PATENT SPECIFICATION

Application Date: Oct. 27, 1919. No. 26,291/19. **159,540**

Complete Left: July 27, 1920.

Complete Accepted: Feb. 28, 1921.

PROVISIONAL SPECIFICATION.

Improvements in or relating to Apparatus for Enabling the Angle of Elevation of an Object to be Observed.

We, LIONEL BARTON BOOTH, of "Delamere," Sandal, Wakefield, Yorks, Optician, and WILLIAM SYDNEY SMITH, of the Royal Aircraft Establishment, South Farnborough, Superintendent of the said Establishment, do hereby declare the nature of this invention to be as follows:—

This invention relates to apparatus for enabling the angle of elevation of an object to be obtained, and more particularly to apparatus for use on aircraft, whereby the altitude of a star or of the sun can be readily obtained for navigational purposes.

The horizon is seldom clearly visible from an aircraft and provision is made whereby a bubble is used as a reference point, from which the altitude of a star or the sun can be obtained.

The apparatus is arranged so that the movements of the bubble due to pitching of the aircraft follow and are equal to the apparent movements of the star or sun from the same cause. The bubble is placed in the focal plane of the objective lens and is seen by reflection from a plane glass reflector through which the sun or star is directly observed. The bubble is illuminated either by the sun in the case of daylight observations, or by an electric lamp, which is controlled by a resistance.

The objective lens through which the bubble is seen is of short focal length and of large aperture to allow of considerable latitude in the position of the eye of the observer when observations are made.

The bubble is in the focal plane of the lens (taking into account the thickness of glass and fluid through which the light passes) and the radius of curvature of the glass disc retaining the bubble must be appreciably the same as the focal length of the objective lens (also taking into account the thickness of glass and fluid through which the light passes). This is an essential condition for the bubble and star to remain in coincidence.

The fluid contained in the bubble is of very low viscosity so that the movements of the bubble have no appreciable effect. The size of the bubble is controlled by an apparatus such as is described in the co-pending Application No. 23,382/19. The reflector is adjustable to enable the image of the bubble to be brought to coincide with the object whose elevation is sought, and multiplying gear is provided whereby the angle through which the reflector is adjusted is shown on an enlarged scale.

A form of apparatus consists of a small case containing a bubble lens suitably illuminated by the electric lamp which is controlled by a resistance. Beneath the bubble lens is a prism which turns the rays passing through it through a convenient angle of say about 120°. The rays then pass through an objective lens whose focal length is equal to the apparent radius of curvature of the bubble container and are again reflected by a sheet of optically plane glass to the eye. The latter reflector is pivoted about a point at or near the axis of the objective lens and can be turned by a cam and large milled head through an angle of 45°. The milled head is divided into degrees and fractions and twice the angle of the plane reflector is read against a datum mark on the case. In order to

[*Price* 1/-]

Price 2s.

make the instrument small and compact, a collimating lens of short length is used, and its aperture is made large in order to allow of considerable eye freedom. The objective lens is, therefore, calculated to be reasonably free from spherical aberration on the axis, from coma, and from colour, taking into account the thickness of the glass of the prism and the lenses and the fluid between it and the bubble.

The method of operation will now be obvious. In the case of altitude of a star, the star is picked up and observed with both eyes, the plane reflector is brought between one eye and the star and in it will be seen the image of the bubble lens. The milled head is now turned till the centre of the bubble appears to coincide with the star, and the altitude is read directly on the milled head against the datum mark on the case. Both eyes are used for observing, and since the bubble is collimated to infinity and its radius is equal to the focal length of the lens (taking into account the thickness of glass and fluid through which the light passes) movements of the observer cause the star and the bubble to sway about in the field together, but do not separate them.

For observing the sun, an optically plane dark glass, the underside of which is slightly matted to destroy reflections, is placed over the instrument and one or both eyes may be used. A coloured screen is preferably placed between the illuminant and the bubble and a much stronger light is used, or the lamp may be withdrawn and the bubble illuminated by daylight.

Dated the 27th day of October, 1919.

A. C. DAY,
Capt., R.A.F.,
Agent for the Applicants.

COMPLETE SPECIFICATION.

Improvements in or relating to Apparatus for Enabling the Angle of Elevation of an Object to be Observed.

We, LIONEL BARTON BOOTH, of "Delamere," Sandal, Wakefield, Yorks, Optician, and WILLIAM SYDNEY SMITH, of the Royal Aircraft Establishment, South Farnborough, Superintendent of the said Establishment, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to apparatus for enabling the angle of elevation or depression of an object to be obtained, and more particularly to apparatus for use on aircraft wherein the horizon is seldom clearly visible, whereby the altitude of a star or of the sun can be readily obtained for navigational purposes. The invention has reference to sextants of the type wherein the object and the bubble are viewed simultaneously, but avoids the use of half lenses which necessitate accurate location of the eye, and avoids the use of an eyepiece for viewing the object.

According to the invention a bubble is used as a reference point and is viewed through a collimating objective lens, at the principal focus of which it lies substantially, the bubble container having the same radius of curvature as the focal length of the objective lens, so that movements of the bubble owing to pitching or inclination of the aircraft or the like follow and are equal to the apparent movements of the sun, star or other object from the same cause. An adjustable plane glass reflector by which an image of the bubble is projected into the eye and through which the object is observed is used to obtain the angle, and both fields are seen with the whole pupil.

An apparatus constructed according to the invention is illustrated in the accompanying drawings, in which:—

Fig. 1 is a sectional elevation from one side;

Fig. 2 is a sectional elevation from the other side;

Fig. 3 is a sectional rear elevation;

Fig. 4 is an under plan; and

Fig. 5 is a top plan.

The numeral 6, indicates the bubble an image of which is projected into the eye by the objective lens 7, and a plane glass reflector, 8, through which latter the sun or star is directly observed. The bubble is illuminated either by the sun in the case of daylight observations, or by an electric lamp, 9, which is controlled by a resistance.

The objective lens is of short focal length and of large aperture to allow of considerable latitude in the position of

the eye of the observer when observations are made.

The bubble is in the focal plane of the objective lens (taking into account the thickness of glass and fluid through which the light passes), and the radius of curvature of the disc, 10, retaining the bubble is the same as the focal length of the objective lens (also taking into account the thickness of glass and fluid through which the light passes). This is an essential condition for the bubble and star to remain in coincidence.

The fluid in the bubble container or lens is of very low viscosity so that the movements of the bubble have no appreciable lag. The size of the bubble may be controlled by any suitable apparatus. The reflector, 8, is adjustable to enable the image of the bubble to be brought into coincidence with the object whose elevation is sought, and multiplying gear, hereinafter referred to, is provided whereby the angle through which the reflector is adjusted is shown on an enlarged scale.

Beneath the bubble lens is a prism, 16, which turns the rays passing through it through a large angle of, say, about 120°. The rays then pass through the objective lens and are again reflected, as aforesaid, by a sheet of optically plane glass, 8, to the eye. The reflector, 8, is pivoted about a point, 11, at or near the axis of the objective lens and can be turned through an angle of 45° by a cam, 12 engaging a pin, 13, projecting from the reflector. The cam is turned by a large milled head, 14. The milled head is divided into degrees and fractions and twice the angle through which the plane reflector is turned is read against a datum mark on the case, 15, of the apparatus. In order to make the instrument small and compact, a collimating lens of short focal length is used as the objective lens, and its aperture is made large in order to allow of considerable eye freedom. The objective lens is, therefore, calculated to be reasonably free from spherical aberration on the axis, from coma, and from colour, taking into account the thickness of the glass of the prism and the lenses and the fluid between it and the bubble.

The method of operation is obvious. In the case of the altitude of a star, the star is picked up and observed with both eyes, the plane reflector is brought between one eye and the star and in the reflector is seen the image of the bubble lens and through the reflector is seen the star, both with the whole pupil of the eye. The milled head is turned until the centre of the bubble appears to coincide with the star, and the altitude is read directly on the milled head against the datum mark on the case. Both eyes are used for observing, and since the bubble is collimated to infinity and its radius is equal to the focal length of the lens (taking into account the thickness of glass and fluid through which the light passes) movements of the observer cause the star and the bubble to sway about in the field together, but do not separate them.

For observing the sun, an optically plane dark glass, the underside of which is slightly matted to destroy reflections, is placed over the instrument and one or both eyes may be used. A coloured screen is preferably placed between the illuminant and the bubble and a much stronger light is used, or the lamp may be withdrawn and the bubble illuminated by daylight.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Apparatus for enabling the angle of elevation or depression of the sun, a star or other object to be observed, wherein a bubble is used as a reference point and is viewed through a collimating objective lens at the principal focus of which it lies substantially, the bubble container having the same radius of curvature as the focal length of the objective lens, so that movements of the bubble which is seen by reflection follow and are equal to the apparent movements of the object which is seen by direct vision, both with the whole pupil of the eye, substantially as described.

2. Apparatus for determining the angle of elevation or depression of the sun, a star or the like, wherein a bubble is situate in the focal plane of an objective lens and an image of the bubble is projected into the eye by the objective lens and an adjustable plane glass reflector through which latter the sun, star or the like is directly observed, substantially as described.

3. Apparatus for determining the angle of elevation or depression of an object according to Claim 1 or 2, and comprising a prism between the bubble container or lens and the objective lens for turning back the rays through a large angle, substantially as described.

4. Apparatus for determining the angle

of elevation or depression of an object according to Claim 2, wherein the reflector is pivoted about an axis near the axis of the objective lens, substantially as described.

5. Apparatus for determining the angle of elevation or depression of an object according to Claim 2, wherein the reflector is adjusted by a cam, substantially as described.

6. Apparatus for determining the angle of elevation or depression of an object constructed substantially as described with reference to and as shown in the accompanying drawings.

Dated the 20th day of July, 1920.

A. C. DAY,
Capt., R.A.F.,
Agent for the Applicants.

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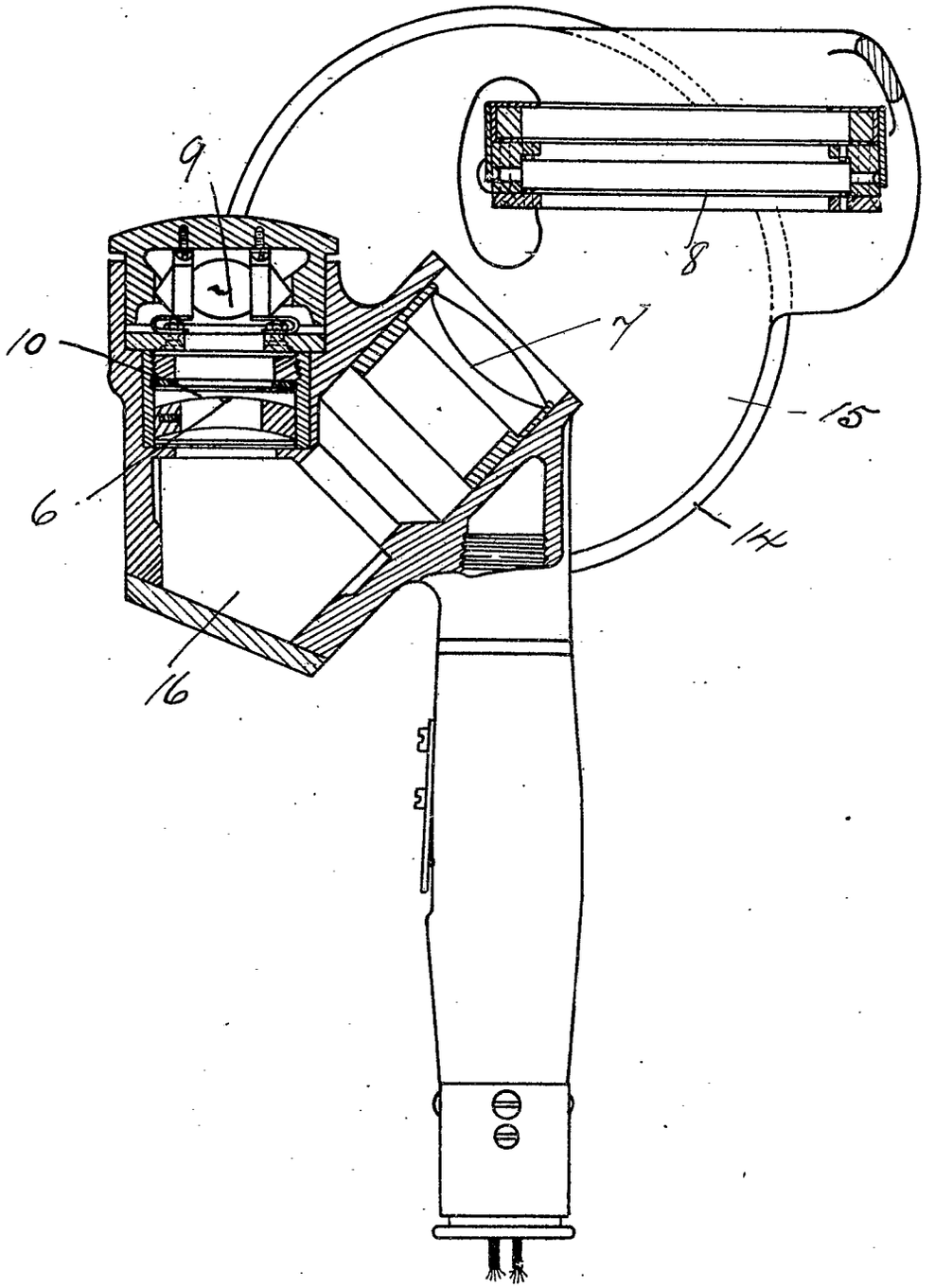

FIG 1.

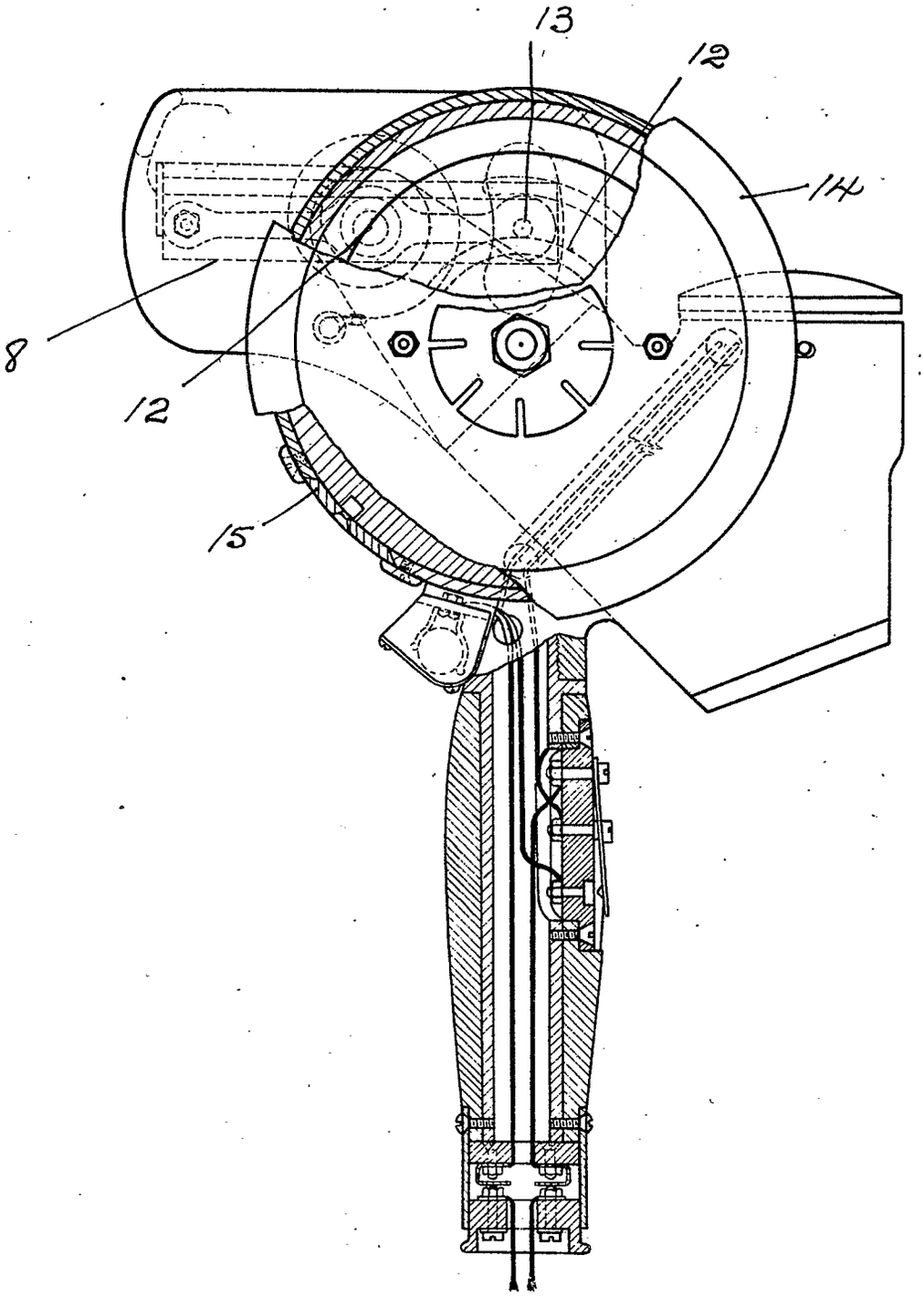

FIG. 2

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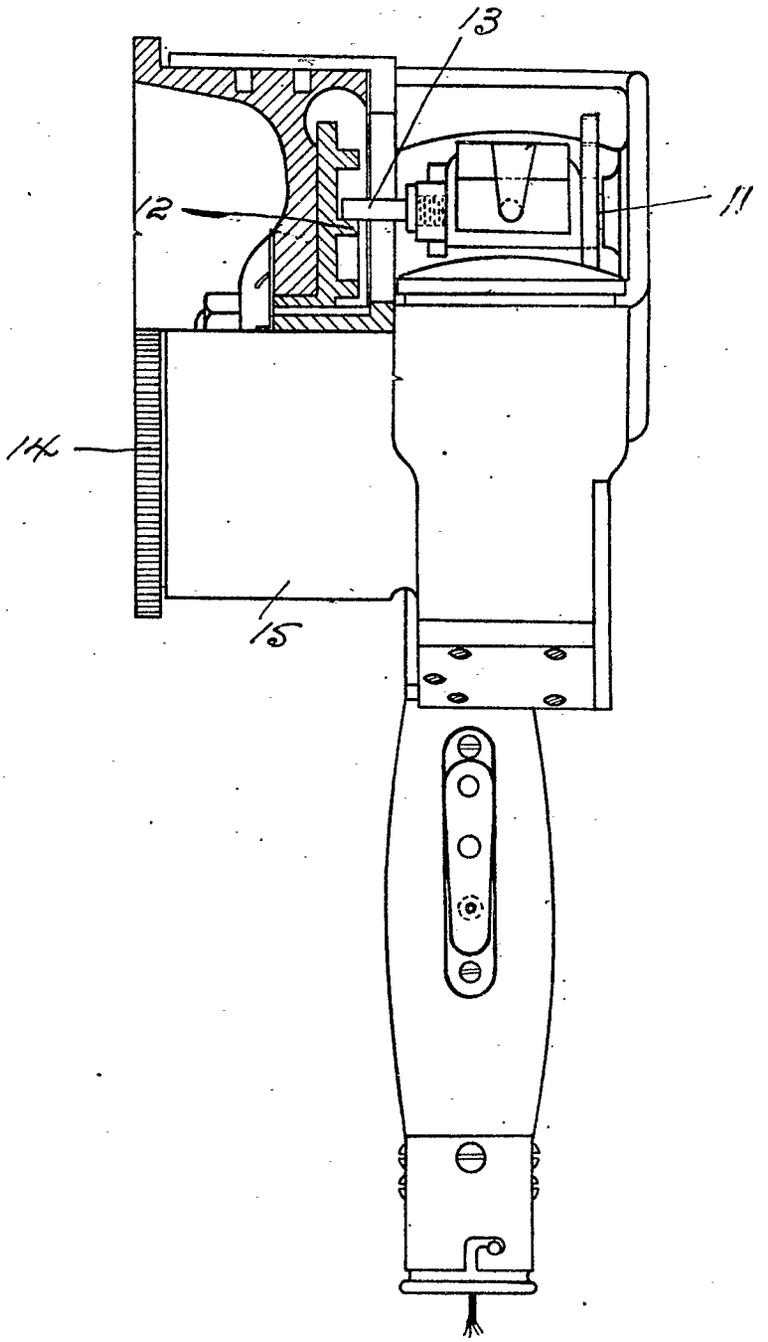

FIG. 3.

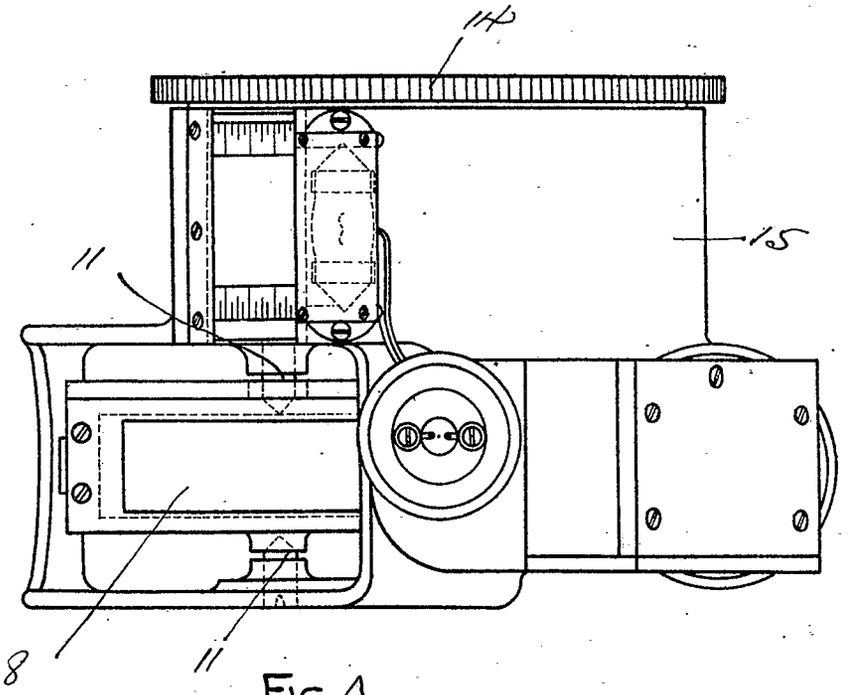

FIG. 4

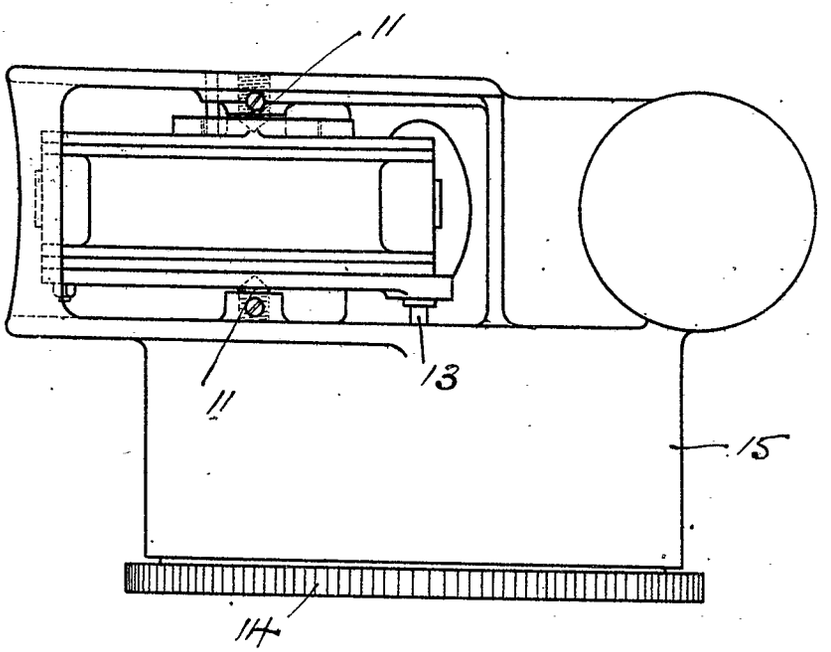

FIG. 5

Malby & Sons, Photo-Litho.