Dec. 18, 1923. 1,477,555

E. GRISSINGER

SOUND AMPLIFYING PROJECTOR

Filed Aug. 20, 1920 2 Sheets-Sheet 1

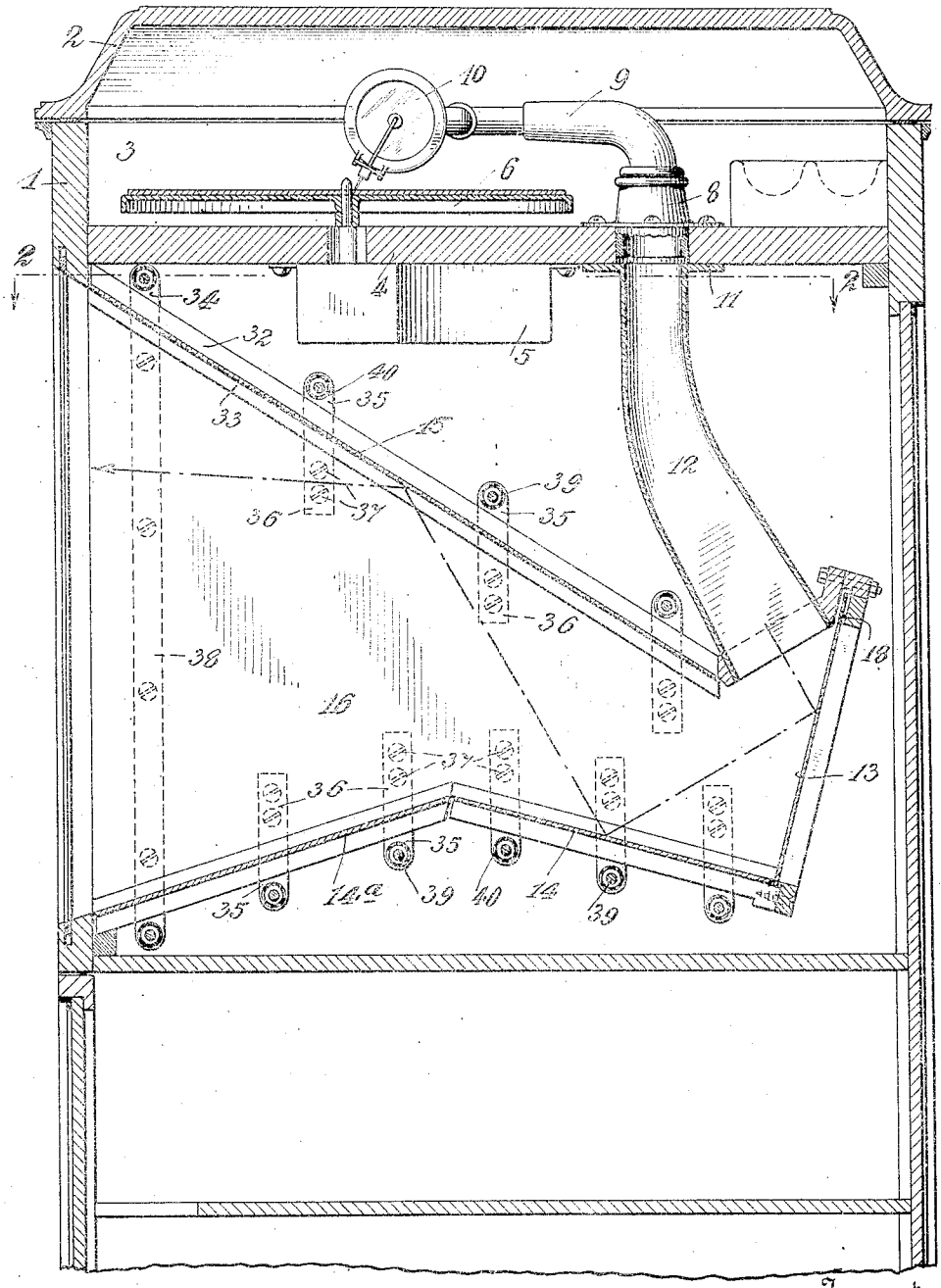


Fig. 1.

Inventor
Elwood Grissinger
By his Attorney
George C. Sloan

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Fig. 2.

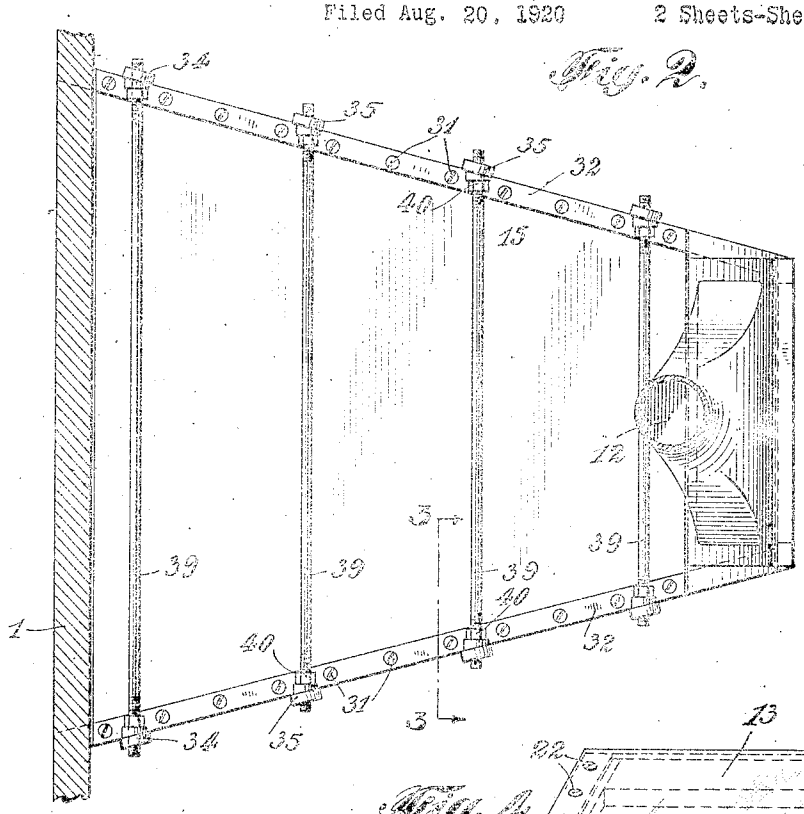


Fig. 4.

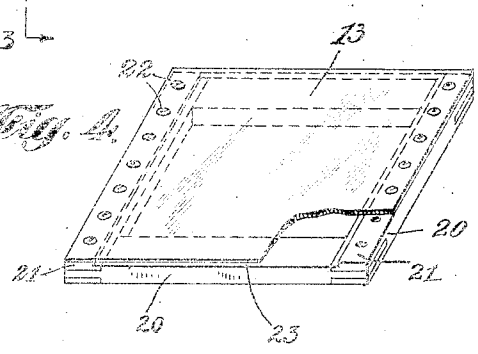


Fig. 3.

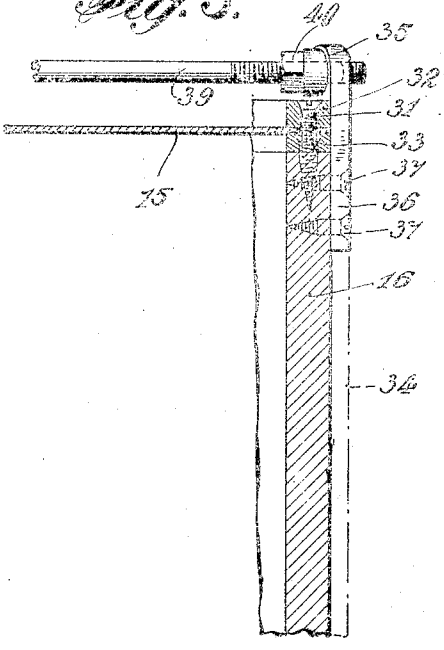
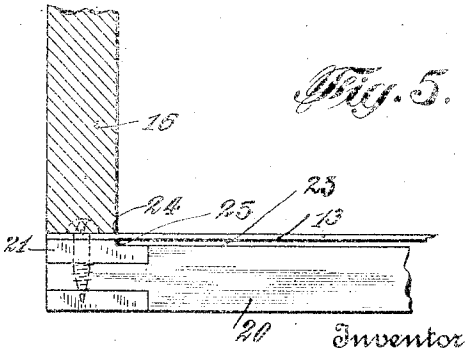


Fig. 5.



Inventor

Elwood Grissinger

By his Attorney

George Allan

Patented Dec. 18, 1923. 1,477,555

UNITED STATES PATENT OFFICE.

ELWOOD GRISSINGER, OF BUFFALO, NEW YORK, ASSIGNOR TO LUCY ASH GRISSINGER, OF BUFFALO, NEW YORK.

SOUND-AMPLIFYING PROJECTOR

Application filed August 20, 1920. Serial No. 404,859.

To all whom it may concern:

Be it known that I, ELWOOD GRISSINGER, a citizen of the United States, and resident of Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Sound-Amplifying Projectors, of which the following is a specification.

My invention includes certain improvements in the sonorous reflecting projectors which are particularly adapted for employment in combination with low frequency reproducers of the types disclosed in my prior patents and applications, though they may be also used in connection with the ordinary standard reproducers now on the market. As described in my prior applications Serial Nos. 298,846 and 305,601, the consonant reflecting plate preferably consists of a sheet or thin plate of sound sensitive material such as the wood used for piano sounding boards, rigidly secured to a rigid frame around the entire periphery of the plate. As contrasted with this, my present invention involves clamping the plates to the side walls at two opposite edges so as to leave these edges of the plate preferably free for vibration of maximum attainable amplitude, without danger of contacting with anything. The latter construction has very important advantages. The plate can be arranged with its clamped insensitive edges joining the side walls so that only the free vibratory edges extend crosswise in the path of the waves to be reflected, thus making the active reflecting area uniformly elastic lengthwise of the projector instead of having it crossed by non-vibratory clamped zones which are unavoidable where the crosswise edges of the plates are clamped as in my prior devices of this type. In the case of plates formed with diverging sides the tendency to omniperiodic resonant reenforcement of the sound is improved because there is less constraint on the plate and it can vibrate more like a set of parallel strings.

Also, a given plate of given thickness, clamped only at two opposite edges, is much more flexible and sensitive and has a lower natural frequency than when clamped about its entire periphery. Hence, plates of minimum permissible thinness may be mounted so as to be more sensitive; also in selecting plates so as to get a desired range of frequencies, or to get a desired ratio between the wave reflecting quality and the wave absorptive and reradiating quality, the plate can be thicker and more substantial than would otherwise be possible.

Moreover, a plate clamped about its entire periphery tends to act somewhat like a diaphragm with reference to its overtone or segmental vibrations, that is to say, its segmental vibrations are not harmonics of its fundamental but are discordant with said fundamental and with each other. When the plates are clamped only at two opposite edges, however, their segmental vibrations tend to follow more nearly the harmonic law characteristic of stretched strings, that is to say, when vibrated by a note corresponding to one of their natural frequencies either fundamental or harmonic, the other natural frequencies excited thereby are harmonious and pleasing instead of discordant.

By proper coordination of the various features of my invention so as to take full advantage of my above described discoveries, sound effects are attainable which are entirely unique as to the loudness, vividness and perfect quality of the reproduced sounds.

An important feature of my invention consists in stressing or stretching the plates by tension applied at the clamped edges. This has the effect of giving the plates the stiffness factor characteristic of stretched strings, in addition to their normal transverse resilience. There are many advantages in thus tensing the plates by stretching them from the edges, particularly if the stress be carefully applied so that the plates are not bowed or otherwise subjected to strain in directions perpendicular to the surface thereof. The much thinner metal can be employed for a given desired stiffness of plate, and while it is possible to increase the stiffness by applying the thrust of stretched strings to the back side of the plates after the manner described in my prior applications above mentioned, my present method is superior because it leaves the entire area of the plate or sheet entirely free of contact with piers, posts or other thrust-applying elements which tend to produce a complicated system of nodes and vents in the vibratory functioning of the plates. In the present structure the

side edges constitute nodes and the crossing edges being free, the vibration is simple and harmonious. It is obvious that my present method affords means for applying far greater tension than can be applied to perpendicular acting members and there is therefore almost no limit to the thinness of the plates which I may employ. Of course the lighter the plates the less the inertia, the friction and the absorption of energy, and the more nearly it becomes possible to adjust the tension for sensitiveness and resonant amplification of the sound waves.

The above and other features of my invention may be more fully understood from the following description in connection with the accompanying drawings, in which—

Figure 1 is a vertical section of a phonograph cabinet of ordinary construction having my improved apparatus embodied therein;

Figure 2 is a detail plan view partly in section on the line 2—2, Figure 1;

Figure 3 is a section on line 3—3, Figure 2;

Figure 4 is a detail perspective of the sonorous back plate with a portion of the plate broken away to show the frame more clearly; and

Figure 5 is a detail view showing a corner joint of the same.

In Figure 1 the various parts of a cabinet phonograph are conventionally indicated. The case 1 has a cover 2, enclosing a shallow cavity 3, having a bottom 4, supporting the phonograph motor case 5, the rotary support 6 for the record, the tone arm swivel 8 and tone arm 9, all of which may be of any known or desired construction.

Communicating with the lower end of the tone arm is the upper end 11 of the tubular conduit 12 leading to the reflecting projector. This conduit has the form of a frustum of a pyramid curved rearwardly and diverging laterally so that at the lower end, where it joins the reflecting projector, it is only a little less than the full width of the latter. This expansion passage is preferably of gray cast iron with its walls about 3/16 inch thick so that, acoustically considered, it forms a natural extension of the sound conducting passage afforded by the tone arm 9.

The sound waves which are propagated from the lower end of conduit 12 impinge upon the sonorous reflecting plate 13 at a high angle. As shown, this angle is 45° for most of the wave front though somewhat less than this for the part that spreads downward from the lower flank of the sound "beam."

The construction and mounting of this reflecting plate 13 is indicated in the various figures but is shown more clearly in Figures 4 and 5. The mounting comprises the very substantial rigid frame 20 which may be of spruce 3/4 inch wide by half an inch thick, or if of metal, may be of less cross section. The side faces at 21, 21 are preferably smoothly finished so as to lie in exactly the same plane. To these faces are secured the sensitive plate 13, by screws 22 arranged at short intervals. The heads of these screws preferably have flat under surfaces to engage squarely with the top surface of plate 13, so as to clamp the same as rigidly as possible. The two other members of the frame are recessed at 23 so as to give a clearance for the adjacent free edges of the vibratory plate 13. The recessing is preferably as shallow as the purpose will permit, a 1/32 of an inch being usually sufficient. In assembling the reflecting plates with the other members of the projector, care is taken to secure a rigid clamping contact applying pressure to the plate 13 at exactly opposite registering points on the upper and lower surfaces thereof, as shown at 24, 25, Figure 5. I find that this precaution is very important as contributing to proper reaction of the plates with reference to the waves impinging thereon.

In assembling the plates in the projector, it is important to arrange the clamped edges of the plates at the sides of the projector and to have the free edges extending transversely. As indicated in Figure 1, the assembly is such as to leave the unclamped edges of the plates free of any possible vibratory contact with adjacent elements and where two plates come together as at the lower right hand corner in Figure 1, it is desirable to have one plate as 13 extended past the free edge of the adjacent plate. The uniform spacing of plate 13 is clearly indicated at 18, Figure 1.

The side walls 16 of the projector may be of solid spruce, 1/2 to 5/8 inches in thickness or they may be of metal, or if desired, they may be of resonant plate construction similar to that above described with reference to plate 13.

All of the sensitive plates may be screwed directly to the tops and bottoms of these side walls and all of them tensed by thrusting apart the side walls by the means hereinafter described. For convenience in manufacture, however, I have chosen to have the back plate a separate frame member as above described, and it will be understood that any other one or more of the plates may be similar frame members. Certain of the plates, however, and preferably all three of the top and bottom plates, are secured after the manner shown in Figure 3 and tension applied by extending the sides as shown in Figure 2, the back plate being screwed on after the tensioning has been effected.

Referring to Figure 3, the plate 15 is very

rigidly secured to the side plate 16 by the screws 31 passing through suitable clamping member 32, perforations in the plate, clamping member 33, and into the side wall 16. The clamping members 32 and 33 may be and preferably are of metal carefully trued and the screw holes in plate 15 are carefully cut so as not to distort the plate. In this way a very true bearing surface and uniform clamping is insured for the edge of the plate. The other side of plate 15 is secured to the other side wall 16 in the same way. The opposite edges of plates 14 and 14ª are secured to the bottom edges of side wall 16 in the same way. Spaced apart along the side walls are arranged opposite upstanding ears 34, 34, 35, 35, etc. The ears on the upper side are preferably spaced apart equal distances with reference to the length of top plate 15, and the corresponding ears on the lower side are preferably spaced apart equally with reference to the lengths of the respective lower plates 14 and 14ª. A greater or less number of these ears may be employed and they may be variously spaced to suit special conditions. They may be integral with the side wall 16, or, as shown in the drawings, they may be separate members, shown in dotted lines at 36, and secured by screws 37. In certain cases such ears may be formed on the ends of a solid side bar 38, shown in dotted lines.

Of course, the side walls may be metal and the ears cast integral therewith, if desired, or the side walls being wood or other material, the ears may be formed on a single casting.

Between the ears are thrust rods 39 threaded at the end and provided with nuts 40. These nuts may be screwed apart to apply any desired tension to the plates. In the form shown in the drawing the amount of tension that can be applied to the several plates is more or less independent, the tension of top plate 15 being entirely independent of that which may be applied to 14 and 14ª. 14 and 14ª are more nearly interdependent, but even here there is wide variation between the tension that may be applied at the rear end of 14 and at the front end of 14ª.

As explained in my prior applications, the reflecting plates may be of such quality and thinness that they will cause resonant reinforcement of the sound and will vibrate responsively thereto. Any vibrations thus set up in the plates cause them to be sources of re-radiated energy propagated at right angles to the surface of the plate. Any such waves generated by plate 13 are mostly propagated directly out of the mouth of the projector. Similar waves re-radiated from 14 will mostly impinge upon reflector 15 and be reflected out of the projector along lines parallel with the radiation from plate 13.

The above described parts are organized so as to afford the graduated expansion of the wave front and application thereof to the outside air over a large area, combined with a desired distance of travel of the waves during such expansion.

A feature of my invention which apparently contributes to the new results attained, is the employment of rolled sheet aluminum or sheet steel for the plates. These are preferably about Nos. 16 to 25 gauge, or say 1/16 to 1/64 inch thick. The 1/16 inch plates are relatively thick and stiff, but they seem to be flexible and sensitive when clamped at the side edges only. The medium and even the very thin plates seem to be better, however, when put under sufficient stretching tension to give them the desired resilience or elastic stiffness. They apparently reflect a large percentage of the energy and such part of the energy as is expended in causing sympathetic vibration of the plates is re-radiated with very small loss, due to the small mass, the dense nature of the metal and the small internal friction. They seem not to use up and dissipate energy to anything like the extent that wooden plates do, even when the latter are of most carefully selected and finished material.

I claim:

1. A sound-amplifying projector having as a wall portion thereof a sheet or plate having two opposite edges each clamped between pairs of rigid, non-vibratory clamping elements and two other opposite edges free, in combination with means maintaining said plate stretched parallel with said free edges.

2. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal having two opposite edges each clamped between pairs of rigid non-vibratory clamping elements and two other opposite edges free, in combination with means maintaining said plate stretched parallel with said free edges.

3. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal secured at two opposite edges and free at two other opposite edges, the secured edges being lengthwise of the projector and the free edges transverse thereto in combination with means for stretching said plate in a direction parallel with the free edges.

4. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal secured at two opposite edges and free at two other opposite edges, and means for stretching said plates transversely.

5. A sound-amplifying projector having as a wall portion thereof a sonorous sheet

or thin plate of metal secured at two opposite edges and free at two other opposite edges, and means holding said plate tightly stretched in a direction parallel with the surface thereof.

6. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal secured at two opposite edges and free at two other opposite edges, and means for adjusting apart the portions of the projector to which said sheets are secured.

7. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal secured at two opposite edges and free at two other opposite edges, the secured edges being lengthwise of the projector and the free edges transverse thereto, and means for applying stress to tension said plates transversely.

8. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal secured at two opposite edges and free at two other opposite edges, the secured edges being lengthwise of the projector and the free edges transverse thereto, and means for applying stress to said plates in a direction parallel with the surface thereof.

9. A sound-amplifying projector having as a wall portion thereof a sonorous sheet or thin plate of metal secured at two opposite edges and free at two other opposite edges, the secured edges being lengthwise of the projector and the free edges transverse thereto, and means for adjusting apart the portions of the projector to which said sheets are secured.

10. A sound-amplifying projector comprising opposite walls and means for adjustably spacing them apart, in combination with thin sheets of resilient metal arranged with opposite edges clamped to the respective sides and transversely tensed by thrust applied to the clamping means by the adjusting means.

11. In the combination specified by claim 10, the further feature of arranging the transverse edges of said sheets free of contact with any solid body.

12. In the combination specified by claim 10, the further feature of having said plates in high-angle, sound-reflecting relation.

13. In the combination specified by claim 12, the further feature of having at the rear end of said projector a reflecting plate adapted to project sound waves upon one of said sheets at a high angle.

14. In the combination specified by claim 13, the further feature of having said rear plate at approximately right angles to said sound reflector, and in combination with means for directing the sound waves on said back plate at a high angle.

15. In the combination specified by claim 14, the further feature of having an angle of approximately forty-five degrees.

16. A sound amplifying projector of approximately rectangular cross section having flat diverging walls, and means for applying tension in the plane of a wall and in a direction transverse to the axis of the projector.

17. A sound amplifying projector of approximately rectangular cross section having flat diverging walls, and means for applying tensions to opposite walls in the plane of each and in a direction transverse to the axis of the projector.

18. A projector of rectangular cross section having diverging walls and means for maintaining a tension on certain of the walls in the plane thereof and in a plane at right angles to the axis of the projector.

Signed at Buffalo, in the county of Erie and State of New York, this 16th day of August A. D. 1920.

ELWOOD GRISSINGER.