April 17, 1951 H. A. VAGTBORG 2,549,145

ELECTRICAL MUSICAL INSTRUMENT

Filed July 28, 1944 3 Sheets-Sheet 1

Fig. 1

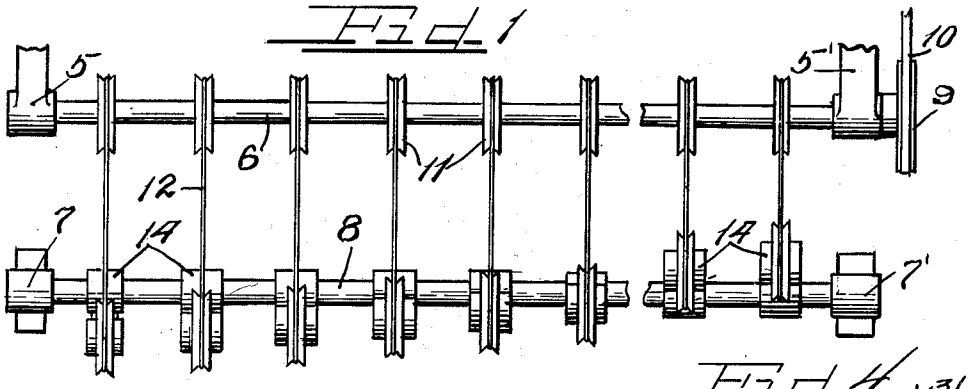


Fig. 4

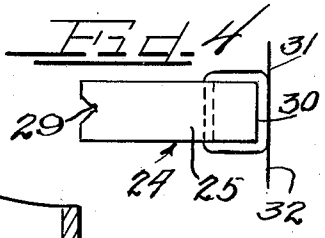
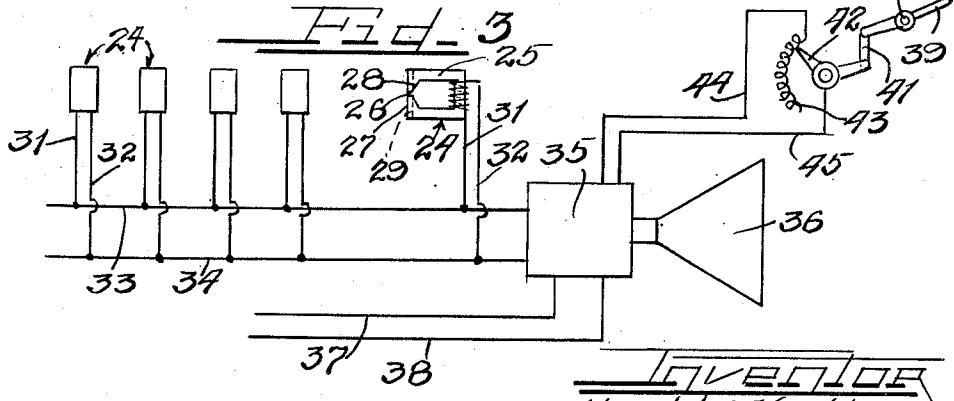


Fig. 2

Fig. 3



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April 17, 1951 H. A. VAGTBORG 2,549,145

ELECTRICAL MUSICAL INSTRUMENT

Filed July 28, 1944 3 Sheets-Sheet 2

Fig. 5

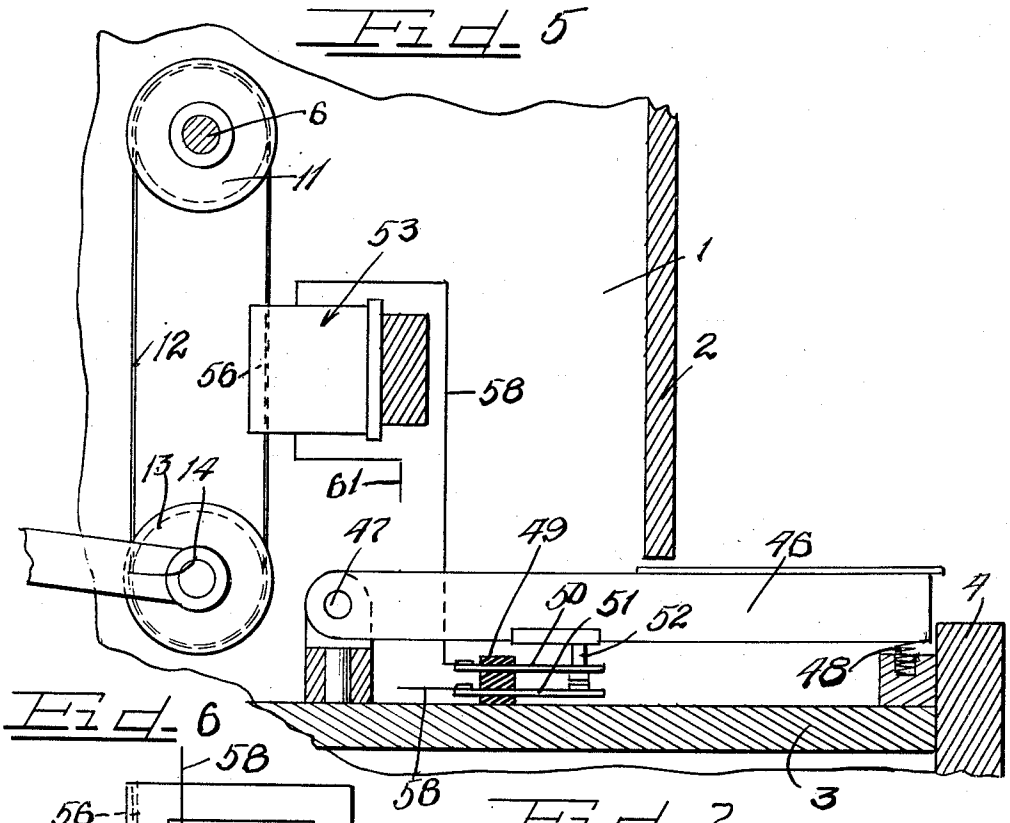


Fig. 6

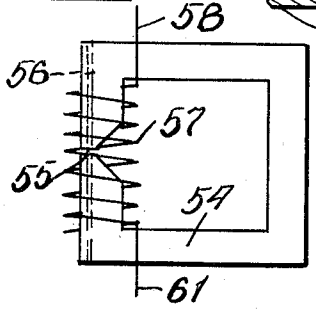
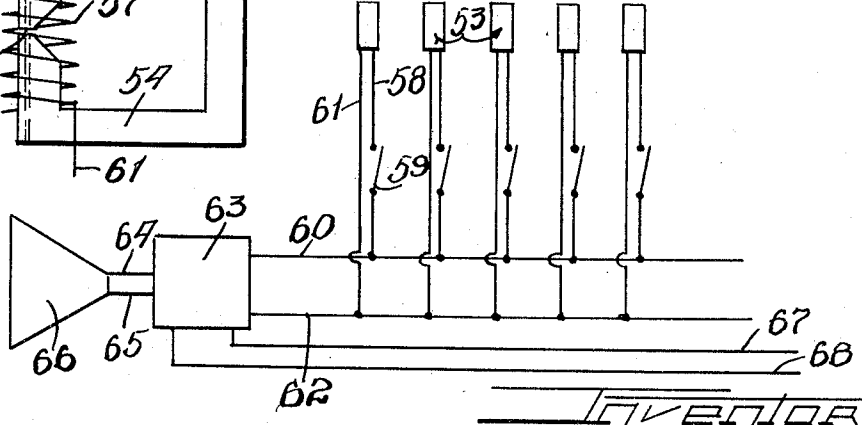


Fig. 7



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April 17, 1951 H. A. VAGTBORG 2,549,145

ELECTRICAL MUSICAL INSTRUMENT

Filed July 28, 1944 3 Sheets-Sheet 3

Fig. 8

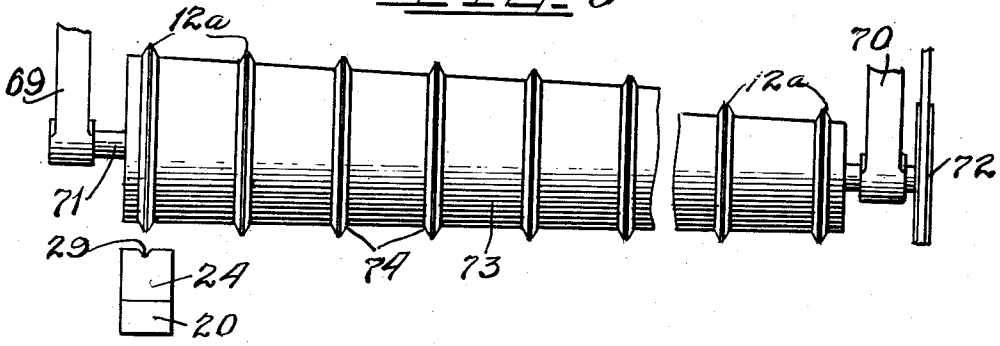


Fig. 10

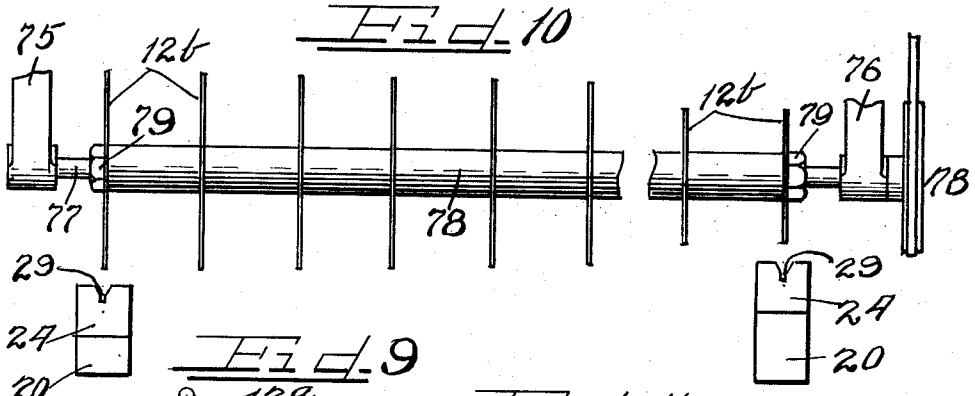


Fig. 9

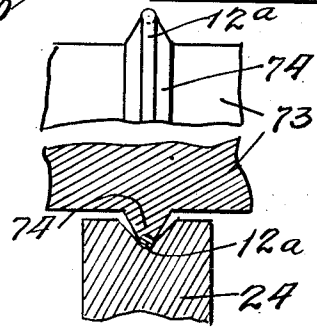
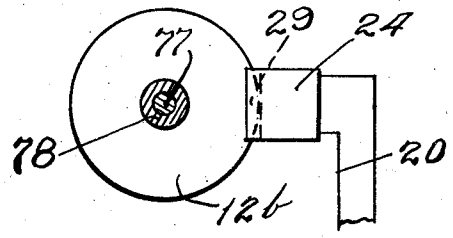


Fig. 11



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UNITED STATES PATENT OFFICE

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ELECTRICAL MUSICAL INSTRUMENT

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Application July 28, 1944, Serial No. 546,995

4 Claims. (Cl. 84—1.15)

1

This invention relates to improvements in electrical musical instruments, and more particularly to a musical instrument of the type of an electrical organ, although it will be appreciated that the instrument may have many and various shapes and size, as will be apparent to one skilled in the art.

In the past, many and various types of electrical pianos and electrical organs have been developed, but in most instances such instruments were objectionably expensive to produce, to repair, and in many cases, to operate. Further, these formerly known instruments, in many instances, involved numerous and complicated moving parts likely to become out of order, and in equally as many instances involved complicated electrical circuits and equipment highly difficult to install in a reasonably small location.

With the foregoing in mind, it is an important object of the instant invention to provide an electrical musical instrument of the character of an electrical piano or electrical organ having a full complement of keys and which is very economical to construct, simple in operation, and highly durable.

Another feature of the invention resides in the provision of an electrical musical instrument which takes advantage of the principles of magnetic recording and reproduction.

It is also an object of this invention to provide an electrical musical instrument embodying a series of recording media magnetized each with a tone different from that of the others and incorporating magnetic reproduction means to selectively reproduce tones from the magnetized media.

A further object of the invention resides in the provision of an electrical musical instrument which eliminates any need of tuning, and wherein it is a simple expedient to completely replace the means for producing a certain tone with new means already equipped to produce such same particular tone, and no adjustment relative to other means for producing other tones in the instrument is necessary at the time of installation, thus making repair operations extremely simple.

Also a feature of the invention resides in the provision of an electrical musical instrument having a piano-like keyboard with a magnetized recording medium for each key, and a recording head associated with each key and rendered operable to reproduce the particular musical sound recorded upon the respective medium upon depression of a key or an equivalent operation.

2

Also an object of the invention is the provision of an electrical musical instrument having a series of playing keys and capable of producing a musical sound in the nature of a chord made up of a number of different musical notes upon the actuation of a single key.

Still another object of the invention resides in the provision of an electrical instrument having a piano-like keyboard and having a recording medium for each key magnetized to record thereon a musical sound different from that recorded on the other media, and a reproducing device movable into operative association with the respective recording medium upon the depression or equivalent actuation of a particular key.

It is also an object of this invention to provide an electrical musical instrument having a piano-like keyboard with a recording medium for each key magnetized to record thereon a musical sound different from that recorded on any of the other media, with a reproducing device in permanent association with each recording medium, and switch means closed by the manipulation of any key to energize the corresponding reproducing device.

It is still a further object of the instant invention to provide a device of the character herein set forth which may be utilized as a signaling or control device, and which comprises a series of substantially permanently magnetizable recording media, each of which is magnetized to record thereon an impulse different from that recorded upon any of the other media, with means provided for the selective reproduction of recorded impulses, either individually or simultaneously in multiple.

Also an object of the instant invention is the provision of an electrical musical instrument of the character set forth herein which embodies substantially unbreakable magnetic media upon which the various musical tones have been magnetically recorded.

Still another object of the instant invention resides in the provision of an electromagnetic musical instrument in which the various musical tones are magnetically recorded on suitable media, and wherein the difference in wave lengths of the different tones throughout the full range of the instrument has been taken into account and the media accordingly constructed so that there will be no breaks in reproduction.

While some of the more salient features, characteristics and advantages of the instant invention have been above pointed out, others will become apparent from the following disclosures,

taken in conjunction with the accompanying drawings, in which:

Figure 1 is a fragmentary elevational view of a portion of a musical instrument embodying principles of the instant invention, showing that part of the instrument carrying the recorded musical tones;

Figure 2 is a fragmentary transverse vertical sectional view, with parts in elevation, of the instrument embodying the structure of Figure 1;

Figure 3 is a fragmentary schematic wiring diagram for the instrument of Figure 2, including a view of one of the reproducing heads in side elevation, with its casing removed, and indicating a volume control for the instrument;

Figure 4 is an enlarged plan view of one of the reproducing heads with its casing removed;

Figure 5 is a fragmentary transverse vertical section view, similar in character to Figure 2, of a musical instrument embodying principles of the instant invention but which is of somewhat different construction than the instrument shown in Figure 2;

Figure 6 is a side elevational view of a recording head used with the structure of Figure 5, with its casing removed;

Figure 7 is a schematic wiring diagram for the structure of Figure 5;

Figure 8 is a fragmentary top plan view of a still different form of that part of the instrument carrying the recorded musical tones, and indicating the association of a reproducing head with this type of construction;

Figure 9 is an enlarged fragmentary part plan part sectional view of the structure of Figure 8 indicating the reproducing association of the head with a recording medium;

Figure 10 is a fragmentary top plan view, similar in character to Figure 8, but showing a still different construction of that part of the instrument carrying the recorded musical tones, and indicating the arrangement of reproducing heads in association therewith; and

Figure 11 is a transverse vertical sectional view of the structure of Figure 10 and indicating a slightly different association of a reproducing head with a recording medium.

As shown on the drawings:

All illustrated embodiments of the instant invention are shown in the form of a musical instrument of the character of an electrical organ. It will be appreciated that such instruments will embody a piano-like keyboard and will have a full complement of keys, such, for example, as eighty-eight in number, it not being necessary to illustrate the full arrangement herein, since all keys will function substantially alike. It will also be appreciated that such instruments embody a box or cabinet that completely encircles the operating parts so as to render the instruments substantially dust-proof, and such box or cabinet may be decorated as may be desired and made of any suitable or desirable material so as to give a pleasing appearance to the instrument as a whole.

With reference to that embodiment of the invention seen in Figures 1 to 4 inclusive, there is shown a box-like structure 1, having a front panel 2, which, if so desired, may function as a music rack. A keyboard shelf 3 is provided which projects forwardly beneath the front panel 2 and which is edged by cross-panel 4.

Inside the box or cabinet 1 a pair of upper bearings 5—5′ journal a shaft 6, and therebelow but not in vertical alignment therewith another

pair of bearings 7—7′ journal a similarly disposed shaft 8. The shaft 6 may be extended beyond one of the bearings 5 to accommodate a suitable pulley 9 to which a belt 10 may be trained from any suitable driving source such, for example, as an electric motor.

Keyed in spaced relationship to the shaft 6 is a series of like pulleys 11, there being one such pulley for each musical tone produced by the instrument. Over each of the pulleys 11 an endless recording medium of paramagnetic material is trained. The same recording medium 12 is also trained over a similar pulley 13 rotatably carried at the end of an arm 14 keyed in fixed position to the shaft 8, as best seen in Figure 2.

In the illustrated instance, each recording medium 12 is in the form of a relatively fine endless wire of substantially permanently magnetizable material. Prior to the installation of each such wire in the instrument, the wire has been magnetized so as to record thereon a musical tone or sound different from that recorded on each of the other wires.

In so recording the different tones throughout the full range of the musical instrument, the wave lengths of those tones must be kept in mind. For purposes of high fidelity reproduction it is desirable to magnetize each recording medium so that it contains the equivalent of one or more complete wave lengths of the particular tone, but no sectional portions of a wave length. Consequently, the recording media are of different lengths. This is because of the considerable variation between the wave length of a tone or note of low pitch such as a bass note, and the wave length of a high pitched tone or note. The arms 14, therefore, supporting the lower pulleys 13 are not in horizontal alignment but are gradually elevated from one end of the arrangement to the other in keeping with the variance in size of the respective wires 12. It will be noted that proper tension may be kept upon the wires 12 by the adjustment of the arms 14. The pulleys 13 are free idling pulleys, and rotate solely by the frictional engagement of the wires therewith.

As best seen in Figure 2, the keyboard comprises a series of keys 15, in the form of piano keys. Each key is pivoted intermediately as indicated at 16, and each key may be provided with a limiting stop, cushioned or otherwise, beneath each end, as indicated at 17 and 18. Connected to the rear end, or inner end, of each key, is a suitable lever mechanism, which, in the illustrated instance, includes a link 19 connected to one end of a bell crank lever 20 pivoted intermediately to a fixed cross shaft as indicated at 21. A cross rest 22 maintains all of the bell crank levers 20 in alignment when in inoperative position. A spring 23 may be provided for each bell crank lever to urge it outwardly against the rest 22 and, through the leverage mechanism, cause the key 15 to elevate into playing position when released after each depression.

Carried on the free upper end of each bell crank lever 20 is a reproducing head 24, which, upon depression of the respective key 15, will be moved inwardly into operative association with the corresponding recording medium or wire 12.

As best seen in Figures 3 and 4, each reproducing head 24 comprises a magnetizable core 25, laminated or otherwise as may be most desired. A non-magnetic gap 26 is provided substantially midway of one leg of the core to define confronting pole pieces 27 and 28. These pole pieces have a groove extending therethrough as

indicated at 29 in Figure 4, which groove is preferably V-shaped in its outer portion so as to insure a clean-cut engagement with the wire.

When the reproducing head 24 is moved into operative association with the corresponding recording medium or wire 12 by the depression of a key 15, the wire is caused to enter the groove and will ride through this groove during its course of travel. With the aid of a coil 30 around one leg of the core 25 the magnetization of the wire is picked up by the reproducing head and this picked up impulse from the wire may then be reproduced audibly so that the listener will hear the particular musical sound or tone previously recorded on that respective wire.

As illustrated in Figure 3, each reproducing head 24 may be connected by a pair of conductors 31 and 32 leading from the opposite ends of the respective coil 30 to a pair of main conductors 33 and 34 respectively. Thus, all of the reproducing heads 24 are connected in parallel to the main conductors 33 and 34 which in turn are connected to a suitable amplifier 35, in turn connected to a loud speaker 36 or the equivalent. The loud speaker 36 may be associated with the box or cabinet 1, or disposed in a separate housing in a location remote from the cabinet 1, as may be deemed most desirable. The amplifier may receive its energy through any suitable line conductors 37 and 38 from any convenient source of electrical energy, such as a common wall outlet.

Means are also preferably provided by which the operator of the musical instrument may control the volume of reproduction and render the reproduced music louder or softer as he sees fit. Such arrangement is indicated diagrammatically in Figure 3 and includes a foot-pedal 39 in the form of a lever intermediately pivoted as at 40 connected through suitable linkage 41 to actuate a rheostat arm 42 which rides over a coil or equivalent resistance element 43. The element 43 may be connected through conductor 44 to the amplifier 33 and the arm 42 is also connected to the amplifier through a conductor 45. Thus, by the manipulation of the foot pedal 39 more or less resistance may be brought into the amplifier circuit and the volume of the ultimate audible reproduction controlled.

In the use of the instrument, the operator first turns on the power to the shaft 6 so that the recording media 12 are constantly in motion. The operator then manipulates the keys in accordance with a particular musical production or score, in similar manner to the playing of a piano or organ. In connection with the present invention, however, it will be noted that upon a sudden depression of a key the reproducing head does not simply strike the corresponding wire 12 and then bounce back, as is the case with a hammer in a piano, but remains in contact with the wire 12 as long as the particular key is depressed. Thus, it is necessary for the operator to hold a particular key depressed just as long as he desires that particular tone to be reproduced. For example, if it is desired to play a whole note, a key must be held depressed four times as long as to play a quarter note.

The invention lends itself to the skill of the musician in that tonal qualities and particularly the magnitude of a tone may be controlled. A tone or note may be brought up to full strength suddenly or relatively gradually as may be desired. Thus an artistic blending of several tones may be accomplished. This feature of the invention results from a control of key depression. A head 24 may be brought into its maximum association with the corresponding medium 12 suddenly or gradually depending upon the manner in which the respective key 15 is depressed. Conversely, a note or tone may be cut out abruptly or faded depending upon the rate of restoration permitted the respective key by the player.

In that embodiment of the invention shown in Figures 5, 6 and 7 the same general construction of instrument is illustrated. The same recording media and mounting means therefore are used. In this instance, however, a somewhat different construction of key is employed and the reproducing head is in constant association with its respective recording medium or wire 12. The circuit through each reproducing head, however, is open, and the depression of a particular key closes the circuit through the corresponding reproducing head, to energize it to pick up the recorded tone or sound upon the respective wire 12.

This structure includes a key 46 of the general nature of a piano key but which is pivoted, as indicated at 47, at the rear end only. A spring 48 or the equivalent may be disposed beneath the forward portion of the key so as to restore it to original position after depression. Beneath the row of keys or at any other suitable location a bar of insulating material 49 extends transversely across the instrument. For each key, this bar carries a pair of spaced resilient contacts 50 and 51. Each key is provided with a mechanical connection 52 to the uppermost contact and so, when the key is depressed, the contacts are brought into engagement with each other to close a circuit therethrough.

In this instance, a reproducing head, generally indicated by numeral 53, capable of reproducing with higher fidelity than the reproducing head 24, may be used. The reproducing head 53, as best seen in Figure 6, is of similar general construction to the reproducing head 24 above described, and embodies a core 54 having a non-magnetic gap 55 in one leg thereof. In this instance, however, the reproducing head does not have a groove through the pole pieces defined by that non-magnetic gap, but instead has an aperture 56 spaced through these pole pieces of sufficient size to accommodate the recording medium 12. In this instance, also, the coil around a leg of the reproducing head is preferably disposed around that leg defining the pole pieces and directly over the non-magnetic gap 55. Such a coil is indicated at 57 in Figure 6. The magnetic impulse is picked up from the wire 12 with more fidelity than with a head of the type of the above described head 24, although it will be appreciated that a head 24 may be used in lieu of the head 53 if so desired.

As indicated diagrammatically in Figure 7, the reproducing heads 53 are each connected in parallel through conductor 58 with its corresponding switch 59, such switch being formed by the above described contact members 50 and 51 closed by the manipulation of the corresponding key 46. This conductor 58 is connected to a main conductor 60, and a conductor 61 from the opposite end of the coil 57 is connected to a main conductor 62 paired with the conductor 60. The conductors 60 and 62 are in turn connected to a suitable amplifier 63 connected by conductors 64 and 65 to a loud speaker 66 or the equivalent. The amplifier 63 may receive its energy through conductors 67 and 68 from any suitable source of current supply.

The structure described in connection with Figures 5, 6 and 7 is operated in substantially the same manner as the structure previously described. It is simply necessary for an operator to depress the keys 46 in accordance with a musical score, holding each key depressed in accordance with the value of each note in that score. Each depression of a key energizes the corresponding reproducing head 53 through the switch means associated with that key and thus a particular musical sound or tone previously recorded on the respective media 12 audibly emanates from the loud speaker 66.

In Figures 8 and 9 I have illustrated a different manner of mounting the recording media, and with this arrangement the reproducing head and associated key structure shown in Figure 2 may well be utilized. In this instance, suitable bearing supports 69 and 70 journal a shaft 71 which may carry a drive pulley 72 on one end thereof. Keyed to the shaft is an elongated drum 73 which is preferably provided with spaced outstanding beads 74 therealong. As illustrated in the drawings, the side walls of each bead preferably converge so as to define, in effect, an outstanding apex, and it is around the apexial portion of each bead that a recording medium 12*a* is mounted. These media 12*a* are of the same general character as the media 12 above described.

The media 12*a* are, of course, preferably of varying lengths, and to accommodate such media the drum itself varies in diameter from one end thereof to the other, so that the media may vary in accordance with differences in wave lengths of the musical sound or tones recorded on the media.

In those structures above described in connection with Figures 1 to 7, inclusive, the arrangement of recording media deviated so slightly that the reproducing heads could all be mounted in the same vertical plane. That is, the heads were in an even row across the musical instrument. This may also be the case in the structure shown in Figures 8 and 9, if so desired. To this end, a shaft 71 is disposed slightly obliquely so that the element of the drum nearest the front of the instrument is substantially a straight transverse line. The reproducing heads 24 may therefore all be mounted to pivot on a single shaft 21 and all be backed by a single cross rest 22.

In operation, when a key is pressed, the reproducing head 24 is moved forwardly by the arm or bell crank lever 20 and the groove 29 in the reproducing head seats over the corresponding bead 74 on the drum. The recording medium 12*a* carried by that particular bead will then seat within the reduced portion at the bottom of the groove 29, as indicated in Figure 9. Thus, an accurate reproduction of the particular sound recorded on that medium may be had.

Still another, and perhaps the most desirable, arrangement of recording media is shown in Figures 10 and 11. In this instance, the media are substantially unbreakable, and any replacement of these media would be necessary at very infrequent intervals. In this instance, bearing members 75 and 76 support a shaft 77 which may be equipped at one end with a suitable drive pulley 78. Fixed to the shaft to rotate therewith is a series of spaced recording media, designated 12*b*, each of which is in the form of a solid paramagnetic disk of sufficient thinness to enter the groove 29 in a reproducing head 24. In order to reinforce the media 12*b* and maintain them in proper spaced relationship, a series of sleeves 78 are disposed over the shaft 77, one sleeve between

each pair of adjacent media. Suitable nuts 79—79 may be engaged with a corresponding threaded portion of the shaft outside of the terminal medium at each end of the shaft.

With a recording element in the form of a permanently magnetizable disk, the circumferential portion of the disk is magnetized to record thereon a musical sound or tone. The disks vary in diameter in accordance with the different wave lengths of the different sounds or tones recorded.

It is not essential to have the forward point of each disk disposed in the same horizontal plane as was the case in the previously described embodiment. In order to illustrate a slightly different arrangement which, of course, may be used in connection with any of the previously discussed embodiments if so desired, I have shown the shaft 77 as extending directly transversely of the machine. The reproducing heads 24 may be caused to properly be engaged with the respective media for reproduction purposes by the simple expedient of varying the thickness of the upper end of the bell crank lever 20 as illustrated in Figure 10. This variation will, of course, be proportionate to the difference in size of the media. Thus, each reproducing head is maintained at the same initial distance from its corresponding disk 12*b* as every other reproducing head, and again only one pivot shaft 21 and one cross rest 22 is necessary for the entire series of reproducing heads.

In operation, the structure of Figures 10 and 11 is equally as simple and effective as the other arrangements previously described. When a key is depressed, the bell crank lever 20 moves its reproducing head 24 to the corresponding disk 12*b*, so that a circumferential portion of the disk enters the groove 29 in the reproducing head, as illustrated in Figure 11. The disk is preferably of sufficient thinness to extend into the reduced inner portion of the groove 29 so that a reproduction of good fidelity may be obtained.

It will be appreciated that if so desired, the reproducing head 24 may be maintained in constant reproductive association with the disks 12*b*, and reproduction controlled by the switch means illustrated in Figure 5. However, for most installations the mechanical forward movement of each reproducing head as shown in Figure 2 may be the more desirable to avoid any noise that might occur by way of a slightly warped disk rubbing a side of the groove 29 in the reproducing head when a reproduction of the recording on that particular disk is not being made.

It should be noted that the structures of Figures 8 to 11, inclusive, permit the same tonal magnitude control by the player as above set forth in connection with the showing in Figures 1 to 3, inclusive, in that the rate of approach and recession of the head 24 may be selectively varied or controlled.

It will be appreciated that the present invention is quite economical to construct, operate and repair. Should one of the recording media need replacement, it is a simple expedient to substitute a new medium already magnetized in accordance with the desired musical tone or sound. No tuning of any part of the instrument is essential. If something should go wrong with a reproducing head, that, also, is a simple replacement job, all of the reproducing heads in a single instrument preferably being alike.

It should also be appreciated that each recording medium might be magnetized so as to record thereon a chord made up of a number of musical

tones or notes played simultaneously. Thus, a relatively small and compact instrument could be devised embodying a comparatively small number of keys and recording media, and upon the depression of each key an entire chord would be reproduced through the loud speaker. Such an instrument could be played by a very unskilled operator, knowing nothing whatever of music, but merely following a chart indicating which key should be depressed next, and how long the key should be held depressed. The resultant musical production would be made up of the various recorded chords produced individually or in multiple.

It will further be appreciated that a device embodying principles of the instant invention might be constructed and utilized for controlling other apparatus in a selective manner or for signalling. In such cases, impulses, audible or inaudible, would be recorded upon the recording media, a different impulse to each medium. Upon the depression of a certain key, therefore, a certain signal could be produced.

It will, of course, be understood that various details of the process may be varied through a wide range without departing from the principles of the invention, and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a musical instrument, a series of pairs of opposed pulleys arranged for constant rotation during operation of the instrument, an endless magnetic wire trained over each pair of opposed pulleys, each wire having a musical sound magnetically recorded thereon different from that on the other wires, a pick-up head associated with each wire, said heads being mounted for selective and varying extent of movement into electromagnetic association with an associated endless magnetic wire, amplifying and audio means connected with said heads, a key for each head for moving said head into electromagnetic association with its associated wire, and means connected between said keys and said heads to cause operation of a pick-up head upon manipulation of the corresponding key.

2. In a musical instrument, a plurality of smooth surfaced magnetic members each having a musical sound magnetically recorded thereon different from that recorded on the other members, means for selectively reproducing sounds from said members, said means including an electromagnetic transducer head for each member, said heads being mounted for selective and varying extent of movement into electromagnetic association with an associated magnetic member and each said member having such length of recording surface as to have recorded thereon an even multiple of wave lengths of the particular sound for that element.

3. In a device of the character described, a rotary shaft, a plurality of spaced smooth-edged magnetic disks carried by said shaft, each said disk having a sound magnetically recorded on the circumferential portion thereof, a reproducing head associated with each disk, means to selectively move the heads into selectively varying degrees of engagement with the respective disks, and means to selectively cause the heads to pick up the recorded impulses from the respective disks, said disks varying in size in accordance with variations in wave lengths of the sounds recorded on said disks.

4. In a device of the character set forth, a plurality of smooth surfaced magnetic members each having an impulse magnetically recorded thereon, certain of said impulses being different from the others, each said member being of such size as to have an even multiple of wave lengths of its particular impulse recorded thereon, and means for selectively reproducing the recorded impulses, said means including an electromagnetic transducer head for each of said members, said heads being mounted for selective and varying extent of movement into electromagnetic association with an associated magnetic member.

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