March 28, 1961 S. N. HOWELL 2,976,730

PYROMETER CONSTRUCTION

Filed June 7, 1957

FIG. 1.

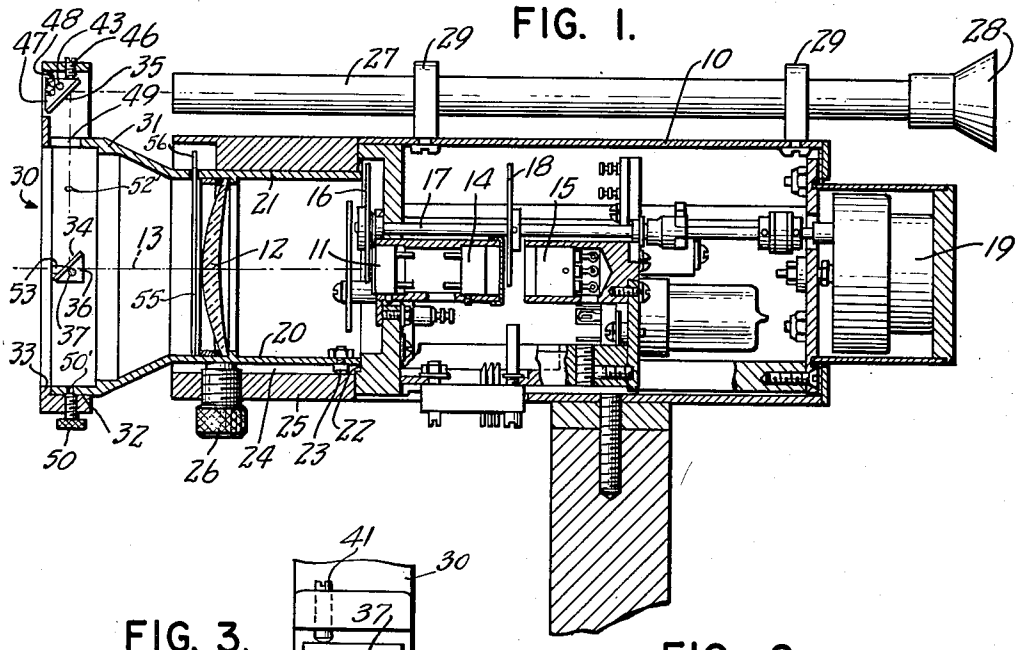


FIG. 3.

FIG. 2.

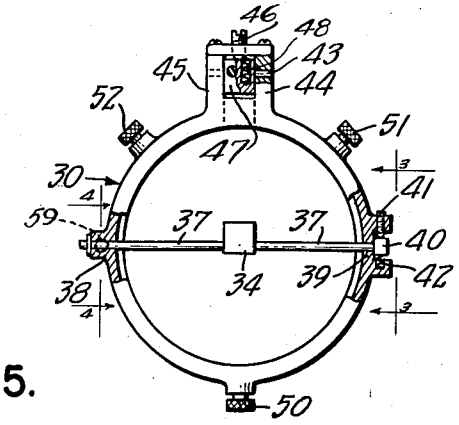


FIG. 4.

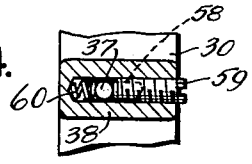
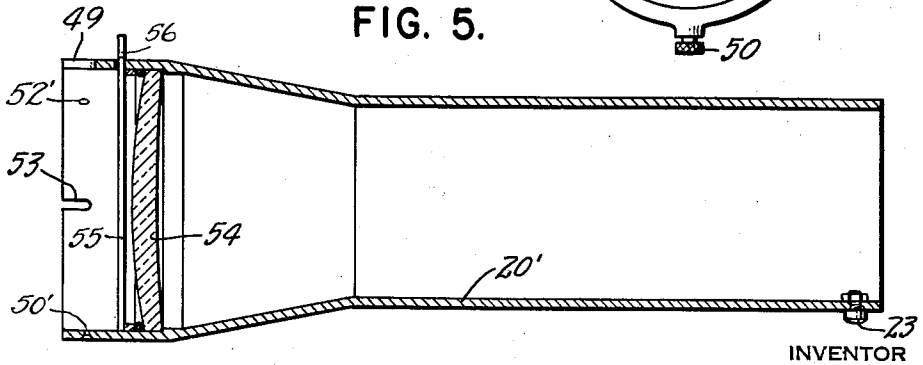


FIG. 5.



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PYROMETER CONSTRUCTION

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6 Claims. (Cl. 73—355)

My invention relates to a radiation-pyrometer construction, and in particular to improved sighting means for such a device. This invention incorporates improvements over the invention disclosed in Wormser Patent No. 2,761,072 and in patent application, Serial No. 481,124, filed January 11, 1955, in the name of William C. Derganc, now Patent No. 2,920,485.

It is an object of the invention to provide an improved device of the character indicated.

Another object is to provide an improved radiation pyrometer construction in which visual sighting may be accomplished without parallax error for the infrared responsive element of the system.

A further object is to meet the above objects with a device which lends itself to interchangeable lenses whereby non-parallax sighting may be available regardless of the focal length of the selected lens.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification and claims in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, a preferred embodiment of the invention:

Fig. 1 is a longitudinal sectional view through a pyrometer incorporating features of the invention;

Fig. 2 is a left-end view of part of the sighting mechanism of Fig. 1, certain parts being broken away and shown in section in order to illustrate mounting details for parts;

Figs. 3 and 4 are enlarged fragmentary views taken respectively in the planes 3—3 and 4—4 of Fig. 2; and

Fig. 5 is a longitudinal sectional view of a lens system interchangeable with the one shown in Fig. 1.

Briefly stated, my invention contemplates an improved infrared radiation-pyrometer construction in which interchangeable focusing elements may be readily adapted to the pyrometer, and yet visual sighting without parallax error may be achieved with the same system of sighting parts, regardless of the focal length of the selected focusing element. The visual-sighting mechanism in connection with which my invention is described is of the telescopic variety, wherein the telescope is oriented generally parallel to the infrared-response axis but offset therefrom, and is mounted, for example, on the exterior of the pyrometer housing. The focusing element may be one of a series of interchangeable lens systems, each complete with its own lens barrel, said barrel having a forwardly projecting part to which a periscopic adapter is removably attachable. Angular locating parts on the lens barrel, on the housing, and on the periscopic adapter assure a given angular orientation of the periscopic adapter, regardless of the lens system employed. The periscopic adapter includes offsetting mirrors, one of which is on the optical axis, and these mirrors are small so as only insubstantially to obscure any collected or collectable infrared energy.

Referring to Fig. 1 of the drawings, my invention

is shown in application to a radiation pyrometer of the type already described in said copending Derganc application. Such a pyrometer is contained within a generally tubular housing **10** and comprises an infrared responsive cell or element, such as a thermistor bolometer contained within a capsule **11** and facing generally in the direction of one longitudinal end of the housing **10**. The optical system may comprise a focusing mirror, but in the form shown, includes a lens **12** of suitable infrared-transmitting material, such as arsenic-trisulfide glass; lens **12** faces out the same longitudinal end of the housing and serves to collect radiation on an optical axis **13** and to focus the same on the cell within capsule **11**. For more quantitative measurements, the pyrometer may include a second similar cell within a capsule **14**, the capsule **14** being oriented to face a reference source **15**. A chopping device or shutter **16** is mounted on a continuously running shaft **17** and serves periodically to interrupt the incidence of radiation on the cell **11**. A similar chopper **18** performs the same operation for reference radiations from the source **15**, incident on the reference cell **14**. Both choppers are driven by suitable means, such as a synchronous motor **19**, which may be mounted at the rear end of the housing. The actual circuitry for processing signals developed at **11**—**14** has been disclosed in other copending applications.

The particular pyrometer of Fig. 1 is of a variety in which the housing **10** is particularly adapted to receive interchangeable lenses so that the same may be caused to image the sensitive area of cell **11** (in various sizes) at remote locations to be monitored. In the form shown, the lens **12** forms part of an interchangeable lens assembly, including an elongated barrel **20** longitudinally slidably received in a suitably formed bore **21** in a lens adapter fitting **25** at the forward end of the pyrometer. The inserted lens is shown to be in properly focused position when the inner end of the barrel **20** strikes a stop or shoulder, as at **22**; for single-purpose applications, this stopped position may represent fixed focus for the desired distance to the unknown source, but for general-purpose use, the stopped position may represent focus at "infinity," the focus for intermediate object distances being selectively available upon slidable adjustment of barrel **20** in bore **21**, as by observing the adjustment against a pre-calibrated range scale (not shown).

For a purpose which will later be clear, I prefer that interengaging angular-locating means shall cooperate between the lens barrel **20** and the housing **10** so that only one angular orientation shall be available for the inserted lens assembly. In the form shown, a key or pin **23** on the lens barrel rides a longitudinal key-way **24** in the front fitting **25** of the housing **10**, and a knurled set screw **26** serves to anchor the inserted lens assembly in proper position.

For relative aperture control, a selected one (**55**) of a variety of aperture plates is provided with an upwardly projecting tab **56** for manual insertion in and removal from a suitable slot and guide means in the barrel **20**. When the pyrometer is not in use, the inserted plate **55** may be unapertured, thereby providing a cover for lens **12**.

In accordance with a feature of the invention, I provide a visual-sighting mechanism involving no parallax error, and specifically adapted to interchangeable lenses, as in the case of the lens assembly **12**—**20**. Such sighting mechanism may comprise a pair of longitudinally spaced "gun-sight" elements on the exterior of housing **10** and on a sighting axis generally parallel to the optical axis **13**, but in the form shown I employ an elongated telescope **27** having an eye piece **28**, said telescope being aligned generally parallel to and offset from the optical axis **13**,

Suitable clamps or mounting brackets **29** permanently secure the telescope **27** in position on the outside of the housing **10**.

In order to bring the visual-sighting axis of the telescope **27** into coincidence with the optical axis **13**, I provide a periscope attachment **30** removably securable to the front end of the lens assembly. In the form shown, the front end is a "sunshade" **31** of generally expanded cylindrical open form and includes a cylindrical portion **32** adapted to longitudinally slidably receive the counterbore of the adapter ring **30**. Said counterbore defines a shoulder or step **33**, whereby an accurate limit or location may be established for application of the ring and for its alignment on the lens-assembly extension **31**. The periscope attachment **30** includes two inclined mirrors **34—35**, one of which (**34**) is aligned with the optical axis **13** and is of small dimensions so as to allow most of the collected radiant energy to pass the lens **12** for focusing at **11**; the second mirror element (**35**) is aligned with the telescope axis, and the inclination of both mirrors is such that their respective reflections of the optical axis and of the telescope axis are aligned with each other. Thus, for a substantially 45° inclination of both mirrors **34—35**, the visual-sighting axis from telescope **27** may be made coincident with the optical axis **30**, and no parallax error is introduced.

For accurate alignment of the visual sight **27** with a given pyrometer, it is desirable to provide for certain small angular adjustment in positioning each of the mirrors **34—35**. In the form shown, the mirror **34** is carried by a triangular prismatic member **36** mounted on a diametrically extending shaft **37**, journaled at diametrically opposite points **38—39** in the adapter ring **30**. At one of these locations (**39**), provision is made for adjustment in angular position about the shaft axis, by mounting a small crank member **40** on the end of shaft **37**, and by providing a set screw **41** to adjust the position of crank **40** against a reacting spring **42** (see Figs. 2 and 3).

The other mirror **35** may be similarly mounted for pivoting about stud or pivot means **43** journaled in supporting brackets **44—45** integral with the attachment ring **30** (see Figs. 1 and 2). The set screw **46** is shown acting on the prismatic block **47** on which the mirror **35** is carried, and adjustments are made against reaction from a spring **48**. An opening **49** in the forward tubular extension **31** of the lens barrel permits sighting access for the radially offset rays between mirrors **34—35**.

A third adjustment of mirror position may be provided in the periscope adapter **30**, for purposes of eliminating any possibility of eccentricity in the alignment of mirror **34**. Such adjustment is available at **38** and is shown in detail in Fig. 4, wherein the end of shaft **37** is seen to have freedom for longitudinal adjustment in an elongated slot **58**. A longitudinally extending set screw **59** adjustably positions the end of shaft **37** against the reaction from a compression spring **60**, thus permitting slight trimming adjustment of mirror position to eliminate eccentricity with respect to optical axis **13**.

A set screw **50** serves to secure the attachment ring **30** in place on the extension tube **31**, and similar set screws **51—52** may be provided at angularly spaced locations, as desired. In order that the angular location of the offsetting mirrors **34—35** shall be correctly established with respect to the housing **10**, I provide inter-engaging angular locating means cooperating between the extension **31** of the lens barrel and the attachment **30**. This is achieved by merely longitudinally slotting diametrically opposite parts of the forward end of the lens-tube extension **31**, as at **53**, so as to receive the shaft **37** and enable the shaft **37** to perform the additional function of keying the attachment ring to the lens tube **20** and therefore also to the housing **10**. Preferably, however, the shanks of set screws **50—51—52** are somewhat pointed, for accurate locating accommodation in counterbored locating holes, as at **50'—52'** (Fig. 1) in the outer cylindrical part **32** of barrel **20**, thereby relying primarily on set screws **50—51—52** for angular location, rather than on keyed engagement at **37—53**.

In Fig. 5 I show a different lens assembly having a longer focal length than the assembly of Fig. 1, but of essentially the same structural characteristics. Thus, the assembly of Fig. 3 may have a more elongated tubular barrel **20'**, accommodating a longer focal-length lens **54**, which may also be of infrared-transmitting material such as arsenic trisulfide. Angular-locating reference to the periscope adapter **30** is achieved at **53—50'—52'**, and similar reference to the housing **10** is achieved by key means **23**.

It will be seen that I have described a relatively simple attachment for a pyrometer of the character indicated, whereby the pyrometer may accommodate interchangeable lenses of various focal lengths and yet may at the same time provide coaxial alignment of the infrared-response axis with that of the visual-sighting means, regardless of the selected lens assembly. The same sighting parts serve all lenses applied to the system, and no adjustment of the telescope or of the periscope parts is needed, regardless of the focal length of the inserted lens, once initial adjustments are made at **41—43—59** for the particular telescope **27** and adapter **30** of a given pyrometer.

While I have described the invention in detail for the preferred form shown, it will be understood that modifications may be made within the scope of the invention as defined in the claims which follow.

I claim:

1. In a radiation pyrometer, an elongated housing containing an infrared-responsive element and having at one end an optical system collecting infrared radiant energy on an optical axis and focusing collected energy on said element, said optical system being removably secured in said housing and said housing being adapted to removably receive a selected one of a plurality of similar optical systems of different focal lengths for focus on said element, a visual sighting mechanism comprising a telescopic member having an alignment axis generally parallel with said optical axis but offset therefrom, and a separate detachably removable periscopic offsetting assembly carried by the front part of said optical system, said periscopic assembly being generally open in the path of energy collected by said optical system and including a relatively small first inclined mirror on said optical axis and a second inclined mirror generally aligned with the telescope axis and spaced from said telescopic member, both said mirrors being inclined to an extent such that their respective reflections from said axes are aligned with each other.

2. In a radiation pyrometer, an elongated housing containing an infrared responsive element on a generally central axis and facing out one end of said housing, a detachably removable lens system responsive to infrared radiation at said end and focusing such radiation on said element, said lens system including a barrel removably securable at said end of said housing, and said barrel including a portion projecting longitudinally beyond the lens element thereof, visual sighting means supported on the outside of said housing and having an alignment axis generally parallel to but offset from said optical axis, and a periscope attachment separate from said visual sighting means and detachably securable to the front end of said barrel, said attachment comprising two relatively small mirrors, one of said mirrors being aligned with the sighting axis and spaced in front of said visual sighting means, the other of said mirrors being aligned with the optical axis, the inclination of said mirrors being such that the respective reflections of said axes are aligned with each other.

3. A pyrometer according to claim 2, in which said attachment includes a mounting ring longitudinally slidably mounted on said barrel, and securing means for holding a mounted position of said ring.

4. A pyrometer according to claim 3, in which said mirror on said optical axis is mounted on an elongated thin shaft extending generally diametrically of opposite sides of said ring, means pivotally supporting said shaft at said opposite sides, and adjustment means on one of said sides for securing an adjusted angular position of said shaft about the axis of said shaft.

5. A pyrometer according to claim 3, in which said mirror on said optical axis is mounted on an elongated thin support carried by and extending generally diametrically of opposite sides of said ring, and means adjustable longitudinally of said optical axis at one end of said thin support for adjusting the position of said mirror to eliminate eccentricity of alignment thereof with said optical axis.

6. A radiation pyrometer, comprising an elongated housing containing an infrared sensitive element facing toward one end of said housing, a lens system comprising a lens and an elongated barrel detachably securable at said end and including means angularly locating said lens to said housing at said end, said lens including an infrared-transmitting lens element focusing collected radiant energy on said sensitive element when in inserted secured

position, said barrel extending longitudinally beyond said lens element, a periscopic attachment removably securable to said barrel, said attachment comprising a ring longitudinally slidably fitting the outer end of said barrel, interfitting angular locating means on said ring and barrel for assuring that said ring and said housing will have a predetermined angular relation when assembled, and an elongated telescope carried by said housing and having its axis oriented generally parallel to the optical axis of the lens system, said periscope attachment having two spaced offsetting mirrors, one of said mirrors being aligned with said telescope and the other of said mirrors being aligned with said optical axis.

References Cited in the file of this patent

UNITED STATES PATENTS

1,302,254	Warnecke	Apr. 29, 1919
1,474,903	Hase	Nov. 20, 1923
2,113,450	Lasky et al.	Apr. 5, 1938
2,122,941	Hufler et al.	July 5, 1938
2,761,072	Wormser	Aug. 28, 1956