

[54] **ELECTROCOUSTIC PIPES FOR ELECTRONIC ORGANS**

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[58] Field of Search **84/1.01; 179/101; 181/31 B**

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[57] **ABSTRACT**

An acoustic radiation system for an electronic organ, in which separate radiators are used for each tone color, the radiators being physically arranged as in a pipe organ and each including a cylindrical pipe having an upwardly directed loudspeaker in its upper end, the loudspeaker being of the minimum diameter capable of acoustically radiating the band of frequencies over which it may be driven, and the pipe having an enclosed volume appropriate to form a Helmholtz resonator tuned near the lowest frequency of the band, the pipe itself being mechanically rigid in terms of the material of which it is fabricated and also acoustically damped at higher frequencies by virtue of acoustical absorbent material which is distributed internally of the pipe so as to damp out standing waves. Each pipe may be provided with a mouth, shaped and positioned to simulate visually the mouth of a true organ pipe, but of a size acoustically selected to resonate with the pipe enclosure at the desired low frequency to flatten the frequency response over the radiated band of frequencies.

25 Claims, 6 Drawing Figures

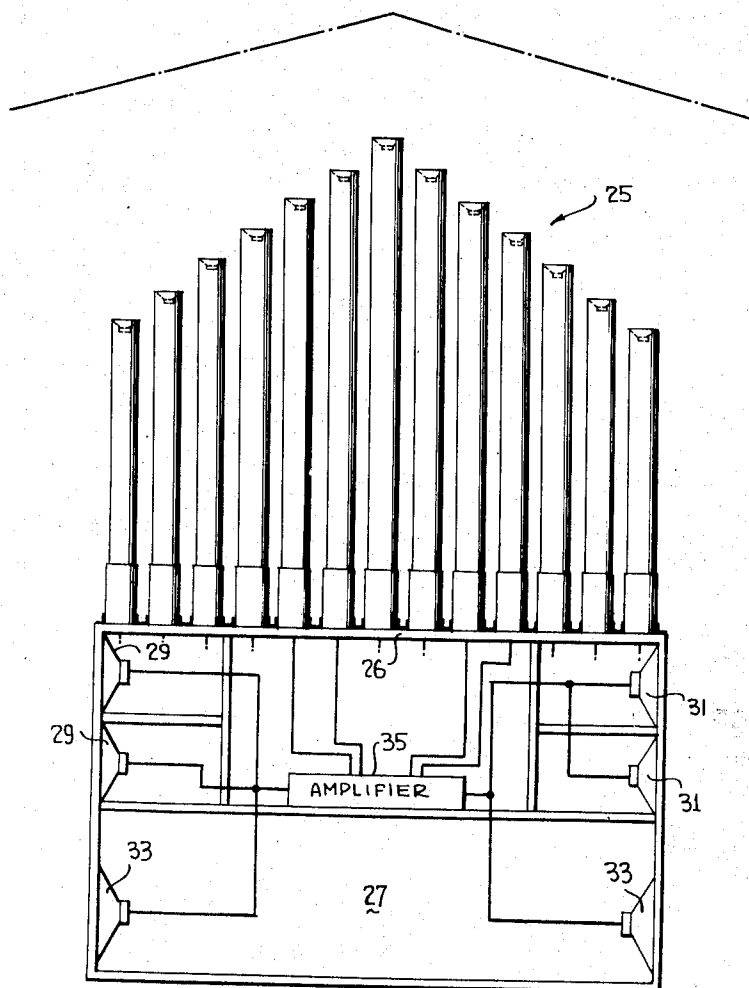


FIG. 1

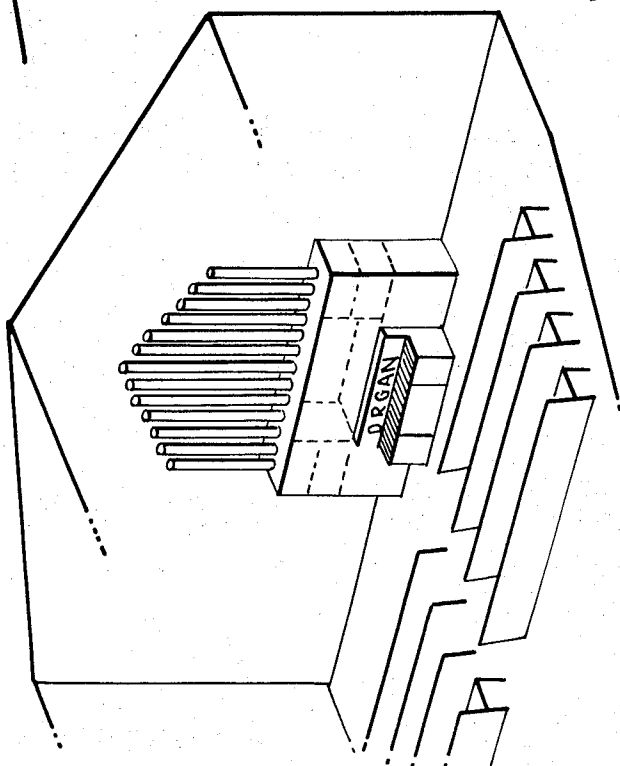


FIG. 2

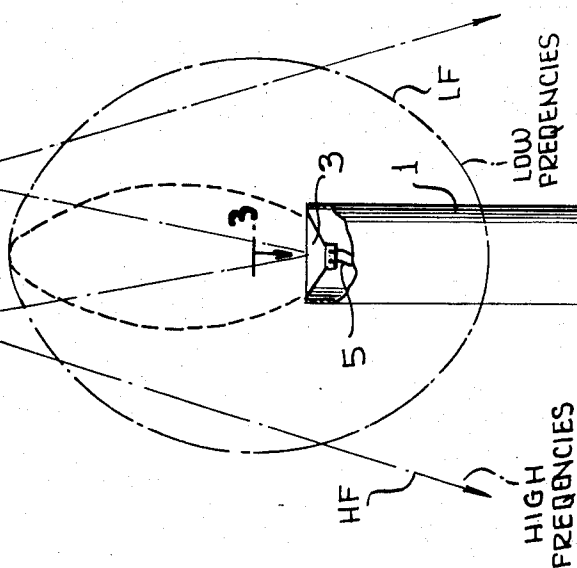


FIG. 3

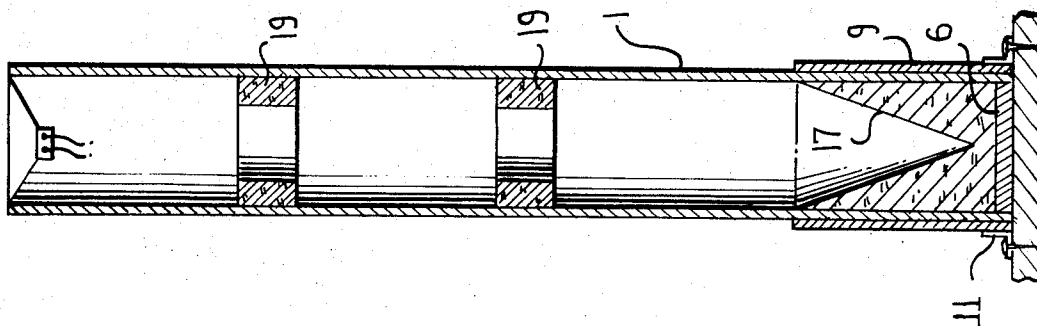
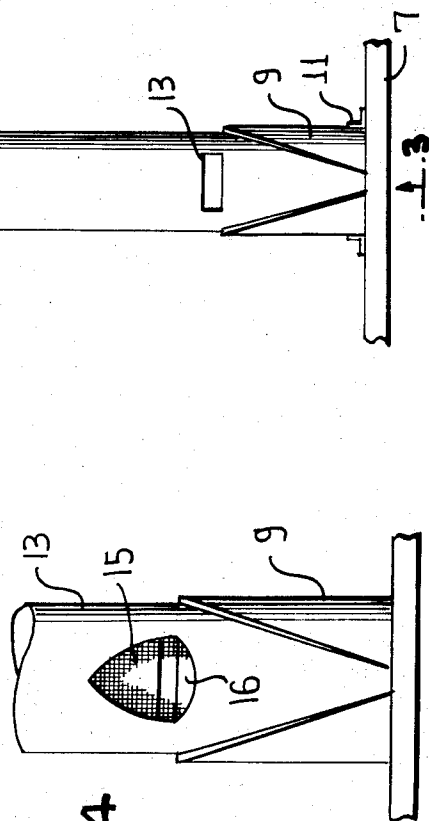


FIG. 4



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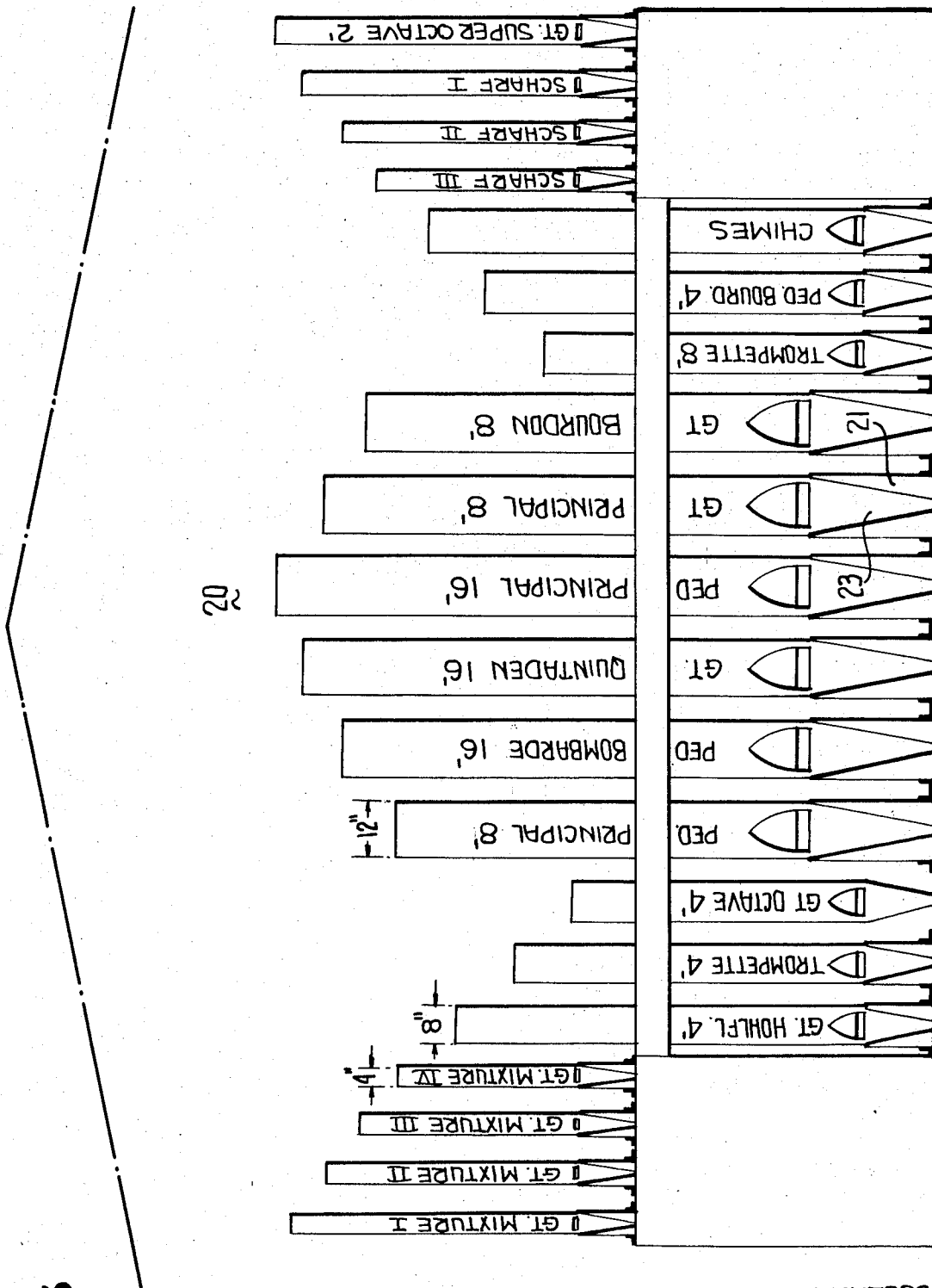
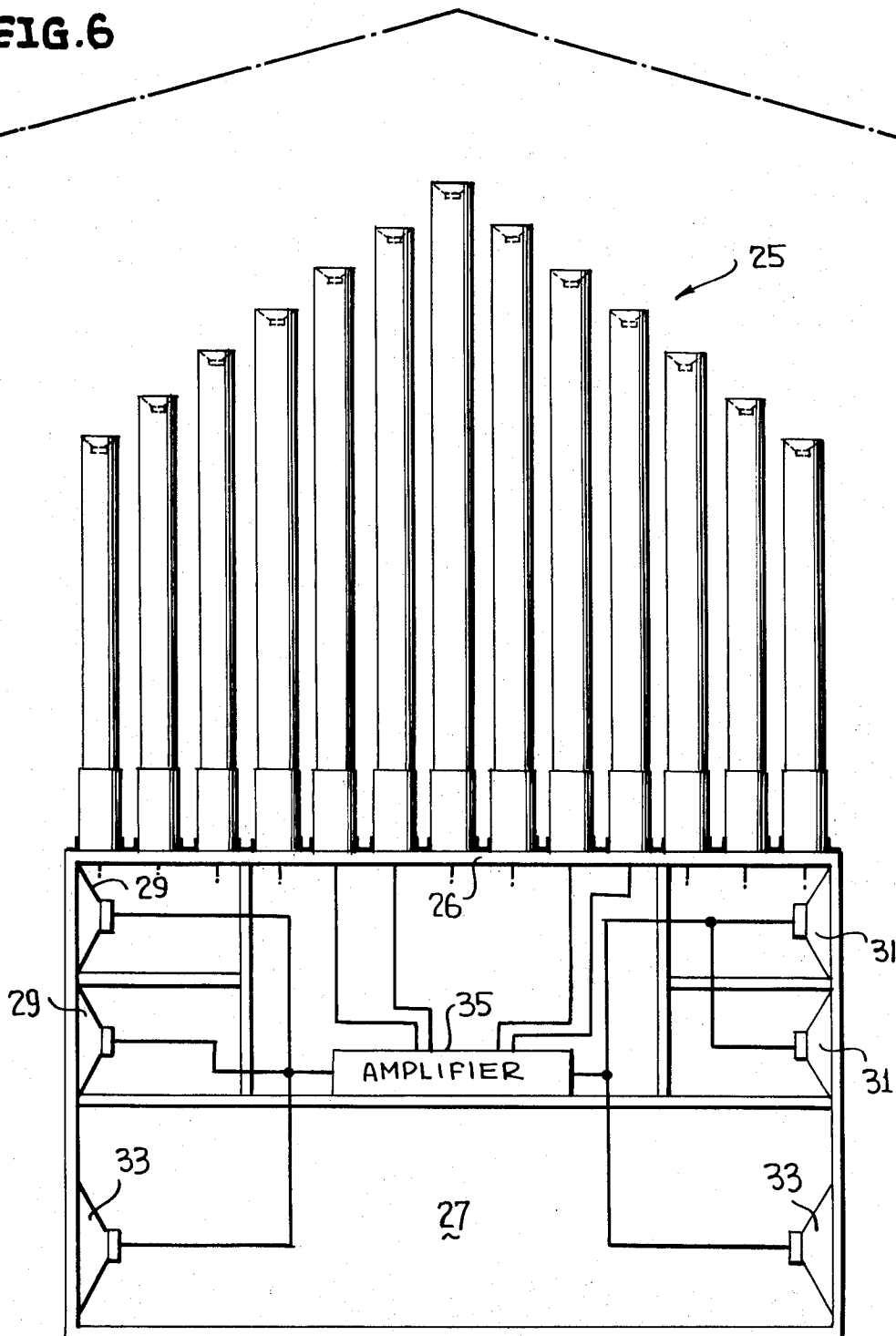


FIG. 5

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FIG. 6



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ELECTROACOUSTIC PIPES FOR ELECTRONIC ORGANS

BACKGROUND OF THE INVENTION

Acoustical measurements and recordings of the tones of organ pipes, supplemented by acoustic theory, have led to the following observations on the acoustical nature of organ pipes as sound sources:

1. Most of the sound from flue pipes comes from the open end and the mouth. (For closed pipes, radiation occurs from the mouth only, but these are relatively few in number and generally rather undeveloped harmonically in their tones.) For open pipes more tone radiates from the open end than from the mouth because the open end is much larger in area than is the mouth.

2. An array of pipes in a pipe organ frequently includes many pipes which are situated behind a "forest" of other pipes, so that the weaker sounds radiated from the mouths of the rear pipes are further weakened when reflected by the pipes farther forward. Only at the lower frequencies (where the sound easily passes around the other pipes without reflection) do the sounds from the mouths emerge from the "forest" at full power.

3. The sound from the open end of the organ pipe is directional along the axis of the cylindrical pipe at very high frequencies, and less directional as frequency decreases. Experimental data confirm that the same physical laws apply to the directivity of this sound and to the directivity of other sound sources of similar diameter (such as loudspeaker cones).

4. Because of the length of the larger pipes and the typical elevated location of the arrays of smaller pipes, the sound sources in a pipe organ are usually high above the floor, especially relative to the listening audience.

5. Because of the high location of the sources and the upward directivity of the high harmonics, the sound coming directly to the listeners from the pipe contains relatively less high-frequency power than the sound which is reflected from the ceiling and walls of the room toward the listener. This is particularly true for installations of exposed pipes within reverberant rooms, as distinguished from tone chambers.

Realistic organ tones can be produced from electrical tone waves, if the following conditions are fulfilled:

1. The electrical input wave-form to the loudspeaker resembles closely the corresponding pipe tone wave-form.

2. The loudspeaker unit faithfully converts the input to sound output without audible distortion.

3. The loudspeaker and the loudspeaker enclosure combine to radiate tone in a pipe-like manner.

4. The loudspeaker enclosures are located, oriented and grouped to resemble a spatial array of organ pipes.

5. The array is installed within an acoustical environment suitable for a pipe organ.

Fulfillment of the first condition depends upon pipe tone research and the development of suitable electrical circuitry. The second involves careful selection of a loudspeaker unit. Condition 5 is a matter of installation room acoustics. This application relates primarily to the fulfillment of conditions 3 and 4, assuming that conditions 1, 2 and 5 are met.

Efforts toward this end, i.e. to transform facsimile electrical signals into fully authentic pipe tones, have now led to the invention of loudspeaker enclosure structures which, for both acoustical and visual reasons, resemble real pipes.

It is not new broadly to direct a loudspeaker axis upward, in producing electronic organ tones. Early tone cabinets radiated the medium and high-frequency sounds from the top upward, and the low-frequency sounds from ports in the side of the cabinet.

However, in order to match the acoustical radiation pattern of a true pipe by means of a loudspeaker and enclosure, it is necessary to decrease the diameter of the space behind the loudspeaker diaphragm approximately to organ pipe size. Reduction is limited to the diameter of the smallest loudspeaker unit which can adequately produce the tones to be called forth. For high-pitched pipes or stops, the loudspeaker diameter can be small, and for low-pitched pipes or stops, the diameter must be larger.

For efficient tone production at low and medium frequencies, with flat frequency response, one must enclose the back of the loudspeaker in sufficient volume to prevent the back enclosure from unduly stiffening the diaphragm acoustically. When the back enclosure has the diameter of the loudspeaker rim, it is thus necessary for the length of the pipe to be large compared to the diameter. This acoustical requirement leads into the range of dimensional proportions for tone radiators according to the present invention, which are also typical of organ pipes (e.g., five or 10 to one).

The use of long enclosures has the additional acoustical advantage of raising physically the easily localized sources of high-pitched tones and harmonics high above the listeners, as they usually are in a pipe organ installation. A practical advantage follows that a small floor area is needed for an electroacoustic pipe or for an array of these. But acoustically the lower frequencies, which radiate in all directions and directly to the listeners in a hall, follow different paths than do the higher frequencies, which radiate chiefly upwardly and must be reflected and dispersed towards the listeners. In order to supplement tone radiation at lower frequencies, where an organ pipe mouth is most efficient, we have provided a bass reflex port in each electroacoustic pipe, the port being both a radiator and a resonating device, dimensioned to resonate acoustically with the enclosure at or slightly below the lowest frequencies required of the pipe. The port is located where the mouth of a conventional pipe would be, so that the combined tone radiation from the top of the pipe and the side of the enclosure via the port will be pipe-like.

When the ceiling height permits the electroacoustic pipe to be long, one can take full acoustical advantage of the additional back enclosure space for the low-pitched organ stops. This is done by enlarging the port area beyond conventional pipe-mouth proportions. Perforating the upper lip area just above the pipe mouth improves the efficiency for low tones, while enhancing visual resemblance to a pneumatic organ pipe.

Without any internal acoustical treatment a pipe enclosure would cause the loudspeaker to respond quite differently for different notes of the musical scale,

because of resonances within the pipe. The air-column resonances which would produce this non-uniform response are effectively removed in the present invention by two types of internal acoustical treatment as follows:

a. An internal conically-tapered sound absorber at the foot of each pipe, for controlling column resonance at the lower resonance frequencies.

b. Spaced acoustically absorbent rings within the length of each pipe, for controlling acoustical resonance at the higher frequencies.

Custom installation of electroacoustic pipes is feasible because (1) several standard diameters can be adapted to various stop (or pitch) requirements, and (2) the lengths can be varied (within reasonable design limits) to achieve a desired visual result to complement the architectural design.

For this purpose it is convenient to provide a base board on which pipe supports (shoes) are preloaded at the factory. The split shoes, which can be spread apart for insertion of the pipes, may be secured to a base board by brackets, for example. The split in the shoe is purposely widened at the top to simulate the appearance of the conical foot of a pneumatic organ pipe.

The air blown pipes of pipe organs operate on a per note basis. In the present invention an electroacoustic pipe radiates various notes of the same organ stop, leading to economies, but also to wide divergence from other known pipe systems, both pneumatic and electronic.

SUMMARY OF THE INVENTION

The tones of electronic organ stops are radiated from one or more rows of vertical pipes each having a loudspeaker facing upward from its upper end, there being a mouth in each pipe near the bottom end and sound-absorbing material within the pipe, shaped conically-open at the bottom and in the form of discrete rings located between the mouth and the top. In a compact system for a home or small chapel installation a tone cabinet may support one or more rows of electroacoustic pipes, with one or more relatively large loudspeakers facing outward from each edge of the cabinet. Each pipe radiates various tones developed for one stop of the electronic organ, or a very few related stops.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in perspective of an installation leading to the invention;

FIG. 2 is a view in elevation of an electroacoustic pipe, having a portion at the top broken away to show a loudspeaker;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 illustrates a broken front view, of a pipe of the type illustrated in FIG. 1, but a variation therefrom in the bass reflex port area;

FIG. 5 is a view in elevation of a row of pipes such as might comprise a typical grouping for the entire Great division of an organ and including several pedal pipes; and

FIG. 6 is a view in rear elevation of a cabinet version of the invention, the back panel having been removed to show the contents of the cabinet.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1 and 2, a vertical pipe 1, preferably of solid plastic, thick-walled impregnated paper tubing or formed Fiberglass, has a loudspeaker 3 mounted at the top thereof. A pair of audio signal leads 5 may pass down through the inside of the pipe 1 and leave via a small hole (not shown) near the bottom rear. The bottom of the pipe 1 may be closed by a plug 6 of suitable solid material. The pipe 1 may be secured in a vertical position on a floor or solid panel 7 by a shoe or sleeve 9 shaped, as shown, to expose a lower portion of the pipe, in correspondence with the tapered shape of a conventional organ pipe. The sleeve 9 may be fastened in place by suitable angles 11. According to the teachings of this invention, a bass reflex port 13 may be located near the lower end of the pipe 1, as illustrated in FIG. 2. Also, in FIG. 4, an upper lip area 15 may be open in the pipe 1 and covered with an acoustically transparent fiber or wire-mesh screen, colored as the pipe 1 to simulate a closed area. Thereby, the appearance of a conventional pipe is retained, while enlarging the port 13 to obtain the additional port area needed to resonate with the enclosed volume of the pipe at a desired lowest frequency for the stop being radiated by the pipe. In FIG. 3, in accordance with a further aspect of the invention, a conically-tapered mass 17 of sound-absorbent material, such as glass fiber wool, may be located at the bottom of the pipe to damp the lowest column resonances of the enclosure. Also, spaced sound-absorbent rings 19 of a similar material may be distributed along the inside of pipe 1 between the port 13 and the loudspeaker 3. The rings are so spaced as to damp higher-frequency acoustical resonances which would otherwise occur at undesired levels, while mass 17 serves to reduce reflections from the bottom of the pipe.

In accordance with further teachings of this invention, an array 20 of pipes, such as illustrated in FIG. 5, may be employed for one or more divisions of an electronic organ. Lower-pitched stops will use long, wide pipes, while higher-pitched stops will use shorter, narrower pipes. The possibilities for spatial distribution and architectural design are practically unlimited. FIG. 5 illustrates particularly an array which is effective to radiate the sounds of the Great and Pedal divisions of an electronic organ, in emulation of the sounds of a pipe organ.

Although the arrangement of the pipe assembly of FIGS. 1-3 shows a sleeve 9, it may be desirable to support pipes directly to the under panel or floor, an area such as 21 (FIG. 5) being finished in a dark color, the remainder of the pipe, as at 23, being finished in a lighter color, such as gray, to simulate the appearance of a conventional organ pipe.

In accordance with a further aspect of the invention, FIG. 6 is a rear elevation of an electronic organ tone cabinet assembly such as might be employed with a smaller organ in a home or other small-room environment. One or more rows of electroacoustic pipes, as at 25, are shown along the top 26 of a cabinet 27. These pipes may be used only for higher-pitched and/or higher-harmonic voices, which are more easily localized by listeners than are lower frequencies. Enclosed relatively-large loudspeakers 29 may be employed for the lower-pitched and lesser-harmonic voices of the

Swell division, while enclosed speakers 31 may serve for the lesser-harmonic and/or lower-pitched voices of a Great division. Large speakers 33 separately enclosed in the same cabinet may serve for the Pedal voices. A cabinet such as 27 would preferably be installed behind the console of an electronic organ and probably in front of a wall. Appropriate multi-channel power amplifiers 35 may be located centrally in the cabinet to supply audio signals of different electronic organ stops to the corresponding electroacoustic pipes and the cabinet loudspeakers.

Although round pipes have been illustrated herein, it will be obvious to one skilled in the art that other hollow configurations, such as square cross-section, can also serve.

With regard to the quantitative aspects of the invention, optimum dimensions, including port areas and widths may be determined empirically for larger-diameter pipes, smaller-diameter pipes then being scaled down to similar proportions. For example, for a 5 foot long, 12 inch diameter pipe employing a 12 inch loudspeaker, a 3 inch $\times$ 10 inch port gave optimum "bass reflex" action as well as visual similarity to a conventional organ pipe. However, when applying the lowest-range notes to such a structure, additional volume was needed behind the loudspeaker to reduce the stiffening effect of the enclosure, which is a function of volume. In lengthening the pipe from the 5 foot length — say to about 8 feet to 10 feet — a substantially-larger port area was found optimum by comparing the frequency-response at the port with that on the axis of the diaphragm. Adding the upper-lip area, such as at 15 in FIG. 4, not only provided sufficient port area for proper resonance frequency and greater efficiency but, when covered by a perforated member, the appearance of the port resembled the mouth and lips of certain conventional organ pipes. Additional port area is available, if needed, by using a lower-lip 16 (FIG. 4) and covering it also with fine-mesh screen, finished to be of the same color as the pipe 1. The optimum port size depends upon the volume of the pipe and the lowest frequency played on the associated organ stop.

With regard to the sound-absorbing material, long strips of tapered-width glass fiber wool of, say 1 inch thickness may be rolled; or a series of rings of graduated inner diameter may be stacked, in order to produce the effectively-conical shape specified for the mass 17. The two hollow rings 19 preferably have an inside diameter about half that of the pipe and may be about 4 inches wide. For example, they may be built up from 1 inch thick hollow discs. A spacing in the pipe of about one-third and two-thirds of the distance from the loudspeaker 3 to the port 13 is effective, although for a short length only one ring at about midway in the pipe was found effective. The optimum location for the rings depends upon the antinodes of these pipe resonances which require damping.

Although a cone loudspeaker has been indicated herein, it will be obvious that any loudspeaker having both front and back radiation will be suitable. For very high-pitched organ stops (e.g., mixtures) it may suffice to use only front radiation from an unloaded horn-driver unit mounted in the top of the pipe.

One typical installation is illustrated in FIG. 5 of the accompanying drawings which is drawn to scale. The

Bourdon 8 foot stop would utilize a 12 inch cone, the Great Mixture IV a 4 inch cone, for example. The sizes of the cones are not critical, but the usual 12 inch, 8 inch, 6 inch and 4 inch cones which are commercially available, are employed, the selection principle being that the cone is as small in diameter as is feasible to radiate effectively at the lowest frequency which is significant in the stop involved. The length of the pipe is usually then about seven to 10 times its diameter, to assure an adequate pipe volume to avoid stiffening the cone unduly within the ban of frequencies to be radiated. The Helmholtz resonance of the pipe enclosure is controlled in part by the area of openings 15 (or 13), some part of the area of which may be covered with sound transmissive material and appropriately masked, so the visual appearance of a pneumatic organ pipe is retained. These same openings act as tone radiators, as is the case in conventional organ pipes. The material of the pipe can be heavy paper board, or plastic, but should be of such character that the pipes do not substantially vibrate mechanically along their bodies, and so that radiation occurs chiefly from the pipe mouth and directly from the upper surface of the loudspeaker. Generally, the latter radiation is by far the greater in intensity.

The utilization of a small loudspeaker, located at the upper opening of an elongated electroacoustic pipe, produces two important acoustical effects. One is that low-frequency tones radiate efficiently in all directions (see pattern LF of FIG. 2), and directly reach the listeners located well below the level of the loudspeaker without the necessity for reflections. High frequencies on the other hand, radiate along the axis of the cone in a highly directional pattern, labeled HF in FIG. 2, and accordingly reach the listener chiefly after reflection and dispersion from the ceiling or upper enclosing wall, of the hall or room. Accordingly, the high frequencies or high partials travel slightly farther than the low frequencies, and also undergo multiple reflections before reaching the listeners. Conventional organ pipes provide much the same effect, even though these radiate on a per note basis while the electroacoustic pipes of the present invention radiate various notes of the same stop. If one note is played, in the system of the present invention, and assuming that that the note has many partials or harmonics, the lower partials will radiate directly to the listeners but the very high partials chiefly by reflection. Intermediate partials radiate partly directly and partly via dispersing or multiplying reflective paths. This kind of radiation pattern for a conventional organ pipe contributes to the tonal character of the stop, i.e., there are relative delays, directivities, and relative intensities, or partials, which are peculiar to the timbre effect of each stop. In the electroacoustic pipe very similar characteristics are achieved, and therefore a close simulation of pipe organ tones, although the electroacoustic pipes must each handle a range of notes.

Pipes are not entirely new for electronic organs. For example, refer to the U. S. Pat. No. 3,327,044 to Markowitz. However, this earlier system employed loudspeakers on a per note basis. Moreover, these loudspeakers are located at or near the bottoms of the pipes, so that internal pipe resonances will profoundly affect the spectrum (harmonic patterns) of the tone

radiated from the other end of the pipe. The goals and results and philosophy achieved by the Markowitz system, which depend upon internal acoustical resonance of the pipe, diverge radically from those of the present system in which internal resonances of the pipe are purposely minimized in effect.

While stress has been placed on the per stop, or per tone color, character of the present system, a single pipe, therein, can radiate a plurality of tone colors, if the acoustical character of the pipe relates suitably to the frequency ranges of the stops. For small installations, this is essential. For large installations, architectural and aesthetic considerations may dictate a very large number of pipes. For smaller installations, low frequencies may be radiated by means of an ordinary loudspeaker cabinet, and only high frequency notes by means of pipes, to achieve the effect of a dispersed sound source, together with the effect of elevated sources, of sources deriving in part from a vertically directed radiator and in part from a mouth, and to achieve the aesthetic visual influence of perceiving organ pipes visually, and providing spatially dispersed multiple source radiators.

I claim:

1. In an electroacoustic transducing system for transducing tone signals generated by an electronic organ within a structure having a sound reflecting ceiling surface, said electronic organ having provision for generating in separate leads tone signals corresponding with different tone colors, the combination of

an elongated hollow internally sound reflecting tube having its longitudinal axis vertical and its lower end totally closed, said hollow tube having a depth to width ratio greater than 4 to 1 and having a longitudinal axis;

a loudspeaker having a sound radiator, said sound radiator having a sound radiating area substantially equal to the cross sectional area of said tube and said loudspeaker being mounted at the upper end of said hollow tube so as to radiate directly upwardly toward said sound reflecting surface, said sound radiator having a sound radiating area designed to radiate the lowermost frequencies of a selected one of said stops essentially omnidirectionally and the highest notes of said one of said stops only upwardly along said axis for reflection downwardly by said reflecting ceiling surface, said hollow tube including acoustic absorbing material in its bottom for damping acoustic reflections from said lower end, said hollow tube including at least one internal discrete narrow acoustic absorbing ring secured to the inner surface of said tube and located to damp only relatively few selected frequencies of said tone color which might otherwise occur at levels not appropriate to said selected tone color, said tube being acoustically rigid and having a volume selected to resonate as a Helmholtz resonator near the lowest frequency of said selected one of said stops.

2. The combination according to claim 1, wherein said hollow member has a substantially rectangular radiative port near its lower end, said port being sized to resonate with the volume of the hollow member at a frequency near the low-frequency limit of the range of said signals.

3. The combination according to claim 1, wherein said first mentioned acoustic absorbing material is a substantially conically-tapered hollow in a mass of sound-absorbent material, said hollow having its apex at said closed end.

4. The combination according to claim 2, wherein said port extends at least at its upper side into a lip opening in said tube sized for tuning said tube, said lip opening being covered with an acoustically transparent covering material which visually obscures said lip opening.

5. The combination according to claim 2, wherein said system includes: a supporting sleeve member for said tube at least partially surrounding said tube only at its lower end, there being a V-shaped opening in said sleeve member under said port, said V-shaped opening having its apex extending downwardly and having its base at least as wide as said port, the configuration of said tube, said V-shaped opening and said port being such as to simulate a pipe of a pipe organ.

6. The combination according to claim 2, wherein said hollow member contains in the lower end thereof a conically tapered hollow in a mass of sound-absorbent material, the apex of said hollow being the lowermost point of said mass.

7. The combination according to claim 6, wherein said tube contains at least one narrow ring of sound-absorbent material located between the upper end of said hollow member and said port, said ring being positioned to damp only relatively few selected frequencies of said tone color which might otherwise occur at levels not appropriate to the selected stop.

8. A tone cabinet for an electronic organ, comprising in combination:

a main box-like enclosure,

at least one row of electroacoustic pipes extending upward from the top of said enclosure,

at least a first relatively-large loudspeaker facing outward from one side of the main enclosure,

at least a second relatively-large loudspeaker facing outward from the other side of said main enclosure and

a multi-channel electronic amplifier for separately supplying amplified organ tone signals via separate channels of each amplifier to each of said loudspeakers, electroacoustic pipes provided on a per stop basis, wherein each of said electroacoustic pipes comprises in combination:

an elongated hollow member having a sound reflective interior and having a length-to-width ratio of the order of 7 to 1,

a further loudspeaker mounted at the top of each of said hollow members with its front radiating surface directed upwardly, said loudspeakers having each a radiating area which is minimum for effective radiation of the frequencies of the stop to be radiated by that loudspeaker and said pipes having the cross sectional area of the loudspeaker supported thereby,

means for damping reflection of acoustic waves from the bottoms of each of said hollow members, and further means for damping out partials which absent said further means would radiate at inappropriate amplitudes, and means for connecting said further loudspeakers to separate channels of said multichannel electronic amplifier.

9. The combination according to claim 8, wherein said main enclosure contains:

- a third relatively-large loudspeaker facing outward from said one side of said main enclosure,
- a fourth relatively-large loudspeaker facing outward from said other side of said main enclosure and
- a plurality of smaller enclosures, one for each of said first and second loudspeakers and one for said third and fourth loudspeakers.

10. In an acoustic radiation system for an electronic organ comprising an array of acoustic radiators arranged to visually simulate the pipes of a pipe organ, said acoustic radiators being located in a room having an acoustically reflective ceiling located above said radiators and a plurality of seats facing said radiators, the combination wherein each of said acoustic radiators includes a vertical hollow pipe having its lower end closed and its upper end terminated by a loudspeaker, said loudspeaker being arranged to radiate vertically upwardly toward said ceiling, said loudspeaker and said pipe having substantially the same transverse areas, a separate source of multi-partial tone signals corresponding with a stop of said organ and comprising plural frequencies of the musical scale having partials appropriate to said stop coupled to drive each of said loudspeakers, respectively, each of said loudspeakers having a radiative area selected to effectively radiate the lowermost frequencies of said tone signals applied to that loudspeaker, each of said hollow pipes being arranged to provide an enclosure for its associated loudspeaker which by virtue of its internal volume and construction is resonant near said lowermost frequencies of said tone signals and contains substantially no internal acoustic standing wave patterns at said lowermost frequencies, whereby different partials of said tone signals produce diverse acoustic radiation patterns, the higher partials radiating directionally only toward said ceiling and the lower partials radiating toward said ceiling and also in azimuth, said seats being located at levels near the levels of the lower ends of said pipes and well below the levels of said loudspeakers.

11. In an electronic organ system, said electronic organ system including an electronic organ providing tone signals pertaining to separate stops of said organ on separate leads, the combination comprising a plurality of vertical hollow tubes, one for each of said stops, a loudspeaker providing a vertically upward radiation pattern secured only at the upper end of each of said tubes, means totally closing the lower end of each of said tubes, acoustic damping means located in the bottom of each of said tubes for damping reflections of acoustic waves upwardly from said bottom of each of said tubes, and means for connecting each of said loudspeakers to a different one of said leads to be driven only by tone signals pertaining to a separate stop of said organ.

12. The combination according to claim 11, wherein each of said tubes has an enclosed volume appropriate to form a Helmholtz resonator tuned near the lowest frequency of the tone signals its associated loudspeaker is called on to radiate.

13. The combination according to claim 12, wherein each of said tubes is sufficiently mechanically rigid that it does not acoustically radiate.

14. The combination according to claim 13, wherein each of said tubes includes a mouth shaped and posi-

tioned to simulate visually the mouth of a true pipe organ but of a size selected to resonate with the enclosure of said tube near said lowest frequency.

15. The combination according to claim 11, wherein said tube has a radiative port near its lower end, said port being sized to resonate with the volume of said tube at a frequency near the low-frequency limit of the range of said signals.

16. The combination according to claim 11, wherein said first mentioned acoustic absorbing material is a conically tapered hollow in a mass of sound-absorbent material.

17. The combination according to claim 11, wherein said port extends at least at its upper side into a lip opening in said tube sized for tuning said tube, said lip opening being covered with an acoustically transparent covering material which visually obscures said lip opening.

18. The combination according to claim 11, wherein said system includes: a supporting sleeve member for said tube at least partially surrounding said tube only at its lower end, there being a V-shaped opening in said sleeve member under said port, said V-shaped opening having its apex extending downwardly and having its base at least as wide as said port.

19. The combination according to claim 11, wherein said hollow member contains in the lower end thereof a conically tapered hollow in a mass of sound-absorbent material, the apex of said hollow being the lowermost part of said mass.

20. The combination according to claim 19, wherein said tube contains at least one narrow ring of sound-absorbent material located between the upper end of said hollow member and said port, said ring being positioned to damp selected frequencies of said tone color which might otherwise occur at levels not appropriate to the selected stop.

21. In an electronic organ system for operation in a room having a reflecting ceiling including an electronic organ having separate output signal leads for separate stops of said organ, separate acoustic radiating means for each of said stops, each of said radiating means including a hollow pipe and an upwardly directed radiator covering the top of said hollow pipe, means closing the lower end of said pipe, a discrete mass of acoustic damping material located at said lower end of said pipe for damping acoustic waves, said pipe being acoustically rigid and having an enclosed volume appropriate to form a Helmholtz resonator tuned near the lowest frequency of said stop, said loudspeaker having the minimum radiative area capable of effectively radiating the band of frequencies covered by said stop, said pipe having an axis directed toward said reflecting ceiling, the radiating area of said loudspeaker being such that the higher frequencies of said stop are reflected from said ceiling in greater proportion than are the lower frequencies and said lowest frequency is radiated approximately omnidirectionally.

22. In an electronic organ, lead means for separately conveying tone signals corresponding with separate stops of said organ, a separate Helmholtz resonant hollow tube for each of said stops visually simulating a pipe organ and having an upwardly directed loudspeaker at its upper end and a mass of acoustic wave absorbing material internally in the lower end, and

means connecting said leads individually to said loudspeakers, each said tube providing an enclosure for one of said loudspeakers, and means for damping out standing waves internally of said tube, the wall of said tube being acoustically rigid.

23. The combination according to claim 22, wherein each of said tubes includes an acoustically radiative mouth visually simulating the mouth of a pipe of a pipe organ.

24. A radiative system for an electronic organ having separate output leads on a per stop basis, comprising a plurality of vertical acoustically rigid pipes each includ-

ing internal means for damping out standing waves, and each including a loudspeaker located in its upper opening, said pipes providing enclosures for said loudspeakers, and means separately connecting said leads to said loudspeakers.

25. The combination according to claim 24, wherein each of said loudspeakers has a radiative area selected to radiate approximately omnidirectionally the lowest frequencies of the stop radiated by it and only vertically upwardly the highest frequencies of said stop.

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