April 29, 1952 B. F. MIESSNER 2,594,967

APPARATUS FOR PRODUCTION OF MUSIC

Filed Nov. 5, 1946 2 SHEETS—SHEET 1

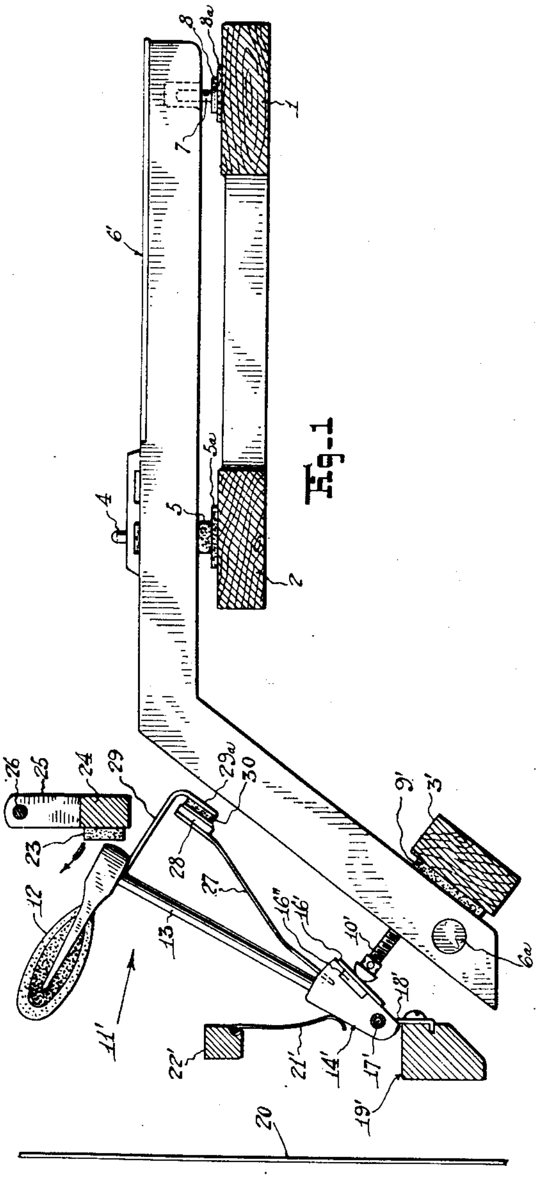

Fig-1

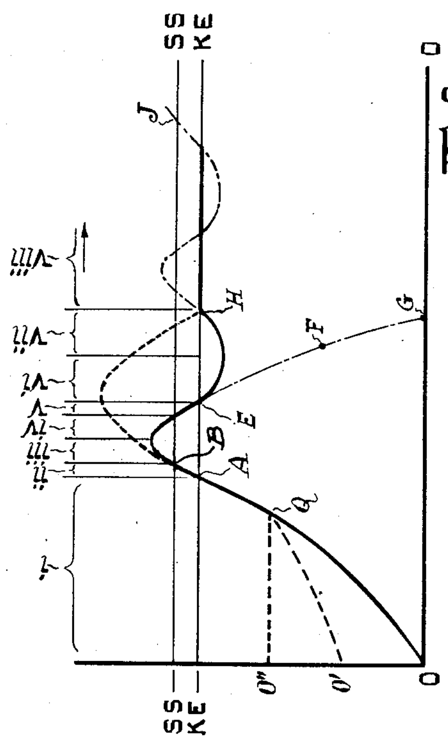

Fig-6

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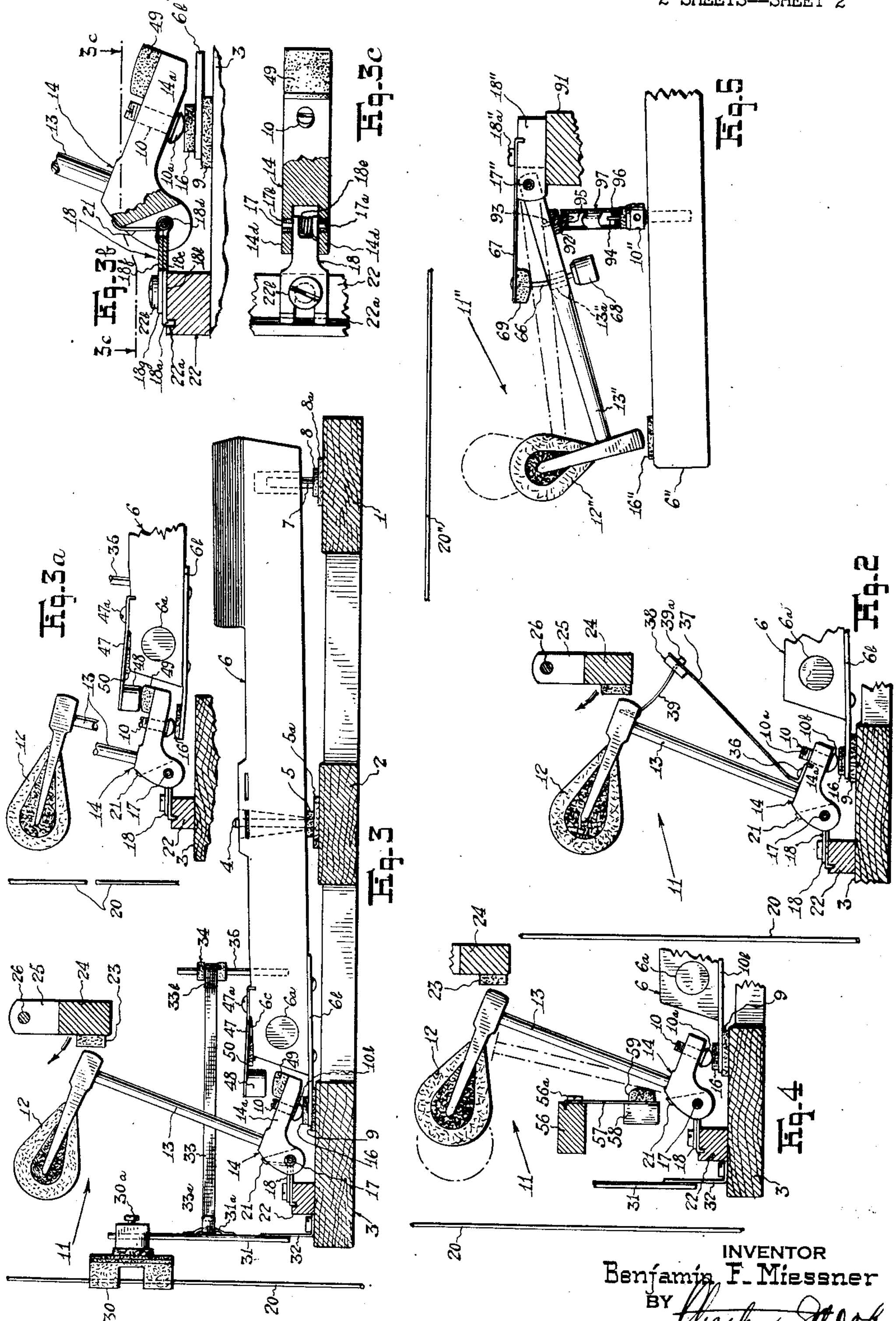

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Patented Apr. 29, 1952

2,594,967

UNITED STATES PATENT OFFICE

2,594,967

APPARATUS FOR PRODUCTION OF MUSIC

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Application November 5, 1946, Serial No. 707,879

17 Claims. (Cl. 84—240)

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This invention relates to musical instruments, and more particularly to those of the type wherein tuned vibrators are subjected to impulse excitation by mechanical means. The invention contemplates especially, though not in all aspects limitatively, instruments of the piano type, wherein tuned strings or other vibrators are percussively excited by hammers under the control of a keyboard. The description will accordingly be presented largely with relation to a piano.

This application is in part a continuation of my copending application Serial No. 566,979, filed on December 7, 1944, on which U. S. Patent No. 2,469,568 has since been issued.

In U. S. Patent No. 2,271,460 issued January 27, 1942, on an application of mine and in the copending application above referred to, I have disclosed vibrator-exciting actions from which there were omitted the tripping or escapement mechanism for displacing a jack, the back-check, and the repetition mechanism, of conventional actions. In these constructions the hammer was permitted to rebound from the vibrator against the same actuating means as had propelled it toward the vibrator (assuming continued key depression); but unwanted rebound of the hammer from the actuating means back toward the vibrator was suppressed by the appropriate application to the hammer of opposing impacts, aided by the appropriate introduction of viscous energy dissipation into the system.

The present invention has for an object the improvement of actions of the type disclosed in the patent and copending application above mentioned.

One disadvantage attendant in some degree on the actions I have disclosed heretofore has been a tendency toward prolongation of the contact of the hammer with the vibrator. It is an object of the present invention to reduce or eliminate any such prolongation.

Another disadvantage attendant in some degree on the former actions has been a slowing of the return of the hammer to redrivable position when the key has been promptly released—an effect which, while still leaving the return favorably comparable with that in conventional actions, can be reduced or eliminated. It is an object of the present invention to reduce or eliminate any such slowing of hammer return to redrivable position.

It is an object to provide an action, of the simplified type above referred to, whose construction is extremely simple and inexpensive.

It is an object to provide an action of the simplified type with which the reduction (as by a "soft pedal") of keystroke will be unaccompanied by any movement of the keys.

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It is an object to provide an action of the simplified type in which the "feel" of the key to the player will closely simulate that of the key in a conventional action.

It is an object to provide a simplified and improved damper construction and control.

It is an object to provide a simplified and improved flange-hammer assembly.

It is a general object to provide a simplified and improved action.

Other and allied objects will more fully appear from the following description and the appended claims.

In the description of my invention hereinafter set forth, reference is had to the accompanying drawings, in which:

Figure 1 is an elevational view of one embodiment of my invention, by way of example illustrating that embodiment in an upright-piano action of the so-called "dropped" type;

Figure 2 is a fractional elevational view of another embodiment of my invention, by way of example illustrating that embodiment in an "undropped" type of upright action such as is more fully illustrated in Figure 3;

Figure 3 is an elevational view of another embodiment of my invention, which I presently believe to be preferable to the preceding two;

Figure 3*a* is a fractional repetition of Figure 3, but showing the key and hammer positions at an intermediate point in the stroke of the key;

Figure 3*b* is an enlargement, with a small part broken away, of a portion of Figure 3;

Figure 3*c* is a cross-sectional view taken substantially along the line **3*c*—3*c*** of Figure 3*b*;

Figure 4 is a fractional elevational view of another embodiment of my invention, by way of example in a type of action similar to that of Figure 3;

Figure 5 is a fractional elevational view of an embodiment, of my invention, which in its broader aspects is similar to that of Figure 4 but is incorporated in a grand-piano action; and

Figure 6 is a group of curves, plotted against time, illustrating the motions of certain important elements in typical embodiments of my invention.

In Figure 1 the numerals **1**, **2** and **3'** respectively designate the front, intermediate and rear rails of the key-assembly portion of an action. Extending upwardly from the rail **2** is shown a pin **4**, encircled by a bushing or pad **5**; and a key **6'** is shown pivotally assembled on that pin and resting on that pad. The front end of the key extends over the rail 1, which is provided with the guide pin 7 extending upwardly and freely into the key, that pin being encircled by the bushing or pad 8 underneath the key. The rear end of the key, beginning a little behind the region of pivoting, is shown as extending diagonally downwardly-and-rearwardly, and as normally resting against a pad 9′ secured on the upward-rearward surface of the rail 3′; appropriate weighting, such as indicated by 6*a*, may be provided in the rear portion of the key. Opposite its point of normal rest against pad 9′, the key is provided with an upwardly-and-rearwardly extending capstan screw 10′. The key assembly as so described is a known one, appropriate to a "dropped" type of upright-piano action; and it will be understood that upon a downstroke of the front end of the key 6′, to bring it into impingement against the top of pad 8, the capstan screw 10′ will be moved a short distance upwardly-and-slightly-rearwardly, in an arc about the pivot pad 5.

Driven by the capstan screw 10′, upon downstroke of the key (i. e., of the front end of the key), is the hammer 11′. This may be considered as comprising the hammer head 12; the hammer stem 13, at the top of which the head 12 is secured; the hammer butt 14′, in which the bottom end of the stem 13 is secured; the pad 16′ covering the downward-forward surface of the butt 14′, against which the capstan screw 10′ exerts its moving force; and preferably the further pad 16″ inset into the butt 14′ underneath the pad 16′ opposite the capstan screw 10′. The butt 14′, and thereby the entire hammer 11′, is pivoted at 17′ to a flange 18′, which in turn is secured to a suitable rail 19′ in the action.

The string which the hammer 11′ is to strike is shown as 20, vertically disposed behind and in the path of movement of the hammer when it pivots about 17′. It will be understood that upon downstroke of the key, the attendant motion of the capstan screw 10′ will rock the butt 14′ rearwardly about 17′, carrying the hammer head 12 toward the string.

The capstan screw 10′ may be so adjusted that at the conclusion of an abnormally slow key downstroke—i. e., one so slow that the pad 16′ remains in contact with the capstan screw 10′—the active (rear) end of the hammer head 12 will have been brought to a very small distance from the string—a distance comparable, for example, with that to which in a conventional action the hammer head has been brought at the time of "tripping" (i. e., displacement of the usual jack from its normal disposition in such an action). This hammer position (of very small distance of hammer head from string) may conveniently be termed the "keystroke-end" position of the hammer.

The normal position of the hammer will be fixed by the resting of the butt 14′ (through pad 16′) against the capstan screw 10′, and the resting of the rear end of the key 6′ (through pad 9) on the rail 3′. The forward displacement of this normal position from the keystroke-end position will of course be determined by the distance through which the capstan screw 10′ moves during keystroke—and this distance of capstan-screw travel is in turn established, as conventionally, by adjustments of the effective thicknesses of pads 8 and 5 (as by choice of the thicknesses of stacks 8*a* and 5*a* of paper or cardboard washers with which fixed-thickness pads 8 and 5 may be supplemented), which adjustments of course fix the length of keystroke (as well as the normal key level).

The action of gravity in normally causing the hammer butt 14′ to rest (through pad 16′) against the capstan screw 10′ may be supplemented, as conventionally, by the action of a light spring 21′. The lower end of this spring may bear forwardly against the rearward-upward surface of the butt 14′, the spring being secured at its upper extremity to a fixed rail 22′.

As a stop against "overshooting" of the hammer forwardly upon key release (due to momentary yieldings of various parts such as pads 16′, 16″ and 9′, etc.), with consequent strain on the hammer stem 12, there may be provided a rail 24 carrying a strip of soft felt or the like 23 on its rear surface, in such a position that on forward hammer motion to slightly beyond normal hammer position the front end of the hammer head 12 will impinge against the strip 23—from which it will, however, normally have a slight spacing. If it be desired that the hammer at times have a reduced spacing from the string 20, the rail 24 may be moved rearwardly—for which purpose it has been shown as forming the cross-arm of a bail one of whose side arms appears at 25, pivoted at 26 to permit the just-mentioned rearward movement (which may be effected by the usual "soft pedal," not shown). As usual under conditions of less-than-normal hammer-to-string spacing, the capstan screw 10′ will, when the rail 24 has been moved rearwardly, be left out of driving contact with the butt 14′ until some initial portion of the keystroke has been completed.

Simply by way of simplification of illustration, there has been omitted from Figure 1 any showing of the usual damper for the string 20; this may, however, be provided in any convenient manner (for example, as I have shown for a similar "dropped" type of action in my co-pending application Serial No. 566,979).

The key 6′, with capstan screw 10, will be understood to form an actuating means for the hammer. Thus when the key 6′ is subjected to downstroke the capstan screw will drive the hammer 11′ to its keystroke-end position. At this point the movement of the actuating means (6′—10′) will be stopped; the hammer is free, however, to continue rearward movement under its own rearward inertia (which it will have acquired during, and in amount dependent on the velocity of, the keystroke, unless the latter has been of altogether abnormally low velocity). The hammer which (*i*) up to this point of keystroke-end had been driven by the actuating means, now (*ii*) does continue its rearward movement, as it is free to do, for a minute interval which ends with its striking of the string; then (*iii*) produces an initial rearward deflection of the string, and during that rearward deflection maintains its contact with the string and thus progresses, though at reducing velocity, rearwardly beyond the string's normal position; then (*iv*) returns forwardly, still in contact with the string, as the string accelerates forwardly from its maximum deflection to its normal position; then (*v*) continues its forward movement under its own forward inertia (becoming free of the string as the string, passing its normal position, decelerates in its forward movement) for the minute interval required to bring it into its keystroke-end position.

The further behaviour of the hammer depends on the "history" of the key, or actuating means, during the intervals (*ii*), (*iii*), (*iv*) and (*v*) above, and is dealt with below.

The motions of the hammer so described are shown diagrammatically in Figure 6, by the solid curve from its lefthand extremity to the point designated E. In this figure time is measured along the horizontal axis, and displacement along the vertical axis. The horizontal axis O—O itself designates the normal position, the horizontal line KE—KE designates the keystroke-end position, and the horizontal line SS—SS designates the string-striking position, of the hammer. The several intervals (*i*), (*ii*), (*iii*), (*iv*) and (*v*) above are laid off by vertical lines at the top of the figure, and are designated by their respective numerals. The letter A designates the beginning, and the letter B the end, of interval (*ii*).

If during the intervals (*ii*), (*iii*), (*iv*) and (*v*) the key has been released, the hammer, on arriving upon the conclusion of (*v*) at its keystroke-end position (i. e., at the point E in Figure 6), will simply continue its forward movement—at a slightly increasing velocity caused by gravity and by the spring **21**. This return of the hammer to normal position has been indicated in Figure 6 by the dash-dot line E—G. Of course, if the key has been only partially released, the hammer's return will not extend all the way to its normal position (e. g., G), but will stop at some intermediate point (e. g., F) determined by the degree of key release. But whether the key has been fully or only partially released, there is nevertheless maintained the maximum possible speed of return of the hammer into a position where it can be effectively redriven by the key—a characteristic described in piano terms as "excellent repetition."

If, however, the key has not been released by the end of interval (*v*) the hammer will at that instant come into impingement against the actuating means (i. e., against **10'** in the system **6'**—**10'**). The hammer then (*vi*) will by its inertia cause a temporary compression of various compliances in the system, including the hammer stem **13** (since the hammer's inertia is principally in the head **12**, whose motion the curve illustrates), the pads **16'** and **16''**; the pad **5**, the pad **8** (in this case, a temporary de-compression) and various other compliances, the hammer moving forwardly at reducing velocity while yielding up its energy to those compliances; then (*vii*) will be moved rearwardly, by the release of the energy acquired by those compliances during interval (*vi*), at a velocity which increases until the hammer again reaches keystroke-end position, by which time all the energy it delivered to the compliances (reduced only by dissipation therein) will have reappeared in the hammer in the form of rearward inertia.

The solid curve of hammer motion in Figure 6 has been extended from E to H to indicate the motions occurring during these intervals (*vi*) and (*vii*), which have been laid off similarly to earlier intervals.

If no counteractive measures are applied, the hammer at the end of the interval (*vii*) will respond to its own rearward inertia by entering (at H) an interval (*viii*) which will be a repetition and rerepetition of the cycle (*ii*)—(*iii*)—(*iv*)—(*v*)—(*vi*)—(*vii*) which began at A; this repetition and rerepetition will continue as an oscillation of the hammer until the amplitude of motion, which decreases with each cycle as a result of such dissipations as there are in the system, has died away. The dash-dot extension of

the curve from H to J indicates a typical first cycle-and-a-quarter of the interval (*viii*); there will be apparent its similarity to the course of the curve beginning at A, excepting only for the attenuation of amplitude.

The amplitude of the hammer oscillation just described is of course a function of the amplitude of the initial string displacement by the hammer, and thus of the velocity of the actuating keystroke. But if the keystroke-end position of the hammer is made properly close to the string-striking position (which should be done for good sensitivity of the action), then with all excepting very weak keystrokes the amplitude of hammer oscillation is usually sufficient to cause the hammer to restrike the string at least once, if not oftener. Thus if the curve in Figure 6, which represents a fairly strong keystroke, were extended in its oscillatory form beyond J, then even in spite of a logarithmically decaying amplitude it would show, following the intended initial one, several repetitive crests reaching above or at least to the line SS—SS. Each such crest would represent a restriking of the string by the hammer even if the string were remaining in its normal position indicated by that line. Of course actually, following the initial contact of the hammer with the string (represented by the first crest), the string is in a state of vibration, or rapid oscillation between points displaced in each direction from the normal position indicated by SS—SS. This fact would have some influence on the exact course of the curve in the dash-dot portion to the right of H—but since largely fortuitous phase and other relationships are involved, it is necessary in extending the curve to assume some average or typical relationships. More importantly, this fact of string oscillation decreases the distance beyond the keystroke-end position (i. e., above line KE—KE) through which the hammer can travel without danger of restriking the string, and thus increases the probable number of restrikings over the number that would be expectable with a string which occupied the fixed normal position except while actually being displaced by the hammer.

Conventional piano actions have circumvented this hammer oscillation by an escapement mechanism which in effect removes the actuating means from the path of the hammer rebounding from the string—and following strong keystrokes have absorbed the very considerable kinetic energy of the hammer at a considerable distance from the string by dissipation in a frictional engagement of the hammer with a back-check. This has been done, however, at the cost of elaborate, delicate and non-altogether perfect arrangements for preserving acceptable repetition, as well as of the escapement mechanism and back-check themselves.

In my U. S. Patent No. 2,271,460 I showed an action in which the actuating means might be rebounded from by the hammer, but in which such rebound was suppressed (*a*) by applying to the hammer, during interval (*iv*) or (*v*) as described herein, a stringward impact opposing and greatly attenuating the hammer rebound from string to actuating means, (*b*) by applying to the hammer, during or immediately after the interval (*vii*) as described herein, a reverse impact opposing the residual tendency of the hammer to rebound from the actuating means, and (*c*) by appropriately introducing viscous energy dissipation into the system. While embodiments of that disclosure perform their functions of avoiding rebound of the hammer from the actuating means, they have exhibited certain disadvantages, among them being a tendency, at least under conditions of slight maladjustment, of the first of the impacts applied to the hammer to prolong the contact of hammer with string, and a considerable undoing by the same impact of the otherwise inherently rapid return of the hammer to redrivable position when the key has been quickly released.

In my co-pending application Serial No. 566,979 I disclosed an action in which I reduced the magnitude of these disadvantages by applying the first impact to the hammer through a spring, thus attenuating the effect of that impact and storing much of the energy thereof for delivery to the second impact on the hammer—which second impact was delivered to the hammer at the time denoted by the point H of Figure 6 herein.

According to the present invention I continue to deliver to the hammer at the time denoted by the point H (of course, assuming that key depression is maintained) an impact opposing the movement of the hammer toward the string. But I so support the inertia means which delivers the impact that it is incapable of delivering to the hammer any impact in the reverse direction, this being achieved for example by using an energy-storing spring as the support for the inertia means. In such a construction the inertia means is effective at least as soon as the string-striking to deliver energy to the spring—and the spring is deflected at least throughout (i. e., during the entirety of) the inertia-effected movement of the inertia means.

In Figure 1 the spring, of "leaf" construction, appears as **27**, with its lower extremity secured in the hammer butt **14'** slightly forwardly of the stem **13**. From the butt the spring **27** extends diagonally upwardly and forwardly, diverging from the stem **13**. On its forward surface at its upper extremity the spring carries the weight **28**, which (supplemented to a relatively minute extent by the mass of the upper portion of the spring) forms the mass or inertia means of the system.

Secured in the hammer **11'**, for example at the juncture of the head **12** with the stem **13**, may be the rear extremity of a light arm **29**, which may extend generally forwardly, at about right angles to the stem **13**, to terminate in a portion **29*a*** folded downwardly at right angles to the rest of the arm **29**. To the rear surface of the arm portion **29*a*** there may be secured a pad **30**, preferably characterized by elasticity accompanied by appreciable viscosity. For the pad **30** there may be employed a suitably shaped lump of viscous material such as a synthetic resin; in this case the imperfect elasticity, and the tendencies to "cold-flow," of such material may be counteracted, and the pad made fully elastic, by encasing that material in a film or skin of rubber (surface-dusted with graphite to obviate any stickiness). More simply and usually satisfactorily, however, a pad **30** of relatively viscous rubber such as "butyl" may be employed.

The length and biasing of spring **27** are such that the weight **28** normally rests in contact—typically, relatively light contact—against the pad **30**. During keystroke, or interval (*i*), the entire hammer including **29—30**, and with it the spring-weight system **27—28**, is moved integrally, and such movement continues during interval (*ii*) as well. But upon the striking of the string by the hammer at the end of interval (*ii*), whereupon the hammer begins its rapid deceleration already seen to occur in interval (*iii*), the rearward movement of the weight **28** is continued under the influence of its own inertia—as illustrated by the heavy dotted line, to the right of A, in Figure 6. Accordingly the weight **28** upon the string-striking leaves contact with the pad **30**, and begins the delivery of energy to the spring—i. e., begins the deflection of the spring. This delivery and deflection continues at a diminishing rate for a space of time which is a function of the time-period of the mechanical oscillating system formed by the spring and weight—and which is followed by another space of time, similarly a function of that time-period, of redelivery of the energy of the spring to the weight and deflection of the spring.

These two spaces of time, taken together, represent an interval of free excursion of the mechanical oscillating system in its own oscillatory mode, beginning at the instant of string-striking by the hammer. The time-period of that system is so fixed, by choice of the relative values of the stiffness of spring **27** and mass of weight **28**, that this interval of free excursion is substantially equalized with the sum of the interval (*iii*)—(*iv*) of hammer contact with string, the interval (*v*) of hammer travel from string to actuating means, and the interval (*vi*)—(*vii*) of hammer contact with actuating means prior to an attempted rebound therefrom. The time-period of the system being so fixed, it is at the end of interval (*vii*)—or at the time denoted by H in Fig. 6—that the weight will be returned to contact with the pad **30**.

This return to contact will of course be an impactive one—constituting an impact of the weight against the hammer opposing the attempted rebound of the latter toward the string. Its objective is to neutralize, by the away-from-the-string kinetic energy of the weight, the toward-the-string kinetic energy of the hammer. This neutralization is readily accomplished by a proper choice of the absolute values of stiffness of spring **27** and mass of weight **28** (the relative values of which are, as seen above, to be so fixed as to achieve the proper time-period).

The heavy straight-line curve to the right of the point H in Figure 6 illustrates the continued positions (throughout continued key depression) of hammer and weight after the weight-hammer impact, when the parameters of the mechanical oscillating system have been properly chosen. It will of course be apparent that the hammer is held in keystroke-end position, wherein it is harmlessly out of contact with the string, even in spite of the vibration of the latter. It may be pointed out that an appreciable viscosity of the pad **30**, abovementioned as desirable, provides considerable tolerance to imperfect choices of parameters of the spring-weight system. When such viscosity is present, then although the curve to the right of point H may be slightly oscillatory as a result of the imperfect choices, nevertheless the energy dissipation caused by the viscosity will (unless the imperfections are relatively gross) limit the amplitude of the oscillations sharply enough to accomplish the objective of obviating any second contact of hammer with string.

The appropriate introduction of a viscous damping of the impact of weight against hammer may be accomplished in other manners than by the use of a pad, such as **30**, through which the impact is transmitted compressively. Thus in Figure 2 I have illustrated an embodiment of my invention wherein the viscous damping is provided by a flexible member characterized by appreciable viscosity, and wherein that impact is transmitted through that member in tension.

Purely by way of example that embodiment is illustrated in an upright action of the undropped type (such as is more fully illustrated in the succeeding Figure 3). Herein the rear end of a straight key is illustrated as **6**, provided for example with a weight **6***a* similar to that of Figure 1. Secured to the bottom of the rear portion of key **6** is a rigid extension plate **6***b*, which extends a short distance rearwardly from the rear end of the key proper and, through pad **9**, rests on the rear action rail **3** when the front end of the key is not depressed. On top of the extending portion of plate **6***b* there may be secured the pad **16**. The hammer **11** again comprises a head **12** and a stem **13**, the lower end of the stem being secured in a butt **14** of somewhat different construction from the butt **14'** of Figure 1. The butt **14** is provided with a forwardly extending "shoe" **14***a* through which, at a little distance forwardly of the stem **13**, there passes the adjusting screw **10**. The top of this screw may be provided with a screw-driver slot **10***a* for adjusting purposes, while the bottom of the screw may be formed into a round head **10***b*.

The butt **14**, and therethrough the hammer **11**, is pivoted at **17** to a rearwardly extending flange **18**, which may be secured to the top of a rail **22** which in turn is secured to the top of the rear action rail **33**. A spring **21**, one extremity of which appears in Figure 2 (but which is illustrated more in detail in subsequent figures) may lightly urge the hammer forwardly about pivot **17**. The forward-and-rearward position of the parts is such as to bring the screw-head **10***b* above the pad **16**, against which it normally rests.

It will of course be understood that in Figure 2 the movement of the hammer by the key **6** is functionally entirely similar to that of the hammer **11'** by the key **6'** in Figure 1, the screw **10** performing the same function as the capstan **10'** in Figure 1. As in Figure 1, the rail **24** (forming, if desired, a portion of a bail one of whose side-arms appears as **25**, pivoted at **26**), provided with the strip **23**, may form a stop for excessive rearward excursions of the hammer (as well as a means for reducing its stroke at will).

In Figure 2 the mechanical oscillating system is shown as formed by the spring **37** and the weight **38**. The lower end of the spring is shown secured, as by the small screw **36**, to the top of the butt-shoe **14***a*; and therefrom the spring extends upwardly and forwardly in generally similar fashion to the spring **27** of Figure 1. The weight **38** is carried at the top of the spring **37**—secured for example to the rearward surface of the spring. The weight (and the spring in contact therewith) may be apertured, and therethrough there may be passed a thin strip **39** of viscous material having self-restoring properties and not significantly subject to "cold-flow"—for example, "Vinylite." This may be formed, immediately in front of spring **37**, into a knot **39***a* incapable of passing through the spring and weight. From the spring and weight the strip **39** may extend rearwardly to the hammer head **12**, its rear extremity being secured therein.

The spring **37** is so biased that it normally places the strip **39** under at least slight tension. Upon depression of the forward end of the key **6**, and consequent raising of the illustrated rear

end of the key, there will occur an integral movement of the hammer **11** and mechanical oscillating system **37—38** toward the string **20**. Upon string-striking by the hammer there will occur a free excursion of the oscillating system **37—38** similar to that of **27—28** of Figure 1—excepting that it will be accompanied by a release of the tension of strip **39** and, consequently, an inert "folding" of that strip.

The free excursion of the system **37—38** in its own oscillatory mode involves, quite similarly to that of the system **27—28** of Figure 1, first a rearward deflection of the spring and then a forward deflection thereof—culminating in a forwardly directed impact of the weight on the hammer. In this instance, however, the forward impact is delivered longitudinally through the strip **39**—this having been "unfolded" by the deflection of the spring, and being placed in tension by the impact.

The solidly shown curve in Figure 6 is equally applicable to the hammer movement in the embodiment of Figure 2. It is to be observed, however, that the viscous damping means in tension (i. e., strip **39** of Figure 2) has proven generally even more effective than the corresponding means shown in Figure 1 in providing tolerance to inexact choices of the parameters of the mechanical oscillating system.

In Figure 6 the solidly shown curve from O to B, the dottedly shown curve from B to H, and the solidly shown curve to the right of H show the relative positions of the weight **28** of Figure 1, or **38** of Figure 2. For the construction of either figure the period from O to A, or interval (i), is one during which the actuating means drives the weight, or energizes the mechanical oscillating system; the period from A to B, or interval (ii), is one during which the weight travels on in contact with a portion (**30** or **39***a*) of the hammer, the oscillating system remaining energized; and the period from B to H is one during which the weight moves first under its own inertia and then under the restoring force of the spring, the oscillating system executing a free excursion in its own oscillatory mode. It will be appreciated that, since the movement of the weight throughout the energization period O to A does not deflect the spring in the constructions of these figures, the energization of the oscillating system in either case is wholly a kinetic energization.

All the folding and unfolding of the strip **39** during the weight excursion is attended by some energy dissipation, which probably becomes especially marked as the strip straightens in the momentary period just before impact. A beneficial effect of this is the elimination of even minor "clicks" or slapping noises, such as otherwise may tend to occur with a weight arranged (as in Figures 1 and 2) to move with approximately the velocity of the hammer head.

In Figures 3, 4 and 5 I show respective embodiments of my invention in which the mechanical oscillating systems are carried elsewhere than by the hammer, but intercept the path of movement of a portion of the hammer. In these embodiments the inertia means deflects the spring, and thus the oscillating system is subjected to internal movement in its own oscillatory mode, during the terminal part of interval (i)—the interval of hammer-actuating movement of the key.

In Figure 3 the rear end of the key **6** is provided, as in Figure 2, with the extending plate

6b secured to the bottom of the key; and again this extension plate 6b may carry the pad 16, and may normally rest through the pad 9 on the rear action rail 3. Again the hammer butt 14, pivoted at 17 to the flange 18 secured to rail 22, may be provided with the forwardly extending shoe 14a, through which passes the adjusting screw 10 whose head 10b normally rests on pad 16. The hammer 11 again includes the stem 13 extending from the butt 14, and the head 12 carried at the top of the stem 13.

In this embodiment the mechanical oscillating system is carried by the key. It comprises the leaf spring 47 secured to the top of the key (as by screw 47a) and extending rearwardly to overhang the end of the key; and the weight 48 secured to the bottom of the overhanging portion of the spring. Behind the screw 47a the key 6 may be slightly reduced in height, so as to provide under the central portion of the spring 47a a surface 6c slightly lower than the bottom of the spring under screw 47a; and on the surface 6c there may be secured a pad 50—the spring 47 being so biased as to normally bear at least lightly against the pad 50.

The front-and-back position of the rear extremity of the spring and weight 47—48 is just a little forward of the adjusting screw 10, permitting access to the latter. The butt-shoe 14a, however, extends forwardly beyond that screw so as to bring the most forward portion of the shoe underneath the weight 48. To the top of this portion is secured a pad 49. Preferably both the pad 49 and the pad 50, abovementioned, will be of elastic material characterized by appreciable viscosity—"butyl" rubber, for example. The height of pad 49 is typically made somewhat less than sufficient to reach the bottom of weight 48 when the parts are at rest.

Upon key depression the screw 10 and with it the butt 14 will be rocked upwardly, and the hammer head 12 rearwardly, about the pivot 17. The pad 49, moving in an arc of greater radius than the screw 10, will presently be brought into contact with the bottom of the weight 48. Figure 3a illustrates a typical position of the parts when this has first occurred; the key may then, for example, have been moved through somewhat over half of its downstroke. Up to this time the weight 48 has been moved simply with the rear end of the key, and the spring 47 has not been deflected. During the remainder of key depression, however, the weight 48 is moved by the pad 49; in view of the step-up of motion in the butt-shoe 14a, this movement is at a greater rate than that of the key-end, and accordingly the spring 47 is subjected to a progressive upward deflection.

In Figure 6 the dottedly shown curve from O′ to Q and the solidly shown curve from Q to A indicate the relative positions of the weight 48 during the keystroke—it being understood, of course, that the motions of the weight as indicated in Figure 6 have been multiplied several times from their actual values, in order to permit the convenient use of the single figure for different embodiments. The solidly shown curve of Figure 6 of course continues to represent the hammer movement.

After the conclusion of keystroke at A the weight 48 continues to move under its own momentum, and continues to progressively flex the spring 47; since the key movement has stopped at A, the rate of spring flexure abruptly increases at A. During interval (ii), or from A to B, the pad 49 (which forms a part of the hammer) maintains contact with the weight 48, and the momentum of the hammer combines with that of the weight in flexing the spring. As in the cases of earlier embodiments, it is upon string-striking—i. e., at B—that the free excursion of the oscillating system in its own mode, represented by the dotted curve from B to H, begins; a distinction from those cases is that in this case the spring 47 had already been considerably flexed by the weight 48 prior to the string-striking.

It has already been noted that the actual movement of the weight 48 is only a fraction of that of weight 28 or 38 in earlier figures, and of course that same is true with respect to its velocity. The requirement for kinetic energy in the weight just before the weight-hammer impact at H remains, however, unchanged; it must equal the oppositely directed kinetic energy of the hammer. This is accomplished with the smaller velocity by a larger weight—the weight requiring to be increased, in general, by the square of the factor by which the velocity has been reduced. The timing requirements for the free excursion of the oscillating system remain as before; the greater weight will accordingly be accompanied by a stiffer spring.

I consider the arrangement of the pad 49 so that it does not contact the weight 48 until key depression is partly effected to be advantageous in keeping at a reasonable value the flexure of the spring 47 already effected at the time of string-striking. This feature, however, has certain additional specific advantages. One of these has to do with the use of the rail 24 to shorten the hammer stroke on occasion. Upon swinging of this rail to shorten that stroke, then if the pad 49 were normally to touch the weight, the rearward swinging of the hammer would be accompanied by a partial depression of the key. Such a partial depression is not normally an incident of soft-pedal operation, and would be objectionable; it is obviated by the spacing under discussion.

Another advantage has to do with the "feel" of the key to the player. In conventional actions there occurs, late in the downstroke of the key, a noticeable and quite sudden increase of key resistance to that downstroke—caused by the greater work required to displace the jack than for the hammer propulsion prior to that displacement. In the embodiment of Figure 3 such an increase of resistance (though of course not the result of displacement of any jack) occurs—caused by the addition of the spring-flexing load to the hammer-moving load already being borne by the key—at the instant in the stroke illustrated by Figure 3a. Naturalness of "feel," for such value as it has to sensitive players, is thus preserved.

It may be pointed out that the much-reduced velocity of the weight in the Figure 3 embodiment (as well as in those yet to be described) effects an ample minimization of "clicks" or slapping noises in the action.

Also as to the Figure 3 and later embodiments, the carrying of the mechanical oscillating system elsewhere than on the hammer fully eliminates all tendencies toward prolongation of hammer contact with string. (These, it was pointed out above, are reduced in the Figures 1 and 2 embodiments by the elimination of any stringward impact.) This is because in these later embodiments none of the stringward inertia of the oscillating system is coupled into the hammer.

In Figure 3 I have shown a very simple and effective damper and damper-actuating arrangement for the string 20. The damper proper appears as 30, secured by the usual set-screw 30a on a rod 31 near the top extremity of the latter. The bottom portion of the rod 31 may be welded to the vertical part of a small spring bracket 32, the horizontal part of which may be secured to the top of the action rail 3; the spring bracket may bias the damper 30 against the string 20. At an intermediate point on the rod 31 there may be welded to its forward surface the extremities of a small stirrup 31a, and through this stirrup there may be passed a loop 33a forming the rear extremity of a flexible tape 33. This tape may extend forwardly, passing alongside the hammer stem 13, and it may terminate in a loop 33b forming its forward extremity. This loop 33b may encircle a small spool 34 which surrounds—and, for example, frictionally engages—a rod 35 extending upwardly from key 6 between the key-pivoting rod 4 and the rear extremity of the key. The tape 33 will be of such length that normally it is just a trifle slack; fine adjustment of this condition may be made by bending of rod 35. Upon key depression, however, the spool 34 will be moved upwardly and forwardly in an arc about the key-pivot pad 5; the tape 33 will be pulled forwardly by the forward component of the spool movement, taking the slack out of the tape and pulling the damper out of contact with the string. The distance of movement of the damper effected by key depression may be regulated by sliding the spool up and down along the rod 35, this being effective for such regulation since it varies the forward component of the spool movement.

In Figure 3 (and 3a and 2) I have shown a flange and spring construction which I have found especially desirable for the pivotal mounting and the biasing of the hammer. This construction appears in enlarged detail in Figures 3b and 3c. As appears in these figures, the hammer butt 14 is bifurcated in the usual manner to form the side-arms 14d straddling the flange 18. The pivot 17 is formed by a pin 17a held in the flange (as hereinafter more fully described) and extending into the felt bushings 17b, which latter are provided as insets in each of the side-arms 14d in the usual manner.

The flange 18 is formed from a single flat sheet of metal, folded back on itself so that the principal portion of the flange comprises two laminations. The rear extremity of the lower lamination is shown as a minute downwardly-turned lug portion 18a, adapted to engage a slot 22a cut in the top surface of the rail 22 near the rear edge of the latter and by such engagement establishing at least an approximate alignment for the flange-and-hammer assembly. From the lug portion 18a the lower lamination extends forwardly, a portion 18b resting on top of the rail 22; a portion 18c of reduced width extends a further distance forwardly. The flange is then folded, upwardly and rearwardly, back upon itself to form the upper lamination, the pin 17a being clamped in the inter-lamination fold 18d (which is arcuately formed to provide essentially 360-degree encirclement of the pin). From that fold the upper lamination extends rearwardly, first having the portion 18f above and in contact with the lower-lamination portion 18c, and then the wider portion 18g above and in contact with the lower-lamination portion 18b. The upper lamination may terminate slightly forwardly of the lug 18a.

The lug portion 18a and the portions 18b and 18g may be bifurcated so that the flange may be slipped under the screw 22b for easy assembly to the rail 22. The portions 18c and 18f and the fold 18d, which are of width just freely fitting between the side-arms 14d of the butt, are also bifurcated, as indicated at 18e. Within this bifurcation the spring 21 is coiled about the pin 17a; one end of the spring is led rearwardly to bear downwardly on the flange portion 18f, while the other end of the spring is led upwardly to bear forwardly on the butt 14 above the pivot 17, and thus to provide the light away-from-string bias of the hammer.

The assembly so described is a rugged and easily formed one. Further, it obviates sliding contact between the hammer-biasing spring 21 and the butt 14—such as characterizes the more conventional hammer-biasing arrangement shown in Figure 1—and the undesirable attendant friction, as a result of the biasing spring having its yieldable portion substantially coincident with (e. g., closely encircling) the hammer pivot.

The embodiment of Figure 4 differs from that of Figure 3 in the form and disposition of the mechanical oscillating system—other elements of the embodiment being, for example, generally similar to those of Figure 3. In Figure 4 the oscillating system is carried by a fixed portion of the action—typically, a rail 56 provided for the purpose a little behind the most rearward position reached by the hammer stem 13, and at an elevation opposite an intermediate portion of that stem. To this rail may be secured, as by screw 56a, the downwardly hanging leaf spring 57, at the lower extremity of which there may be secured to the rear surface of the spring the weight 58. To the forward surface of the spring 57, opposite the weight, may be secured a pad 59—of "butyl" rubber, for example. The dimensioning and disposition of the parts may be such as to bring the pad 59 opposite a relatively low portion of the hammer stem 13—and to space the pad 59 at such a distance from that stem that it will be struck by that stem when the hammer has been propelled toward the string to the extent of some fraction of its normal spacing therefrom. In Figure 4 the dash-dot illustration of the hammer and stem shows a typical position at which the stem will strike the pad 59—for example, when the hammer has been propelled very slightly less than half-way toward the string. From the description as so presented it will be appreciated that in this embodiment the mechanical oscillating system is normally free of any constraint—e. g., rests normally in the disposition to which it is urged by its own spring 57 and its own mass 58.

In this embodiment the first portion of key depression will not produce any energization of the mechanical oscillating system 57—58—59—i. e., any movement of the weight or deflection of the spring. This quiescent condition of the system is indicated in Figure 6 by the dotted line O''—Q. But when the hammer has reached the position illustrated in dash-dot lines, the weight will be moved rearwardly with the velocity of the hammer-stem portion opposite the pad 59. This is indicated in Figure 6 by the curve from Q to A, beyond which latter point the action of the system is fairly analogous to that of the system of Figure 3. The solidly shown curve of course again represents the hammer movement—and again the motions of the weight as indicated in

Figure 6 are several times multiplied from their actual values (relative to hammer motions). Actually, with the proportions shown in Figure 4 relative to those shown in Figure 3, the motions and velocities of the weight will be somewhat less—and it is for this reason that the weight 58 has been illustrated as somewhat larger than the weight 48 of Figure 3, which will be found necessary in following with this embodiment the criteria set forth above with respecet to proportioning of weight and spring.

This embodiment will be recognized to retain the features, of the Figure 3 embodiment, both of permitting normal "soft-pedal" action (through rail 24) without unwanted key displacement, and of providing a sudden increase of resistance to key depression at an intermediate point in keystroke. (The first of these features of course inherently characterizes this embodiment, whether or not the finite spacing normally exists between the weight and the hammer portion which moves it; such a spacing was, however, required in the Figure 3 construction to achieve this feature.)

It is to be understood that none of the embodiments of my invention is limited to use with an "upright" action. While this should be obvious to those skilled in the art, it has been illustrated—by way of example, in connection with the embodiment of Figure 4—in Figure 5. Herein the rear portion of a pivoted key appears as 6''. Suitably spaced above it is the horizontal string 20'' of a "grand" type of piano. Arranged to strike the string from underneath is a hammer 11'', comprising the head 12'' and the stem 13'' at the rear extremity of which that head is carried. The forward portion of the stem 13'' is rectangularly formed, and its forward extremity is pivoted as at 17'' to the flange 18'' secured on top of a suitable action rail 91. On and extending downwardly from the bottom of the forward portion of the stem 13'' a little to the rear of pivot 17'' there is secured the small pin 93, surrounded by the pad 92 in contact with the stem 13'', and projecting downwardly beyond that pad. Below the pin 93 there extends upwardly from the key 6'' the capstan screw 10'', adjustable in height relative to the key; and from the center of that capstan screw there may in turn extend upwardly the small pin 94. A coupling from key to hammer may be provided by a cylinder 97 provided at its top and bottom extremities with the end-closing bushings 95 and 96 respectively, those bushings being centrally apertured to freely admit the pins 93 and 94 respectively.

It will be understood that the normal position of the hammer may be fixed by adjustment of the capstan screw 10'', the keystroke-end position being determined by the distance through which the capstan screw moves during keystroke (which distance is subject to adjustment in the usual manner)—all in analogy to the constructions set forth in connection with Figure 1. And for a stop against overshooting of the hammer downwardly upon key release, the key 6'' may be extended rearwardly and may have secured to its surface underneath the bottom end of the hammer head 12'' a pad 16'' of suitable thickness.

The extremities of pins 93 and 94 within the cylinder 97 are free to assume various angles to the axis of the cylinder without binding, as a result of the cylinder diameter being substantially larger than that of the pins. The length of each pin may be great enough to preclude detachment of the cylinder from the action while the latter remains in assembled condition and in place under a normally positioned string.

In this embodiment the mechanical oscillating system may comprise a leaf spring 67 having its forward end secured (for example, by the same screw 18a'' as secures the flange 18'' to the rail 91) to the top of the flange 18'', and extending rearwardly therefrom to overhang a portion of the hammer stem 13''; a rod 66 secured in a rearward portion of the spring 67 and hanging downwardly therefrom through an oversize aperture 13a'' in the hammer stem 13'' (and preferably arcuately shaped, so as to limit the size of aperture 13a'' required for obviation of binding in that aperture upon hammer movement); a weight 68 secured on the bottom of the rod 67 a little below the downmost position of the hammer stem 13''; and a pad 69 secured to the bottom of spring 67 surrounding rod 66.

The dimensioning and disposition of the parts will of course be such that the hammer stem 13'' strikes the pad 69 at an intermediate point in keystroke, entirely analogously to the striking of pad 59 by stem 13 in Figure 4—excepting that, purely by way of example of variation, the dash-dot illustration in Figure 4 of the position at which this striking will occur has been made to show a hammer movement of a little over (rather than under) half-way from normal position toward the string.

The correspondence of function to that of the embodiment of Figure 4 will be apparent, and need not be detailedly developed.

In all the embodiments of my invention the choices of mass and stiffness of the weight and spring in the mechanical oscillating system will be made according to principles already stated. It is of course to be understood that these parameters may require variation between the several notes of the instrument. This results from the criterion that the interval of free excursion of the mechanical oscillating system shall equal the sum of intervals (iii), (iv), (v), (vi) and (vii)—and the facts (1) that the lengths of intervals (iii) and (iv) are influenced by the mass of the hammer and the mass and stiffness of the string, (2) that the lengths of intervals (vi) and (vii) are influenced by the mass of the hammer and the stiffness of various compliant portions of the action (e. g., the hammer stem, various pads, and to some extent the key itself), and (3) that at least the mass and stiffness of the string and the mass of the hammer are usually progressively varied throughout the scale of the instrument.

It has already been pointed out that the pad 39 of Figure 1, the strip 39 of Figure 2, and the pads 49, 59 and 69 of Figures 3, 4 and 5 respectively are desirably characterized by appreciable viscosity, so that they may perform an energy-dissipating function upon the impact of hammer against actuating means—thereby increasing the attenuation of oscillations which may tend to occur after the weight-hammer impact, and so increasing the tolerance of the system to inexactness of choice of parameters. To a reduced extent, the same function is aided by viscosity of the several other pads immediately associated with the key and hammer in the several embodiments—and for this reason each of those other pads (e. g. in Figures 3, 5, 8, and 16) may desirably be characterized by appreciable viscosity or energy dissipation.

While I have disclosed my invention in terms of particular embodiments thereof, and with reference to a piano as a typical musical instrument and to a string as a typical vibrator, I intend thereby no unnecessary limitations. Modifications in many respects will be suggested by my disclosure to those skilled in the art, and such modifications will not necessarily constitute departures from the spirit or scope of the invention, which I undertake to define in the following claims.

I claim:

1. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a mass moved by said actuating means coincidentally with at least the final portion of movement of the hammer by the actuating means, and moved by its own inertia after the hammer strikes the vibrator; and a spring, deflected by said mass at least during said last-mentioned movement, and supporting said mass in the action.

2. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a mass moved by said actuating means coincidentally with at least the terminal portion of movement of the hammer by the actuating means, and moved by its own inertia after the hammer strikes the vibrator; and a spring deflected by said mass at least throughout said last-mentioned movement of said mass.

3. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a mass moved by the actuating means coincidentally with at least the terminal portion of movement of the hammer by the actuating means and moved by its own inertia after the hammer strikes the vibrator; and a spring deflected by said mass at least during a portion of each of said two movements of said mass.

4. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a mass supported for movement relative to the hammer but for the delivery of impactive force from the mass to the hammer only in a direction of opposition to movement of the hammer toward the vibrator; and means for damping impactive forces delivered from the mass to the hammer.

5. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a mass supported for movement relative to the hammer but for the delivery of impactive force from the mass to the hammer only in a direction of opposition to movement of the hammer toward the vibrator, and further comprising a flexible length of material characterized by high internal damping, through which in tension such impactive force is delivered and damped.

6. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a spring, and inertia means, kinetically energized by the actuating means and effective at least as soon as the hammer strikes the vibrator to deliver energy to said spring for storage therein.

7. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a spring, an inertia means, kinetically energized by the actuating means and supported for movement relative to the hammer but for the delivery of impactive force from the mass to the hammer only in a direction of opposition to movement of the hammer toward the vibrator, for delivering energy to said spring for storage therein.

8. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising an oscillating system, formed by cooperating mass and compliance, at least partially intercepting the path of movement of a portion of the hammer.

9. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising an oscillating system, formed by cooperating mass and compliance, subjected by the actuating means to internal movement simultaneously with a movement of the hammer preceding its striking of the vibrator and capable of executing a free excursion thereafter.

10. In an action, for exciting the vibrator of a musical instrument, including a vibrator striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising a mechanical oscillating system subjected to internal movement at least as soon as the hammer strikes the vibrator and capable of executing a free excursion thereafter, said system comprising a cooperating spring and mass jointly having a period of free excursion substantially equal to the sum of the intervals of hammer contact with vibrator, of hammer travel from vibrator to actuating means, and of hammer contact with actuating means im-

mediately prior to an attempted rebound therefrom.

11. The combination, with an action for exciting the vibrator of a musical instrument and including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator, of an anti-rebound device comprising means for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said impact-delivering means extending to intercept the path of movement of a portion of the hammer.

12. The combination, with an action for exciting the vibrator of a musical instrument and including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator, of an anti-rebound device comprising means for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said impact-delivering means being secured to a stationary portion of said action and extending therefrom to intercept the path of movement of a portion of the hammer.

13. The combination, with an action for exciting the vibrator of a musical instrument and including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator, of an anti-rebound device comprising means for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said impact-delivering means being carried by the actuating means.

14. The combination, with an action for exciting the vibrator of a musical instrument and including a vibrator-striking hammer and actuating means therefor against which the hammer may rebound after striking the vibrator, of an anti-rebound device comprising means for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said impact-delivering means being carried by the actuating means and extending therefrom to intercept the path of movement of a portion of the hammer.

15. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer: the combination of a flange, means pivoting the hammer to said flange, and a spring having a central portion coiled about said hammer-pivoting means and having terminal portions extending therefrom to bear against said flange and said hammer, respectively.

16. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and movable actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an inpact opposing a rebound of the hammer from the actuating means, said device comprising an oscillating system, formed by cooperating mass and compliance, subjected by the actuating means to internal movement simultaneously with at least the terminal portion of the movement of the hammer by the actuating means and subjected to further internal movement by its own inertia after the hammer strikes the vibrator.

17. In an action, for exciting the vibrator of a musical instrument, including a vibrator-striking hammer and movable actuating means therefor against which the hammer may rebound after striking the vibrator: an anti-rebound device for delivering to the hammer an impact opposing a rebound of the hammer from the actuating means, said device comprising an oscillating system, formed by cooperating mass and compliance, both bodily and internally movable, subjected by the actuating means to both bodily and internal movement simultaneously with at least the teminal portion of the movement of the hammer by the actuating means and subjected to further internal movement by its own inertia after the hammer strikes the vibrator.

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