Jan. 1, 1935. F. M. ROBB 1,986,531

WAVE ORGAN

Filed Nov. 5, 1931 3 Sheets-Sheet 1

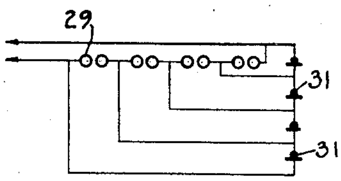

FIG-1

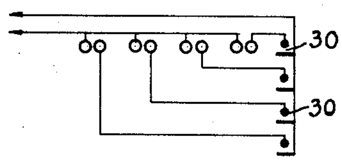

FIG-2

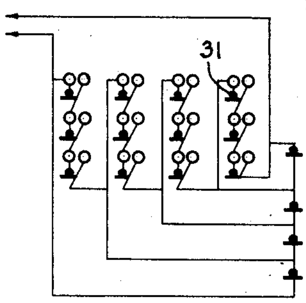

FIG-3

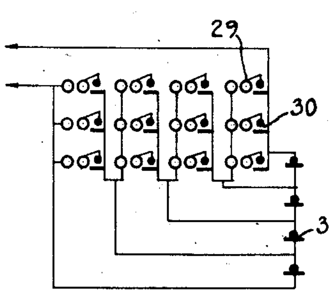

FIG-4

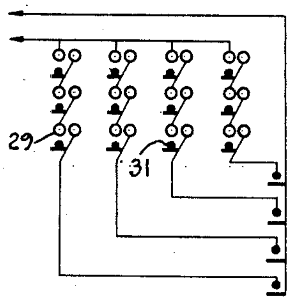

FIG-5

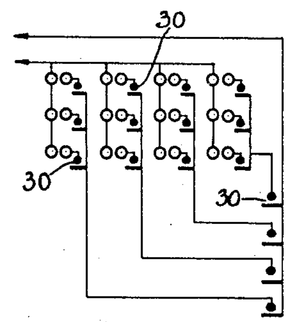

FIG-6

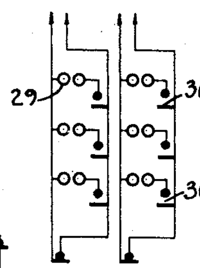

FIG 7

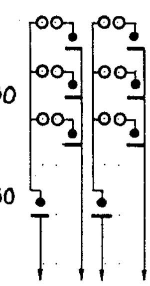

FIG 8

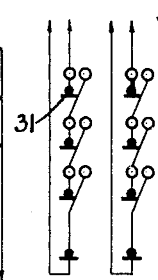

FIG 9

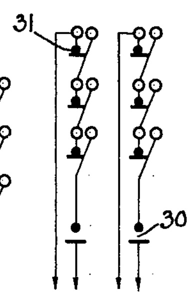

FIG 10

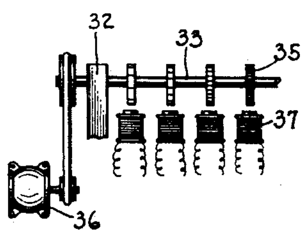

FIG-11

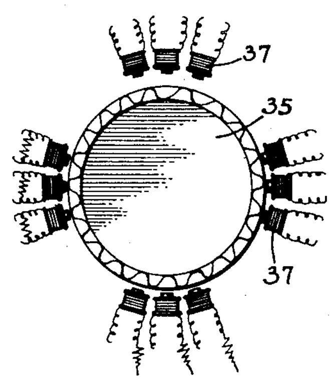

FIG-12

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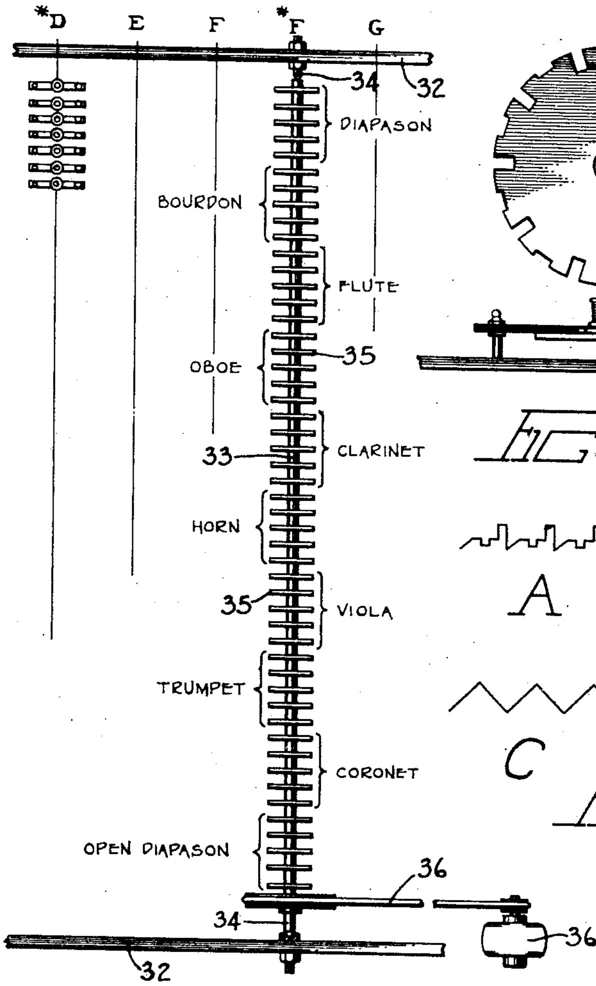

FIG-13

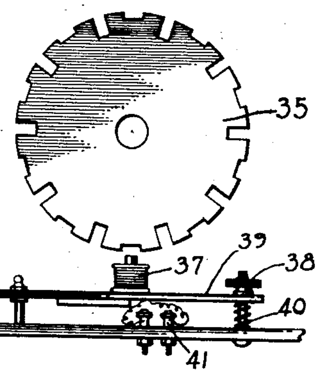

FIG-15

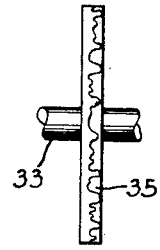

FIG 16

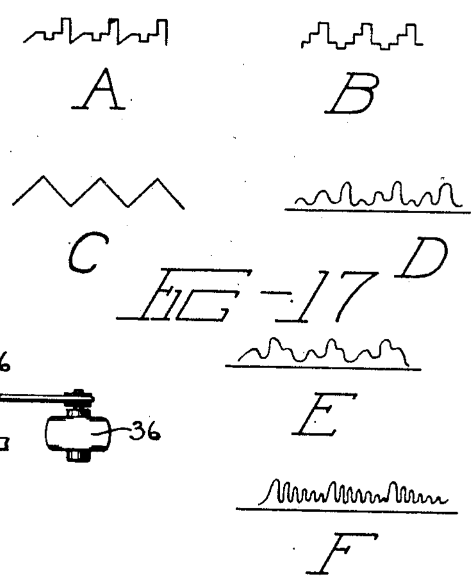

FIG-17

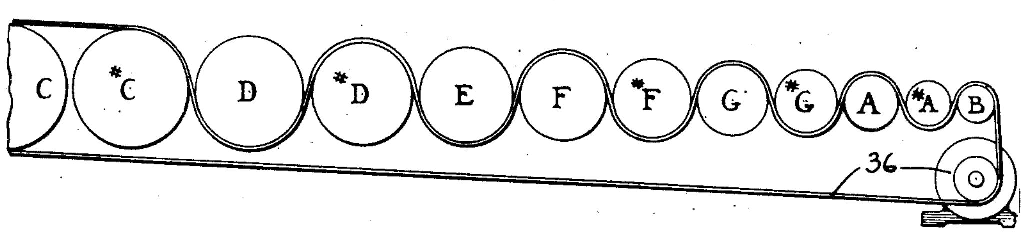

FIG-14

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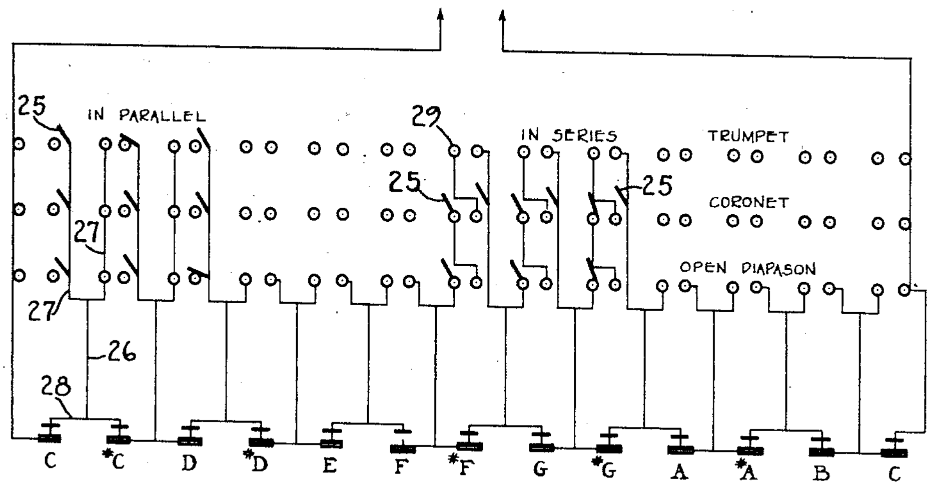

FIG-18

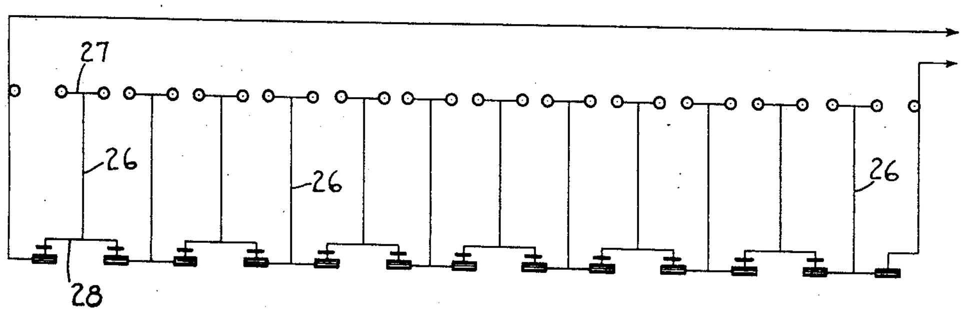

FIG-19-A

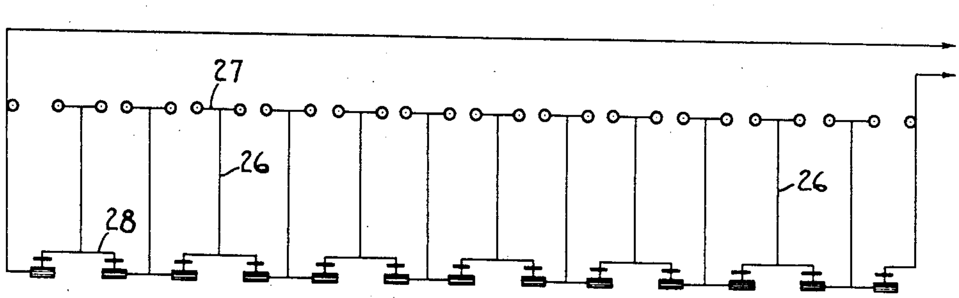

FIG-19-B

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Patented Jan. 1, 1935 1,986,531

UNITED STATES PATENT OFFICE

1,986,531

WAVE ORGAN

Frank Morse Robb, Belleville, Ontario, Canada

Application November 5, 1931, Serial No. 573,123

1 Claim. (Cl. 84—1)

This invention relates to wave organ methods and means, and more especially to certain improvements in the construction and operation of wave organs by which perfectly satisfactory music and sound reproduction may be obtained, and without the shortcomings heretofore apparent in such instruments.

The present invention employs a tone-disc and magnetic pickup device for the production of tone. Such devices in themselves are old; one such is disclosed in an old patent to Severy. Such an instrument as his, however, is both practically and theoretically impossible, as without amplification, far greater than the microphone type he suggests, nothing but the faintest trace of tones could be heard. The mere addition of amplification to his instrument would not be invention. If this were done, moreover, the instrument could not be made to function musically as the circuit and wiring arrangement set forth in his patent would preclude that possibility due to internal resistance in the magnets. Every impulse generated by the tone disc would be absorbed in the circuits to such an extent that amplification would be impossible.

An object of the present invention is to improve electrical organs of this type in order to produce satisfactory music.

Another object is to devise a system of wiring in connection with such instruments which will have advantages over present-known wiring methods.

Another object is to provide a system of pulleys or gears of diminishing size, tuned to proper pitch for the note that is to sound from any disc on their shafts.

A further object is to provide in such a device means of obtaining all the octave notes of any note by doubling and redoubling the wave forms on the discs on one shaft.

All these and other objects as suggested herebelow are attained by the methods and means now to be described, and illustrated in the accompanying drawings, in which—

Fig. 1 shows four keys wired in series.

Fig. 2 shows four keys wired in parallel.

Fig. 3 shows four keys with three stops wired in series throughout.

Fig. 4 shows three stops in parallel, with series wiring to the keys.

Fig. 5 shows the wiring diagram for three stops on four keys.

Fig. 6 shows three stops on four keys wired in parallel throughout.

Fig. 7 shows two keys with three stops.

Fig. 8 shows the wiring diagram in which two keys and three stops are wired in the same way with an individual amplifier for each key in the octave.

Fig. 9 shows two keys with individual amplifiers.

Fig. 10 is the same as Fig. 9, except that it is so arranged that depressing the key closes the circuit to the amplifier.

Fig. 11 shows an instrument for the composition of any quality of sound.

Fig. 12 shows a diagram of a tone disc with a number of pick-ups disposed around its circumference, and suitable resistances in their lines.

Fig. 13 is a partial view of the arrangement of the wave organ frame.

The arrangement of pulleys and the endless belt passing in and out, and around the motor, is shown in Fig. 14. This is the preferred arrangement at present.

The adjustment may be varied up and down by means of a thumb nut, as in Fig. 15, which shows this arrangement.

Fig. 16 shows a disc on which the wave forms have been cut laterally.

Fig. 17, subs A to F inclusive, shows various wave forms.

Fig. 18 shows the wiring of the wave organ.

And Figs. 19A and 19B represent an alternate method of wiring to Fig. 18, and one which may also be used.

Such a feature as the single amplifier of Figs. 1 to 6 is a great advantage in small organs because of simplicity and cheapness. It will be noted that one set of key contacts serves for any number of stops, which is an additional important advantage.

The contacts of Fig. 1 open to make the note sound, as each pick-up is short-circuited until the key is depressed.

In Fig. 2 the contacts close to make the notes sound.

Both stop and key contacts of Fig. 3 open to make notes sound. Even though a key be depressed, no note will sound unless one or more stops have been opened.

The stop contacts in Fig. 4 close to sound. The key contacts open to make the notes sound.

The stops in Fig. 5 are wired in series and the keys in parallel. The stop contacts open to sound. The key contacts close to make the notes sound.

All contacts in Fig. 6 close to sound.

Each key in Fig. 7 is wired in parallel to a

separate amplifier which means that in an organ so built, there would be twelve amplifiers, one for the first C on the keyboard and all the octaves. The second amplifier would be for all the octaves of C♯, the third for D and all its octaves, and so on. It will be observed that the input circuit of the amplifier is short circuited at the key. Depressing the key opens the circuit, allowing any pick-up to feed in if the stop contact is closed.

In Fig. 8 the input to the amplifier is not short-circuited. Depressing the key closes the circuit.

Three stops in Fig. 9 are wired in series to the amplifier. Stop contacts open to sound. Key contacts open also to make notes sound as the input line of the amplifier is sorted until the key is depressed.

When it is desired to build the organ with a number of amplifiers, each stop is wired to its individual amplifier as in Figs 1 or 2, and each stop will thus have its own set of key contacts as in pipe organs.

Figs. 7, 8, 9 and 10, as previously described, show methods of wiring where each key in the octave has its individual amplifier, and that particular note in any octave in all stops in the organ will feed into that amplifier. These wiring methods are probably most suitable for organs of a large number of stops.

It will be noted in Fig. 11 that the first or lefthand disc has the fewest slots or wave forms, the second disc has a multiple of them to represent the first harmonic, the third disc has a further multiple to represent the second harmonic, and so on. Of course, the first disc represents the fundamental tone. These discs may be continued up to 20 or more harmonics or partials. This view depicts an electro-magnet positioned beneath each disc, their wires leading to high resistance rheostats and through to amplifiers and loud speakers as in the organ model to be later described. By this means, the fundamental and any partials or harmonics may be sounded, each one of them being regulated to any desired intensity.

There are in Fig. 13, twelve shafts (see Fig. 14), each with a different sized pulley which has been tuned to make the shaft revolve at the right speed for the pitch of one of the notes in the octave of the even-tempered scale. The F♯ shaft is shown with its ten sets of discs representing various stops or qualities. There are five toned discs in each set, representing five octaves of the keyboard. For instance, in the diapason, the first disc on each of the twelve shafts has five wave forms cut on it and these twelve discs represent the first twelve notes at the lowest end of the keyboard. The wave forms, of course, are cut on the discs from a pattern of the diapason wave forms which have been recorded.

The discs in the second line are cut with the same wave-form which has been reduced in proper proportion so that ten wave-forms may be put around the periphery of a disc. This means that at the same speed such a disc will give a note an octave higher than one with five wave-forms; therefore, the second line of discs on the shaft represents the second octave in the keyboard.

The third line of discs has 20 wave-forms on each disc, the fourth line 40, and the fifth line 80. Therefore, the first five discs on a shaft are the octave notes in the complete keyboard for whatever note that particular shaft has been tuned to. The first five lines of discs throughout the twelve shafts represent the whole keyboard in the diapason quality.

The same arrangement exists for every other quality; note, for instance, the clarinet, half way down the shaft. The first line of discs in this set has been made with five clarinet wave-forms, the second line with ten, and so on. In this way, a complete organ of many qualities or stops is built up on twelve shafts, each of which has a pulley of proper diameter to produce the speed necessary for correct pitch.

Beneath each disc on a shaft, Fig. 14, is an electro-magnetic pick-up adjusted at a slight distance from the edge of the disc. The line of picks-ups beneath a shaft is shown on the D shaft line in Fig. 13.

Simple forms, Fig. 17, may be cut into the disc on an ordinary milling machine. It is obvious however, that through the many mechanical and photo-mechanical processes at the inventor's disposal, even the most intricate wave forms, such as those which have been recorded, may be cut or engraved or stamped on the tone discs. This means that the wave organ as disclosed here is capable of producing any musical quality that exists, providing that quality has first been incorporated into the organ.

Any suitable type of tight frictionless bearings may be used to mount the shafts which mount the tone discs.

The tone disc of course must be made of iron or other magnetic material, or at least the edge on which the wave form is cut must be thus. The wave forms may be either hill-and-dale or lateral cut.

As many magnetic pick-ups may be placed around a disc as there is room for, and through different adjustments of distances, various qualities may be taken from a single wave form. This is because the magnetic effect does not decrease proportionately with the distance. Therefore, the electric wave generated in a pick-up at one millimeter will not have the same wave-form as that generated at three or four millimeters. Therefore, the magnets around a single disc may be wired for that note in several different stops in the organ.

It is of course possible to use worm gears on the shafts instead of pulleys, having these gears made to proper size and engaged with the thread on a lead screw running the length of the twelve shafts; or a spiral gear arrangement may be used.

A study of Fig. 18 shows that all pick-ups are short-circuited except when their particular keys are depressed. The diagram represents one octave with three qualities or stops. The key of F is shown depressed so that the key contact is opened. Therefore the open diapason pick-up will send its electric impulses generated by the revolving disc, into the lines leading to the amplifiers and reproducers, but all the other pickups will not sound because they are short-circuited at the keys.

It is possible to combine the various pick-ups of the different stops in parallel, for each note in the scale. Or they may be combined in series. Both ways are shown in this diagram. The short lines 25, Fig. 18, are contacts or switches to bring the stops into circuit. In the diagram, some of these contacts are shown open and some closed. In the complete instrument of course, all such switches in a single stop are thrown in or out by a single movement of a multiple switch, which is

very like the arrangement for bringing the electric contacts of stops in pipe organs into action.

It will be seen from this diagram that no matter what stops are opened or closed, no note will sound in the reproducers until the proper key is pressed; and the stops may be used in any combination.

In Fig. 19A and 19B each stop has its own set of contacts on the keys like those in the modern pipe organ; and each stop feeds into a separate stage of amplification. All of these stages may be fed into one big amplifier, or each stage may have its separate channel of amplification leading to its individual loudspeaker. It is this latter form of wiring that is shown in Figs. 19A and 19B.

Volume is controlled in this wave organ invention by a swell pedal which operates a variable resistance in the B current of part or all of the amplifier, or in the loud speaker fields.

The scheme employed in this invention of twelve tuned shafts, each representing its notes in five or more octaves, is a feature which will greatly facilitate manufacture of the wave organ, since one pattern or die will serve for twelve discs, and the same wave-form may be used, reduced in proportion, for every line of twelve discs which go to make up any particular quality. In any other scheme known heretofore, difference in pitch was obtained by individual recording for each note. Therefore, in an organ of many qualities, thousands of individual recordings, dies, patterns, and so on, would be required. Besides facilitating and cheapening manufacture, the present arrangement of discs and shafts allows the wave organ to be made very compact and efficient.

While the wiring in Fig. 18 shows only one octave, it will of course be understood that the same wiring may be carried out for any number of notes in the scale. It should be noted that the C's, for instance, would all be wired to the pickups beneath one shaft. That is to say, in a single stop, the diapason for instance, the wiring runs from the contacts on the lowest key of C on the keyboard to the pickup beneath the first disc on the C shaft. The wires from the second C key run to the pickup beneath the second disc, the wires from the third C key run to the pickup beneath the third disc, and so on.

The necessity for developing the wiring scheme shown in Figs. 18, 19A and 19B was that it was found that for successful building up of volume as each note of a chord is added, the pickups must be wired in series. For instance, the various qualities of a single note may perhaps be wired in parallel down to the key wiring itself, which, however, must be in series. If the pickups are wired in series, the only way to cut them in and out of the circuit is to short-circuit them as is done here at the key contacts. This form of wiring has proven eminently successful, allowing the chords to build up naturally as successive pickups are opened into the circuit. The prior art discloses that some inventors have suggested wiring in which all magnets or pickups were open all the time, and the tones sounded by movement of the pickup toward the discs when the keys were depressed. This system, however, suffers from the same trouble due to resistance before mentioned.

The present type of wave organ as here disclosed uses, of course, the ordinary type of amplifiers, which however, must be properly matched to the input. Either cones or horns may be used to reproduce the tones. From Figs. 18, 19A and 19B, it will be seen that a single wire 26 carries down from one binding post 27 of each of two pickups, and divides again at the key contacts 28 to serve two of these. This is just a doubling up, using one wire instead of two. The first and last wires, of course, serve only one contact at each end. It will be seen that every second wire serves two of the upper contacts and every intermediate wire serves two of the lower.

It is believed that this system of wiring is most important and aids greatly in making the present invention of a wave organ simpler and better than any other.

While a series of driven pulleys of different diameters has been shown to obtain the necessary different speeds of shafts, it is of course understood that the invention contemplates broadly any means for rotating these shafts at their necessary speeds. Thus, instead of using pulleys of various diameters, there could be used an individual drive for each shaft, the speed of this drive being controlled by means of synchronization with a tuning fork of the required pitch, which tuning fork is kept vibrating automatically by any of the various well known means.

Particular attention is directed to the fact that the present instrument provides a means of obtaining the same musical quality in five or more octaves from the same shaft, by doubling and redoubling the number of wave forms on the disc. For instance, in the present disclosure, the first disc on a shaft has five wave forms around its circumference; the second disc has ten wave forms and is the octave; the third disc has twenty wave forms and is the next octave up, and so on.

Such an arrangement has heretofore been confined to pitch only, and the question of quality was absent, although it is all important. The idea in the past has been to use toothed discs which would result in a more or less pure tone. Inventors have shown five teeth on the first armature, ten teeth on the second, and so on, but none of them has shown any conception for complex musical qualities kept consistent throughout the whole scale.

By means of the present invention, it is possible to take any musical quality of even the most complex wave form, and by continually reducing that wave form in exact proportion, to make it fit first into half the original length, then into a quarter the original length, then into an eighth and so on, but no matter what multiple is used, the wave form will be an exact reduction of the original as far as proportions of the various crests and troughs are concerned.

In this way a musical quality may be preserved in the scale from the lowest note to the highest. It should be noted that the amplitude of any particular wave form may be increased or decreased without altering the true proportions of the wave form. That is to say, it will often be desirable to have the electric impulse generated by the discs with 40 or 80 or more wave forms, a little stronger than would be the case if the amplitude of the wave forms had been reduced proportionately with the length. Therefore, the short wave forms will have their amplitude greater in regard to their length than will the long wave forms.

It is by the use of this plan that the present wave organ can be made with any number of stops of different qualities, and with each quality consistent throughout the scale. No other inventor has dealt with the problem in this manner, and this is therefore one of the principal features of the invention.

Throughout the drawings and particularly in the wiring diagrams, the numeral 29 designates binding posts of the pickup; the numeral 30 designates the key contacts when open; the numeral 31 designates the key contacts when closed; and the arrows indicate the wires leading to the amplifier.

In Fig. 13, the frame of the instrument is designated by the numeral 32, one of the shafts by 33, its bearings by 34, the tone disc by 35, the motor drive by 36, this being through a belt and pulley as shown; and the pulleys on succeeding shafts are of varying diameter, as clearly shown in Fig. 14.

The electromagnetic pickups 37, Fig. 15, are adjusted toward and away from the tone disc by means of a knurled nut 38 moving one end of its pivoted base member 39 against the tension of a spiral spring 40, the binding posts for the pickups being shown at 41.

Thus it will be seen that this invention differs radically from a construction appearing in the prior art, which old form consists of a twelve shaft apparatus, the shafts revolving at different speeds to get the octave, and a set of notched discs on each shaft, the number of notches being doubled on each successive disc of the shaft, for instance, 2—4—8—16—32.

In contrast to the above, one of the most important features of the present invention, and which permits the wave organ to be developed into an instrument of numerous different stop qualities, is the idea of doubling and re-doubling not merely notches, but complex wave forms, the exact wave form being condensed or "squashed up" into half, and a quarter or an eighth of its length on the first disc of the set, without altering the true quality or waveform. Thus, in a way, it may be said to resemble photographic reduction.

The old notched disc apparatus can never have any real musical value; only when we use the present invention of putting complex tonal quality on the discs can a true organ result. This invention, then, permits the taking of several octaves of notes off twelve shafts, and still not lose the tone quality in any note.

Of great importance, too, in the present invention, are the methods and means of wiring up the pickups or electro-magnets and of wiring the stops, for without this part of the invention, the proper production of tones, of balanced intensity and without "robbing" effects in chords, is quite impossible.

Note, too, that each shaft of applicant's wave organ may be tuned to any desired frequency, whole or fraction, and so get exact tuning. And the magnets remain in the same position, the contacts bringing the tone in or out.

It is to be understood that the present disclosure is for the purpose of illustration only, and that the invention is not limited thereto. To those skilled in the art, many modifications of the invention will be readily apparent, and it will also be obvious to such skilled persons that part of the method and means may be used without other parts thereof, many such combinations of the parts readily suggesting themselves. Therefore, it should be, and is to be distinctly understood that for a definition of the limitations of the invention, reference must be had to the appended claim.

Having now described the invention, what is claimed as new and for which Letters Patent of the United States is desired, is:—

In combination in an electrical musical instrument, a tone disc having a complex wave form, a magnetic pick-up associated therewith, and means for adjusting the pick-up relative to the wave form on the tone disc to produce different tone qualities.

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