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Kage

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[54] **DEVICE FOR RENDERING VISIBLE ACOUSTIC VIBRATIONS**

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[51] **Int. Cl.** **G10l 1/00**
[58] **Field of Search** ..... 179/1 VS; 350/161; 84/464

[56] **References Cited**

UNITED STATES PATENTS

2,879,337	3/1959	Reis	350/161
3,048,075	8/1962	Wright	84/464
3,163,078	12/1964	Elliott	84/464
3,234,847	2/1966	Williams	84/464
3,547,520	12/1970	Lee et al.	350/161
3,580,126	5/1971	Forkner	84/464
3,604,852	9/1971	Weintraub	84/464

FOREIGN PATENTS OR APPLICATIONS

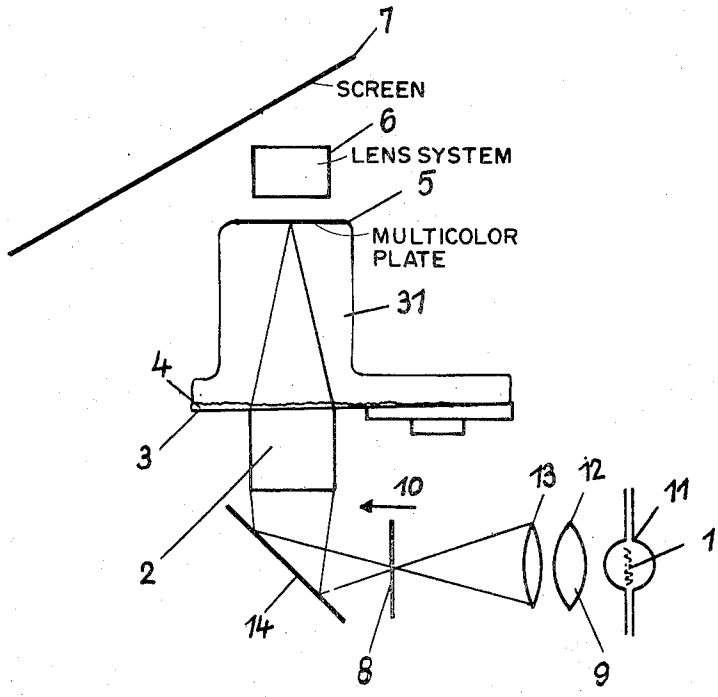
1,071,693	6/1967	Great Britain	179/1 VS

Primary Examiner—Kathleen H. Claffy
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[57] **ABSTRACT**

The invention relates to a device for rendering visible acoustic vibrations, in which a fluid medium held on a foundation is caused to execute wave notions with the help of a movable wall or wall section, and in which the wave motions thus engendered are rendered optically visible.

25 Claims, 9 Drawing Figures



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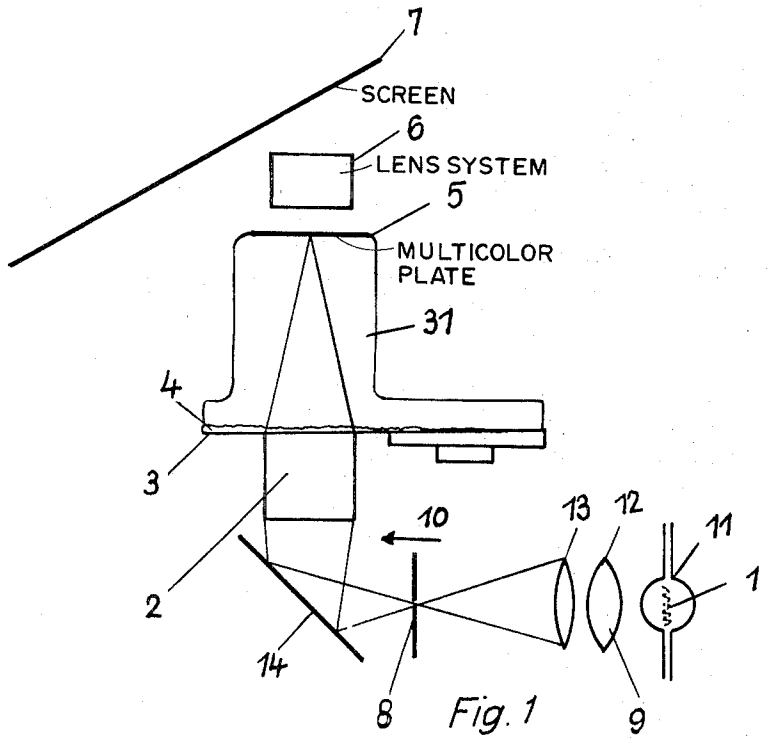


Fig. 1

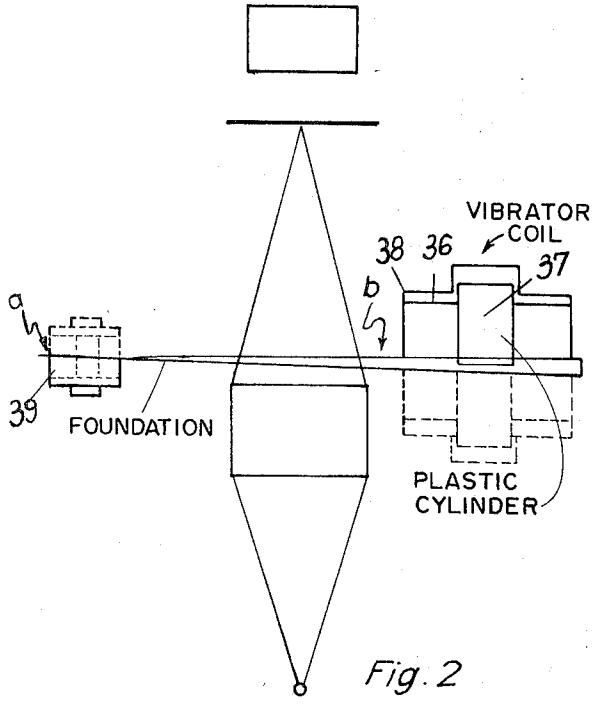


Fig. 2

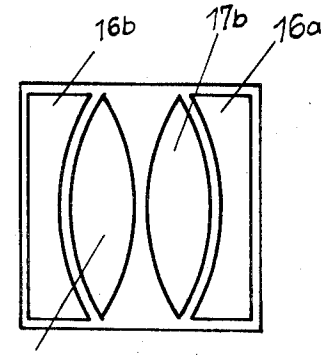


Fig. 5

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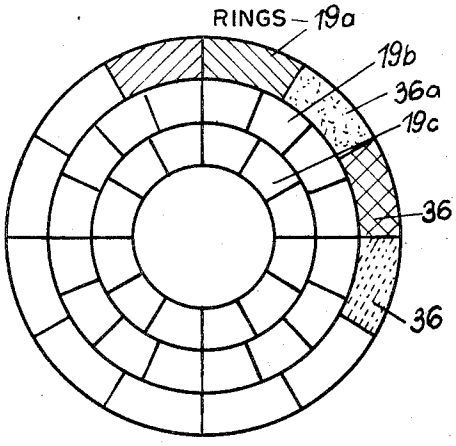


Fig. 3

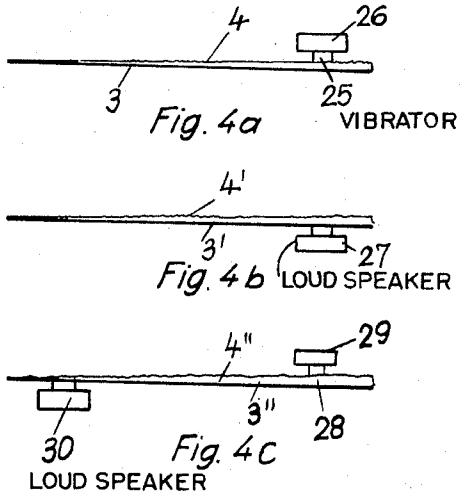


Fig. 4a

Fig. 4b

Fig. 4c

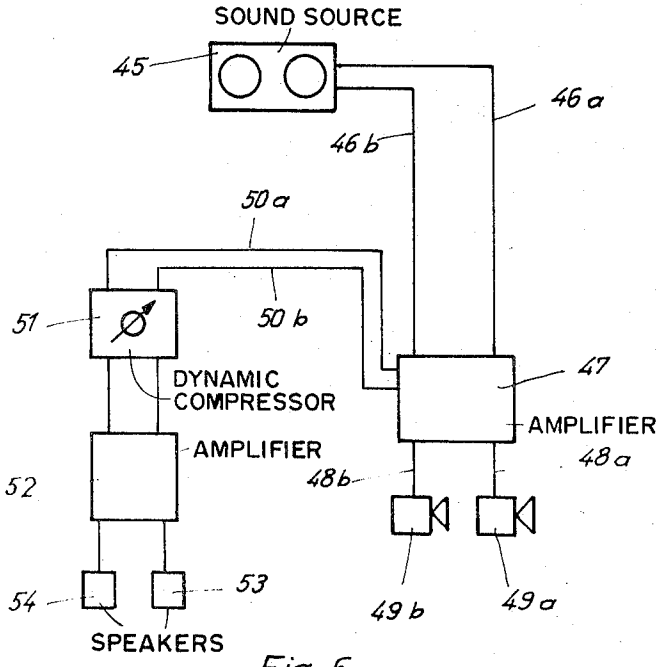


Fig. 6

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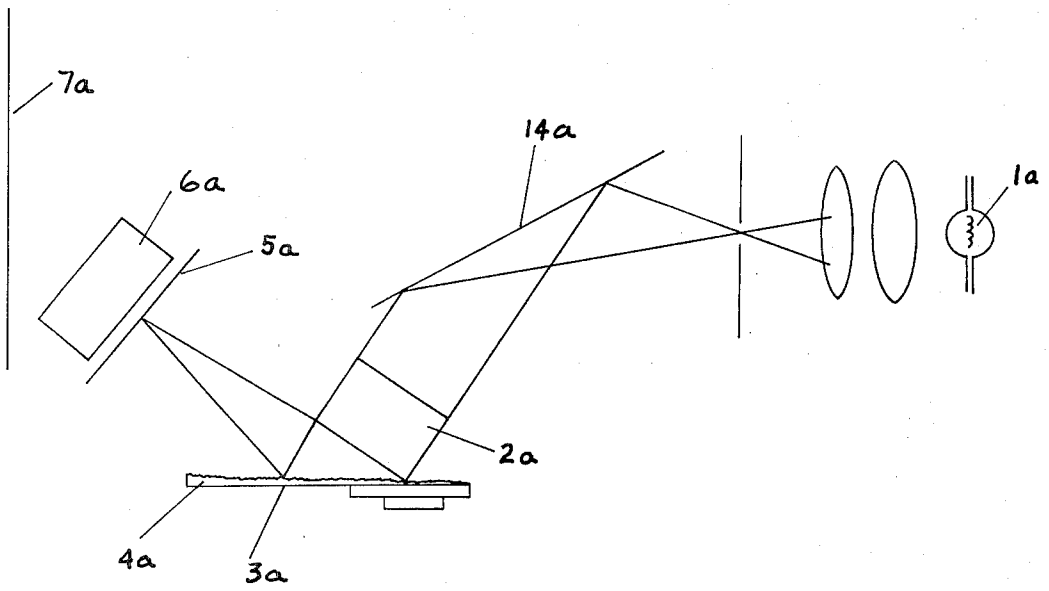


FIG. 7

DEVICE FOR RENDERING VISIBLE ACOUSTIC VIBRATIONS

The object of the present invention consists in making an arrangement with whose help acoustic vibrations such as arise when pieces of music are played, or during speech, can be converted into continuous successive manifestations which may be observed, a certain dependency as regards amplitude and frequency of the vibrations generated being recognisable.

For the above purpose, according to the invention, in the new arrangement, the foundation containing the fluid tramsmitting medium consists of a material which is transparent or which reflects the light in the manner of a mirror, there being on one side of the foundation a first optical group consisting of a light-source, e.g., a so-called xenon lamp, and particularly a so-called HBI lamp, and a reproducing optical system serving to reproduce a light-spot originating from the light source and, on one side of the foundation, there is a second optical group consisting of a multicoloured patterned viewing plate with a surface which has a grid ora network of lines at right angles to each other, preferably made of glass, in the region of the focal point of the reproducing optical system, and also consisting of an objective arranged behind the viewing-plate when, seen in the direction of the beam of light, said objective serving to project the beam coming from the light-spots on the multicoloured viewing-plate on to a screen.

The arrangement according to the invention enables astonishing optical effects to be achieved with relatively simple means. If, for example with the help of loudspeakers, continuous successive sounds are generated, such as occur, for example, when music is played, multicoloured images may be seen on the screen of the new device, the shape of the individual components, and the intensity and shading of the colours being clearly seen, even by the lay observer, to be dependent on the pitch and intensity of the individual sounds. The individual vibratory shapes are repeatable, i.e., they are each associated with only one sound. A complete vibration picture is made up of different figure-fields, of which each can have a different generative basis; the foundation may vibrate in resonsance to the appropriate sound, or the resonsance frequency of the membrane may feed back, or eddies may form within the fluid, absorbing the sound frequency.

Embodiments of the subject-matter of the invention are shown by way of example in the drawing, which shows:

FIG. 1: an arrangement according to the invention, in diagrammatic side elevation;

FIG. 2: a diagrammtic side elevation of a detail of a variant of the arrangement in FIG. 1, on a larger scale;

FIG. 3: a plan view of the viewing-plate of the arrangement in FIG. 1;

FIG. 4*a*: a side elevation of a possibility of generating the wave motions in the transmitting medium;

FIG. 4*b*: another side elevation of another possibility of generating the wave motions;

FIG. 4*c*: another side elevation of another possibility of generating the wave motions;

FIG. 5: a disgram of a further detail of the arrangement according to the invention,

FIG. 6: a diagrammatic view of another detail of the arrangement according to the invention; and

FIG. 7: a further modification of the invention in diagrammatic side elevation.

The invention proceeds from the interference tests described by Pohl in his "Einfuhrung in die Physik," vol. 1, Berlin, 1940, in which a fluid medium was caused to vibrate by a movable wall, e.g., a rod or the like, giving rise to circular radiating wave motions which were projected, so that a whole auditorium could observe these movements. The arrangement according to the invention contains as essential components a light-source **1**, a reproducing optical system **2**, a foundation **3** for the fluid transmitting medium **4**, a multicoloured viewing-plate **5** and a lens system **6** with which is associated a visual screen **7**. According to the invention, the foundation containing the medium **3** consists of a medium which is transparent, or reflects the light in the manner of a mirror, and on one side of the foundation there is provided the light source **1** and the producing optical system serving to generate a reproduction of a light-spot originating from the light source, these parts forming a first optical group, while a second optical group is likewise provided on one side of the foundation, this group containing a multicoloured patterned viewing-plate **5**, preferable of glass, in the region of the focal point of the reproducing optical system **2**, and a lens system **6**, arranged behind the viewing plate, sesn in the direction of the beam of light, said system **6** serving to project the beam coming from the light-spots on the multicoloured viewing plate on to the screen **7**. In the embodiments shown in the drawing, the arrangement is such that, with the help of the acoustic vibrations to be rendered visible, and through a movable wall influenced by these vibrations, dynamic phenomena are brought about in the transmitting medium, which are observale in the transmitted light.

The foundation **3** may consist of transparent material, e.g. material transmitting 80 percent or more light; it may also however consist of reflective material, e.g., of material reflecting more than 80 percent of the light striking it. In the former case it may consist of a glass plate, but also for example of a sheet of plastics material, e.g., the material known commercially as "Hostafan." A condition of satisfactory operation according to the invention is that on the one hand it has a maximum diffusion strength, so that it is as impermeable as possible to the fluid, and on the other hand in certain cases it is very thin, e.g., 15 μ, as it must, as will be discussed below, pass vibrations on to the transmitting medium, energising the latter in order to generate the wave motion. When the foundation is transparent, the abovementioned optical groups are located on opposite sides of the foundation; when the foundation is reflective, both optical groups are on the same side of the foundation. A special fluid is preferably used as a transmitting medium, e.g., a fluorine chemical, preferably the fluid known by the commercial title "F C "**75**," a further condition being that the boiling point is relatively high, e.g., at the level of the boiling point of water, so that the fluid does not evaporate rapidly, that in addition its viscosity is low, e.g., corresponding to one third of the viscosity of water, so that no wetting additive is needed. It is also necessary to cause or promote the minimum corrosion of the casing.

The foundation **3** for the transmitting medium can be bowl- or trough-shaped, the arrangement preferably being such that the bowl or trough shape becomes shal-

lower from the centre of vibration outwards, in order to simulate the running of waves on to a shore, and to avoid as far as possible the occurrence of standing waves. In the embodiments shown in the drawing, the foundation forms an acute angle with the horizontal angle, e.g., of up to 10°. In any case, the arrangement must be such that the free surface of the transmitting medium contained in the obliquely extending foundation is contained in a horizontal plane, the thickness of the layer of medium resting on the foundation increasing continuously from one side to the diametrally-opposed side. In the variant of the subject-matter of the invention in FIG. **2**, the edge portion "*a*" of the foundation is not covered by the medium, while the diametrally opposed edge portion "*b*" corresponds to the region of greatest thickness of the layer of medium resting on the foundation. Such an arrangement enables quite fantastic effects of light, form and colour to be achieved.

The light source **1** can consist of a so-called "Xenon" lamp, or of a so-called "HBI" lamp; a condition of this is that it provides a light-spot of the sharpest contours. In order to determine the effective cross-section of the beam of light emerging from the light-source, an aperture diaphragm **8** is provided between the light-source and the reproducing optical system **2.** Associated with the light-source there is a lens **9** which, seen in the direction of the path of the light **10,** consists of a lens system **11** on the other side of the light-source, a condenser **12** and a subsequent collector lens **13.** Between the reproducing optical system **2** and the optical system **9** facing the light-source **1,** there is provided, seen in the direction of the light and behind the diaphragm, a flat mirror **14** which is directed, for example, at an angle of 45° to the optical axis of optical system **9,** and whose purpose is to reflect the beam coming from the light-source on to the reproducing optical system. The result is that the optical axis of the system **9** associated with the light-source forms an angle of 90°, with that of the reproducing optical system **2.**

The reproducing optical system **2** is so designed that it reproduces the image at aperture diaphragm **8** on viewing plate **5,** which can consist of glass, in a ratio of 1:1. Optical system **2** is more preferably designed as a so-called schlieren optical system, which contains, coacially to each other at both outer ends, a plane-concave divergent lens **16***a*, **16***b*, between which biconvex collector lenses **17***a*, **17***b* with intense curvature are provided. The light-source **1,** the optical system **9** associated therewith, the aperture diaphragm **8,** the mirror **14** and the optical system **2** are located, in the embodiments shown in the drawing, on the side of the foundation **3** facing away from the transmitting medium **4.**

On the side of the foundation facing the transmitting medium there are located the viewing plate **5,** optical system **6** and screen **7.** In this case the optical axis of optical system **2** and the axis of viewing plate **5** coincide. The viewing plate consists of several parts of different colours, preferably three concentric rings **19***a*, **19***b*, **19***c* on different planes and which can be moved, e.g., turned, relative to one another. Each ring is subdivided into parts **35, 36, 37,** of equal length, succeeding one another along the circumference, which are formed as sectors, each part being of a different color from the preceding one. The succeeding parts of the rings can be blue, yellow, red, violet, etc., the colouring of the parts also being different from ring to ring. In order to turn the rings, a slow-running synchronous induction motor can be provided, which can operate continuously or imtermittently, and which can be in a driving connection with the ring or rings through intermediate members, e.g., in the form of a gear system or the like. Each ring can have its own drive motor, or one common motor can be associated with all of them. The surface of the viewing plate **5** bears a grid, or a network of lines at right angles to one another. The viewing plate is followed by the objective, which throws the images formed on to the screen.

The wave motions may be generated in various ways. Thus for example the fluid transmitting medium **4** may be energised with the help of the vibrator armature **25** or matrix of a loudspeaker **26,** said armature dipping in the medium, involving to a certain extent in this case energisation from above, i.e., from the free surface of the medium. However, the transmitting medium may be energised from below, i.e., from the surface in contact with the foundation, to a certain extent involving energisation from below. For this purpose a loudspeaker **27** is used, setting the foundation **3'** carrying the transmitting medium **4'** vibration, in turn energising the transmitting medium itself. Finally, the fluid transmitting medium **4''** may also be energised both from the free surface and from the opposed underside, in order to cause the wave motion. In this case the fluid transmitting medium **4''** is energised on the one hand on the free surface by the vibrator armature **28** or matrix of the loudspeaker **29,** which dips in the medium, and on the other hand by causing foundation **3''** to vibrate by means of a loudspeaker **30.** In all these cases the loudspeaker is arranged eccentrically relative to the foundation. Preferably, according to FIG. **2,** in the loudspeaker serving to generate the wave motions, the vibrator coil **36,** instead of having the conventional diaphragm, is connected to a movable wall, e.g., by adhesion, said wall forming part of a cylindrical member **37** made of a very light plastics material which is not soluble in the transmitting medium, preferably of the plastics material known by the commercial title "Styropor," said wall preferably forming the end-portion of this cylindrical member. In the embodiment in FIG. **2** two loudspeakers **38,39** are provided to generate the wave motion, both speakers being arranged eccentrically relative to the foundation and thus being each associated with two diametrally opposed points on the circumference of the foundation or of the medium contained in it, one speaker being associated, as a high-frequency speaker, with the high-pitched sounds, e.g., of a frequency from about 5,000 Hz up, and the other, as a low-frequency speaker, associated with the low-pitched sounds, in this case lying opposite the part of the foundation covered by a thick layer of medium, while the high-frequency speaker is associated with the part of the foundation which is not covered at all, or only by a thin layer of the medium. Both loudspeakers may energise the medium from above, or by direct contact from below, yet the arrangement can be such that one speaker, e.g., the low-pitch speaker, energises from above, and the other from below. By means of the disposition of the transmitting medium on the foundation (cf. FIG. **2**), and by means of the special method of energising the medium, all sounds from a wide range of high and low frequencies can be made effective, and every imaginable variation of single and multiple tones can now be expressed optically. The energisation of the

transmitting medium generates wave motions, the waves formed being picked up optically at a point remote from the centre of energisation and close to the energisation point, and are projected in the transmitted light. Because of the intense dispersion of the radiation speed of the waves, very interesting dynamic images result.

The transmitting medium and the foundation carrying it, and the farthest optical parts of the device, are enclosed in a casing **31**, on one side of which there is located the objective projecting on to the screen, while on the other side there is the light-source with its associated optical system.

FIG. 6 shows the electrical part of the device. **45** is the sound source: a magnetic tape, a disc, a microphone (e.g., human voice). This sound source is connected by cables **46***a*, **46***b* to the amplifier **47**, from which on the one hand the cables **48***a*, **48***b* go to the speakers **49***a*, **49***b* reproducing the sound waves coming from the sound source (stereo reproduction), and on the other hand the cables **50***a*, **50***b* go to a regulable and adjustable so-called electronic dynamic compressor **51**, whose purpose is to "smooth out" the music to a certain extent, making loud sounds quieter and quiet sounds louder. Part **51** is connected to the amplifier **52**, to which the low-frequency speaker **53** and the high-frequency speaker **54** are connected, serving to energise the medium in the way described above. In this way a "sound" and a "sight" branch are to a certain extent established, in such a way that regulation and adjustment in accordance with requirements at any moment can be undertaken independently in both branches.

As shown in FIG. **7**, in which the parts are given the same reference characters as in FIG. **1**, but with the subscript a, the foundation **3***a* is reflective and the whole optical system is on the same side of the base.

I claim:

1. A device for rendering visible acoustic vibrations, in which a fluid transmitting medium held on a foundation is caused to execute wave motions with the help of a movable wall or wall section, and in which the wave motions thus engendered are rendered optically visible, in which on one side of the foundation there is a first optical group comprising a light-source (**1**) and a reproducing optical system (**2**) including means to reproduce a light-spot originating from the light-source and, on one side of the foundation, a second optical group comprising a multicolored patterned viewing plate (**5**) with a surface which has a grid in the region of the focal point of the reproducing optical system, and also comprising a lens system (**6**) arranged behind the viewing plate when seen in the direction of the beam of light, said lens system serving to project the beam coming from the light-spot on the multicolored viewing plate on to a screen (**7**).

2. A device as in claim **1**, in which the foundation has a maximum diffusion strength, and consists of transparent material, and said optical groups are located on opposite sides of the foundation.

3. A device as in claim **1**, in which the foundation consists of a reflective material and both optical groups are located on the same side of the foundation.

4. A device as in claim **1**, characterised in that the thickness of the layer of transmitting medium resting on the foundation continuously increases from one side to the diametrally opposed side.

5. A device as in claim **4**, characterised in that one edge portion of the foundation is not covered by the transmitting medium, while the diametrally opposed edge portion corresponds to the region of grestest thickness of the layer of transmitting medium resting on the foundation.

6. A device as in claim **1**, in which, in order to determine the effective cross-section of the beam of light from the light-source (**1**), an aperture diaphragm (**8**) is provided between the light-source and the reproducing optical system (**2**).

7. A device as in claim **1**, in which the light-source (**1**) has associated with it an optical system (**9**) which, seen in the direction of the beam of light (**10**), consists of a lens system (**11**) on the same side as the light-source, a condenser (**12**) and a subsequent collector lens (**13**).

8. A device as in claim **7**, characterised in that the optical axis of the reproducing optical system (**2**) forms an angle of 90° with that of the optical system (**9**) associated with the light-source.

9. A device as in claim **8**, characterised in that there is provided between the reproducing optical system (**2**) and the optical system (**9**) associated with the light-source (**1**) a flat mirror (**14**), arranged at an angle to the optical axis of said system (**9**), said mirror reflecting the beam coming from the light-source in the direction of the reproducing optical system.

10. A device as in claim **1**, in which the reproducing optical system (**2**) includes means to introduce the image at the aperture diaphragm (**8**) on the viewing-plate (**5**) in a raio of 1:1, and comprises an optical system which contains, coaxial to one another, plane-concave divergent lenses (**16***a*, **16***b*), between which biconvex collector lenses (**17***a*, **17***b*) with intense curvature are provided.

11. A device as in claim **1**, characterised in that the viewing-plate (**5**) consists of several parts (**19***a*, **19***b*, **19***c*) of different colors.

12. A device as in claim **11**, characterised in that the viewing-plate (**5**) is subdivided into sectors succeeding one another along the circumference, each succeeding sector being of a different color from the preceding one.

13. A device as in claim **11**, characterised in that the viewing-plate (**5**) consists of three or more concentric rings (**19***a*, **19***b*, **19***c*), said rings being rotatable relative to one another, said viewing-plate (**5**) being subdivided into parts of equal length succeeding one another along the circumference, each succeeding part being of a different colour from the preceding one.

14. A device as in claim **13**, characterised in that, in order to drive the rings, slow-running synchronous induction motors are provided, which are in a driving connection with the rings through intermediate members.

15. A device as in claim **1**, characterised in that a special fluid is used as a transmitting medium (**4**), its boiling-point roughly corresponding to that of water, yet whose viscosity is considerably less than that of water.

16. A device as in claim **1**, characterised in that the fluid transmitting medium (**4**) is energised, in order to generate the wave motions.

17. A device as in claim **1**, characterised in that the fluid transmitting medium (**4**) is energised, in order to generate the wave motions.

18. A device as in claim 1, characterised in that the fluid transmitting medium (4'') is energised on a free surface by the vibrating armature (28) of a loudspeaker, dipped in the fluid, and is also energized by causing the foundation (3'') to vibrate by another loudspeaker (30).

19. A device as in claim 17, characterised in that the fluid transmitting medium (4) is energised with the help of a movable wall of a loudspeaker in which the vibrator coil is connected, to a movable wall which dips into the transmitting medium.

20. A device as in claim 17, characterised in that, in order to generate the wave motions in the transmitting medium, two loudspeakers arranged eccentrically to the foundation are used, which are located adjacent two diametrically opposed points on the circumference of the foundation one of said speakers, as a so-called high-frequency speaker, being associated with a part of the foundation covered in a thick layer of the transmitting medium, and being associated with the high-frequency sounds, and the other, as a so-called low-frequency loudspeaker, being associated with the lower-frequency sounds, and with the part of the foundation covered at most by a thin layer of the transmitting medium.

21. A device as in claim 1, in which the foundation has a thickness of 15μ.

22. A device as in claim 11 in which said parts are movable relative to one another.

23. A device as in claim 13 in which the rings are on different superposed planes.

24. A device as in claim 1 in which the fluid medium has a vicosity not more than one-third the viscosity of water.

25. A device as in claim 19 in which the movable wall forms part of a cylindrical body of light plastic material.

* * * * *