March 13, 1956 J. W. GRATIAN 2,737,840

MUSICAL INSTRUMENT EMPLOYING TAPE RECORDING

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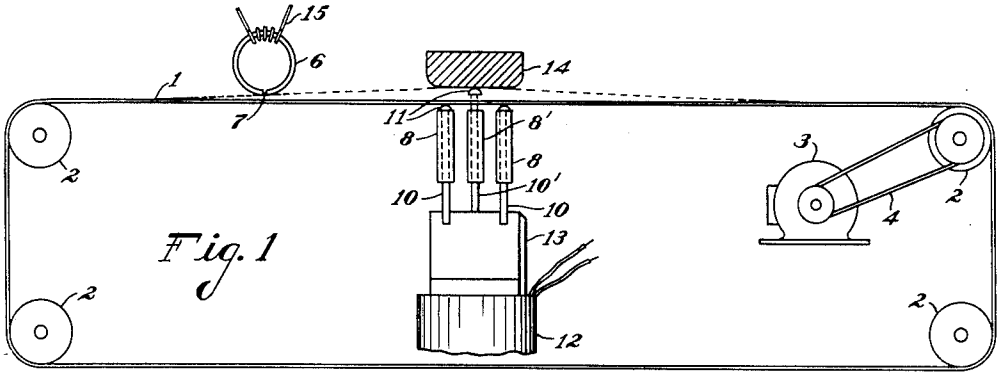


Fig. 1

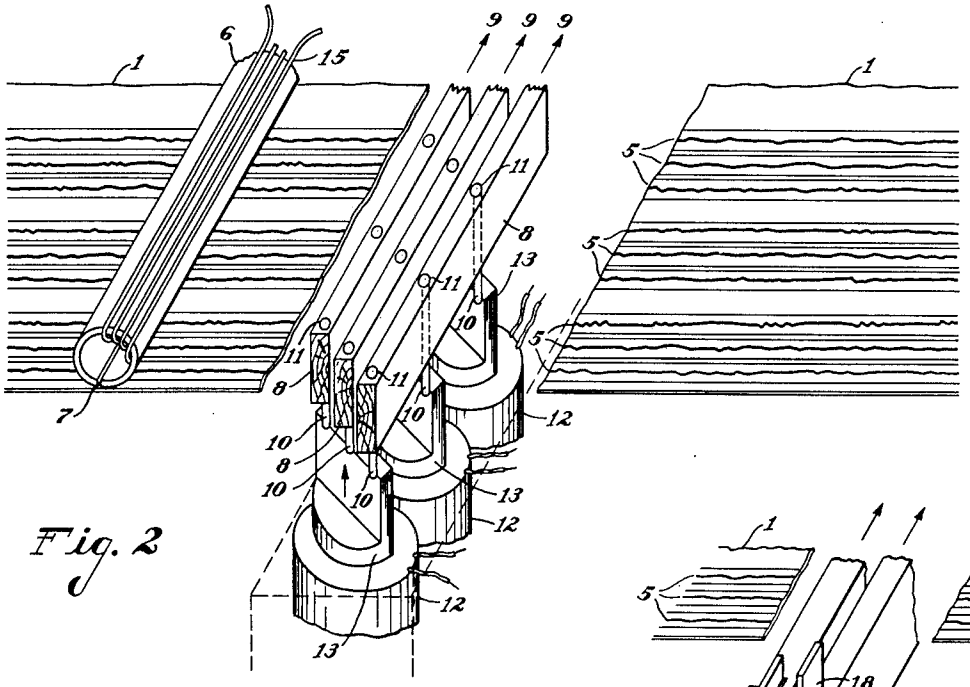


Fig. 2

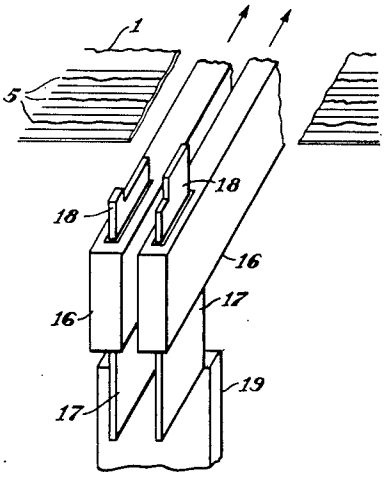


Fig. 3

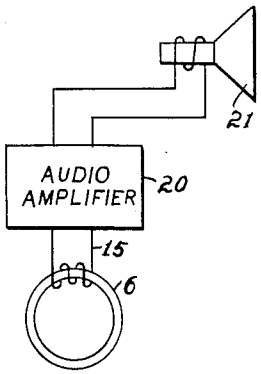


Fig. 4

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MUSICAL INSTRUMENT EMPLOYING TAPE RECORDING

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16 Claims. (Cl. 84—1.28)

My invention relates to musical instruments, and is particularly applicable to electrical and electronic musical instruments, especially electronic organs.

It is an object of my invention to provide a new and useful musical instrument which may be played by actuating the playing keys of a keyboard.

It is a further object of my invention to provide a new musical instrument of the playing keyboard type in which a magnetic recording medium is used as a tone source.

It is a still further object of my invention to provide a musical instrument in which a plurality of continuous musical tones are recorded in parallel sound tracks on a magnetic medium, and in which means are provided for moving individual ones of these sound tracks toward a magnetic recording playback head through actuation of various playing keys.

It is yet another object of my invention to provide a musical instrument of the playing keyboard type in which various portions of a magnetic medium are brought within pickup range of a magnetic recording playback head in response to the actuation of various playing keys, the actuating means being carried by a plurality of stop bars which can be engaged or disengaged at the will of the person playing the instrument.

It is another object of my invention to provide a musical instrument in which means are provided for distorting a continuously-moving magnetic recording medium, upon which is recorded a plurality of sound tracks carrying continuous musical tones, such that at least one of these tracks is brought within pickup range of a magnetic recording playback head.

It is a further object of my invention to provide an electronic organ of better tonal quality and attack characteristics than heretofore achieved.

It is still another object of my invention to provide an electronic organ having an improved stop bar arrangement which can be produced at low cost.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawing in which Fig. 1 is an elevational view of one embodiment of my invention, Fig. 2 is an isometric presentation of the same embodiment, Fig. 3 is an isometric drawing of another embodiment of my invention, and Fig. 4 is a schematic diagram, partly in block form, of a suitable circuit for my invention.

Referring now to Fig. 1, I provide in accordance with my invention a continuous flexible member **1**, which may be made of rubber or the like. This member may be of endless-belt form supported by pulleys **2**. A motor **3** drives one of the pulleys by means of belt **4**, thereby causing the flexible member **1** to be transported in one direction or the other at substantially constant speed.

The flexible member **1** has dispersed thereon a magnetic medium, the medium being so thin that it has not been shown in the drawing. It is to be understood, however, that this medium is present on one surface of the flexible member **1**, preferably the outer surface as viewed in the drawing.

The magnetic medium has recorded thereon a plurality of substantially parallel sound tracks **5**. These are represented in Fig. 2, where the flexible member **1** has been shown in broken-apart form in order to make clear the arrangement of parts beneath. If the musical instrument constructed in accordance with my invention is to resemble an organ, these tones may be directly recorded from corresponding actual continuous acoustical-organ tones, but in other cases may be derived from other musical instruments or sources or may be synthesized, as by vacuum-tube tone generators, without departing from the spirit of my invention. Regardless of the source of these tones, however, the sound tracks **2** carrying them are arranged, in this embodiment of my invention, in groups, each group comprising tones of the same pitch but of various overtone characteristics. The tracks are recorded in the longitudinal direction of the flexible member **1**.

A magnetic recording playback head **6** is disposed above the magnetic medium **1** at a distance beyond pickup range from the sound tracks **5**. The airgap **7** of the head **6** is oriented nearest the magnetic medium, and is disposed transversely relative to the sound tracks **5**.

Also arranged transversely relative to the sound tracks is a plurality of stop bars **8**. These stop bars derive their name from the fact that my invention finds its most obvious application to a musical instrument of the organ type, and that a conventional organ has stop knobs or tabs on the playing console which, when engaged, result in the tonal effects of the sort my invention is adapted to provide.

In accordance with my invention, the stop bars **8** can be moved in the direction shown by the arrows **9** by mechanical linkage (not shown) to a knob, tab, or other actuating means on the playing console of the instrument. Each of the stop bars **8** has a disengaged position and an engaged position as determined by the player of the instrument through the medium of a corresponding knob or tab provided on the playing console. The stop bars **8** are shown in Fig. 2 in their disengaged position.

Each of the stop bars movably supports a plurality of plungers **10**. These plungers have enlarged heads **11** at their upper end to prevent dropping down through the respective stop bars supporting them, and are sufficiently heavy, in the absence of upward force, to drop down until their heads **11** are flush with the top of their stop bars.

When a particular stop bar is moved in the direction **9** into its engaged position, the plungers **10** of that stop bar are then poised above a plurality of plunger-actuating means, which may be a plurality of solenoids **12**. Each of the latter is energized in response to the depression of a corresponding playing key on the console of the instrument. When the individual solenoids are energized, they drive their respective armatures **13** upward against whichever of plungers **10** are supported by those of stop bars **8** which happen to be in the engaged position.

From the foregoing, it will be clear that the actuation of a plunger requires first, that the stop bar supporting that plunger be in the engaged position, and second, that a particular playing key on the keyboard of the instrument be pressed in order to energize a particular solenoid **12**. The ensuing action may be more clearly understood by reference to Fig. 1, which shows playback head **6** with its air gap **7** disposed beyond pickup range above the magnetic medium on the flexible member **1**.

In response to the actuation of a playing key and the setting of a particular stop bar **8'** in its engaged position,

a corresponding plunger 10' is driven upward against the flexible member 1. This motion, which may be limited by a back stop 14, is sufficient to bring at least one of the sound tracks 5 within pickup range of the playback head 6. An electrical signal corresponding to the tone recorded on that particular sound track is therefore induced in the winding 15 of the playback head 6.

From the foregoing, it is apparent that the flexible member 1 must be sufficiently flexible to permit only the particular one of the sound tracks 5 above the actuating plunger to be moved upward, the remainder of the flexible member 1 remaining substantially beyond pickup range; in other words, the distortion of the flexible member 1 resulting from the actuation of a plunger 10' must move only a portion of the flexible member upward into pickup range of the playback head. More than one of the stop bars 8 may be moved into their engaged positions to position their plungers 10 opposite corresponding ones of the tracks within a group, whereupon more than one playing key on the console of the instrument may be actuated to bring sound tracks in various groups of tracks on the magnetic medium into pickup range of the playback head 6 independently of each other.

In accordance with my invention, the electrical signals corresponding to the musical tones recorded on the sound tracks 5 which are induced in head 6 are amplified, as shown in Fig. 4, preferably through the use of a high-gain audio amplifier 20 of good quality, and are then converted into audible sound for the pleasure of the listener by means of a loudspeaker 21. Since the audio amplifier and loudspeaker are well-known in the art, these units have been illustrated in black diagram form only in the drawing.

In accordance with one of the objects of my invention, the procedure of moving the magnetic medium within pickup range of a playback head by means of a plunger movably supported by a stop bar provides a new, long-wearing and inexpensive means for controlling the rate of attack at the start of each tone to give the most pleasing and most organ-like effect where such an effect is desired. In particular, the generally undesired clicking sound prevalent in conventional electronic organs is avoided. If direct actuation of the plungers 10 by the playing keys of the instrument appears desirable, mechanical linkages between plungers 10 and the keys may be provided in place of solenoids 12. Such linkages are not shown because their construction is well within the skill of organ technicians.

A second embodiment of my invention is shown in Fig. 3. Again the flexible member 1 is shown only in fragmentary form for maximum clarity in exposition. As in the embodiment of Fig. 1, the magnetic medium carries longitudinally-recorded sound tracks 5, and the stop bars have an engaged and a disengaged position as determined by the setting of a knob or tab on the playing console of the instrument. However, the tones recorded on the tracks within a given group are harmonically related, and each stop bar 16 carries a single plunger 17. The upper end 18 of each plunger is contoured such that, when actuated by plunger-actuating member 19, the plunger will distort the flexible member 1 in accordance with the contours of its upper end.

A playback head is provided above the flexible member 1 but beyond pickup range of the sound tracks when the flexible member 1 is in its normal horizontal plane. Since this playback lead is positioned in substantially the same position as that shown in Fig. 2, it has not been repeated in Fig. 3. The distortions resulting from the movement of a plunger 17 against the magnetic medium on flexible member 1 are sufficient to bring certain of the sound tracks within pickup range of the head, and consequently an electrical signal is induced in the head. This signal has components corresponding to the tones recorded on the uppermost of the sound tracks, and may be amplified and converted into audible sound by an audio amplifier and loudspeaker, as indicated by Fig. 4.

The sound issuing from a musical instrument constructed in accordance with this embodiment of my invention will thus have its overtone characteristics determined by the particular stop bar engaged and by the particular playing key depressed. By providing a variety of plungers 17 having various contoured ends 18, I am able to provide all of the stops commonly found on a grand organ, and to provide them with a degree of fidelity to the original organ tone not previously known before my invention.

While I have shown and described my invention as applied to two specific embodiments, other modifications will readily occur to those skilled in the art. I do not, therefore, desire my invention to be limited to the specific arrangements shown and described, and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim is:

1. In a musical instrument, the combination of a flexible magnetic medium; a plurality of longitudinal substantially parallel sound tracks recorded on said medium, each said sound track carrying a single continuous musical note; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said medium at substantially uniform speed transversely relative to the airgap of said head; means for transversely distorting said medium such that at least one of said sound tracks is brought within pickup distance of said head, whereby there is induced in said head an electrical signal corresponding to at least one of said musical tones; means for amplifying said electrical signals; and means for converting said electrical signals into audible sound.

2. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said medium, each said sound track carrying a single continuous musical note; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; means for transversely distorting said member such that at least one of said sound tracks is brought within pickup distance of said head, whereby there is induced in said head an electrical signal corresponding to at least one of said musical tones; means for amplifying said electrical signals; and means for converting said electrical signals into audible sound.

3. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said track, each said sound track carrying a single continuous musical note; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; means for transversely distorting said member such that a plurality of non-adjacent ones of said sound tracks is brought within pickup distance of said head, whereby there is induced in said head an electrical signal corresponding to at least one of said musical tones; means for amplifying said electrical signals; and means for converting said electrical signals into audible sound.

4. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said member, said tracks being divided into groups, and the tracks of each group carrying a single continuous musical note which is individual to their group, the tone recorded in each group bearing an octave relationship to tones carried in others of said groups, the notes recorded on individual tracks within each of said groups differing from each other in their overtone characteristics; a magnetic recording playback head located beyond pickup range from said medium;

means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; means adapted in response to the actuation of a playing key of said musical instrument to distort transversely said member such that at least one of said sound tracks is brought within pickup range of said head, whereby there is induced in said head an electrical signal corresponding to said musical tone carried by said one sound track; means for amplifying said electrical signal; and means for converting said electrical signal into audible sound.

5. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said member, said tracks being divided into groups, and the tracks of each group carrying a single continuous musical note which is individual to their group, the tone recorded in each group bearing an octave relationship to tones carried in others of said groups, the notes recorded on individual tracks within each of said groups differing from each other in their overtone characteristics; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; means adapted in response to the actuation of a playing key of said musical instrument to distort said member transversely such that a plurality of non-adjacent ones of said tracks is brought within pickup range of said head, whereby there are induced in said head a plurality of electrical signals corresponding respectively to said musical tones carried by said non-adjacent tracks; means for amplifying said electrical signals; and means for converting said electrical signals into audible sound.

6. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said member, said tracks being divided into groups, and the tracks of each group carrying a single continuous musical note which is individual to their group, the tone recorded in each group bearing an octave relationship to tones carried in others of said groups, the notes recorded on individual tracks within each of said groups differing from each other only in their overtone characteristics and each of said overtone characteristics being repeated in each of said groups in the same spatial order; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; means adapted in response to the actuation of a playing key of said musical instrument to distort said member transversely such that a plurality of said sound tracks is brought within pickup range of said head, no one of said plurality of tracks being in the same group as another, whereby there are induced in said head a plurality of electrical signals corresponding respectively to said musical tones; means for amplifying said electrical signals; and means for converting said electrical signals into audible sound.

7. In a musical instrument, the combination of a magnetic medium having a plurality of longitudinal substantially parallel tracks recorded thereon, each of said tracks containing a recorded signal, said tracks being divided into a plurality of groups; a magnetic recording playback head located beyond pickup range from said medium and oriented at right angles to said tracks; means for transporting said medium at substantially uniform speed in the longitudinal direction of said tracks; a plurality of stop bars disposed parallel to each other and substantially at right angles to said tracks, each of said bars having an engaged and a disengaged position; a plurality of sets of plungers, each of said sets being movably supported by one of said stop bars, said plungers in each of said sets in each said stop bar being spaced apart by a distance equal to the distance between corresponding tracks of said groups and being disposed opposite said tracks only when that one of said stop bars carrying said set is in said engaged position; a plurality of plunger-actuating means, each of said means being located to displace one of said plungers in each of said stop bars when said stop bars are in engaged position, said plunger displacement being toward said medium and being operative to bring that portion of said magnetic medium carrying the one of said tracks corresponding to said plunger within pickup range of said playback head, thereby inducing in said playback head an electrical signal corresponding to said signal recorded on said one track; means for amplifying said electrical signal; and means for converting said electrical signal into audible sound.

8. In a musical instrument, the combination of a flexible belt having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said belt, said tracks being divided into groups, each of said tracks carrying a single continuous musical tone having a fundamental frequency which is common to its group, the tone recorded in each group bearing an octave relationship to tones recorded in others of said groups, the notes recorded on individual tracks within each of said groups differing from each other only in their overtone characteristics, and each of said overtone characteristics being repeated in each of said groups in the same spatial order; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said belt at substantially uniform speed transversely relative to the airgap of said head; a plurality of stop bars disposed parallel to each other and transversely to said belt, each of said stop bars having an engaged and a disengaged position; a plurality of sets of plungers, each of said sets being movably supported by one of said stop bars, said plungers in each of said stop bars being spaced apart by a distance equal to the distance between tracks having notes of corresponding overtone characteristics, said plungers in each one of said sets being positioned opposite tracks having notes of corresponding overtone characteristics when the stop bar in which said one set of plungers is carried is in said engaged position; a plurality of plunger-actuating means operative in response to the actuation of a playing key of said musical instrument, each of said means being located to displace one of said plungers in each of said stop bars toward said belt when the respective ones of said stop bars are in their engaged positions, said displacement being sufficient to distort said belt and bring the sound tracks corresponding to said displaced plungers within pickup range of said playback head, whereby there is induced in said head an electrical signal corresponding in said musical tones recorded on said sound tracks corresponding to said displaced plungers; means for amplifying said electrical signal; and means for converting said electrical signal into audible sound.

9. In a musical instrument, the combination of a continuously-moving recording medium of substantially plane form having a plurality of tracks recorded thereon; a stop bar having an engaged and a disengaged position; a plurality of spaced-apart plungers movably supported in said stop bar, each individual one of said plungers being positioned opposite an individual one of said tracks only when said stop bar is in said engaged position; a plurality of plunger actuators, each positioned to operate one of said plungers when said stop bar is in said engaged position, each of said plungers being proportioned to move different portions of said medium in a direction perpendicular to the plane of said medium; a magnetic recording playback head having an airgap extending transversely across all of said tracks, said head being located relative to said medium to be within pickup range of said medium when any one of said plungers is operated, but otherwise beyond said pickup range.

10. In a musical instrument, the combination of a continuously-moving recording medium of a substantially

plane form having a plurality of tracks recorded thereon; a plurality of stop bars, each having an engaged and a disengaged position, and each movably supporting a plurality of plungers, each individual one of said plungers being positioned opposite a corresponding individual one of said tracks only when the particular one of said stop bars carrying said individual plunger is in its engaged position; a plurality of plunger actuators, each of said actuators being positioned to operate one of said plungers supported by any one of said stop bars which is in its engaged position, each of said plungers being proportioned to move a different portion of said medium in a direction perpendicular to the plane of said medium; a magnetic recording playback head having an airgap extending transversely across said tracks, said head being located relative to said medium to be within pickup range of said medium when any one of said plungers is operated but otherwise beyond said pickup range.

11. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of substantially parallel sound tracks longitudinally recorded on said member, said tracks being divided into groups, each group comprising tracks carrying harmonically-related continuous musical tones; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; means adapted in response to the actuation of a playing key of said musical instrument to distort said member toward said head such that at least one of said tracks is brought within pickup range of said head, whereby there are induced in said head electrical signals corresponding to said musical tones recorded on those ones of said sound tracks brought within pickup range of said head; means for amplifying said electrical signals; and means for converting said electrical signals into audible sound.

12. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of substantially parallel tracks longitudinally recorded on said member, said tracks including a group of tracks, each carrying a continuous musical tone, said tones carried by said tracks being harmonically related to each other; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; a plurality of stop bars, each of said stop bars having an engaged and a disengaged position and being oriented substantially at right angles to said tracks; a plurality of plungers, each of said plungers being movably supported in a corresponding one of said stop bars; a plurality of plunger-actuating means operative in response to the actuation of individual playing keys of said musical instrument, each of said means being located to displace any of said plungers which are supported by those of said stop bars in engaged position, said plunger displacement operating to distort said member toward said head such that at least one of said tracks is moved within pickup range of said head, whereby there is induced in said head electrical signals corresponding to said musical tones recorded on those ones of said sound tracks brought within pickup range of said head; means for amplifying said electrical signals; and means for converting electrical signals into audible sound.

13. In a musical instrument, the combination of a flexible member having a magnetic medium dispersed thereon; a plurality of longitudinal substantially parallel sound tracks recorded on said member, said tracks including a group of tracks, each carrying a continuous musical tone, said tones carried by said tracks being harmonically related to each other; a magnetic recording playback head located beyond pickup range from said medium; means for transporting said member at substantially uniform speed transversely relative to the airgap of said head; a plurality of stop bars, each of said stop bars having an engaged and a disengaged position, said stop bars being oriented substantially at right angles to said tracks; a plurality of plungers, each of said plungers being movably supported in a corresponding one of said stop bars, and each of said plungers having a contoured end; a plurality of plunger-actuating means operative in response to the actuation of a playing key of said musical instrument, each of said means being located to displace toward said member any of said plungers supported by those of said stop bars which are in engaged position, said plunger-displacement operating to bring said contoured end into contact with said medium, thereby distorting, in accordance with the contours of said end, said medium in a plane perpendicular to the direction of said transport, and consequently moving various ones of said tracks within pickup range of said head, whereby there is induced in said head an electrical signal comprising components corresponding individually to said notes carried on said tracks, the magnitude of each of said components being proportional to the distance from the particular track carrying the corresponding note to said head, as determined by the contours of said contoured end; means for amplifying said electrical signal; and means for converting said electrical signal into audible sound.

14. In a musical instrument, the combination of a continuously-moving recording medium having a plurality of tracks recorded thereon; a stop bar having an engaged and a disengaged position; a plunger having a contoured end and movably supported by said stop bar; a plunger-actuator operative in response to the depression of a playing key of said musical instrument, said actuator having an actuating force in a direction toward said plunger, but operable against said plunger only when said stop bar is in said engaged position; a magnetic recording playback head having an airgap extending transversely across said tracks, said head being positioned to be beyond pickup range from said medium except when said plunger is moved by said actuator.

15. In a musical instrument, the combination of a continuously-moving recording medium having a plurality of tracks recorded thereon; a stop bar having an engaged and a disengaged position; a plunger having a contoured end and movably supported by said stop bar; a plunger-actuator operative in response to the depression of a playing key of said musical instrument, said actuator having an actuating force in a direction toward said plunger, but operable against said plunger only when said stop bar is in said engaged position; a magnetic recording playback head located beyond pickup range from said medium when said plunger is in said disengaged position, said head having an airgap extending transversely across said tracks, said plunger being proportioned to distort said medium toward said head when moved by said actuator, said distortion being sufficient to bring at least one of said tracks within pickup range of said head.

16. In a musical instrument, the combination of a continuously-moving recording medium having a plurality of tracks recorded thereon; a stop bar having an engaged and a disengaged position; a plunger having a contoured end and movably supported by said stop bar; a plunger-actuator operative in response to the depression of a playing key of said musical instrument, said actuator having an actuating force in a direction toward said plunger, but operable against said plunger only when said stop bar is in said engaged position; a magnetic recording playback head located beyond pickup range from said medium when said plunger is in said disengaged position, said head having an airgap extending transversely across said tracks, said plunger being proportioned to distort said medium in a plane perpendicular to the direction of said continuous movement, said distortion being in accordance with the contours of said contoured end and being sufficient in magnitude to bring various portions of said medium within pickup range of said head, thereby inducing in said head

an electrical signal comprising components individually corresponding to said musical notes, the magnitude of each component of said signal being proportional to the distance from the particular track carrying the corresponding one of said notes to said head, as determined by the contours of said contoured end; means for amplifying said electrical signal and means for converting said electrical signal into audible sound.

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