June 20, 1950 L. G. HENYEY ET AL 2,512,153

SPLIT-FIELD DUAL-POWER TELESCOPE

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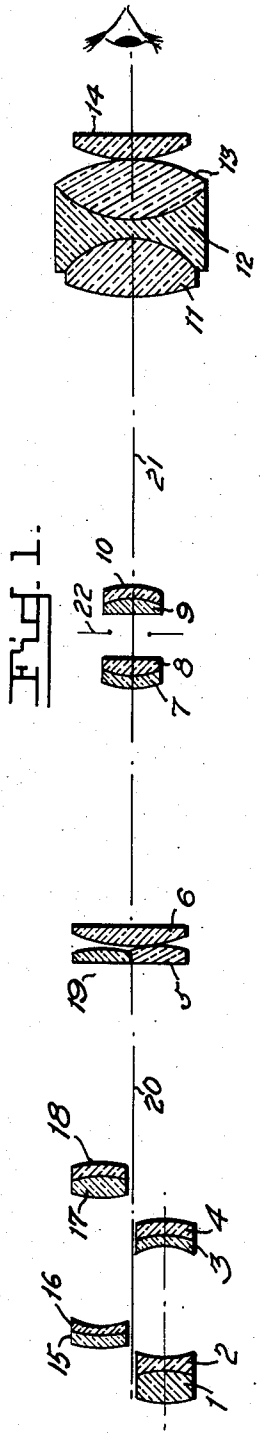

Fig. 1.

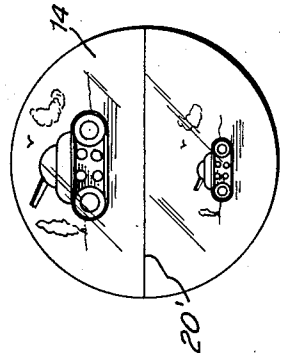

Fig. 4.

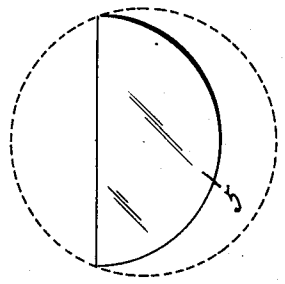

Fig. 3.

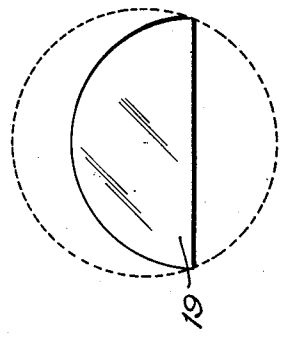

Fig. 2.

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SPLIT-FIELD DUAL-POWER TELESCOPE

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4 Claims. (Cl. 88—32)

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This invention relates to a split-field dual-power telescope which, while of general utility, is particularly useful in combat tanks and other armored vehicles. As is well known, the vision from the interior of a tank is extremely limited because of the necessity for protection to the operating personnel. This condition of limited vision is aggravated by the restricted space within the tank turret. In the case of tanks carrying relatively large calibre guns, the gunner has numerous duties to perform in addition to those customarily performed by the gunner of an emplaced gun. For example, the tank gunner must ordinarily select a target, judge the range, instruct the gun loader as to type of ammunition, watch the target movement to correct for lead, and manipulate the controls, all under the stress of battle and in a cramped position within the vehicle.

Under the foregoing conditions, it is a great aid to the gunner to have available two closely adjacent images of one and the same field of view, and at different magnifications. The field of view of lower magnification in covering a larger area, enables inspection over a relatively wide area and the selection of a target therein. This target may then be inspected at greater magnification for precise and accurate aiming; and both observations may be made without any substantial movement of the gunner's head.

It is therefore the principal object of the invention to provide a split-field dual-power telescope having the inherent advantages mentioned.

A further object is to provide a dual-power telescope of simplified and improved optics over previous telescopes of like type.

Another object is to provide a telescope of the type mentioned that is relatively inexpensive and simple to manufacture, of reasonable length and capable of withstanding the rough usage, shocks and jars to which combat tank instruments are inevitably subjected.

Other objects, advantages and uses will appear as the description proceeds.

In the drawing:

Figure 1 is a longitudinal vertical section of a telescope embodying the invention, the tube, mounting and other well-known details being omitted for simplicity of illustration and description;

Figure 2 is a view showing the manner of producing the upper eccentric collective lens,

Figure 3 is a view showing the manner of producing the lower eccentric collective lens, and

Figure 4 is a typical view of an enemy tank at

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two different magnifications, as it appears in the field of the telescope.

The lower objective is a telephoto lens of 10.6'' focal length consisting of a pair of doublets 1, 2 and 3, 4. The collective 5 is a semi-circular eccentric lens cut as shown at Figure 3, from a large ordinary circular lens and having its flat edge in the horizontal plane through the central axis of the instrument.

The upper objective is an inverted telephoto lens of 3.18'' focal length, consisting of the doublets 15, 16 and 17, 18. These particular objectives are required to make it unnecessary for the objective of longer focus to project an excessive distance in front of the other. The eccentric collective 19 is cut from an ordinary lens, as shown in Figure 2. To prevent light from one objective from passing to the wrong collective and producing false images, the two objectives are separated within their common tube, by a thin metal vane 20. This appears as a diametral line 20', Figure 4. In the absence of specially-cut collectives 5 and 19, the entrance pupils would be imaged at different points behind the eyepiece and both would be displaced off the main optical axis 21. By the use of the collectives, cut as shown at Figures 2 and 3 to have a prismatic action, the entrance pupils are focussed to produce a single round Ramsden disk behind the eyepiece. In the model shown, the optical axes of the objectives are displaced 0.55'' above and below axis 21, respectively. Lenses 5 and 19 may be molded in plastic and cut from an ordinary lens 2.46'' in diameter by a straight chordal cut offset 0.55'' from their center, and a semi-circular cut centered on the midpoint of the chord.

The second collective lens 6, is a single element extending over both objectives. This lens may have a flat rear face and is designed to be free of significant aberrations. The rear vertex of lens 5 lies in the same transverse plane as the front of lens 6. The front faces of lenses 5 and 19 are coplanar and, since these two are of different thickness, as shown in the accompanying table, the plane of the vertex of 19 lies .014'' forwardly of the plane of the vertex of lens 6. By this arrangement, the two reticles may be boresighted with respect to each other at the factory and one boresighting in the field properly adjusts both. Reticles of any suitable type and of desired form, may be provided, as by etching, upon the flat faces of these lenses.

The erector consists of the two doublets 7, 8 and 9, 10, of conventional form, designed to be free of significant aberrations. A diaphragm 22, of

0.56'' aperture is positioned midway between the lenses. The second erector is made adjustable for focussing, by any well known mount.

The orthoscopic eyepiece consists of a triplet **11**, **12**, **13** and a plano-convex element **14**. Most of the bending of the rays is done by the rear surface of element **13**, which is aplanatic, and by the rear surface of element **14**. The front surface of this element is centered on the exit pupil. The entire instrument, in the model selected for illustration, is enclosed in a tube about 27'' long and 2¾'' in external diameter.

Thus, at a single round exit pupil the observer sees two images of a target as shown at Figure 4. In the lower half of the eyepiece he is able to obtain a view over a relatively wide field. In the model selected for illustration, the field of view of the wide angle side, with a 1.5X magnification, is 40° wide and 20° high. In the upper half, a magnification of 5X is provided with a field 12° wide and 6° high. No change of eyepiece, or motion of the observer's head is required to shift from one magnification to the other; and no light is lost by splitting the entrance rays into two parts. In short, the invention is the equivalent of two telescopes with the added advantage of elimination of motion of the observer's head. The definition of the image is of high quality over both fields.

The following table gives the actual values used in the model illustrated, the lens number corresponding in each instance with the numbers used upon Figure 1.

[All dimensions in inches]

Lens	Radii		Thickness	Separation	Clear Aperture
1	+1.738	−4.443	0.460	0	1.00
2	−4.443	+5.838	0.124	2.166	1.00
3	−1.103	−3.266	0.102	0	1.00
4	−3.266	−1.983	0.203	5.2	1.00
5	flat	−4.217	0.270	0	1.1 x 2.2
6	+4.309	flat	0.250	5.409	2.13
7	+3.021	+1.353	0.136	0	1.10
8	+1.353	−11.50	0.306	1.60	1.10
9	+11.50	−1.353	0.306	0	1.10
10	−1.353	−3.021	0.136	6.3	1.10
11	+5.41	−1.493	1.00	0	2.50
12	−1.493	+1.838	0.20	0	2.70
13	+1.838	−2.345	1.12	0.01	2.70
14	+2.870	flat	0.33	1.6	2.25
15	+1.955	+4.283	0.154	0	1.00
16	+4.283	+1.109	0.099	2.74	1.00
17	+4.691	−0.858	0.310	0	1.00
18	−0.858	−1.695	0.099	4.2	1.00
19	flat	−4.674	0.249	0.014	1.1 x 2.2

We have thus provided a telescope that is relatively simple and inexpensive to produce in quantities. At the same time the instrument is compact and can be built to withstand the shocks, jars, and rough handling incident to service in the field.

In order fully to comply with the requirements of the patent statutes, we have disclosed a specific form of the invention. However it will be obvious to those skilled in the art that different absolute and relative magnifications may be employed and that the fields of view may be varied as to absolute and relative areas. Furthermore, substitutions of equivalents and changes in the relations of the parts will occur to those skilled in the art after a study of the present disclosure. For example, the two areas of different magnifications may be separated in a horizontal direction or in any other direction relative to the horizontal or the vertical, merely by arranging the conventional range reticles on the flat surfaces of elements **5** and **19**, so that they will be vertical and horizontal when the telescope is in the desired position of rotation about its optical axis. In the absence of such reticles, of course, or where their use is not required, the desired position of rotation may be obtained simply by mounting the telescope in its support for rotation about its optical axis. Also, the line of separation between the two fields may be displaced from the diametral position to give any desired ratio between the areas of the two apparent fields. For these reasons, the disclosure should be taken in an illustrative rather than a limiting sense; and it is our desire to reserve all such changes as fall within the scope of the subjoined claims.

In the claims, the term "eccentricity" as referred to eccentric-collective lenses **5** and **19**, means the distance between the optical axis of the spherical lens from which the eccentric lens was cut, and the geometrical center of the eccentric lens. Thus, in the model shown, lenses **5** and **19** have an eccentricity of 0.55''.

Having thus fully disclosed our invention, what we claim and desire to secure by Letters Patent is:

1. In a split-field dual-power telescope having a central optical axis, a first objective comprising a first telephoto lens in normal position and having its principal axis offset a predetermined distance from and parallel with, said central axis, a second objective comprising a second telephoto lens in inverted position and of lesser focal length than said first lens, said second lens having its principal axis offset by said predetermined distance from said central axis, said two principal axes forming diametrically opposite elements of a cylinder having its axis on said central optical axis, a first semi-circular eccentric collector lens optically centered on the principal axis of said first objective, a second semi-circular eccentric collector lens optically centered on the principal axis of said second objective, said collector lenses having an eccentricity equal to the radius of said cylinder and having their diametral edges contiguous and their forward faces coplanar, a third collector lens adjacent and extending over both said first and second collector lenses, erector lens means and an eyepiece both having their principal axes coincident with said central optical axis, said collector lenses bringing to a common focus the entrance pupils of discrete differently magnified images of a common field of view projected by said objectives and centered on said central optical axis, and an opaque vane in said telescope on said central axis and extending between said objectives and first and second collector lenses.

2. In a split-field, dual-power telescope having a principal optical axis, first and second objectives of different focal lengths having their central axes parallel with and offset on respective diametrically opposite sides of said principal optical axis, said first and second objectives being separate telephoto lenses in side-by-side parallel relation, one said telephoto lens being inverted with respect to the other to project at different magnifications, discrete images of the same remote field of view, a single eyepiece centered on said principal axis rearwardly of said objectives, and optical means comprising first and second prismatic collective lenses lying in a common plane across said principal axis between said objectives and eyepiece, each said collective lenses being constructed and arranged to direct the entrance pupil of a respective objective into said

eyepiece to form a single exit pupil rearwardly thereof.

3. In a dual-power, split-field telescope having a central longitudinal axis, a first objective having its principal axis parallel with said central axis and offset therefrom a predetermined distance, a second objective having its principal axis parallel with said central axis and offset therefrom on the side opposite the principal axis of said first objective, all said axes lying in a common plane, said objectives being separate telephoto lenses lying in side-by-side relation, one said telephoto lens being inverted with respect to the other, a common erector lens and an eyepiece for both said objectives, and centered on said central axis, first and second coplanar semicircular prismatic collector lenses mounted with their diameters in contact between said objectives and said eyepiece, each said collector lens having an eccentricity equal to said predetermined distance and constructed and arranged in conjunction with said erector lens and eyepiece, to focus the entrance pupil of its objective to a single exit pupil rearwardly of said eyepiece.

4. In a dual-power, split-field telescope having a central longitudinal axis, first and second objectives of different focal lengths in fixed adjacent side-by-side relation with their respective optical axes parallel to and equally spaced on opposite sides of said central axis, said objectives comprising separate telephoto lenses one of which is inverted with respect to the other, an eyepiece having its principal axis coincident with said central axis, and a collective lens comprising first and

second semi-circular eccentric lenses in a common plane between said objectives and eyepiece, said collective lenses each having an eccentricity equal to the spacing of each said optical axis from said central axis and having their diametral edges contiguous, said collective lenses focusing together in a common plane through the focal point of said eyepiece, the entrance pupils of said objectives, whereby an observer at said eyepiece may see in the exit pupil, discrete images of a common field of view at different magnifications.

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