

March 17, 1959

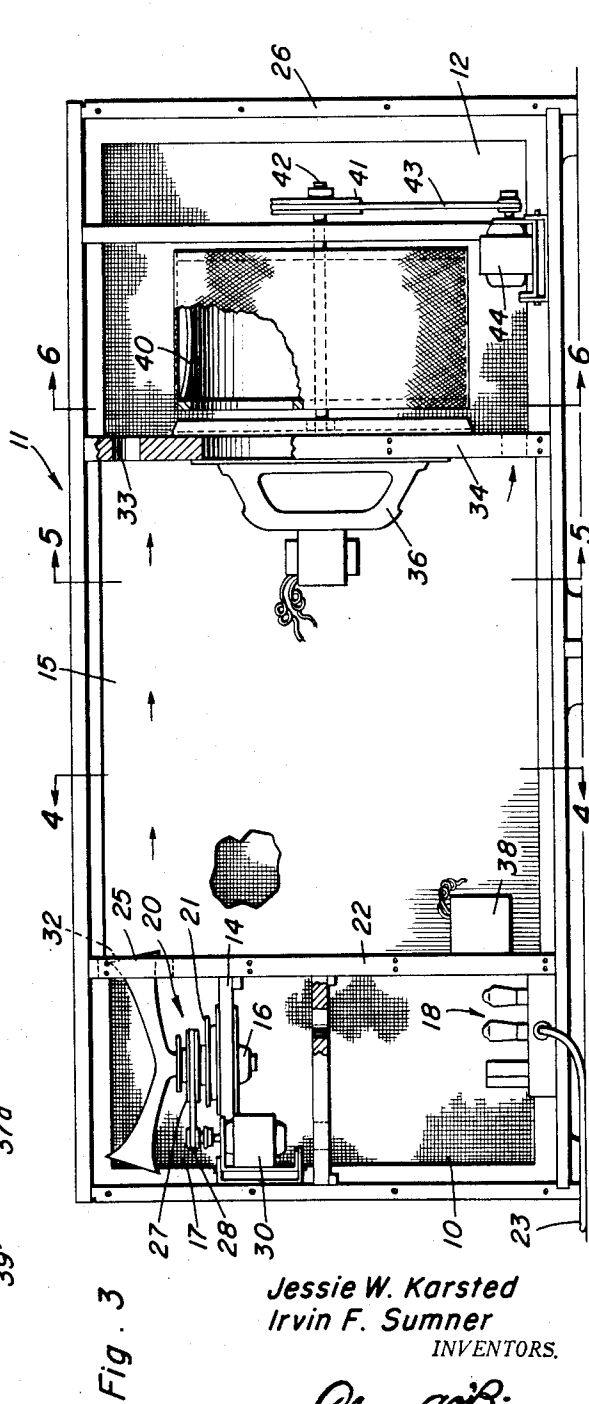
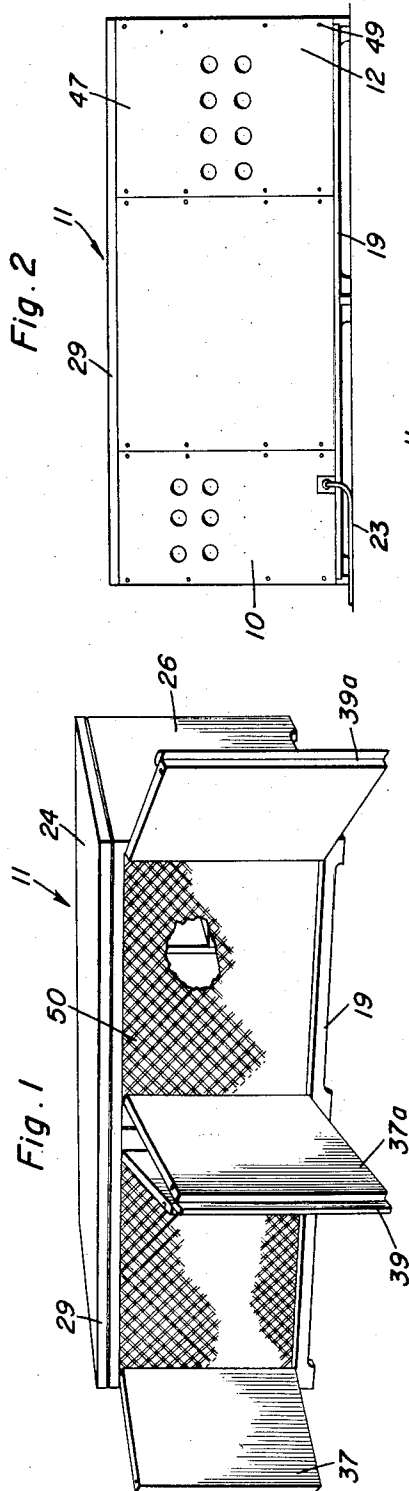
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2,877,862

SOUND PRODUCER

Filed March 1, 1956

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4

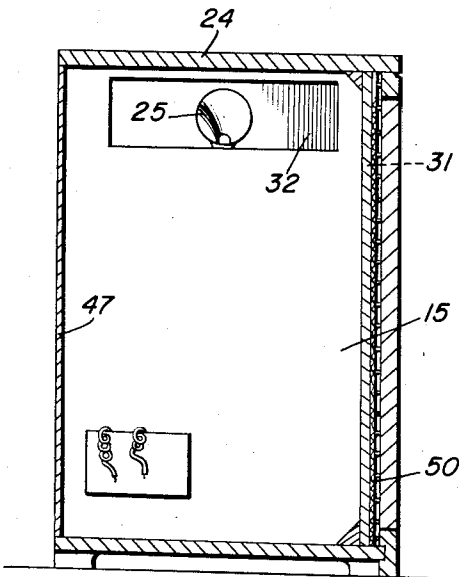


Fig. 5

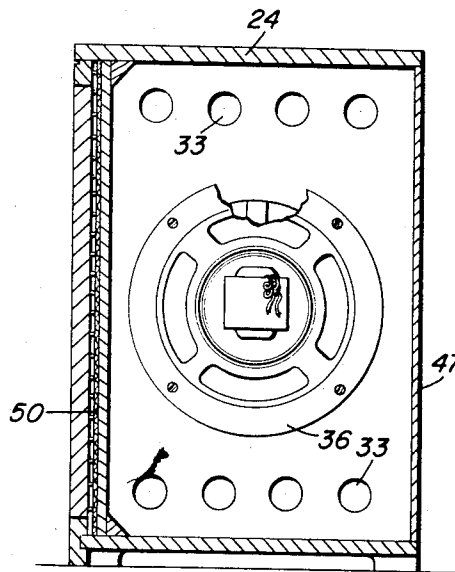


Fig. 7

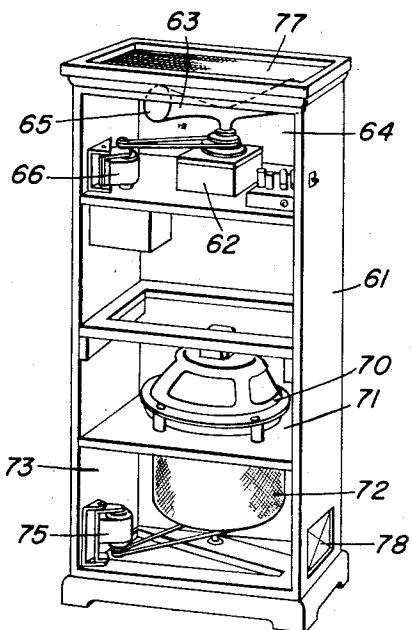
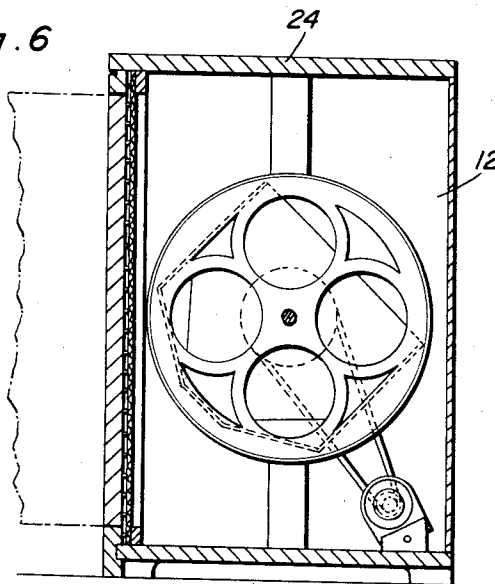


Fig. 6



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2,877,862

SOUND PRODUCER

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4 Claims. (Cl. 181—27)

This invention relates to rotatable tremulant sound producers of the type in which the quality of musical production is enhanced by producing a pitch tremolo or vibrato effect which is due to a rotational movement of a sound transmitting channel.

The pitch tremolo or vibrato effect of this arrangement is not the result of actual pitch variations, but is due to the rotational movement of a sound transmitting channel which, during its rotation, alternately moves towards and away from the listener, and thus causes variations in the pitch of the tone received according to Doppler's principle.

While the pitch tremolo or vibrato effect based on Doppler's principle produces a great improvement in the tone quality in the case of electric organs, there is still much difference between the playing of the same musical selection on a pipe organ and on an electric organ. While this difference in tone quality, as well known, is of a most elusive character and is only partly susceptible of being analyzed and measured; it is at least partly due to certain properties of the electrical sound producing equipment and to the limitations imposed by the said equipment, which limitations are only partly eliminated by the above described rotating tremulant sound producer.

Among the known causes of a deficient tone quality of the electric sound generator is the fact that every electric sound generator or speaker contains a membrane, usually a conical membrane which, to obtain maximum fidelity and to reduce distortion to a minimum, is as nearly aperiodic as possible. This aperiodicity not only eliminates distortion but also those oscillations which produce richness of tone. In a pipe organ, for instance, the pipe sounds with a plurality of frequencies, with a plurality of harmonics and during the sounding of the pipes especially when sounding chords, further frequencies are introduced by the pipe assembly. Further, the pipes, while arranged close to each other, nevertheless, sound from different places at different levels all located in a substantially horizontal zone and as the sound beam spreads they intermingle giving a so-called "tout ensemble" effect, which cannot be reproduced by conventional electrical sound generators.

The rotatable tremulant speaker arrangement, like most high fidelity sound producers, is provided with two speakers one for the high and medium frequencies ("treble tones" with frequencies between 4000 and 4500 to 15,000 C. P. S.) and the other for the low frequencies ("bass tones" with frequencies below 4000 C. P. S.), each frequency range being emitted through a separate, rotatable, tremolo producing transmission channel.

To produce the Doppler effect and to avoid one of the main disadvantages of the electric sound reproducers, namely the so-called "point source" effect, the sound emission for the treble tone speaker takes place through the top of the cabinet containing the speakers, and in addition through an opening in the side wall of the cabinet.

This is imperative as the transmission of sound through a side wall opening of the cabinet alone would produce a

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reception with pulsating intensity and would impair the Doppler effect. Emission through two paths, one supplementing the other is therefore indispensable.

On account of the directive properties of high and medium frequency beams the sound emitted through the top of the cabinet must be reflected toward the listener so that a most important part of the sound emission is dependent on external reflecting surfaces, such as the ceiling and the walls of the room in which the speaker arrangement is operated. The high and medium frequencies which are emitted through different openings and in two directions and the low frequencies which are emitted at the lower end of the cabinet are thus solely combined by the fact that they reach the listener's ear simultaneously from these three emission sources.

The necessity of the sound emission through the top leads to a vertical superposition of the speakers which produces a cabinet structure of undesirable height and unusual dimensions and proportions which makes it difficult to introduce the cabinet into a home and especially to assign it to a place in those rooms of the home in which a speaker arrangement is actually used.

The invention has for its main object to correct some of the defects which are not corrected by the tremulant rotatable speaker arrangement or which are inherent in the same as now used. It has especially for its object to produce an improved tone quality and to re-introduce some of the effects which the known tremulant double speaker arrangement has eliminated.

Further the invention has for its object to provide a tremulant speaker arrangement which may be housed in a cabinet of chest-like appearance which has the look and the proportions of a well designed piece of furniture thus making it possible to introduce a speaker arrangement into homes and to place it in those rooms of a home in which they are actually used, as a piece of furniture fitting the remainder of the furniture.

The improvement of the tone quality is essentially produced by conducting that portion of the sound which, in the known tremulant speaker arrangement, is emitted through the top, through a substantially horizontal transmission compartment or intercompartment channel connecting the treble speaker compartment with the bass speaker compartment into the latter and emitting it from said compartment. The substantially horizontal intermediary intercompartment channel adds to the passing sound certain reverberation effects, while conducting it to the bass speaker compartment from which high frequencies and low frequencies are now simultaneously emitted.

The portion of the sound which is conducted to the low speaker compartment is supplemented by the direct sound emission through an opening in the compartment of the treble speaker.

The method of emitting a major portion of the high and medium frequencies from the compartment from which also the low frequencies are emitted, after their passage through the intercompartment reverberation channel introduces not only the desired amount of reverberation, which may be regulated by a proper design of the channel, but also permits to use the speaker arrangement for instruments other than organs; it further produces a complete mingling of the frequencies before they reach the listener's ear which together with the horizontal spreading of the sound emission due to the horizontal alignment of the sound emission sources produces an effect which is very similar to the "tout ensemble" effect of the pipe organ.

The insertion of the intercompartment channel by introducing a desired reverberation effect eliminates a well known disadvantage of the electric speaker arrangement which consists in the instantaneous setting in of every

tone, a property which has often been criticized especially in connection with electric organs and harmoniums. The above described arrangement by virtue of the combined way of emitting the higher frequencies using two different emission channels eliminates this instantaneous response and thus produces a tone quality which is more assimilated to that of a non-electric instrument.

The attenuation of the higher frequencies due to reflection is compensated by the direct emission of the high frequencies through an opening in the cabinet which in a horizontal arrangement may be beamed directly towards the listener, seated at a convenient distance, rather than being beamed into space above the listener's head, as is the case with the known tremulant speakers in which the top of the cabinet must be located at a considerable height with the rotatable horn directed upwardly, thus necessitating beaming through the opening of the cabinet at a relatively high level.

A number of further objects of the invention and a number of further advantages will be apparent from the following detailed specification.

The invention is illustrated in the accompanying drawings showing one embodiment thereof by way of example. It is however to be understood that the embodiment of the invention illustrated in the drawings is shown by way of example only with a view of explaining the principle of the invention and the best mode of carrying the principle into effect. It will be clear to the expert skilled in this art that modifications of the invention introduced to adapt the invention for various instruments may be introduced without in any way departing from the principle of the invention.

In the drawings:

Figure 1 is a perspective view of a tremulant sound producer unit according to the invention, the cabinet having the shape of a low chest provided with several doors.

Figure 2 is an elevational rear view of the cabinet.

Figure 3 is an elevational partly sectional view of the unit with the doors, front wall and textile covering in front removed, the partition walls being partly shown in section.

Figure 4 is an elevational sectional view of the unit, the section being taken along line 4—4 of Figure 3.

Figure 5 is an elevational sectional view of the unit, the section being taken along line 5—5 in Figure 3.

Figure 6 is an elevational sectional view of the low frequency speaker compartment, the section being taken along line 6—6 in Figure 3.

Figure 7 is a perspective view of the unit according to the prior art.

To produce by means of an electromagnetic sound generator a tonal quality which is closer to that of tones produced in pipe organs the speaker assembly illustrated in Figure 7 has been developed. This arrangement forms part of the known art and has been described in patent Re. No. 23,323 to Leslie. It is based on the principle of reproducing the higher and medium frequencies on one hand (treble tones) and the lower frequencies (bass tones) by means of different electromagnetic speakers to obtain a higher fidelity; in addition a pitch tremolo or vibrato of each tone is produced by associating the stationary part of each speaker with a rotating sound transmitting channel, the mouth of which is arranged at a distance from the axis of rotation.

As seen in Figure 7 which represents such a prior art arrangement a cabinet 61 contains in its uppermost portion a compartment 64 containing a treble speaker 62, the stationary part of which, including a membrane and voice coil, emits sounds which are collected by an exponential horn 63 which is rotatably arranged and turns around an axis which is coincident with the axis of the speaker membrane. The mouthpiece 65 of the exponential horn is arranged at a distance from the axis of rotation and it therefore moves at a predetermined circum-

ferential speed. The horn is suitably mounted on a table with its inner or entrance end facing the membrane of the speaker; it is journaled in bearings on said table and is preferably driven at a speed of 300 to 450 R. P. M. by means of an electric motor 66 and a belt drive.

It will be noted that the axis of the treble speaker is vertical and that the exponential horn which forms the rotatable sound transmission channel is upwardly directed.

The bass speaker 70 is mounted in the lowermost compartment 73 of the cabinet 61 which carries a sound emitting horn 72 of a constant cross section which is rotatably mounted on the sound board. This horn also rotates around a vertical axis; it is driven by a separate motor 75 and a belt drive.

The cabinet 61 has a sound opening 77 at the top and a further sound opening (not shown) in the front wall at the level of the mouth 65 of the exponential horn of the treble speaker. Further, sound openings are provided at the bottom of the cabinet at the level of the zone of movement of the mouth of the rotating horn 72 of the bass speaker, one of said openings being shown at 78.

Such a speaker arrangement in order to be effective must be arranged in the manner illustrated showing a vertical super-position of the speakers with the treble speaker arranged on the top. This arrangement is necessary for several reasons one of them being that the sound produced in the treble speaker must escape through the top of the cabinet, in order to provide continuous sound emission with the intended pitch variation, resulting in a pitch tremolo or vibrato produced by the Doppler effect which is due to the movement of the mouth of the horn. Such vibrato or tremolo would not result if the moving horn would solely emit sounds through a lateral opening of the cabinet as the high and medium frequencies on account of this directional characteristic would be beamed at the listener only during the passage of the mouth of the horn behind the lateral opening. The pitch tremolo or vibrato would be attenuated while the intensity variations would be very marked.

To emit the sound through the top an upwardly directed exponential horn must be used and the sound beam must be reflected on the side walls of the cabinet compartment 64. The advantage of this arrangement consists in distributing the sound emission over a considerable area, thus avoiding the detrimental influence on the tone known as a "single point source" effect. The main advantage of the arrangement is, however, to produce the Doppler effect which varies the pitch without submerging it beneath considerable intensity variations of the sound. However, this type of sound emission also is accompanied by some disadvantages, as the emitted sound is attenuated and must be emitted upwardly at a high level. It reaches the listener partly by reflection from the ceiling and the side walls of the room in which the speaker arrangement is located, and the tone quality is thus partly governed by the height of the ceiling, the proximity of other walls and other external circumstances. Further, the dimensions are necessarily such that the speaker assembly cabinet forms a piece of furniture of objectionable height, size and proportions as it must be relatively narrow and high and does not fit into customary furniture proportions.

The bass speaker is necessarily close to the floor in this case and while low frequency beams expand easily the listener has to combine sound waves arriving from three directions: the sound waves emitted by the bass speaker coming from below, the sound waves beamed directly through the opening in the cabinet, and the high frequency sound waves which reach the listener by reflection from the ceiling and the side walls of the room.

Now the division of frequencies between upper and lower speakers is arbitrary from the standpoint of the listener, as it does not follow any musical principle, but

is due to the somewhat variable capability of the speaker membrane to reproduce sound with fidelity. The line is usually drawn at frequencies of about 4000 to 4500 C. P. S. the frequencies ranging from 4000 to 15,000 C. P. S. being emitted through the high frequency speaker. Speech, vocal music and many instruments produce however sounds which fall in both ranges, thus producing for the listener the somewhat startling effect of hearing the same voice or instrument from different directions. On account of this the arrangement is limited to electric organs where this distribution is not as disturbing as in other instruments, but even in organs the lower frequencies are separated from their harmonics and the mingling of the sound is imperfect so that the so-called "tout ensemble" effect is lost.

By means of the invention some major causes for the difference in the performance between the electric sound producer and the original musical instrument are eliminated and a higher tone quality is obtained. Further, the limitation of the rotary arrangement to an electric organ is no longer necessary and other music can be produced with good quality.

According to the invention the compartments containing the two rotating sound transmission channels are no longer completely independent sound emitting units, emitting sounds separately, but are joined by an inter-compartment transmission channel shaped and arranged to form an acoustically active intermediate reverberation compartment which has the multiple function of transmitting that part of the higher frequencies, which, in the known arrangement, is emitted through the top, to the low frequency compartment and of producing a desired amount of reverberation by reflection within the cabinet. Thus a complete intermingling or blending of high and low frequencies coupled with a reverberation effect within the cabinet is produced which greatly improves the tone quality and makes it independent of the surroundings.

The principle of using, in addition to the transmission of the high and medium frequencies through the intermediary compartment to the low frequency compartment, the direct beaming of high and medium frequencies toward the listener by means of an opening in the high frequency compartment is however retained. The arrangement of an intermediary reverberation compartment and the emission of part of the high and medium frequencies through the low frequency compartment makes a vertical arrangement unnecessary and permits a horizontal arrangement. This horizontal arrangement in the first place is an improvement insofar as the production of music by means of tones all generated along a horizontal plane or along a substantially horizontal zone is the rule and is something to which the listener is accustomed, as most instruments (piano, organ, harmonium and all orchestras) show a horizontal spacing of the tone producing sources.

In addition to this material improvement of the tone effects the arrangement also permits a radical change in the outward appearance of the cabinet making it possible to design a cabinet in the shape of a low chest. This is a major advantage as such a design permits the use of the cabinet within a home without producing an incongruous effect, such as is necessarily produced by a cabinet with a vertical superposition of the speakers which almost invariably has unusual proportions, conspicuously differing from known furniture proportions and which therefore does not harmonize with existing furniture. Further the general utility of a low chest within a home is unquestionable, while not much use can be found in a vertical structure.

As seen in Figure 1 the unit according to the invention comprises a cabinet 11 having the approximate proportions of a low chest with top and bottom walls 19 and 29 and side walls 26 which may be permanently joined to each other. A rear wall 47 (Figure 2) which may be made of one piece, but which preferably consists of

several pieces, is attached by screws 49 which can be removed for the purpose of mounting, dismounting and repairing the various units arranged in the interior. If the rear wall is subdivided it preferably consists of three parts, each covering one of the compartments to be described below.

The front of the cabinet may be completely covered by a textile fabric 50, irrespective of whether or not a sound emitting or a non-emitting compartment is arranged behind it, in order to produce a unitary and pleasing appearance of the front. In order to improve the impression of an attractive piece of furniture the cabinet may be provided with doors 37, 29, 37a, 39a which may be closed when the instrument is not in use and which are opened in the manner shown in Figure 1 during the use of the speaker arrangement. In this position of the doors all the sound emitting compartments are uncovered.

The cabinet 11 is divided into compartments, two of these compartments being speaker compartments 10, 12 which are arranged near the two ends of the cabinet. These two speaker compartments are joined by a sound transmitting intercompartment channel 15 in the shape of an intermediary compartment which also forms a reverberation chamber.

The compartment 10 houses a speaker 20 emitting the high and medium frequencies, usually the range of frequencies above 4000 to 4500 C. P. S., which speaker is mounted on a sound baffle or sound board 14 arranged in the upper part of the compartment 10. This baffle or sound board 14 acts as a support for the rotating sound emission assembly 20 and forms a partition, so that the speaker assembly 20 is enclosed within a sub-compartment 17 of the compartment 10. The speaker assembly corresponds essentially to that described in connection with the known unit already described in connection with Figure 7 although the arrangement of parts in detail may somewhat differ. The speaker is preferably fixedly carried by the sound board 14 itself and the voice coil of the speaker is driven by an amplifier 18 which may be arranged in the lower subcompartment of the compartment 10. The amplifier is shown to be connected by means of a cable 23 with the console of a musical instrument (for instance, an organ) of which the sound producer forms a part.

As well known the oscillating currents into which the sound oscillations have been translated must be divided and distributed between the two speakers according to their frequency and this distribution of the frequencies between the treble and bass speakers is performed by a so-called dividing network 38 which may be arranged in the lower subcompartment of the compartment 10 or may be mounted on the partition wall 22 separating the compartment 10 from the intermediate compartment 15.

The speaker 16 is a treble speaker and is provided with a membrane arranged in front of the exponential directional horn 25 which is rotatably supported on a horn support 21 resiliently mounted on the baseboard 14. The rotatable support 21 is provided with a pulley 27 driven by means of a belt drive 28 by an electric motor 30. The rotating exponential horn preferably forms part of a symmetrical structure, only one side of which contains an exponential channel. The mouth of the exponential horn must be located at a distance from the axis of rotation.

The upwardly directed inclination of the exponential horn is less pronounced than the inclination of the horn according to the known arrangement. This is due to the fact that in the known arrangement the horn is supposed to emit sound against the wall of the compartment in which the speaker is enclosed from which wall the beam is reflected towards the top. The marked upward inclination of the exponential horn, required in the known arrangement, is however a disadvantage in connection with the transmission of the treble tones through the sound

opening provided in the compartment. A high frequency sound beam is decidedly directional and this still holds good for the medium frequencies. The exponential horn accentuates the directional effect and therefore the treble frequencies are beamed through the opening over the head of the listener and reach the listener only after reflection on the ceiling and on the walls of the room in which the speaker assembly is operated. The proper intermingling of the treble frequencies with the bass frequencies which are emitted from another point is therefore largely dependent on the room in which the instrument is played and on the location of the instrument within the room.

In the improved arrangement according to the invention the emission at the top of the cabinet is eliminated and the treble speaker emits its sound mainly into the intermediary compartment 15. This is done by means of a large elongated opening 32 which is provided in the wall 22 separating the treble speaker compartment 10 from the said intermediary compartment 15.

The specific arrangement may be such that in the position illustrated in Figure 3 the mouth of the exponential horn enters said opening in the intermediary compartment 15 while during other phases of the rotational movement of the exponential horn the sound enters the compartment after reflection from the walls of the treble speaker compartment 10.

Further, the front of the treble speaker compartment 10 is open or may be provided with an opening 31 through which the sound is emitted directly towards the listener. The exponential horn 25 is somewhat upwardly inclined, while the treble speaker compartment is normally arranged below the level of the listener's ear. The beam emitted by the exponential horn of the treble speaker emitted in an upwardly inclined direction may thus reach the ear of the listener directly during that phase of the rotation during which the exponential horn is pointed towards the front and will thus supplement the treble frequencies which reach the listener after reflection.

The intermediary compartment 15 is of suitable size and is completely closed or surrounded by walls on all sides, the side walls 22, 34, leading to the compartments 10 and 12 of the speakers, being provided with openings or perforations 32, 33. The side wall 22 is preferably provided with one large opening 32 while the other wall 34 is provided with series of openings 33 leading to the low frequency or bass speaker compartment 12.

The wall 34 separating the intermediary sound transmission channel 15 from the bass speaker compartment 12 may be used as a baffle or sound board for the bass speaker 36 which may be centrally arranged with respect to this wall in such a manner that its frame projects into the intermediary compartment 15. In front of the membrane of the bass speaker 36 a rotary transmission channel 40 is provided which is similar to the one already described in connection with the prior art but which in this case is mounted horizontally. It is rotated around the horizontal axis 42 which carries the pulley 41 driven by a small electric motor 44 by means of a belt drive 43. The motor 44 may be mounted on the bottom wall of the compartment 12. The horizontal arrangement of the axis of rotation has the great advantage that on account of the vertical position of the axis of rotation of the assembly 20 vibrations due to mechanical influences are not likely to occur, thus excluding a troublesome source of disturbances.

The front of the bass speaker compartment 12 is completely or partly open. It may be provided with the customary louvers or grill. As already mentioned, the open portions of both speaker compartments 10 and 12 may be covered by a textile fabric 50 which also covers, for the sake of better appearance, the closed wall of the intermediary intercompartment transmission channel.

In operation it will be clear that the frequencies coming from the electric organ are divided into treble and

bass frequencies by the dividing network, the former being supplied to the treble speaker 20. The sound produced by the treble speaker partly is transmitted through the opening 32 and partly through the front opening 31 of the treble speaker compartment. The vibrato or tremolo effect due to the rotation of the transmitting exponential channel remain essentially unchanged. However, the sound emitted, penetrates into the intermediary compartment or intercompartment transmission channel 15 through the elongated opening 32. This intermediary compartment or intercompartment transmission channel 15 produces a certain amount of reverberation which is highly desirable to improve the tone quality and which can be so chosen that the optimal tone quality is obtained. As seen this tone quality is independent of the surroundings. From the intercompartment transmission channel 15 the sound penetrates into the compartment 12 of the bass speaker through the openings 33 and is emitted through the bass speaker compartment opening simultaneously with the lower frequencies coming from the bass speaker. The high frequencies and the low frequencies are therefore mingled and blended and the resulting tone is thus felt by the listeners to be of a much better quality than a tone beamed from two different places which becomes a composite frequency tone merely in the listener's ear. Also, the necessary amount of reverberation is imparted to it without affecting the desired tremolo or vibrato effect which is practically unchanged. This arrangement thus largely eliminates the majority of the defects of the electric sound generator.

The invention thus produces a number of advantages relating to the greater assimilation of the quality of the musical sounds produced to the known manually operated musical instrument, and further relating to the reduction of disturbances, as well as to the shape, the general esthetic qualities and the utility of the cabinet.

It will be clear that unessential changes may be made without in any way departing from the principle of the invention as defined in the annexed claims.

What is claimed as new is as follows:

1. A cabinet for electrically operated musical instruments comprising a plurality of horizontally aligned compartments, a sound generator producing sounds of the upper frequency range in the first one of the said compartments, a sound generator producing sounds of a lower frequency range in a second one of said compartments, said first and said second compartment being arranged at a horizontal distance from each other, a third one of said compartments between said first and said second compartment, forming an intermediate reverberation producing sound transmitting channel, aligned passages leading from the first into the intermediate compartment, and from the intermediate compartment into the second compartment respectively, each of the sound generator housing compartments being provided with sound outlets leading to the outside, the sound generator producing sounds of the upper frequency range including a rotating horn having a sound orifice sweeping during rotation past the outlet opening in the first compartment leading to the outside and the passage leading to the intermediate compartment, the sounds of the upper frequency range being thus alternatively emitted through the outlet opening in the first compartment and transmitted through the aligned passages of the reverberation producing intermediate compartment into the second compartment, from whence they are emitted through the outlet opening of said second compartment.

2. In a music producing apparatus with a plurality of electric sound generators, each operating within a definite frequency range, the generator emitting higher frequencies being provided with a horn having a sound emitting orifice, rotating at a predetermined speed about an axis transverse to the horn axis: a cabinet with a plurality of separate, spaced sound generator compartments, each provided with a sound outlet opening, said

compartments being joined by an intermediate compartment forming a sound channel producing a predetermined amount of reverberation during sound transmission, and means for emitting alternatively with varying sound intensity through said outlets of said separate spaced sound compartments the high frequency sounds produced by the high frequency generator and emitted through the rotating horn, said means including aligned passages between the high frequency sound producer compartment and the intermediate compartment and between the latter and a second one of the plurality of spaced separate sound generator compartments, the first named of said aligned passages being also aligned with the annular zone along which the sound emitting orifice of the rotating horn moves during rotation, the high frequency sound thus reaching the listener alternatively and with varying intensity through the outlet openings of the two sound generator compartments located at a distance.

3. A music producing apparatus with a plurality of electric sound generators, each operating within a definite frequency range, the sound generator emitting sounds of higher frequency being provided with a horn having a sound emitting opening rotating at a predetermined speed about an axis transverse to the horn axis, comprising an elongated cabinet having a plurality of longitudinally spaced sound generator compartments, each compartment housing one of the electric sound generators, an intermediate compartment between the sound generator compartments, said intermediate compartment forming a sound transmission channel producing a predetermined reverberation during sound transmission, the compartment housing the generator emitting sounds of higher frequency being closed at the top and being essentially provided with two emission openings arranged to be successively faced by the sound emitting opening of the

rotating horn during rotation, one of the aforesaid two sound emission openings being an outlet opening leading to the outside and the other opening leading to the intermediate compartment, positioned so as to provide a straight passage of the sound emitted by the rotating horn into and through the intermediate compartment, said last-named compartment being provided with a further opening, aligned with said straight sound passage and leading to the sound generator compartment housing the low frequency sound producing generator, the latter compartment being further provided with an outlet opening, the high frequency sound leaving the rotating horn being thus emitted from the cabinet through the longitudinally spaced outlet openings with periodically increasing and decreasing intensity, the increase and decrease of the intensity of the sound emitted through the longitudinally spaced openings occurring at different times.

4. The musical sound producer as claimed in claim 3, wherein the sound generator producing sounds in the lower sound frequency range is provided with a rotating horn, the axis of rotation of which is at right angles to the axis of rotation of the horn of the sound generator producing sounds in the higher frequency range, the high frequency sounds entering the compartment housing the sound generator producing sounds in the lower frequency range passing said compartment in substantial parallelism to the axis of rotation of the horn in said compartment.

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