March 24, 1931. R. H. KRUSE 1,797,237

STRING GALVANOMETER

Filed Jan. 6, 1930

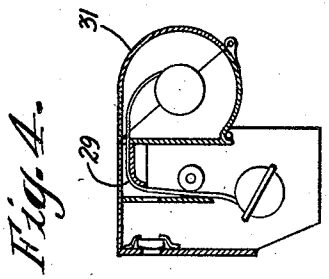


Fig. 4.

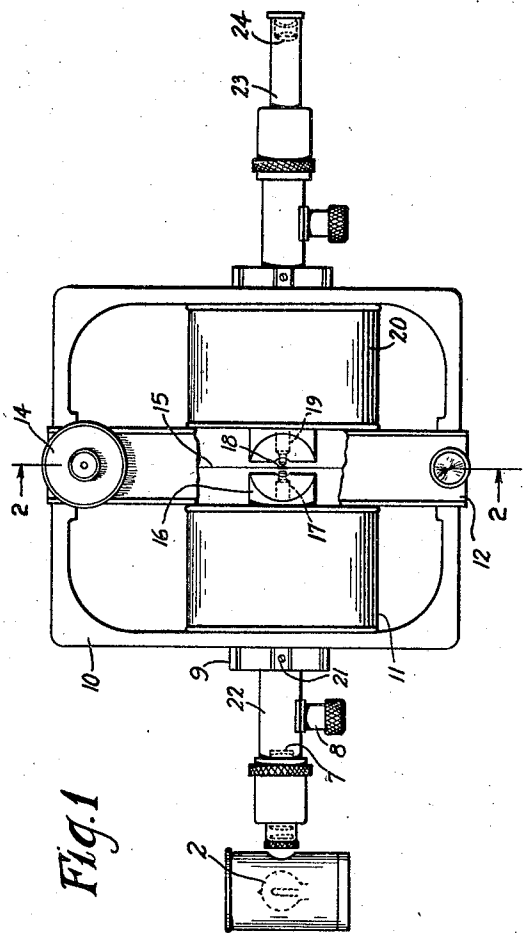


Fig. 1

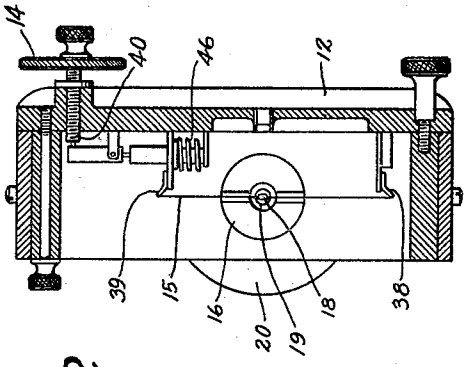


Fig. 2

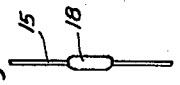


Fig. 3

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UNITED STATES PATENT OFFICE

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STRING GALVANOMETER

Application filed January 6, 1930. Serial No. 418,691.

The present invention relates to string galvanometers.

It is an object of the present invention to improve upon string galvanometers, to the end that their weight and size may be decreased, their portability enhanced and their cost of manufacture lessened. Other and further objects will be explained hereinafter, and will be particularly pointed out in the appended claims.

With the above ends in view, a feature of the invention resides in using a conductive string member that is very thin, except that the portion of the string member that is disposed in the path of the light beam is sufficiently thick so that its oscillations may readily be observed with the ordinary optical system.

The invention will now be more fully explained in connection with the accompanying drawings, in which Fig. 1 is a view of a string galvanometer embodying the present invention; Fig. 2 is a section upon the line 2—2 of Fig. 1, looking in the direction of the arrows; Fig. 3 is an enlarged fragmentary view of the string member; and Fig. 4 is a diagrammatic sectional view of a camera.

A brief description of one type of string galvanometer will now be given to serve as a setting for an explanation of the features of novelty of the present invention. The galvanometer is provided with a permanent magnet or electromagnet, shown O-shaped, and having two slightly spaced pole pieces 16. The energizing coils for the magnet are indicated at 11 and 20. The invention may, of course, be used also in other types of galvanometers, such as are illustrated, for example, in the above-named patent, or in United States Patent No. 1,702,650, granted February 19, 1929, the type shown in the drawings being for illustrative purposes only. It may be stated, however, that the illustrative galvanometer is of very much smaller size. The frame 10 is continuous, or O-shaped, providing a double-magnetic return circuit. This, with the centrally disposed arrangement of the coils 11 and 20, permits economy in weight without proportionate loss of magnet strength.

The string member 15 is suspended in the electromagnetic field produced in the restricted air gap between the slightly spaced pole pieces 16, and at the focus of the beam of light rays that proceed from a lamp or other source of light 2, through tubes 22 and 23, to a light-sensitive film 29 in a photographic camera 31, shown suitably positioned in Fig. 4. The light from the lamp 2 is condensed by a condenser system and is focused on the string member by a microscope 17, and is projected to the camera 31 by a lens system 24. The magnification may be from 20 to 1,000 times. In electrocardiography, for example, it may be 500 times.

The string member 15 is shown in Fig. 2 as carried by a base, frame or support 12. One end of the string member 15 is secured to a supporting head or anchorage member 38 and the other to a supporting head or anchorage member 39, the former being stationary upon the frame 12 and the other adjustable. The adjustable head 39 is yieldingly but firmly held in adjusted position by a spring 46. The adjustment of the movable head 39 is effected by means of a screw 40 that may be turned by a thumb wheel 14. By reason of the various adjustments, and the positions of the anchorage members 38 and 39 above and below the small space between the pole pieces 16, it is possible to adjust the tension of the string member 15, so as to stretch it lengthwise of itself between the anchorage members, and to position an intermediate portion of the string member at the proper point in the said small space, transversely to the magnetic flux between the pole pieces.

The string of such a galvanometer is ordinarily constituted of a quartz or glass thread, very thinly coated with gold or other metal to render it conductive. The measurements obtained with such instruments depend for their accuracy upon the exceedingly slight, sidewise or transverse movement of the electro-conductive string member, in response to exceedingly small changes in current therein. Notwithstanding the thinness of the metal

coating, the electro-magnetic field of an instrument sufficiently small for ordinary portability can not actuate the ordinary string member 15 with sufficient precision when the string member is properly tensioned.

According to the present invention, therefore, the string member 15 is made of even less than ordinary thinness, so as to render it as light as possible. So thin a string member would leave no appreciable trace or line upon the film 29 of the camera 31. The string member is, therefore, slightly thickened, or made of larger cross section, at an intermediate point 18, where it is disposed between the slightly spaced pole pieces 16. The extremely thin string member is easily actuated by the magnetic field, and the enlarged or belted portion leaves just as effective a shadow upon the sensitive film as though the whole string member were of the same uniform thickness throughout.

The length of the belted portion need not be very great. A one-millimeter length is sufficient to cast the required shadow on the film 29. In practice, however, it is possible to use longer belts, even belts extending throughout the full width of the pole faces. Thus, a belt one-eighth inch long on a string member two and one-half inches long operates very satisfactorily. So small a belt does not appreciably change the period of vibration of the unbelted string member, nor its stiffness, so that the string member operates almost exactly the same as though it were unbelted, and the sensitivity of the resulting instrument is of the same order as that prevailing in the very much larger and more expensive galvanometers. The longer the extent of the enlarged section, the greater is the weight of the resulting string member, and the less marked become the advantages described herein. In practice, therefore, it is preferable to have the enlarged section as small as possible, say, of substantially the same length, or but slightly larger than, the width of the beam of light rays at the point where the string member is positioned between the pole pieces.

The novel string member may be made in many ways, as by bombardment by cathodic sputtering, with shields placed on both sides of the portion of the string member to be belted; or by condensing organic material on the string from the vapor form; or by applying a lacquer film; or by dissolving away, on each side of the belted portion, the coating of an ordinary string member having its coating throughout its length. A very effective way is to lower the string member into a drop of electrolyte, and to electroplate on the string member a length equal to the length of the drop. By controlling the length of the drop, it is possible to control the length of the belt; and the diameter of the belt is a function of the current and the time. Various metals may be used, such as copper and gold.

A very small Einthoven galvanometer is thus provided, that will give good photographic reproduction, even on very fast, transverse movements of the string member. Because of the thinness of the string, the galvanometer does not lose in sensitivity, and the belt produces a satisfactory shadow. Indeed, because of the thin nature of the string member, the period of vibration may be even higher than in present-day galvanometers.

Modifications will also occur to persons skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. In a string galvanometer, an electro-conductive string member having an intermediate portion of enlarged cross section.

2. In a string galvanometer, a magnet having opposed slightly spaced pole pieces, and an electro-conductive string member stretched lengthwise of itself with a portion of the string member positioned in the space between the pole pieces, the said portion of the string member being of enlarged cross section.

3. In a string galvanometer, a magnet having opposed slightly spaced pole pieces, and an electro-conductive string member stretched lengthwise of itself with a portion of the string member positioned in the space between the pole pieces transversely to the path of the magnetic flux between the pole pieces, means for producing a beam of light traversing the space between the pole pieces, and means for receiving or recording the shadow produced by the string member in the beam of light, the portion of the string member in the beam of light being of enlarged cross section, and the enlarged cross section being of substantially the same length as the width of the beam of light at the point where the string member is positioned between the pole pieces.

4. In a string galvanometer, a magnet having opposed slightly spaced pole pieces, two anchorage members disposed respectively above and below the space between the pole pieces, an electro-conductive string member the ends of which are carried by the anchorage members so that the string member is stretched lengthwise of itself between the anchorage members, with a portion of the string member positioned in the space betwen the pole pieces transversely to the path of the magnetic flux between the pole pieces, the said portion of the string member being of enlarged cross section, means for producing a beam of light traversing the space between the pole pieces, and means for receiving or recording the shadow produced by the string member in the beam of light.

5. In a string galvanometer, an O-shaped

magnet having opposed slightly spaced pole pieces, centrally disposed energizing coils, two anchorage members disposed respectively above and below the space between the pole pieces, an electro-conductive string member the ends of which are carried by the anchorage members so that the string member is stretched lengthwise of itself between the anchorage members, with a portion of the string member positioned in the space between the pole pieces transversely to the path of the magnetic flux between the pole pieces, the said portion of the string member being of enlarged cross section, means for producing a beam of light traversing the space between the pole pieces, and means for receiving or recording the shadow produced by the string member in the beam of light.

In testimony whereof, I have hereunto subscribed my name.

RALPH H. KRUSE.