June 30, 1931. L. DE FOREST 1,812,687

SOUND CHAMBER AND SET FRAME THEREFOR

Filed Sept. 4, 1925 2 Sheets-Sheet 1

Fig. 1.

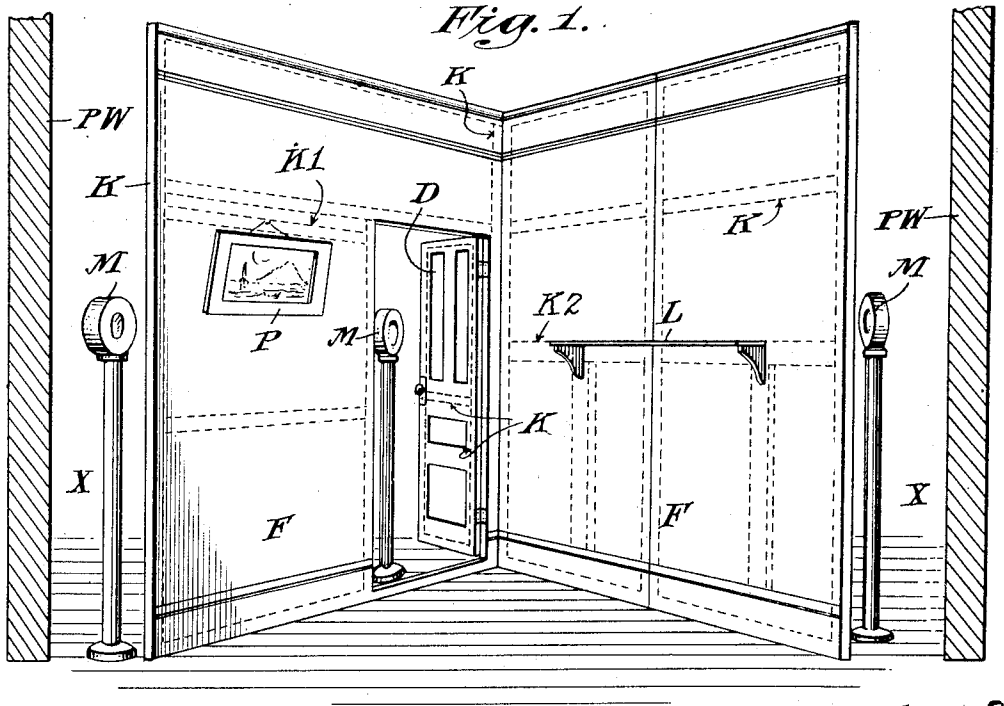


Fig. 2.

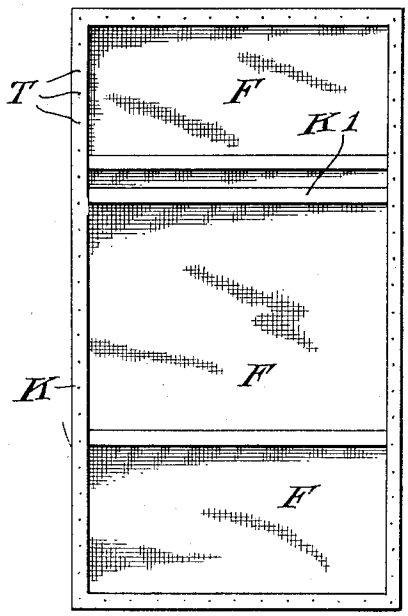
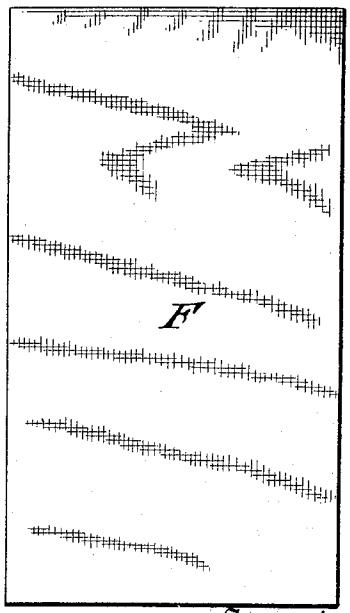


Fig. 3.



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SOUND CHAMBER AND SET FRAME THEREFOR

Filed Sept. 4, 1925 2 Sheets-Sheet 2

Fig. 4.

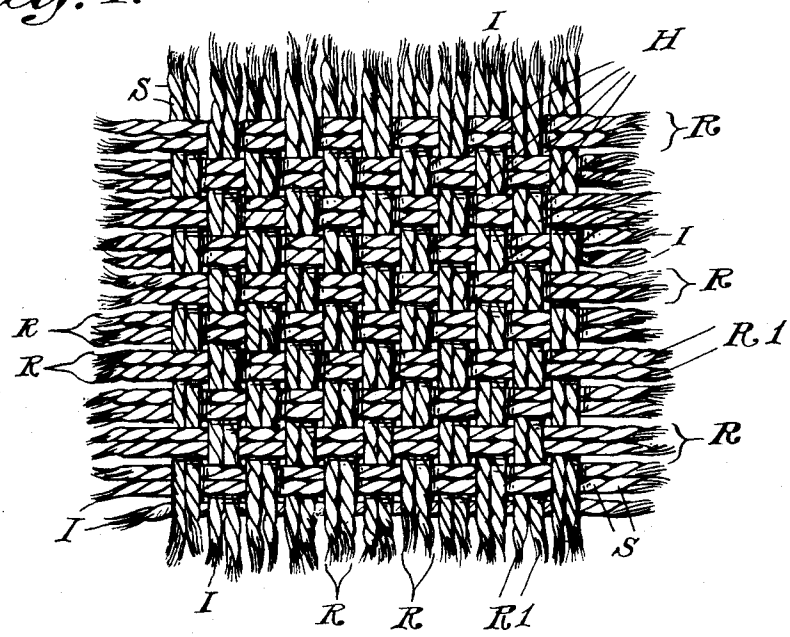
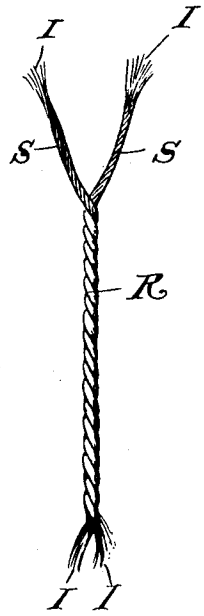


Fig. 5.



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Patented June 30, 1931 1,812,687

UNITED STATES PATENT OFFICE

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SOUND-CHAMBER AND SET-FRAME THEREFOR

Application filed September 4, 1925. Serial No. 54,397.

This invention relates to sound-chambers and set-frames therefor for use in the electrical transmission of sounds originating in chambers provided with such frames, particularly in the making of sound-photographs and more particularly in making sound-and-motion photographs such as those photographed and projected by my phono-film system.

The most particular object of the invention is the construction of sound-chambers and of set-frames as elements thereof which will permit a good photographic record to be made on a motion-picture film of the sounds which accompany the motions or actions, both the sounds and the actions being recorded simultaneously on the film to constitute the sound-and-motion pictures; the object being to provide such a construction as will prevent such reflections of the sound as will cause an inferior sound photograph to be produced.

The invention consists of the sound-chamber, the set-frames therefor, and a certain important element of the set-frame, substantially as shown in the drawings, of which:

Fig. 1 is a view of a sound-and-motion picture set constructed of my novel set-frames so as to constitute a sound-chamber suitable therefor;

Fig. 2 is a rear elevation of one of the set-frames constituting the sound-chamber of Fig. 1;

Fig. 3 is a front elevation of such set-frame;

Fig. 4 is a triple enlargement of the filling for the set-frame of Figs. 2 and 3; and

Fig. 5 is an enlarged detail illustrating the warp and filling strands of the fabric of Fig. 4.

The walls of sound-chambers or sets for motion pictures heretofore have consisted of a thick, hard, heavy composition board known as "compo" and substantially opaque to sound, that has been used in lieu of the portable canvas "scenes" used generally in the theatrical art. Such compo walls of motion-picture sets have various advantages in the motion-picture art over canvas scenes, and they have been quite satisfactory so long as only motion, and not sound, is photographed; but when such compo boards are used in "sets" used for scenes in the photography not only of the action but also of the sounds made by the actors, it has been found that such boards cause sound reflections which seriously impair the quality of the sound-photographs, (that is, the sound record on the side of the motion-picture film, alongside the motion photograph thereon), the result being that complex sound waves are delivered to the microphone of the sound-recording apparatus, such waves being composed both of the waves direct from the initial source or origin of the sound inside the set and also of the wall-reflections thereof from the compo-board set back to the microphone inside the set. In short, the compo-board set walls have acted as sound reflectors, just as do the walls of the building or permanent room themselves, in which the set usually is made up for the purpose of taking pictures. Thus, the compo-board set walls have not differed from the building or permanent room walls save as they are temporary portable walls on which may be temporarily placed the desired scenes or attachments desired for a given motion picture in question.

Prior to the present invention no practicable means has been found, so far as I am aware, of providing set walls or any units thereof, which would prevent harmful sound reflections. Canvas, as employed for scenes in the general theatrical art, produces sound reflections, and the compo-board walls above-mentioned have been preferred to canvas notwithstanding that the compo itself is a good sound reflector.

I have now discovered, however, a sound-chamber composed of what I term "set-frames" which not only completely overcomes the sound-reflecting difficulty above-described, and permits the production of sound photographs which lack the defects resulting from reflection, but which possess certain additional advantages to be described.

In Fig. 1, PW indicates the walls of the building or room constituting the motion-picture studio, (if not outdoors) these walls

being usually of great height, and the set being made up on any desired location of the floor and extending vertically only a fraction of the height of side walls PW. The set shown in Fig. 1 within the side walls PW consists of a plurality of vertical set-frames such as that shown in Figs. 2 and 3. These set-frames comprise a skeleton support K and a suitable front filling F to be described, and these set-frames resemble, in general superficial dimensions, the usual portable canvas "scenery" of the theatrical art, being usually of greater vertical than horizontal dimensions; and the walls of the set of Fig. 1 being composed of a plurality of such set-frames, located vertically and edge-to-edge as indicated in Fig. 1; the individual set-frames being readily portable, and having low weight on account of the filling construction to be described.

As shown in Fig. 2, the filling-fabric F laps around the skeleton support K, around the sides and preferably the backs of the side and end thereof, where it is secured to frame K in any desired way as by small tacks T. The skeleton back support or backing K, as shown in Fig. 2, may consist of wooden slats for combined economy and lightness, constituting a set-frame which is readily portable. In the best form of my set-frame, the skeleton support is "stream-line" in the sense that while mechanically strong, yet it opposes to the sound waves originating within the set or sound-chamber constituted of my set-frames, a minimum amount of sound-reflecting surface of the elements of support K itself. It is in this sense that support K is of skeleton construction, as well as in the sense of permitting an air backing in rear of front filling F and between the slats to permit sound transmission to the microphones M (Fig. 1) when they are located outside the sound-chamber or set instead of inside the set as heretofore.

As indicated in Fig. 1, the sound-chamber set constituted of the new set-frames may be located as close to permanent side wall PW as two feet or eighteen inches, as indicated by space X; and the set frames may be located as far from wall PW as may be desired or convenient. Practical use has shown that the nature of the new set frame is such that under the above conditions of location, there will be no harmful sound reflection from wall PW even altho sufficient of the sound volume from within the sound-chamber passes outwardly through the set-frames sufficiently to operate the microphones M. This is in contrast with all previous sound-chamber walls for sets in motion-picture photography, which either themselves have been efficiently sound reflecting or else have been so transparent to sound waves as to cause reflections from the permanent walls PW back to the microphones inside the set. The air space in back of front filling F and between the slats constituting skeleton frame K constitutes a portion of the total air space X in rear of the set frames and between front filling F and the permanent walls PW; and in connection with the skeleton construction of backing frames K, the nature of front filling F is of essential importance. In addition to various practical advantages to be described, the material I employ for front filling F possesses the capacity of preventing sound reflections from its surface, by virtue of the cooperative functioning of solid portions of filling F and of certain perforations therethrough, the latter being in direct communication with the air space back of front filling F, between the slats of skeleton frame K and general air space X within building walls PW and outside of the set constituted by the novel set-frames.

I have discovered that if filling F is constructed in special fashion, such as illus rated in Figs. 4 and 5, it will absolutely prevent harmful sound reflections from it, originating inside the set, when mounted on skeleton frames K not too closely adjacent to permanent (sound-reflecting) walls PW. As shown in Fig. 4, the filling consists of a coarse, loosely woven fabric, the warp and filling of which consist of substantially coarse strands R so interwoven as to produce small holes or perforations H extending entirely through the fabric and located between each four adjacent portions of interwoven warp and filling strands; the coarse strands R themselves being substantially thick and constituting a sound-absorbing surface; and the holes H preferably being smaller than the strands themselves. The weave described and shown in the drawings is what is commonly known as a "basket-weave" and the preferred form illustra ed in Fig. 4 is known in the textile trade as a "two and two basket weave". The character of these coarse strands R and their surfaces is such as to absorb a large proportion of the volume of the air-waves of sound reaching the fabric; but the difficulty, and probable practical impossibility, of absorbing the entire sound volume is compensated for by the provision of the holes H, which permit the free passage, through fabric filling F, of such volume of the sound as otherwise might result in reflections from the surface of filling F, even altho composed of strands R if no such holes H were provided. Thus, as in Fig. 1, a certain proportion of the sound volume may penetrate through filling F from the interior of the set, to the space X between the rear of the set and the permanent walls PW; but the sound-absorbing properties of the interwoven strands R are such as to reduce the volume of sound passing through filling F so that the same is insufficient to cause sound reflections from walls

PW which can retraverse space X and come back through holes H (Fig. 4) to the interior of the set or to the microphones wherever they may be.

Filling F, in being assembled with skeleton back K, is drawn fairly taut over the front of the latter, but not to such degree of tautness as will distort fabric F and cause an undesirable proportionate area of strands R and holes H.

Specifically, I have discovered that a very effective construction of front filling F is one wherein each strand R is a double strand, consisting of two duplicate strands or small ropes R1 laid side by side and closely adjacent, as shown in Fig. 4, the holes H (Fig. 4) lying between such pairs of strands. In Fig. 4 the filling F is shown at about triple scale. Holes H, although plainly discernible when front filling F is held toward the light, yet are much smaller than sound-absorbing strands R, and preferably smaller than double-strand ropes R1. Each individual strand R1 preferably consists of a pair of yet smaller strands S, Fig 5; and each strand S preferably consists of a plurality of very fine fibers I, as shown in Fig. 5. Holes H preferably are smaller than small strands S. In a very efficient front filling F, the holes H of Fig. 4 are about 1/64 inch square; the complete double strands R1 of Fig. 4 are about $\frac{1}{16}$ to $\frac{3}{32}$ inch wide; and each individual small strand S of Fig. 5 is about $\frac{1}{32}$ inch. In close-up, front filling F resembles a mat with holes which appear rather large and circular; but I have found that a structure with such holes, (permitting the desired sound-transparency of the frabric-holes H in cooperation with the sound-absorbing properties of the fabric strands), is entirely satisfactory with respect to the motion-picture camera, in that the lens of the latter does not "see" through the filling F in such a set as Fig. 1—notwithstanding that holes H are of substantial size.

Preferably the minute fibres I of Fig. 5, comprising strands S, are short waste cotton not suitable for use in ordinary cotton fabrics, but well adapted in the construction disclosed to constitute strands R of sound-absorbing properties.

The results of the structure of Figs. 2 and 3, consisting of the combination of the skeleton frame K and the front filling F, are that a portion of the volume of the sounds originating within the sound-chamber or set is absorbed within the solid portions of the fabric, and that the remaining sound volume is permitted to pass through the fabric; the net result being a substantially total elimination of sound reflection, that is, there is no harmful reflection from the front of the set-frames toward the interior of the set, and there is no harmful reflection from permanent walls PW at all, either back to the interior of the set or to the space X between the set and walls PW. Thus, the set-frames are partially opaque and partially transparent to sound waves, this result being obtained preferably by a single thickness of the woven fabric F of the above-described construction, i. e., a weaving of rather coarse or thick strands in a rather loose weave sufficient to provide holes H of the desired size relative to strands R. While this filling F is a fairly thick fabric, yet it is comparatively light, and when assembled with skeleton frames K, constitutes a structure which is so light as to be readily portable, even when the frames are several feet in horizontal dimension and several yards in vertical dimension.

The fabric preferably is woven of natural colored strands and superficially resembles in structure the well-known burlap employed in the manufacture of sacks or bags for potatoes and the like; but holes H are much smaller than the ordinary holes in the burlap fabric, and preferably strands R and the fabric itself are thicker, and heavier per unit area. I have found that holes H must not be too large so as to permit too great a proportion of the volume of sound originating in the said chamber of Fig. 1, to pass through the individual unit set-frames to the outside of the set, i. e., to the space X between the set and the permanent walls PW; and that these holes H should not be so large as to cause filling F to be sound-transparent to a degree sufficient to set up injurious reflections from walls PW. It is sufficient, as a practical matter, if holes H be sufficient in size to permit transmission through filling F of such volume of sound as, if prevented from such transmission, would cause reflections from filling F notwithstanding the sound-absorbing qualities of fabric-strands R. Holes H are sufficiently large for the useful sound-transmitting purpose when they are not so large as to be "seen" by the lens of the motion-picture camera. Another important advantage of filling F with holes H of the proper size for use in photography of sounds and moving objects simultaneously, and with the fabric strands R as above described, is that such fabric-filling F is adapted to take scene-paint without serious impairment of the sound-absorbing property of strands R or the sound-transmitting property of holes H, all as described later. In fact, this is such an important advantage that it is very useful even if walls PW be padded against sound-reflection therefrom.

While the primary purpose of the set-frames consisting of skeleton K and front filling F is to prevent sound reflection therefrom inside the set, yet I have discovered that the set frames as above described possess a further important advantage in connection with the use of the microphones M (Fig. 1) which electrically transmit, to the sound-photographing apparatus, the sounds

originating inside such a set as that of Fig. 1. For example, heretofore, on account of the use of the sound-opaque compo-board walls, it has been customary in producing talking-motion pictures to locate the microphone inside the set, where, of course, it is practically necessary to camouflage the sound-receiving microphone in respect of the lens of the motion-picture camera. In the employment of the new set-frames for the purpose of preventing sound reflections confusing the microphones, I have discovered that holes H (Fig. 4) permit a sufficient sound-transparency of the set-frames to operate the microphones when the latter are located, as shown in Fig. 1, in back of the set frames and outside the sound-chamber, in the low-volume sound-zone X between the filling F and the permanent sound-reflecting walls PW. This is a very important advantage in practical sound-and-motion picture photography in that it permits a plurality of microphones to be located in various positions outside of but adjacent to the set, so that the ordinary motion-picture problems are not interfered with by the necessity of camouflaging, inside the set, a plurality of microphones so located as to receive sounds from the actors in their various locations inside the set at different angular relations to the walls thereof. Obviously, the difficulties involved in camouflaging a single microphone inside the set are very greatly complicated by the provision of a plurality of microphones. The set of Fig. 1, when composed of set-frames as described, in effect constitutes a high-volume inner sound-chamber surrounded by a low-volume outside air-zone X between the outside of the set and the permanent sound-reflecting walls PW; this being so whether or not permanent building-walls PW are padded against sound-reflection. With the set-frames hereof it is practicable to have the sound volume in zone X so small as not to cause reflections from walls PW (even if unpadded) which affect even the microphones M located in zone X, and at the same time to have that volume sufficiently large to operate microphones M satisfactorily (via holes H in filling F) to cause the production of sound photographs on the motion-picture film. It will be understood, however, that the desired sounds reaching the microphones can be amplified to any desired extent by the audion amplifying tubes employed in the sound-photography apparatus; and it is not to be understood that absolutely all sound reflections from walls PW are prevented by any and all forms and locations of the set-frames hereof. Practical use of such set-frames, however, has demonstrated not only that any minor reflections from walls PW will not injuriously affect the microphones if located inside the set, but will not do so even if the microphones be located in the zone X as shown in Fig. 1.

When the set-frames hereof are provided with a filling-fabric F, substantially as herein described, the filling F can be washed by water or the like as for cleansing, without shrinkage, and while secured to and on skeleton K so as not to tear itself away from its securing means such as tacks T; and such cleansing can be effected without injuriously affecting the construction of filling F which permits it to be partially sound-opaque and partially sound-transparent as above described.

The fact is emphasized in Fig. 1 that the set-frames hereof have nothing striking or characteristic about their appearance inside the set. The only portion of the set-frames which is visible inside the set is the front filling F (Fig. 3), and that in a natural color of strands as preferably woven has a natural neutral color which is suitable to represent in the set the walls of a room, for example. But filling F may be decorated or painted as described hereinafter.

For cases where it is not convenient to obtain a special weave of fabric-filling F as above for mounting on the skeleton backs K, I have found ordinary coarse fabric known as monk's cloth to be highly desirable as the front filling sound-absorbing element of the set-frames, the same being a material frequently purchased by housewives in its natural neutral color as it comes from the loom and by them dyed and cut as window draperies. Such cloth as a standard article of commerce I have found to possess to a very high degree the properties above set forth as suitable for this element of the set-frames hereof, because it usually has a construction substantially the same as that shown in Figs. 4 and 5.

Skeleton back K may be composed of other material than wood, such for example as a light weight metal as aluminum, but wood is quite satisfactory (altho of course inflammable) and is adapted as a wall support for pictures and the like constituting parts of a complete set. In fact, in the matter of affixing parts of the set to the set-frames hereof when representing side walls as in the set of Fig. 1, the present invention is superior to the compo boards heretofore employed in motion-picture photography in the following respects. For example, if it be desired to hang a picture on the "wall", as at P, Fig. 1, or to put up a wall shelf, as at L, Fig. 1, etc., all that is necessary, if the location is not at a portion of wooden skeleton K already existing, is to nail to already-existing wooden slats of skeleton backing K one or more additional slats, as at K1, K2, Fig. 1, in which the nail or nails for the picture, shelf or the like may be driven; and such additional skeleton parts as K1, K2, will not substantially affect the characteristic skeleton construction of support K, and it need not injure

the filling F, especially as holes H, Fig. 4, are sufficiently large to receive the points and then the shanks of small nails. Furthermore, when the front filling F has substantially the constituency above described, I have found that upon it, in position on skeleton K, it is practicable to paint desired decorations or scenes on its front face which, provided that the paint is not too thickly applied, will not substantially impair its sound-reflecting property. Apparently such light paint coatings do not impair the sound-absorbing qualities of the coarse strands R and do not so block up holes H as to interfere with sound transmission therethrough. Also, not only can the filling F be washed for ordinary cleansing, but the thin coat of scene-paint itself can be removed while filling F remeans secured to the skeleton K, by any desired paint removers, without injury to the fabric, thereby permitting the entire set-frame to be used repeatedly in various different sets. Even without painting filling F by direct application of a brush, it may be stippled in color so that the joint effect of its natural neutral state and the stippling in color provides a very desirable appearance as a representation of room walls.

The set-frames hereof are light in weight for size, which is a most important desideratum in motion-picture studio work where the sets are composed of portable units which are carried about and set in place and taken down and stored and handled generally, all by manual labor.

The temporary "room" or sound-chamber of Fig. 1, composed of two or more side walls, may or may not have a "ceiling" composed of the set frames hereof, depending upon whether the space in which the set is made up is provided with a low permanent sound-reflecting ceiling. Usually the structures or studios in which sets are made up either have such high ceilings or roof as to cause sound reflection thereof to be negligible in its effect upon the microphones, or else they have no ceilings or roof at all and consists only of a permanent platform, so that usually the set-frames hereof are not needed as ceiling elements.

When the studio is an open-air one and has no permanent part save a platform, without side walls, the sound reflections heretofore in such cases have been caused by the thick and heavy compo boards constituting the walls of the set; and the set-frames hereof, even in the absence of any permanent sound-reflecting walls PW (Fig. 1) provide against harmful sound reflections.

In no case have I found that the sound reflection from carpeted floors has any injurious effect on the microphones, for with walls of sets composed by my set-frames and with the usual high ceilings or roofs of the studio buildings, all injurious sound-reflecting action has been eliminated. Preferably the floor, Fig. 1, is to be carpeted or more or less covered with rugs.

The set-frames and sound-chambers hereof have been tested out fully under actual operating conditions in my own talking-motion picture studio and have been proved to possess all the desirable properties above described.

In Fig. 1 is shown an example of a permissible modification of the set frames to provide for representations of windows or doors, as shown at the door D, which is shown as partly open, disclosing another microphone M arranged in the low-volume sound-zone X outside of the set. Door D itself may consist of a suitably shaped unit of the set-frame hereof provided with its own separate skeleton back K; and the set-frame above door D can be supported by having its wooden slats of skeleton K nailed to the wooden slats of the adjacent set-frames arranged edge-on to it at the opposite edges thereof. This illustrates the fact that the set-frames hereof are valuable in their simplicity and the ease with which desired lengths of filling F can be cut and applied to a skeleton K readily constructed for special occasions out of the nailed-together wooden slats.

It is to be noted that the property of the set-frames hereof in preventing injurious sound reflections from either their own surfaces or from the permanent sound-reflecting walls PW (Fig. 1) outside the set (when such permanent walls exist), is due to the fact that a certain proportion of volume of sounds originating inside the set is permitted to pass freely through holes H (Fig. 4) of front filling F through the air spaces between the slats of skeleton backing K, and to the fact that substantially all the remainder of the volume of sounds originating inside the set is caused to be absorbed by the material F of the filling itself, the minute fibres I (Fig. 5) of individual strands S being so closely woven into such individual strands as to constitute substantial sound-opacity; so that the properties of set-frames K—F of partial sound-opacity and partial sound-transparency act jointly in preventing the injurious sound reflections. This is true whether or not the frame-filling F be scene-painted.

Inasmuch as the screens of this invention absorb part of the sound and allow part of the sound to pass through they may be called sound-translucent although there is no distortion of the sound but only partial absorption.

I particularly point out and distinctly claim the part, improvement or combination which I claim as my invention or discovery as follows:

1. A sound-permeable motion picture background for use in the simultaneous photography of sound and motion, consisting of

side-walls which include a skeleton support and a filling of a sheet of coarse-weave, open-mesh cloth mounted on said support, the holes in said cloth being in free communication with substantial air-spaces inside and outside the background; and an electrical sound-transmitter associated with said background and hidden thereby.

2. A temporary sound-originating motion picture set for supplying sound-waves to an electrical sound-transmitter, said set being formed by side-walls including a basket-weave cloth in a plurality of sheets located edge to edge and independently mounted on light portable skeleton frames.

3. A non-sound-reflecting portable set-frame including a light skeleton support and a front filling thereon consisting of a light thin sheet of non-sound reflecting material formed with sound-transmitting holes, the relative proportion of such holes and material and the character of the material permitting transmission, without undesirable reflection, of sounds originating on the front side of the sheet to an electrical sound-transmitter located on either side thereof.

4. A portable sound-permeable set-frame which comprises a skeleton support having mounted thereon a light porous sheet of non-sound-reflecting material.

5. A scenery set comprising a frame covered with non-sound-reflecting, sound-transmitting, porous fabric which is photographically opaque and provided with a decoration-receptive face.

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