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W. D. BUCKINGHAM ET AL

2,330,334

LIGHT VALVE

Filed June 19, 1941

FIG. 1

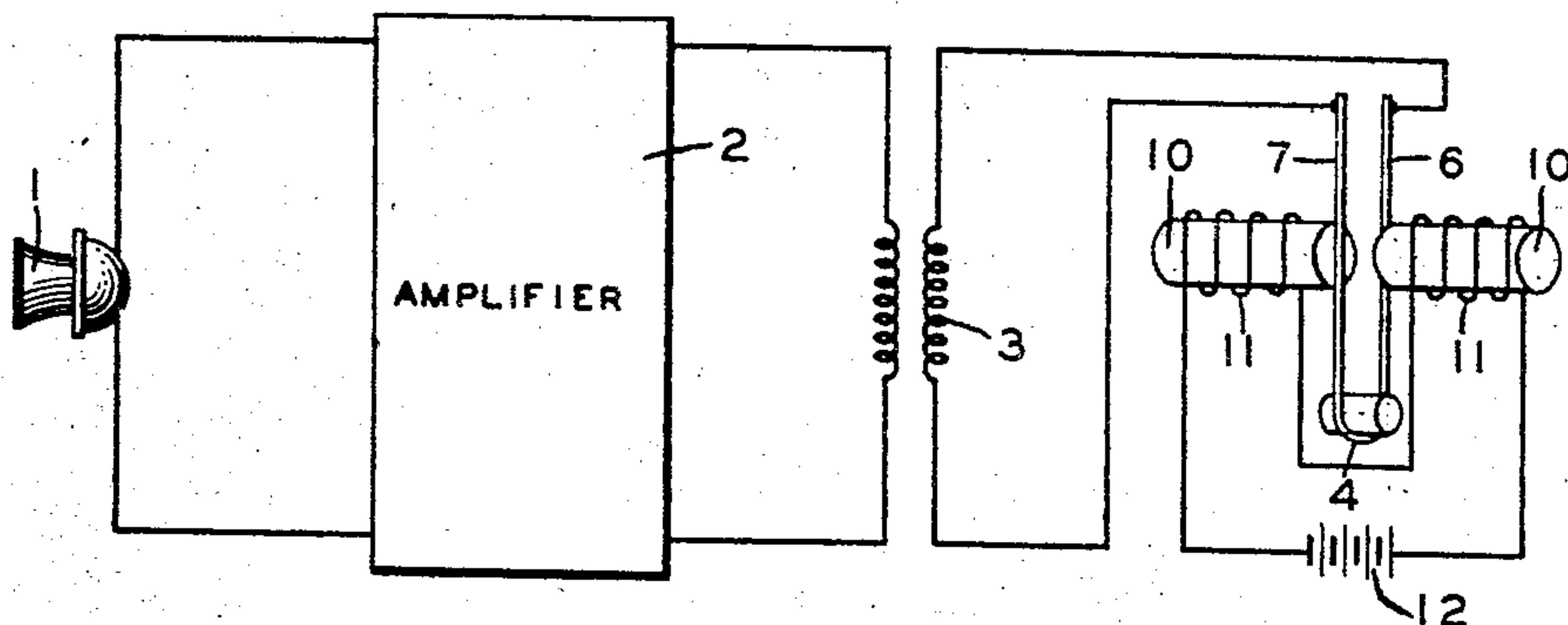


FIG. 4

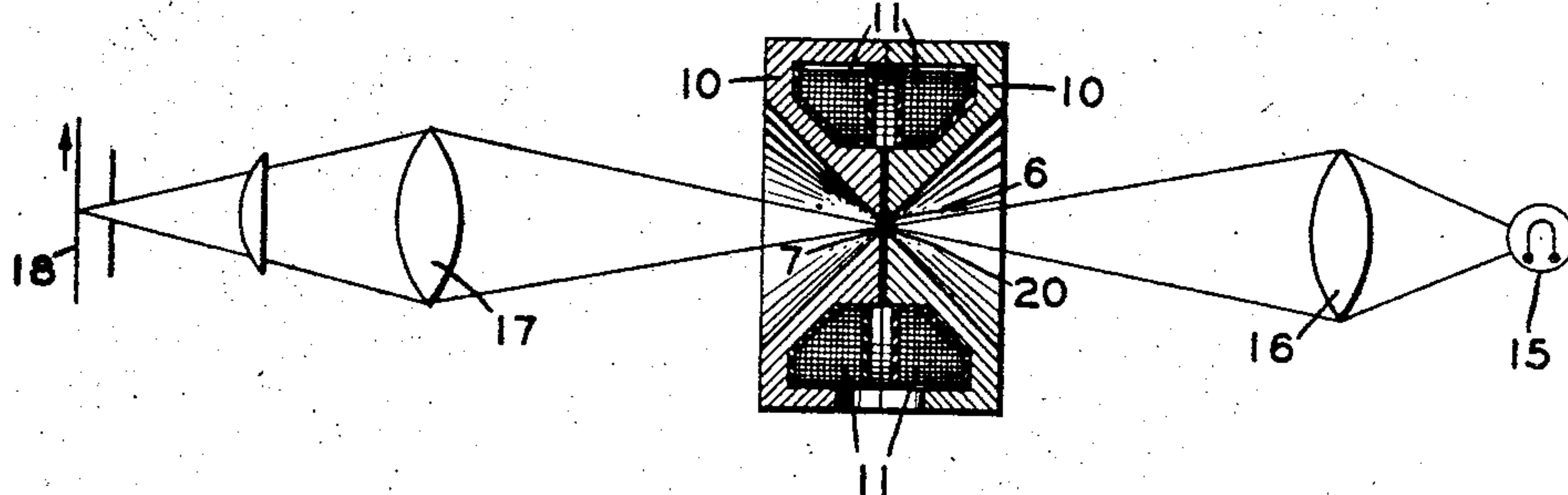


FIG. 3

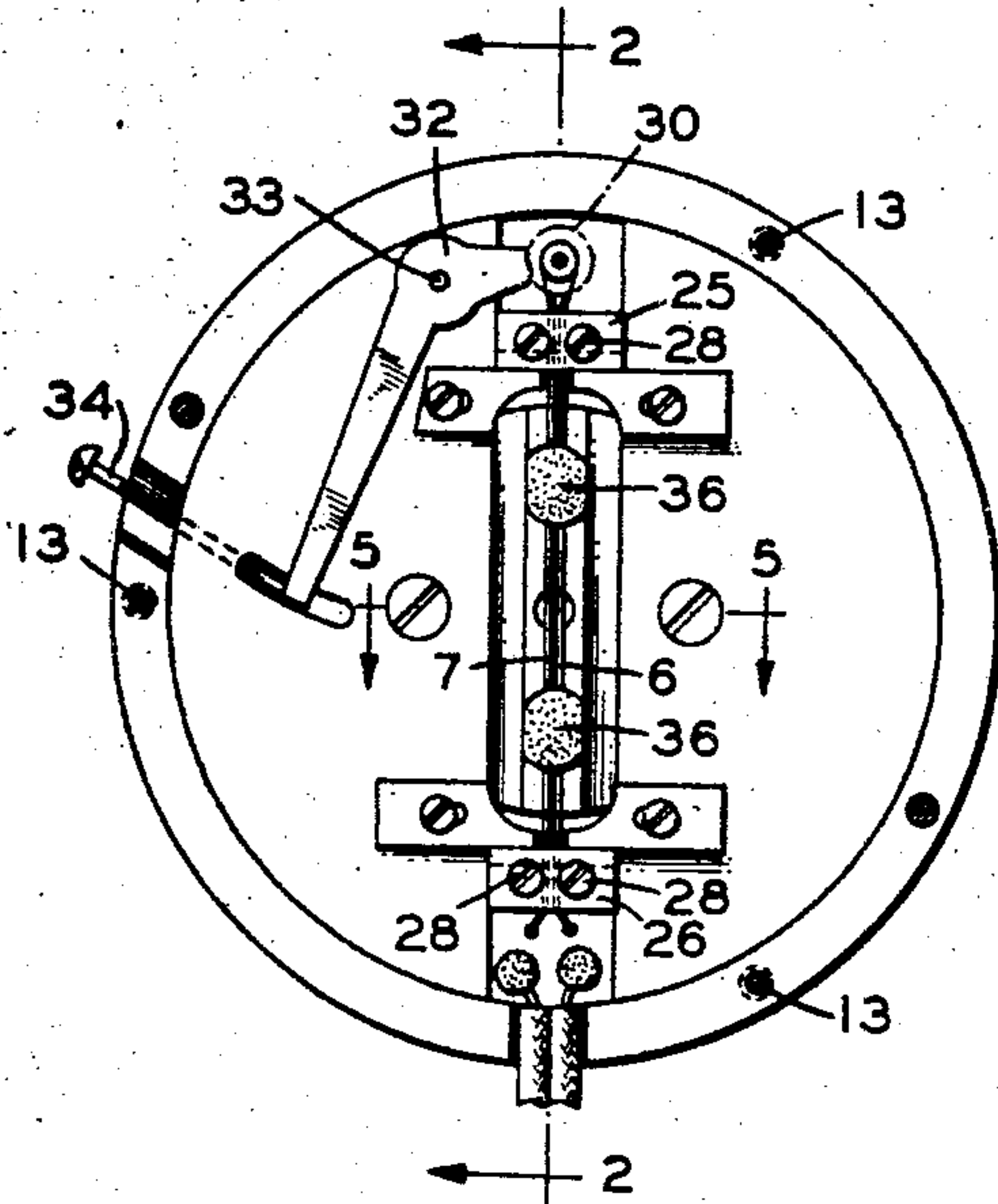


FIG. 2

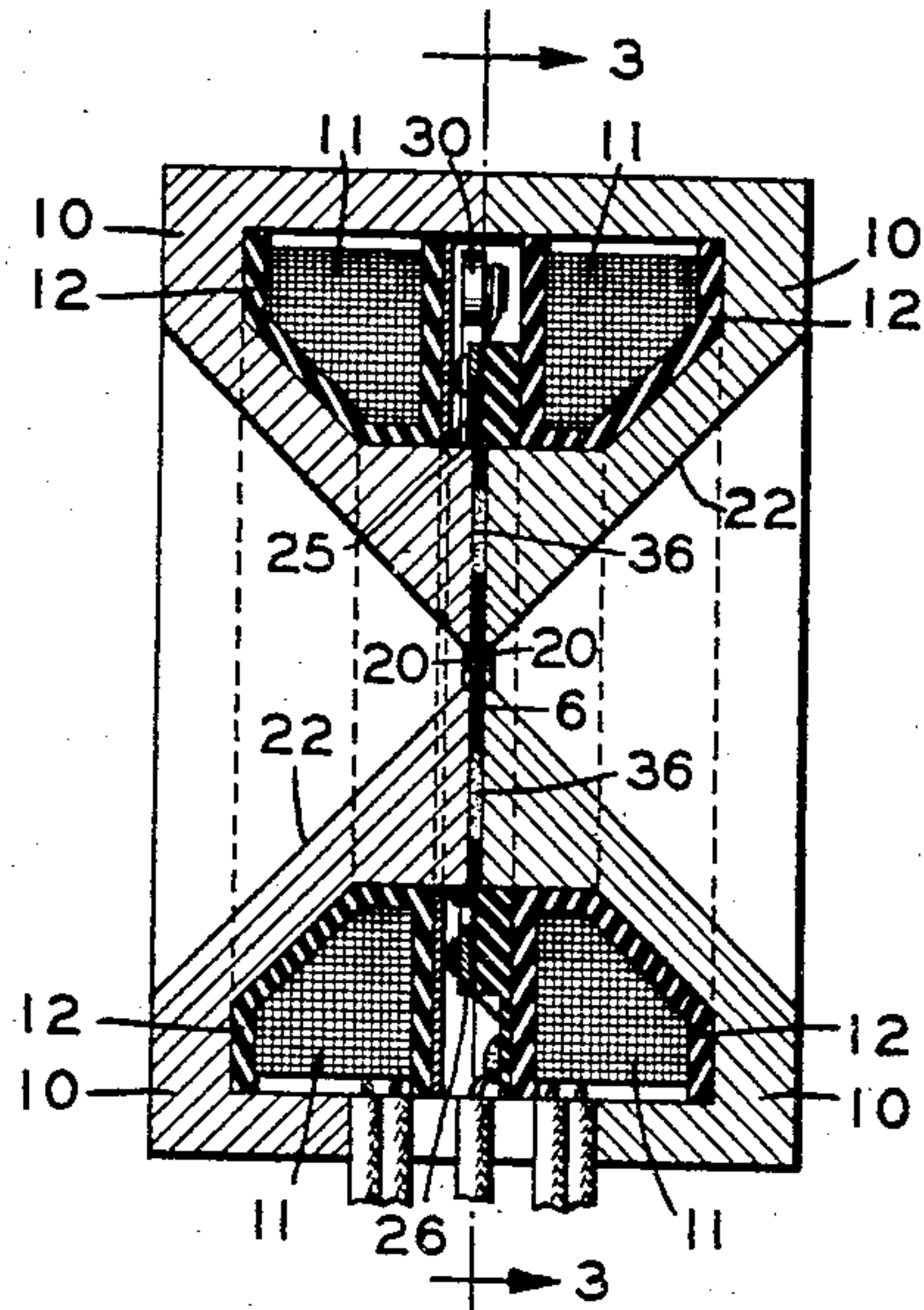
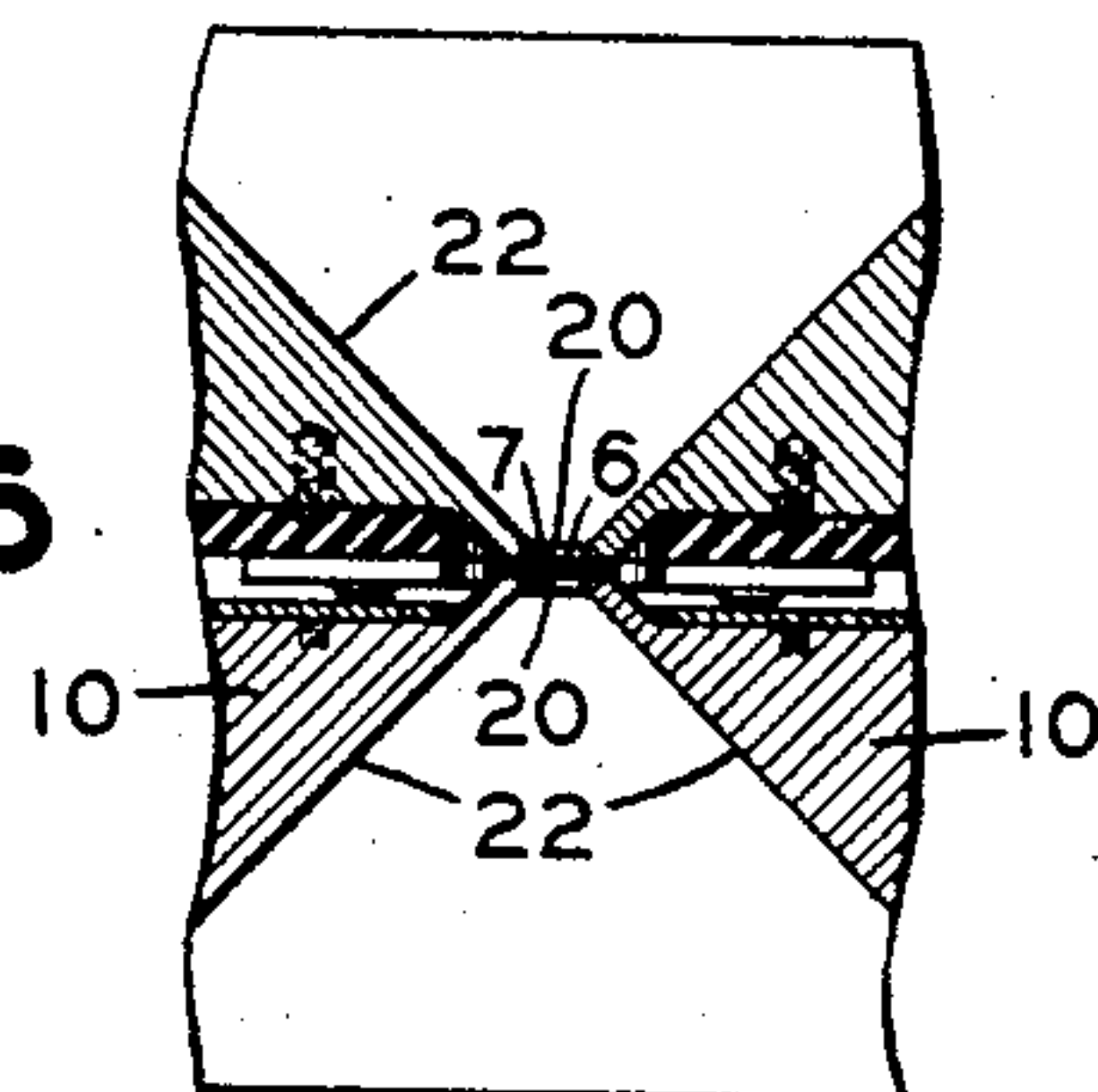


FIG. 5



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## UNITED STATES PATENT OFFICE

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## LIGHT VALVE

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4 Claims. (Cl. 88—61)

This invention relates to electro-optical systems in general and more particularly to electro-mechanical devices for modulating a beam of light in accordance with electrical signaling currents.

The subject of this invention solves certain of the difficulties encountered in the use of light valves of the type including a pair of current conductive strings or ribbons which pass varying amounts of light in accordance with the value of the electrical current passing through said ribbons. It has been found that metallic ribbons or strings are subject to crystallization or other deterioration which causes rupture within a very short period, thus necessitating frequent replacement of parts, together with consequent expense and loss of operating time. This difficulty is caused by the lack of proper supporting structure and more particularly the lack of a resilient support which permits adjustment of tension.

Accordingly, the principal object of this invention is to provide a new support for the current conductive string or ribbon in a light valve which will extend the useful period of operation of said string or ribbon.

A further object of this invention is to provide a resilient support for a string or ribbon in a galvanometer type light valve to thereby prevent rupture or other failure of the string or ribbon.

Further objects and advantages of this invention will be apparent from consideration of the following description taken in connection with the drawing, wherein:

Fig. 1 is a diagrammatic illustration of an electrical circuit for operating a string galvanometer type light valve;

Fig. 2 is a plan view in cross section of a string galvanometer light valve constructed in accordance with this invention;

Fig. 3 is a cross section taken on line 3—3 of Fig. 2;

Fig. 4 is a diagrammatic illustration of the relation between the light valve and a light beam which it is desired to modulate; and

Fig. 5 is a cross section taken on line 5—5 of Fig. 3.

An example of an application of this invention is illustrated in Fig. 1 of the drawing wherein a voice operated electrical circuit is connected to a string or ribbon galvanometer type light valve. This circuit includes a microphone 1, which may be any one of the many well known types of microphone suitable for converting sound or voice frequency into equivalent electrical currents, connected to a conventional amplifier 2 wherein the above mentioned electrical currents are amplified to a useful amplitude. The output of amplifier 2 is fed to transformer 3, and through a conductive ribbon or string loop 4 of a string galvanometer light valve which will be described

in more detail in the following description. The sides 6 and 7 of the ribbon loop 4 traverse an air gap of electromagnet 10 which creates a magnetic field in said air gap induced by coils 11 and source of potential 12.

Voice currents generated in the sound sensitive apparatus 1 and 2 flow in opposite directions through the conductive strings or ribbons 6 and 7 and thereby cause movement of the respective ribbons in opposite directions under the influence of the magnetic field existing in the air gap between the pole pieces of electromagnet 10. It will be seen from the following description that vibrations of ribbons 6 and 7, which vary in amplitude in accordance with the amplitude of the voice currents flowing therein, may be utilized for the purpose of increasing and decreasing the quantity of light in a light beam directed on a photocell or other light sensitive means such as a photographic film.

Figs. 2, 3 and 5 illustrate the details of construction of the light valve. The magnet cores 10 are in the form of discs which are conically recessed to form a pair of pole pieces 22 and light pervious apertures 20. Coils 11 are nested in each of the pole pieces and are provided with suitable insulation 12. The cores 10 may be joined together by any suitable means such as screws, indicated in Fig. 3 at 13. Coils 11 magnetize the cores 10, as explained above in connection with Fig. 1, to create a magnetic field in the air gap between pole pieces 22.

The metallic ribbons 6 and 7 which are necessarily conductive to electric currents are formed into a loop, and positioned between the pole pieces 10 and across apertures 20. The closed end of the loop passes over a pin 30 which is supported on a bell crank 32 pivoted at the point 33 and operated by means of adjusting screw 34 whereby movement of bell crank 32 may vary the tension in ribbons or strings 6 and 7. Ribbons 6 and 7 are supported and positioned in a manner to prevent displacement of the loop while permitting free vibration of the central portion thereof by means of the bridge members 25 and 26 constituting rigid supports at each end of the ribbon loop and member 26 fixedly secures the open end of the loop. It is to be noted that member 25 loosely supports the ribbons 6 and 7 whereby adjustment of ribbon tension is possible.

It has been found, however, that the supporting structure recited hereinbefore is insufficient as the ribbon life is limited to a period of a few hours in ordinary use. Vibration of the ribbon causes crystallization or other deterioration which results in the above mentioned frequent breakage. Therefore it is desirable to provide further support of a resilient nature which will allow adequate amplitude of vibration of said ribbon and prevent such deterioration or crystal-



lization. These results are obtained by forming supports 36 of resilient material which may comprise any form of liquid which coagulates into a resilient substance. A suitable substance given by way of example only is found to be liquid or latex rubber which coagulates into a live rubber and surrounds the ribbons or strings 6 and 7 to provide resilient support in all directions between the pole pieces 22. These supports may be located between the pole pieces at any point so long as adequate amplitude of vibration is possible and so long as the rubber does not touch the bridge members 25 or 26. It is necessary that the point of support be chosen to prevent breakage of the ribbons under the influence of the coagulation process which imposes tensional stresses on the ribbon.

Fig. 4 of the drawing diagrammatically illustrates by way of example only the relationship between a light valve and other optical apparatus which is necessary to make use of a beam of light for signaling, recording or measuring purposes. The optical system including a light source 15 and lenses 16 and 17, is associated with the film 18 for the recording of light variations which correspond to line signals. A photoelectric cell may be substituted for film 18 when it is desired to utilize the light beam for signaling over extended distances. These variations in the quantity of light received by film 18 are produced by means of the light valve diagrammatically illustrated in Fig. 1. Thus as the ribbons 6 and 7 are vibrated in accordance with voice current values, the amount of light passing through the aperture 20 in the pole pieces 22 is varied as said ribbons are arranged to normally block at least a portion of said aperture and to spread apart under the influence of said currents to pass more or less light in accordance with signal values.

From the above it will be evident that this invention provides a means of lengthening the life of conductive strings or ribbons in galvanometer light valves of the type described. It will further be obvious to those skilled in the art that this invention is not limited to any particular light valve or to any particular form of string or ribbon as it is adaptable to any device utilizing fragile conductive ribbons which normally vibrate in operation. Various modifications of this invention will occur to those skilled in the art and therefore it is desired that this invention shall be limited only by the prior art and the scope of the appended claims.

We claim:

1. In a light valve for modulating a light beam, an electromagnet comprising a magnetizing coil and a core structure, said structure being shaped to provide a pair of pole pieces separated by an air gap and a light pervious aperture in each of said pole pieces, a loop of metallic ribbon supported on said core structure to place the sides of said loop in the air gap and across said aperture whereby a flow of current in said loop causes the sides of the loop to approach and recede from one another to regulate the quantity of light passing through said aperture, means including spaced rigid supports engaging the loop for positioning said loop on said core, means whereby the tension of said loop may be adjusted and rubber supports enclosing the sides of said loop and being interposed in the air gap between the aperture and each of said rigid sup-

ports for yieldingly supporting the central portion of said loop, said rubber supports being anchored to the walls of said air gap to localize vibration of the loop principally to said central portion thereof between the rubber supports.

2. In a light valve for modulating a light beam, an electromagnet comprising a core structure, said structure being shaped to provide a pair of pole pieces separated by an air gap and a light pervious aperture in each of said pole pieces and a coil on said core for magnetizing the same, a loop of conductive ribbon supported on said core structure to place the sides of said loop in the air gap and across said aperture whereby a flow of current in said loop causes the sides of the loop to approach and recede from one another to regulate the quantity of light passing through said aperture, means including spaced rigid supports engaging the loop for positioning said loop on said core, and rubber supports enclosing the sides of said loop and being interposed in the air gap between the aperture and each of said rigid supports for yieldingly supporting the central portion of said loop, said rubber supports being anchored to the walls of said air gap to localize vibration of the loop principally to said central portion thereof between the rubber supports.

3. In a light valve for modulating a light beam, an electromagnet comprising a core structure, said structure being shaped to provide a pair of pole pieces separated by an air gap and a light pervious aperture in each of said pole pieces and a coil on said core for magnetizing the same, a loop of conductive material supported on said core structure to place the sides of said loop in the air gap and across said aperture whereby a flow of current in said loop causes the sides of the loop to approach and recede from one another to regulate the quantity of light passing through said aperture, means including rigid supports adjacent the ends of said loop for positioning and adjustably supporting the central portion of said loop whereby the tension of said loop may be adjusted and rubber supports enclosing the sides of said loop and being interposed in the air gap between the aperture and each of said rigid supports for yieldingly supporting the central portion of said loop, said rubber supports being anchored to the walls of said air gap to localize vibration of the loop principally to said central portion thereof between the rubber supports.

4. In a light valve for modulating a light beam, a magnet structure, said structure being shaped to provide pole pieces separated by an air gap, a loop of conductive material, the sides of said loop being disposed in the air gap whereby a flow of current in said loop causes the sides of the loop to approach and recede from one another, rigid supports for positioning the ends of said loop and rubber supports enclosing the sides of said loop and being interposed in the air gap between the center of said loop and each of said rigid supports, said rubber supports being anchored to the walls of said air gap to localize vibration of the loop principally to the central portion thereof between the rubber supports.

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