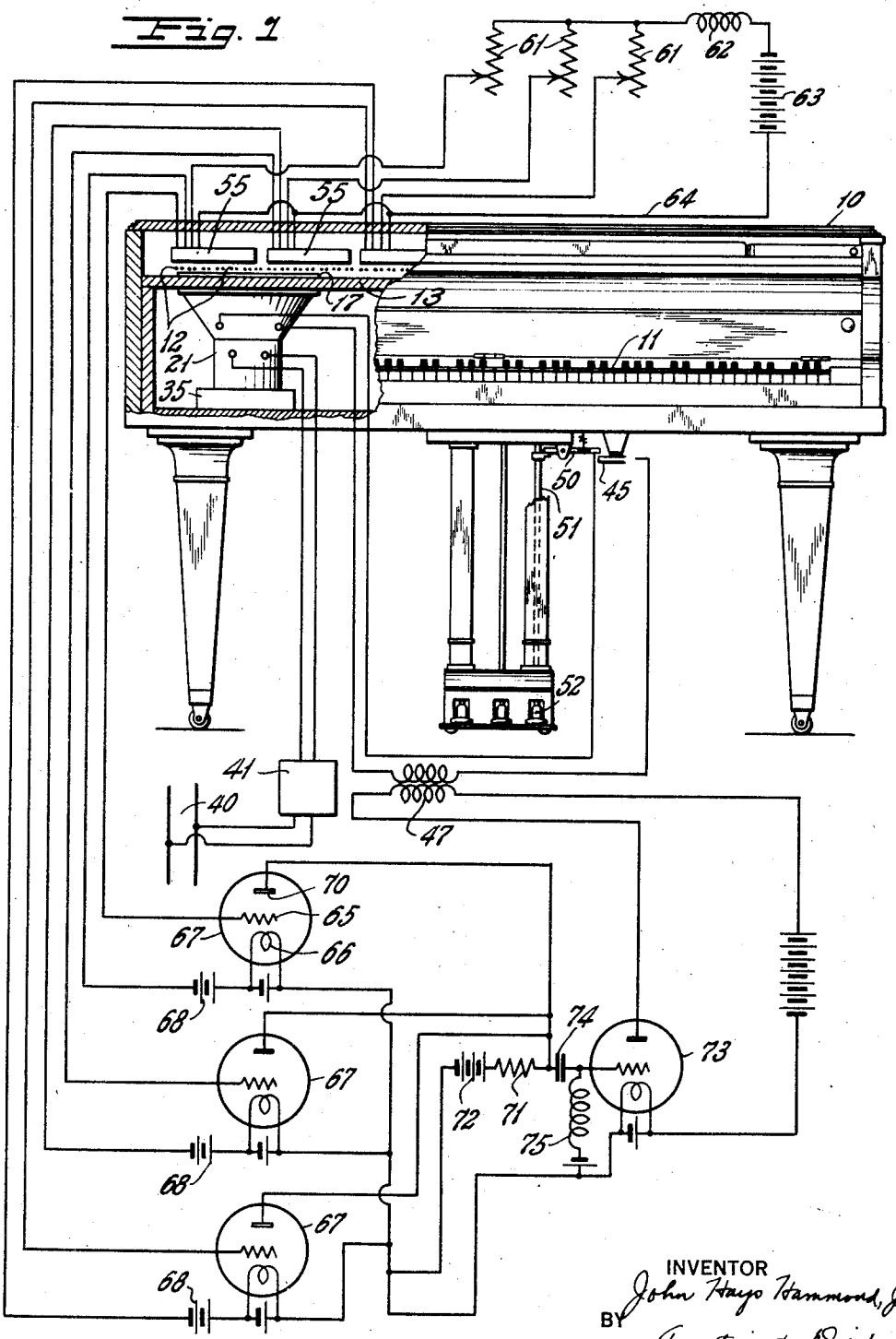
Jan. 10, 1933. J. H. HAMMOND, JR 1,893,895

MUSICAL INSTRUMENT

Original Filed June 13, 1929 2 Sheets-Sheet 1

Fig. 1



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Fig. 2

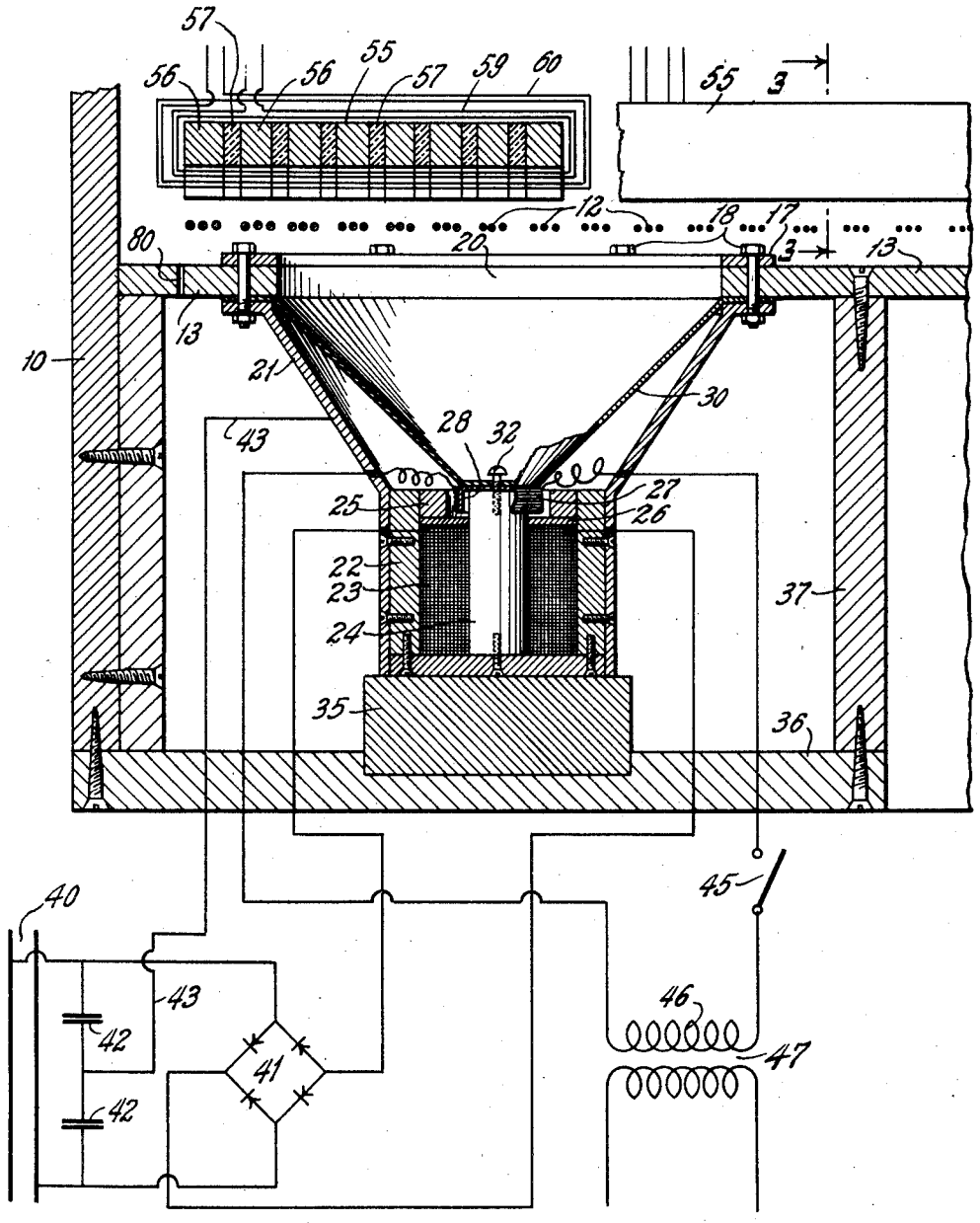
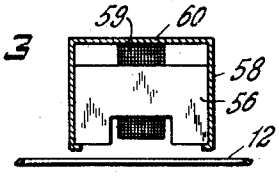


Fig. 3



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UNITED STATES PATENT OFFICE

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MUSICAL INSTRUMENT

Original application filed June 13, 1929, Serial No. 370,484. Divided and this application filed August 23, 1930, Serial No. 477,325. Renewed October 7, 1932.

This invention relates to musical instruments of the percussive type, and more particularly to a piano having sound propagating and reenforcing means associated therewith.

This application is a division of my copending application Serial No. 370,484, filed June 13, 1929, for piano with reaction loud speaker.

In accordance with the present invention a sound propagating device, such as the so-called loud speaker which is capable of converting electrical vibrations into compressional waves, is applied to a portion of the sounding board of a piano which is substantially inactive for each of the notes of the musical scale. The loud speaker may thus be utilized for the reproduction of programs without interfering with the operation of the piano or the reenforcing qualities of the sounding board.

The invention further provides for magnetically picking up the vibrations of the strings of the piano, amplifying the same and applying the amplified energy to the loud speaker whereby the volume emitted by the piano may be controlled within the range of the amplifier.

The invention also provides for amplifying the vibrations of the various strings as groups and for independently controlling the amount of amplification of each group.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 is a diagrammatic view of the pick-up and amplifying means showing the location of the various elements with respect to the piano;

Fig. 2 is an enlarged sectional view of the loud speaker and the support showing the electrical circuits associated therewith; and

Fig. 3 is a section taken on the line 3—3 of Fig. 2.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the drawings more in detail, the invention is shown as applied to a grand piano 10 having the usual keyboard 11, strings 12 and sounding board 13. Said strings are secured to the sounding board of the piano in the usual manner.

Sounding board 13 is provided with a circular opening 20 below which is mounted a frame 21 (Fig. 2) formed partly cylindrical and partly conical. This frame is bolted to the sound board 13 and to an annular ring 17 by means of bolts 18. In the cylindrical portion of frame 21 is mounted a cylinder 22 of magnetic material inside of which is a winding 23 mounted on a magnetic core 24. Associated with the end of cylinder 22 is an annular ring 25 of magnetic material, which is separated from coil 23 by a ring 26 of non-magnetic material. A coil 27, of comparatively fine wire, is supported in any convenient manner as by cup-shaped member 28 and is free to move within ring 25. Said member 28 is rigidly mounted to the apex of the cone 30, the periphery of which is secured between sounding board 13 and frame 21. Screw 32 is carried in core 24 and serves as a guide for insuring the proper alignment of coil 27 with respect to ring 25. Cone 30 may be of any suitable material such as heavy paper which is capable of transmitting compressional wave vibrations to the surrounding medium. The entire unit is supported by spring means such as a block 35 of sponge rubber from the horizontal member 36, one end of which is secured to the casing of the piano 10 and the other end of which is fastened to a diagonal brace 37 on the underside of sounding board 13.

The above described unit represents a loud speaker of the so called dynamic type which comprises a moving coil mounted in the field of an electromagnet. This form of loud speaker, is shown by way of example only and not as a limitation upon the scope of the invention. As shown in Fig. 2, the coil 23 is supplied with direct current from an A. C. main 40 through a rectifying device 41. Condensers 42 are connected across the A. C. main 40 in the usual manner and are grounded to a frame 21 as by conductor 43. It is obvious that any suitable type of rectifying device may be employed for rectifying the alternating current from main 40 and applying same to coil 23 for producing the powerful magnetic field which is required in a speaker of this type. The armature coil 27 is connected through switch 45 with a secondary 46 of an audio frequency transformer 47. Switch 45 may be operated by lever 50 which is pivotally secured to the frame of piano 10 and is operated by plunger 51 connected to pedal 52.

A plurality of magnetic pick-ups 55 are mounted over the various strings of the piano and are designed to be actuated by the action of said strings for producing a pulsating electric current. These pick-up devices consist of a plurality of segments 56 each of which is located directly above the strings comprising a single note of the piano. Segments 56 are separated by magnetic insulating segments 57 and are mechanically secured together in any suitable manner as by casing 58. A pair of windings 59 and 60 which may be wound in the form of a single coil, as shown in Fig. 3, are carried on each group of segments. One of said windings of each group, for example, winding 59 is connected through a variable resistance 61 and choke 62 to battery 63, said battery being provided with a common return wire 64 to each group 55. The windings of each group, are connected through individual resistances 61 so that the amount of current flowing in each winding 59 can be individually adjusted. Windings 60 of the various pick-ups are connected to the grids 65 and filaments 66 of a plurality of space discharge devices 67. A battery 68 may be employed for maintaining said grids at the proper potential. The plates 70 of said space discharge devices are joined through a resistance 71 to a common source of plate current, such as battery 72. The output circuit of space discharge devices 67 is coupled to the input circuit of amplifier 73 in any suitable manner, such as by condenser 74 and impedance 75. The output circuit of amplifier 73 is connected to the primary of audio frequency transformer 47.

Although a particular form of amplifier has been illustrated by way of example, it is obvious that the invention is not limited thereto and that any desired type of amplifier may be employed for separately amplifying the current variations induced in coil 60 by the vibration of strings 12 and applying the amplified energy to the armature coil 27 of the loud speaking device.

In the operation of the above described apparatus the current flowing in coil 59 from battery 63 produces electromagnetic lines of force in segments 56 thereby producing a magnetic field in which the strings 12 of the piano are positioned. The strings in effect form the armature of the electromagnet and their spacing from the coil pieces of the electromagnet determines the reluctance of the magnetic path. The field produced in segments 56 by the current in winding 59 accordingly varies in strength in accordance with the vibrations of the adjacent strings. This varying magnetic field induces an electric current in coil 60 which is amplified by space discharge amplifiers 67 and 73 and applied through transformer 47 to the armature coil 27 of the loud speaker. This coil is thus caused to vibrate in the magnetic field produced by the electromagnet 23 and to thereby reproduce the vibrations of strings 12.

The amount of amplification of each group of strings can be determined by the positions of resistances 61 which governs the amount of current flowing in the various coils 59. It is accordingly possible to amplify a given group of notes, for example, the treble notes, a greater amount than the notes of another group, whereby any desired effect may be reproduced. The action of the amplifier is controlled by foot pedal 52 which may be the usual loud pedal of the piano. When this pedal is depressed switch 45 is closed thereby permitting the energy picked up by the magnetic pick-up device to be fed back into the loud speaking device. This energy is again mechanically transferred to the strings 12 by the action of the compressional waves produced by the loud speaker whereby a regenerative effect is obtained. By properly adjusting the various elements it is accordingly possible to produce a sustained note which will continue as long as the key is depressed.

The reactance of the frame 21 of the loud speaking device is mechanically transmitted through said frame to sounding board 13 whereby the sounding board is caused to vibrate at the frequency of a note being emitted and to reenforce the vibrations produced by the vibrating cone 30. In order to permit the sounding board adjacent the loud speaker to vibrate more readily a slot 80 may be formed in said sounding board adjacent the point of support at the side and the front of the piano.

It has been found that the compressional waves traveling through the air pass from the loud speaking mechanism to the sound-

ing board 13 with a sufficient intensity to cause said sounding board to vibrate. Accordingly the loud speaker may be mechanically disjoined from said sounding board and the above mentioned regenerative action will be obtained by the transmission of energy from the loud speaker to the sounding board in the form of compressional waves instead of direct mechanical vibrations.

The relative amounts of amplification of the various pick-ups 55 can be predetermined and the resistances 61 set at the desired value. The piano is then played in a normal manner and the amplifying apparatus is controlled by foot pedal 52. When this pedal is depressed for a loud note the amplifying device is brought into operation and the sound waves are amplified and reenforced in the manner above pointed out. The device will be utilized as a straight amplifying arrangement for merely amplifying the various notes, or by a suitable adjustment of the various parts may be caused to regenerate for producing a sustained note. In the latter case the sustained note would be maintained while the key is held down and the string is free to vibrate. When the key is released the felt stop will come in contact with the string in a manner well known in the piano art and will interrupt further vibration thereof. It is accordingly possible in accordance with this invention to cause a piano to emit an undamped note of a duration which is dependent upon the length of time the key is depressed.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In a piano having a plurality of strings, arranged in groups, means for amplifying the vibrations of each of said groups, and means for separately controlling the amount of amplification of each group.

2. In combination with a piano having strings, a plurality of magnetic pick-ups associated with said strings, means for independently adjusting said pick-ups, means for amplifying the energy of said pick-ups and applying the same to a loud speaking device.

3. In a piano, a plurality of strings, a plurality of pick-up means, each said pick-up means being associated with a group of said strings, means controlled by said pick-up means for amplifying the energy of vibration of said strings and feeding said energy back to said strings for decreasing the damping of said vibrations, and means for independently varying the amount of feed back controlled by each pick-up means.

4. In a piano, a plurality of strings, a plurality of pick-up means, each said pick-up means being associated with a group of said strings, means controlled by said pick-up means for amplifying the energy of vibration of said strings, and for producing compressional waves by said amplified energy.

5. In a piano, a plurality of strings, a plurality of pick-up means, each said pick-up means being associated with a group of said strings, means controlled by said pick-up means for amplifying the energy of vibration of said strings, and a loud speaking device responsive to said amplifying means and adapted to propagate compressional waves of a greater amplitude than that caused by said strings.

6. In a piano, a plurality of strings, a plurality of pick-up means, each said pick-up means being associated with a group of said strings, means controlled by said pick-up means for amplifying the energy of vibration of said strings, a loud speaking device responsive to said amplifying means and adapted to propagate compressional waves of a greater amplitude than that caused by said strings, and means for independently varying the amount of amplification derived from each group of strings.

7. In a piano, a plurality of strings, a plurality of pick-up means, each said pick-up means being associated with a group of said strings, means controlled by said pick-up means for amplifying the energy of vibration of said strings, a loud speaking device responsive to said amplifying means and adapted to propagate compressional waves of a greater amplitude than that caused by said strings, and means controlled by the loud pedal of said piano for rendering said amplifying means effective.

8. In a piano, a plurality of strings, a plurality of pick-up means, each said pick-up means being associated with a group of said strings, means controlled by said pick-up means for amplifying the energy of vibration of said strings and feeding said energy back to said strings for decreasing the damping of said vibrations, and means controlled by the loud pedal of said piano for rendering said amplifying means effective.

9. In combination with a piano having a sounding board and strings, a loud speaker having an independent sound propagating element mounted adjacent said sounding board, means for picking up the energy of vibration of said strings, amplifying said energy and applying the same to said loud speaker, said loud speaker being so mounted with respect to said sounding board that the compressional waves emitted therefrom react on said sounding board and produce vibrations therein.

10. In a musical instrument, a plurality of strings, each vibratable at a different tone frequency, a plurality of pick-up devices associated with said strings for picking up said tone frequencies, a plurality of separate control means for independently controlling the several tone frequencies, an amplifier fed by said pick-up devices and a translating device fed by said amplifier.

11. In a musical instrument having a vibrating string adapted to produce a musical note, a pick-up device comprising a magnet with both its opposite poles adjacent said string, means for causing a direct current flux through said magnet and string, a coil on said magnet, an amplifier fed by said coil and a loud speaker fed by said amplifier.

12. In a piano having a loud pedal, a pick-up device applied to a vibrating part of the piano, an amplifier fed by said pick-up device, a loud speaker fed by said amplifier and means for changing the energy fed to said loud speaker by said loud pedal.

In testimony whereof I have hereunto set my hand.

JOHN HAYS HAMMOND, JR.