with a cavity 78 in the end thereof, in which there is positioned a plurality of small elastic particles 80 in the manner described in connection with Fig. 6. However, the cavity 78 is closed by means of a plug member 90 having a reduced end portion 91 which fits snugly into the end of the cavity 78. With this arrangement, a sufficient number of particles 80 may be positioned within the cavity 78 properly to damp the tone bar 71 after which the plug member is inserted into the cavity 78 and the end surface 92 of the plug 90 is then ground off a predetermined amount so as to tune the tone bar assembly to the desired frequency.

In the alternative, the construction of Fig. 8 may be employed wherein the particles 80 are positioned atop the free end of the tone bar 71 and are enclosed by means of a cap member 95 which fits over the end of the tone bar 71 and is provided with a central cavity 96 therein. The cap member 95 is preferably of a lightweight plastic such as polystyrene or the like, and is of sufficiently small mass so that it does not affect the tuning of the tone bar. Also, the tuning of the bar may be made sufficiently sharp without the cap 40 so that it will be correctly tuned with the cap in place.

Another alternative arrangement, shown in Fig. 9, consists in providing a hollow chamber 97 which slides over the end of the tone bar 11 and may be secured in place at the free end thereof by any suitable means, the chamber 97 completely enclosing the damping particles 80. The tone bar 11 is then tuned in the conventional manner by grinding off the free end of the bar without interfering with the receptacle 97 which holds the damping particles.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention as defined in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a carillon or similar device, the combination of, a tone bar, means for striking said bar to produce tone vibrations therein, a damping ring of elastic material loosely encircling said bar, and means comprising two movable restraining members for limiting the movement of said ring along said bar, said ring having a small mass as compared with the mass of said bar to produce a gradual decay of said tone vibrations without excessively damping the higher partials of said tone.

2. In a carillon or similar device, the combination of, a tone bar, said bar having a neck portion adjacent one end thereof, said tone bar also having a substantially uniform cross-sectional area from said neck portion to the other end of said bar, means for striking said bar to produce tone vibrations therein, a damping ring of elastic material loosely encircling said bar, and two movable restraining members for limiting the movement of said ring along a portion of said uniform cross-sectional area of said bar, the maximum clearance between said ring and said tone bar being smaller than the maximum amplitude of vibration of said bar thereby to produce a gradual substantially uniform increase in the rates of decay of all of the partials of said tone.

3. In a carillon or similar device, the combination of, a tone bar clamped at one end and having the other end free to vibrate, said tone bar having a substantially uniform cross-sectional area

adjacent said other end and along the vibrating length of said bar, means for striking said bar to produce vibrations therein corresponding to a predetermined musical tone, a damping ring of elastic material loosely encircling said bar, movable washers for retaining said ring on said uniform cross-sectional area of said bar, said ring having a small mass relative to the mass of said bar, the maximum clearance between said ring and said bar being smaller than the maximum amplitude of vibration of said tone bar, thereby to produce a gradual substantially uniform increase in the rates of decay of all of the tone partials.

4. In an electronic carillon or similar device utilizing a mass element, a tone bar, means for securing said tone bar to said mass element, a striker, means including said striker for vibrating said tone bar, the combination comprising: a damping ring of elastic material encircling said tone bar, two retaining members, said retaining members being positioned in spaced apart relationship on either side of said damping ring whereby said damping ring is afforded freedom for movement along the length of said bar, the maximum clearance between said ring and said bar being smaller than the maximum amplitude of vibrations of said bar, thereby producing a gradual substantially uniform increase in the rates of decay of all partial tones.

FRANK H. SLAYMAKER.
WILLARD F. MEEKER.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,140,932	Young	May 25, 1915
1,145,213	Remane	July 6, 1915
1,843,553	Gladstone	Feb. 2, 1932
2,155,052	Byland	Apr. 18, 1939
2,180,539	Miller	Nov. 21, 1939
2,195,041	Von Schlippe	Mar. 26, 1940
2,302,670	Buchanan	Nov. 24, 1942
2,375,818	Peters	May 15, 1945
2,519,306	Zimmerman	Aug. 15, 1950
2,606,474	Kunz	Aug. 12, 1952