

DAY AND NIGHT SIGHTING SYSTEM

1 BACKGROUND OF THE INVENTION

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3 The present application relates to an integrated
4 day and night sighting system and to a laser
5 rangefinder having the integrated day and night
6 sighting system. This invention addresses the need
7 for minimum size and weight in handheld laser
8 rangefinders used by military ground forces in
9 nighttime as well as daytime conditions. Integrated
10 optics are needed to provide the following functions:
11 a telescopic day vision sight; telescopic night vision
12 sight; sighting reference (e.g., crosshair reticle)
13 for both day and night operations; laser beam
14 divergence reduction; and target return signal
15 collection and focusing onto a laser ranging receiver.

16 Telescopic day vision is usually achieved with
17 direct view optics such as used in conventional
18 telescopes and binoculars. These optics operate in
19 the human visual light spectrum of 0.4 to 0.7 μm
20 wavelength. In their simplest form they comprise an
21 objective lens that focuses the scene image onto the
22 focal plane of an eyepiece. The ratio of objective
23 focal length to eyepiece focal length establishes the
24 magnification. To present a non-inverted image to the
25 user, an imaging erection prism is added between the
26 objective lens and the focal plane.

27 Telescopic night vision is achieved with an image
28 converter, which can be an image intensifier or a
29 thermal imaging module. Objective optics collect the
30 scene light and focus it onto the image converter.
31 The input aperture of these optics needs to be as
32 large as possible (small f-number) to maximize image
33 intensity at the image converter. The image

1 intensifier is a single component in which a weak
2 (moonlit, starlit) scene image focused on the input
3 photocathode produces electrons that are amplified and
4 directed to a phosphor coating on the output surface
5 where they produce an amplified image for viewing with
6 an eyepiece. This operates in the 0.7-1.1 um
7 wavelength region. The simplest thermal imaging
8 module comprises an uncooled, staring (non-scanned)
9 detector array whose output is presented to a flat
10 panel display that is viewed with an eyepiece. This
11 operates in the 8 to 14 um wavelength region. Other
12 implementations of a thermal imaging module can
13 operate in the 3 to 5 um wavelength region, employ
14 thermoelectric or Stirling cooled detectors, and/or
15 use a cathode ray tube (CRT) as the display.

16 To aim a laser rangefinder requires a sighting
17 reference, such as a crosshairs reticle, that
18 boresights the day and night vision optics to the
19 laser beam. The reticle can take a number of forms.
20 A day sight can use a passive reticle plate residing
21 in the common focal planes of the objective and
22 eyepiece. An image intensified sight can produce the
23 reticle with a light emitting diode (LED) array and
24 project it into the eyepiece using a beamsplitter to
25 combine the image intensifier image and the reticle.
26 A thermal imaging sight can produce the reticle on the
27 flat panel or CRT display. The two latter forms of
28 the reticle also allow alphanumeric data and/or
29 indicators to be displayed without additional
30 elements.

31 The output beam divergence of a laser transmitter
32 (resonator) is not usually narrow enough to produce a
33 small spot on a distant target such as a vehicle so
34 that an afocal beam collimation telescope is

1 necessary. This comprises a negative power input lens
2 and a positive power output lens. The resulting
3 output beam diameter is enlarged and the beam
4 divergence is reduced. To avoid possible eye damage
5 to a person accidentally exposed to the beam, the
6 laser wavelength is commonly in the 1.5 um region, for
7 which the eye has poor transmission.

8 The laser receiver requires optics to collect
9 return signal power from the target and focus it onto
10 the receiver's detector. Maximum input aperture
11 results in maximum range capability. The receiver
12 incorporates an optical filter to minimize sunlight
13 detection and thereby maximize receiver sensitivity.

14 The above functions can be achieved with separate
15 apertures and corresponding optical arrangements.
16 However, striving for a single aperture and using
17 optical elements for more than one function minimizes
18 the size of the optics. That is the aim of this
19 invention. The invention is applicable not only to a
20 handheld laser rangefinder but to any rangefinder and
21 to any day and night sighting system.

22 The Phillips patent No. 5,084,780, for a
23 telescopic sight for day/night viewing illustrates a
24 scope adaptable for use on weapons and includes a
25 single objective lens with two parallel light paths,
26 one for day viewing and one for night viewing.
27 Separating mirrors transmit light from the objective
28 along the night path and reflects light from the
29 objective lens to the day path. The night path
30 includes an image intensifier assembly. A mirror at
31 the end of the night path reflects the light from the
32 image intensifier assembly to a beam splitter on the
33 day path. The beam splitter transmits the light from
34 the day path and reflects the light from the night

1 path along the same path to an ocular assembly for
2 viewing. A second embodiment is similar except that
3 it contains two objective lens assemblies for
4 collecting the light, one for the night path and one
5 for the day path. Since this embodiment has two
6 separate objective lens assemblies, separating mirrors
7 are not included. A third embodiment includes a
8 projected aiming reticle in a direct view for day
9 viewing, which replaces one of the objective lens
10 assemblies. This prior patent combines the daytime
11 and nighttime optics in a telescopic sight by
12 separating the optics into two separate paths between
13 the objective lens and the eyepiece assembly. In
14 contrast, the present invention uses a coaxially
15 mounted lens with a night light mirror objective lens
16 in the same optic path for the day and night light.

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18 SUMMARY OF THE INVENTION

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20 An integrated day and night sighting system and
21 laser rangefinder apparatus has a refractive day sight
22 having an objective lens, an image erecting prism, and
23 an eyepiece and a night sight having a reflective
24 objective, an image converter module, and the same
25 eyepiece as the day sight. The objective includes
26 primary and secondary mirrors (e.g., a Cassegrain
27 design) that are coaxial with the day sight. This
28 objective has an aperture larger than the day sight,
29 and the day sight objective lens blocks the central
30 portion of the night sight aperture. A lens
31 introduced in the day sight has one surface coated for
32 transmission of visual wavelengths and reflection of
33 infrared wavelengths and acts as the secondary mirror
34 for the night sight objective. The image converter

1 module can be an image intensifier or a thermal
2 imaging module. The input surface of the image
3 converter is placed at the focal plane of the night
4 sight objective, and the output surface is placed at
5 the same location as the focal plane of the day sight.
6 This allows the same eyepiece to be used for both day
7 and night sights. The image converter module can be
8 rotated or translated out of view for day sighting and
9 into view for night sighting.

10 If the lens surface that acts as the secondary
11 mirror for the night sight is coated to reflect
12 essentially all wavelengths longer than the visual
13 spectrum, then it will block wavelengths coming
14 through the day channel that would cause night image
15 washout (loss of contrast). Similarly, there would be
16 no washout in the day sight due to unfocused visual
17 wavelengths coming through the night channel.
18 However, for maximum night sight sensitivity, it is
19 desirable to achieve a spectral crossover region of
20 the image intensifier and visual spectra that lies in
21 the red region of the latter. In that case, selection
22 of one or more materials and coatings in the day sight
23 channel can provide the additional wavelength blocking
24 to prevent night image washout, and a coating on the
25 display beamsplitter cube can block the residual
26 visual red coming from the night channel and
27 interfering with the day image.

28 A sighting reference and data display includes an
29 active source, such as an LED array, and a
30 beamsplitter. The reticle is placed at the
31 beamsplitter-reflected focal plane of the eyepiece.
32 Thus, the day or night sight scene image, reticle,
33 and data display are superimposed when viewed through
34 the eyepiece. Night sight boresight is achieved by

1 positioning the reticle so that it centers on the
2 image of the laser beam spot at a target (as
3 determined by direct viewing with the image converter
4 module or by use of benchtop focusing optics that
5 produce a burn spot visible in the sight). Day sight
6 boresight is achieved by using Risley prisms in the
7 day sight optics to allow the image of the laser spot
8 to be centered on the reticle. The image converter
9 module position in the focal plane is not critical to
10 boresight because the output image is always in the
11 same relationship to the input image.

12 A laser beam collimation telescope has the same
13 objective lens as the day sight, a beamsplitter, and
14 an input negative lens. The beamsplitter is coated
15 for transmission of visual wavelengths and reflection
16 of the laser wavelength. Additional optics useful for
17 aligning the output beam of the laser transmitter with
18 the telescope axis are: Risley prisms for angular
19 alignment and a steering block for translational
20 alignment.

21 The laser receiver optics has the same reflective
22 objective as the night sight, a beamsplitter, and a
23 lens to set the desired focal length and allow the
24 receiver to be positioned outside of the optical area.
25 The beamsplitter is coated for transmission of visual
26 and IR wavelengths and reflection of the laser
27 wavelength.

28 Corrective optics for the night sight has two
29 tilted lenses with central openings to avoid
30 interference with the day sight and laser telescope.
31 These lenses allow use of a simple spherical surface
32 on the primary mirror, and tilting these lenses
33 corrects the astigmatism induced in the night sight
34 image by the laser receiver beamsplitter. The

1 astigmatism is not a problem for the relatively high
2 f-number permitted for the day sight, but becomes a
3 problem for the low f-numbers desired for night sight
4 performance.

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6 BRIEF DESCRIPTION OF THE DRAWINGS

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8 Other objects, features, and advantages of the
9 present invention will be apparent from the written
10 description and the drawings in which:

11 Figure 1 is a sighting system and laser
12 rangefinder optical schematic in accordance with the
13 present invention;

14 Figure 2 is the optical schematic of Figure 1
15 having the daylight light path;

16 Figure 3 is the optical schematic of Figure 1
17 having the night light path;

18 Figure 4 is the optical schematic of Figure 1
19 having the reticle/display path;

20 Figure 5 is the optical schematic of Figure 1
21 having the laser rangefinder transmitter light path;

22 Figure 6 is the optical schematic of Figure 1
23 having the laser rangefinder receiver light path;

24 Figure 7 is an elevation of the swing latching
25 mechanism for the image intensifier; and

26 Figure 8 is an optical schematic of an
27 alternative embodiment of a sighting system having a
28 thermal imager.

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30 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

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32 Referring to the drawings, Figure 1, an
33 integrated day and night sight laser rangefinder 10
34 illustrates the basic implementation of the

1 rangefinder which includes a coaxial day and night
2 sight configuration and includes a window 11 for
3 sealing the optics within a housing. A pair of night
4 sight corrector lenses 12 and 13 have an opening 14
5 through their center to provide for the day objective
6 lens 15. The day objective lens 15 also serves as the
7 positive objective lens for the laser transmitter
8 telescope for which lens 16 is the negative input
9 lens. An eyepiece lens assembly 17 is mounted at the
10 outer end of the daylight optical path, which optical
11 path includes a daylight negative lens 18 to set focal
12 length, followed by a pair of day Risley prisms 20, a
13 Schmidt/Pechan image erecting prism 21, and lens 22
14 whose primary purpose is to provide a surface that
15 acts as the night secondary mirror. The night primary
16 mirror 23 has an aperture 24 therethrough. An image
17 intensifier 25 is shown in the light path behind the
18 night primary mirror and is adapted to be swung out of
19 the light path behind the opening 24 and the night
20 primary mirror 23. That is, the image intensifier 25
21 can be put into the path along the sighting system
22 central axis 26 or removed from the path, which is
23 done by the operator through manual or electrically
24 actuated means. The reticle display 27 is produced by
25 an LED and a lens 28 provides correction as required.
26 Beam splitter 30 directs the reticle display into the
27 eyepiece lens 17. The image intensifier 25 includes
28 a photocathode surface 31 and a phosphor screen 32
29 which produces the intensified image.

30 The laser rangefinder portion of the system
31 includes the laser transmitter 33 which directs a
32 laser beam through the laser beam alignment optics 34
33 and laser telescope negative lens 16 against a mirror
34 35 and onto a beam splitter 36 which directs the beam

1 through the laser telescope daylight objective lens 15
2 and to a target sighted through the sighting system.
3 The reflected light from the laser beam then returns
4 through the night light optics and has a portion
5 deflected by the receiver beam splitter 37 through a
6 receiver lens 38 that sets focal length and onto a
7 surface of a detector in the receiver 40, which
8 detects the return beam for determining the range of
9 an object which has been aimed with the rangefinder.

10 The integrated day/night sight and laser
11 rangefinder in accordance with Figure 1 provides for
12 a coaxial day and night sight configuration in which
13 the day sight uses refractive optics for a light path
14 following the central axis 26 from the objective lens
15 15 to the eyepiece lens 17, as illustrated in Figure
16 2. The light path 41 passes through the window 11 and
17 through the daylight objective lens 15 where it is
18 refracted through the aperture 14 of the lens 13 and
19 passes through the beam splitter 36 and through the
20 daylight negative lens and day risleys 20 and through
21 the Schmidt/Pechan prism 21 whereupon the light path
22 passes through the night secondary mirror 22 and
23 through the night primary mirror 23 central opening
24 24.

25 As seen in Figure 2, the image intensifier 25 of
26 Figure 1 has been moved out of the daylight light path
27 along the axis 26 so that the daylight light path 41
28 passes directly through the beam splitter 30 and
29 through the eyepiece lens 17. Thus, during daylight
30 hours, visible light is used for sighting a target for
31 the rangefinder. A user can sight and align the
32 rangefinder for determining the range to an object at
33 which time the output from the laser 33 through the
34 laser output optics 34 and negative lens 16 is

1 directed by the mirror 35 against the beam splitter 36
2 and out the daylight objective lens 15, which is also
3 the laser output lens. The laser beam is directed
4 towards the target and the return signal is reflected
5 by the receiver beam splitter 37 and directed against
6 the receiver 40.

7 Turning to Figure 3, the optical schematic of
8 Figures 1 and 2 is illustrated having the night sight
9 light path 42 illustrated. The night light
10 wavelengths of interest are those in the infrared
11 suitable for use with an image intensifier 32 or an
12 alternative thermal imager. The image intensifier is
13 sensitive to wavelengths in the far red to near
14 infrared portion of the spectrum. The night light or
15 infrared energy passing through the night light path
16 42 passes the window 11, which is transparent to both
17 visible and infrared light, and through the night
18 objective corrector lenses 12 and 13 centered around
19 the daylight objective lens 15 where the infrared
20 energy is directed against the night primary mirror
21 23. The primary mirror 23 reflects the infrared light
22 onto lens 22 which acts as the night secondary mirror.
23 The lens 22 is coated to transmit visual wavelengths
24 and to reflect infrared wavelengths. If the night
25 sight uses an image intensifier, the coating reflects
26 far red to near infrared. If the night sight uses a
27 thermal imager, the coating reflects either mid IR in
28 the 3-5 μm band or the long IR in the 8-14 μm band.
29 The night light is reflected by the night secondary
30 mirror 22 through the opening 24 in the night primary
31 mirror 23 and onto the receptor surface 31 of the
32 image intensifier or thermal imager 25 where the image
33 is displayed as visible light on the screen 32. The
34 image on screen 32 is seen by the user through the

1 eyepiece lens 17. It will, of course, be clear that
2 the rangefinder portion of the system transmits a
3 laser beam and receives a reflected beam so that it
4 operates day or night in accordance with the laser
5 wavelength. The sighting system is for the benefit of
6 the user being able to sight the rangefinder on a
7 target.

8 The coaxial design, as illustrated in Figures 1-
9 3, takes advantage of the two different focal planes
10 for the day and night sight and swings the image
11 intensifier 25 onto the common optical axis 26 when
12 employing the night sight. This allows the use of the
13 same eyepiece for both day and night sight. Night
14 sight optics require a faster design than the day
15 sight so the night sight focal plane can occur at the
16 input plane of the intensifier. The output plane 32
17 of the intensifier in the day sight focal plane can be
18 coplanar with the daysight image plane as required for
19 use of a common eyepiece lens 17. The night sight
20 boresight is insensitive to an intensifier cross-axis
21 position so the swinging of the image intensifier into
22 and out of alignment with the light does not have to
23 be achieved with a high degree of tolerance. It
24 should also be realized that the image intensifier 25
25 can also be a thermal night sight module which is
26 merely substituted for the image intensifier. One
27 implementation of this is with an uncooled focal plane
28 detector array and a small flat panel display, such as
29 an LCD display, and the required electronics for the
30 thermal night sight module can be integrated or can be
31 a separate package.

32 Turning to Figure 4, the optical schematic of
33 Figure 1 is illustrated with the LED reticle and
34 display ray path. The reticle/display light 43,

1 produced by the reticle/display LED array 27, passes
2 through the lens 28, which provides necessary optical
3 correction, and is reflected by the beam splitter 30
4 into the eyepiece lens 17. This allows the aiming
5 point and display to be viewed with either the
6 daylight or night light sighting system. The LED
7 reticle is, of course, used to align the rangefinder
8 with the target being sighted.

9 In Figure 5, the laser transmitter ray path 44 is
10 illustrated in the optical schematic of Figure 1. The
11 laser beam can be seen passing through the laser
12 output optics 34, which serve to align the beam with
13 the output telescope created by lenses 15 and 16. The
14 beam is deflected by the mirror 35 onto the beam
15 splitter 36 and through the opening 14 of the lens 13
16 and then through the day objective and laser positive
17 output lens 15.

18 The infrared light 45 returned from the target is
19 illustrated in Figure 6. The light path 45 passes
20 through the window 11 and through the night objective
21 corrector lenses 12 and 13. These rays are reflected
22 by the primary night mirror 23 onto the night
23 secondary mirror 22 which reflects the infrared energy
24 onto the receiver beam splitter 37 which in turn
25 reflects the rays through the receiver lens 38 and
26 into the receiver 40.

27 Figure 7 is an elevation of the swing latching
28 mechanism for the image intensifier 25 which has the
29 viewing screen 32. The image intensifier is mounted
30 in a clamp 50 having a clamping bolt 51 and rotates on
31 an pin 52. A manual lever 53 interfaces with an arm
32 for shifting the image intensifier 25 from the
33 position shown to a position shown in phantom out of
34 the optical axis when the sight is being used for

1 daytime sighting. A spring latching mechanism 54 is
2 also attached to the frame 55 and holds the clamp 50
3 and the image intensifier 25 in the operative position
4 for nighttime viewing or in the daytime viewing
5 position swung out of the central axis.

6 Figure 8 shows an alternate embodiment of an
7 integrated day and night light laser rangefinder 10
8 having a window 11 and a pair of night sight corrector
9 lens 12 and 13 having an opening 14 therethrough
10 providing for the day objective lens 15. The sighting
11 system central axis 26 also has the beam splitter 36
12 and the day light negative lens 18 and day Risley
13 prisms 20 and the image erecting prism 21 mounted
14 along the axis 26. The night primary mirror 23 has
15 the opening 24 and reflects the night light onto the
16 lens 22, as in the previous embodiment. The night
17 light is transmitted through the opening 24 and onto
18 the beam splitter 56, which replaces the image
19 intensifier and directs the night light against a
20 thermal imager 57 which produces a video signal
21 through the line 58 into the display 60. The display
22 60 produces the night image onto a beam splitter 61
23 which directs the image into the eyepiece assembly 17.
24 The beam splitter 61 also passes the received laser
25 light into the laser receiver 40. The day light path
26 passes the light through the beam splitter 56 and
27 through the day sight reticle 62 and through the beam
28 splitter 61 onto the eyepiece assembly 17. The laser
29 transmitter 33 directs a laser beam onto the beam
30 aligning optics 34 and then through the lens 16 and
31 onto the mirror 35 which directs the beam against the
32 beam splitter 36 and out the objective optics along
33 the central axis 26. As can be seen, this embodiment
34 replaces the image intensifier with a thermal imager

1 and eliminates the swing mechanism while utilizing the
2 beam splitter 61 to direct the night light display
3 into the eyepiece assembly and simultaneously direct
4 the received laser energy into the laser receiver 40.
5 The day light path follows the central viewing axis 26
6 as in the prior embodiment.

7 It should be clear at this time that the daylight
8 objective lens 15 does double duty as the objective of
9 the laser transmitter beam collimation telescope and
10 that the night sight objective does double duty as the
11 laser receiver objective. Except for Figure 8, the
12 beam splitter for the receiver tends to produce
13 excessive astigmatism in the fast night sight optics.
14 However, the refractive elements at the night sight
15 aperture lens 12 and 13 not only allow for a simple
16 spherical surface on the primary mirror but also tilt
17 to eliminate the astigmatism, as illustrated in Figure
18 3. Tilting one lens compensates for beamsplitter
19 astigmatism but puts an on-axis coma into the system.
20 Tilting the other lens corrects for the coma and gives
21 diffraction limited on-axis performance. The optimum
22 focal plane at this time has been found to be about
23 one degree to the on-axis input direction.

24 An integrated day and night sight and laser
25 rangefinder has been provided which provides for a
26 very compact design in which the user can quickly
27 sight at night or in low light level with a night
28 sight system or can readily use the same sight for a
29 day sighting system by the moving of the image
30 intensifier into and out of the common light path.
31 However, it should also be clear that the present
32 invention is not to be considered as limited to the
33 forms shown which are to be considered illustrative
34 rather than restrictive.

CLAIMS:

We claim:

- 1 1. An integrated day and night sighting system
2 (10) comprising:
3 a daylight objective lens (15);
4 a night light corrector lens (12,13) mounted
5 adjacent said daylight objective lens (15);
6 an eyepiece lens assembly (17);
7 an image converter (25) for night light use and
8 being movably supported for movement between a
9 daylight position out of the light path and a night
10 light position in the light path, said image converter
11 (25) being positioned for said eyepiece lens assembly
12 (17) to focus thereon when said image converter (25)
13 is in said light path;
14 a night light primary mirror (23) positioned to
15 reflect light from said night light corrector lens
16 (12,13); and
17 a night light secondary mirror (22) positioned to
18 receive light from said night primary objective mirror
19 (23) and to focus the light onto said image converter
20 (25) when said image converter (25) is in a night
21 light position, whereby an integrated night and day
22 light optical system (10) is provided in a compact
23 packaging.

- 1 2. An integrated day and night sighting system
2 (10) in accordance with claim 1 in which night light
3 secondary mirror (22) is positioned in said light path
4 and is coated to pass visible light therethrough and
5 to reflect infrared light.

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1 3. An integrated day and night sighting system
2 (10) in accordance with claim 2 in which said image
3 converter (25) is an image intensifier.

1 4. An integrated day and night sighting system
2 (10) in accordance with claim 1 in which said day
3 objective lens (15) and said night light corrector
4 lenses (12,13) are mounted together with said night
5 light corrector lens (12,13) mounted coaxial of said
6 day objective lens (15).

1 5. An integrated day and night sighting system
2 (10) in accordance with claim 3 in which said night
3 secondary mirror (22) has a curvature for focusing
4 infrared light onto an image plane between the primary
5 objective mirror (23) and the daylight objective focal
6 plane so that the image plane coincides with the input
7 surface of said image intensifier (25) when the image
8 intensifier is in the night light position.

1 6. An integrated day and night sighting system
2 (10) in accordance with claim 5 including at least one
3 day risley lens (20) mounted in said optical path
4 between said daylight objective and said eyepiece lens
5 assembly (17).

1 7. An integrated day and night sighting system
2 (10) in accordance with claim 6 including a daylight
3 negative lens (18) mounted in said optical path
4 between said daylight objective lens (15) and said
5 eyepiece lens assembly (17).

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1 8. An integrated day and night sighting system
2 (10) in accordance with claim 3 including a reticle
3 display (27) positioned between said image intensifier
4 (25) and said eyepiece lens assembly (17).

1 9. An integrated day and night sighting system
2 (10) in accordance with claim 8 in which night reticle
3 display (27) includes a beamsplitter (30) positioned
4 in front of said eyepiece lens assembly (17) for
5 directing said reticle display (27) onto said eyepiece
6 lens assembly (17).

1 10. An integrated day and night sighting system
2 (10) in accordance with claim 1 including:
3 a laser (33) positioned for directing a laser
4 beam through said daylight objective lens (15); and
5 a rangefinder receiver (40) for receiving
6 reflected laser light received by said sighting
7 system, whereby a laser rangefinder is formed in a
8 compact design with a day and night light sight.

1 11. A laser rangefinder system (10) in
2 accordance with claim 10 including a laser
3 beamsplitter (36) for directing said laser beam
4 through said daylight objective lens (15).

1 12. A laser rangefinder system (10) in
2 accordance with claim 11 including a receiver
3 beamsplitter (37) for directing light being received
4 by said integrated day and night sighting system (10)
5 onto a rangefinder receiver (40).

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1 13. An integrated day and night sighting system
2 (10) in accordance with claim 1 in which said night
3 corrector lens (12,13) is tilted to compensate for
4 astigmatism.

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6 14. An integrated day and night sighting system
7 (10) in accordance with claim 13 in which said night
8 light corrector lens (12,13) includes a pair of tilted
9 lens elements (12,13).

1 15. An integrated day and night sighting system
2 (10) in accordance with claim 14 in which said day
3 objective lens (15) has a pair of larger night
4 corrector lens (12,13) mounted coaxially thereto
5 whereby the day objective lens (15) directs light
6 through an opening (14) in said night corrector lens
7 (12,13).

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1 16. An integrated day and night rangefinder
2 system (10) comprising:
3 a daylight objective lens (15);
4 a night corrector lens (12,13) coaxially mounted
5 to said daylight objective lens (15);
6 an eyepiece lens assembly (17);
7 an image converter (25) for night light use and
8 being mounted to receive infrared light thereon, said
9 image converter (25) being positioned for said
10 eyepiece lens assembly (17) to focus thereon;
11 a laser (33);
12 a laser beamsplitter (36) for receiving a laser
13 beam from said laser (33) thereon and directing said
14 beam through said day objective lens (15);
15 a night objective mirror (23) positioned to
16 reflect night light from said night corrector lens
17 (12,13);
18 a night secondary mirror (22) positioned to
19 receive light from said night objective mirror (23)
20 and to focus the night light onto said image
21 intensifier (25); and
22 a receiver beamsplitter (37) positioned in said
23 light path, said receiver beamsplitter (37) directing
24 received light to a rangefinder receiver (40),
25 whereby an integrated rangefinder system (40) is
26 provided in a compact design with a night and day
27 light sight.

1 17. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 in which said
3 night corrector lens (12,13) is tilted to compensate
4 for astigmatism.

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1 18. An integrated day and night rangefinder
2 system (10) in accordance with claim 17 in which said
3 night correction lens (12,13) includes a pair of
4 tilted lens elements.

1 19. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 in which a
3 night secondary mirror (22) is positioned in said
4 light path to pass visible light and to reflect
5 infrared light.

1 20. An integrated day and night rangefinder
2 system (10) in accordance with claim 19 in which said
3 image converter (25) is an image intensifier.

1 21. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 including a
3 reticle display (27).

1 22. An integrated day and night rangefinder
2 system (10) in accordance with claim 21 in which said
3 receiver beamsplitter (30) is positioned for directing
4 the image of said reticle display (27) onto said
5 eyepiece assembly (17).

1 23. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 including
3 visible light optics (18,20) located between said day
4 objective lens (15) and said eyepiece lens assembly
5 (17) for focusing daylight onto said eyepiece lens
6 assembly.

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1 24. An integrated day and night rangefinder
2 system (10) in accordance with claim 23 including a
3 day light image erecting prism (21).

1 25. An integrated day and night rangefinder
2 system (10) in accordance with claim 21 including a
3 beamsplitter (30) positioned between said image
4 intensifier (25) and said eyepiece lens assembly (17)
5 for directing said reticle display into said eyepiece
6 lens assembly (17).

1 26. An integrated day and night sighting system
2 (10) in accordance with claim 16 in which said night
3 corrector lens (12,13) is coaxially mounted to said
4 day objective lens (15) whereby the day objective lens
5 (15) directs light through an opening (14) in said
6 night corrector lens (12,13) and said night corrector
7 lens (12,13) directs infrared light received around
8 said day objective lens (15).

THIS SHEET HAS BEEN
REPLACED





1 27. An integrated day and night optical system
2 (10) comprising:
3 an eyepiece lens assembly (17);
4 a daylight optical system (15,18,20,21) having
5 daylight optics for collecting and focusing visible
6 light onto said eyepiece lens assembly (17);
7 an image converter (25) positioned for viewing
8 with said eyepiece lens assembly (17); and
9 a night light optical system (12,13,22,23)
10 partially mounted coaxially of said daylight optical
11 system (15,18,20,21) and having night light optics
12 (12,13,22,23) for collecting and focusing night light
13 onto said image converter (25), whereby an integrated
14 day and night optical system (10) has a portion of the
15 day and night light optics coaxially mounted.

1 28. An integrated day and night optical system
2 (10) in accordance with claim 27 in which said image
3 converter (25) is an image intensifier and is movably
4 supported (Figure 7) for movement between a daylight
5 position out of the optic path in front of said
6 eyepiece lens assembly (17) and a night light position
7 in said light path, said image intensifier (25) being
8 positioned for said eyepiece lens (17) to focus
9 thereon when said image intensifier (25) is in said
10 light path.

THIS SHEET HAS BEEN REPLACED





1 29. An integrated day and night optical system
2 (10) in accordance with claim 28 in which said night
3 light optic system (15,28,20,21) includes a night
4 primary mirror (23) positioned to reflect received
5 infrared light and a night secondary mirror (22)
6 positioned to receive light reflected from said night
7 primary mirror (23) and to focus said infrared light
8 onto said image intensifier (25) when said image
9 intensifier (25) is in a night light position.

1 30. An integrated day and night optical system
2 (10) in accordance with claim 29 including:
3 a laser (33);
4 a rangefinder receiver (40);
5 a laser beamsplitter (36) for receiving a laser
6 beam from said laser and directing said laser beam
7 through a portion of said day light optics (15); and
8 a receiver beamsplitter (37) positioned in said
9 light path, said receiver beamsplitter (37) directing
10 received light to said rangefinder receiver (40);
11 whereby an integrated night and day optical
12 rangefinder (10) has a compact design.



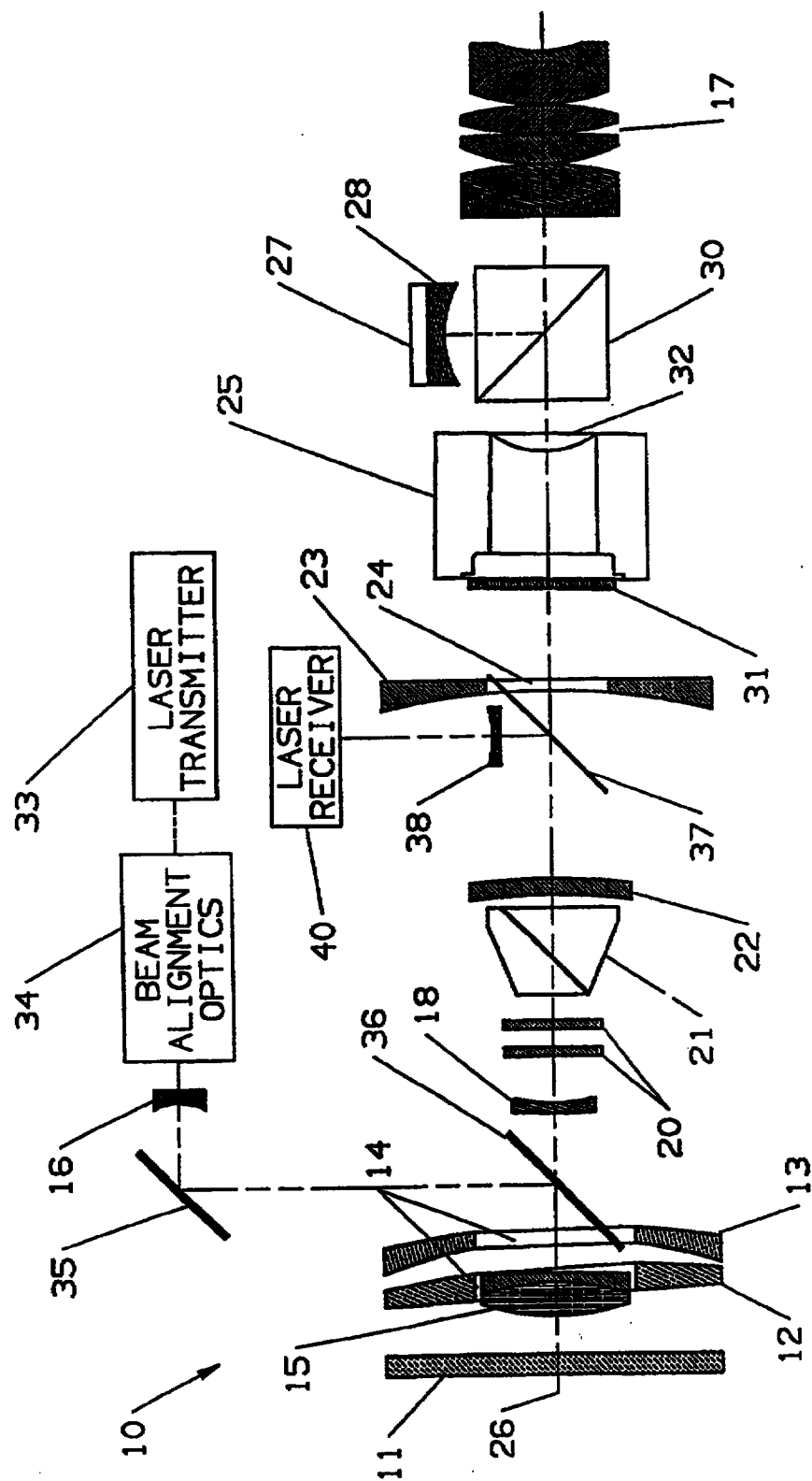


FIGURE 1

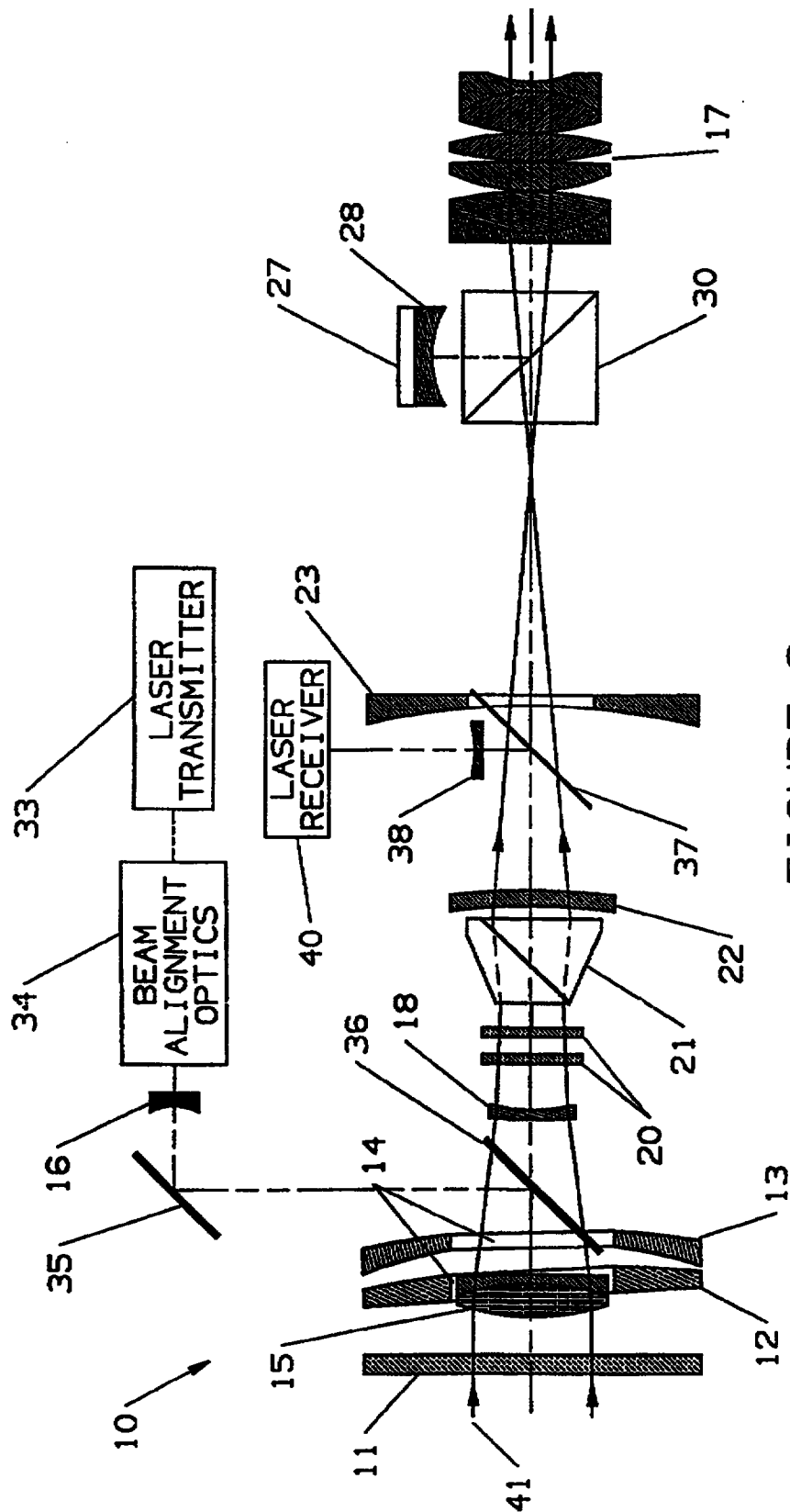


FIGURE 2

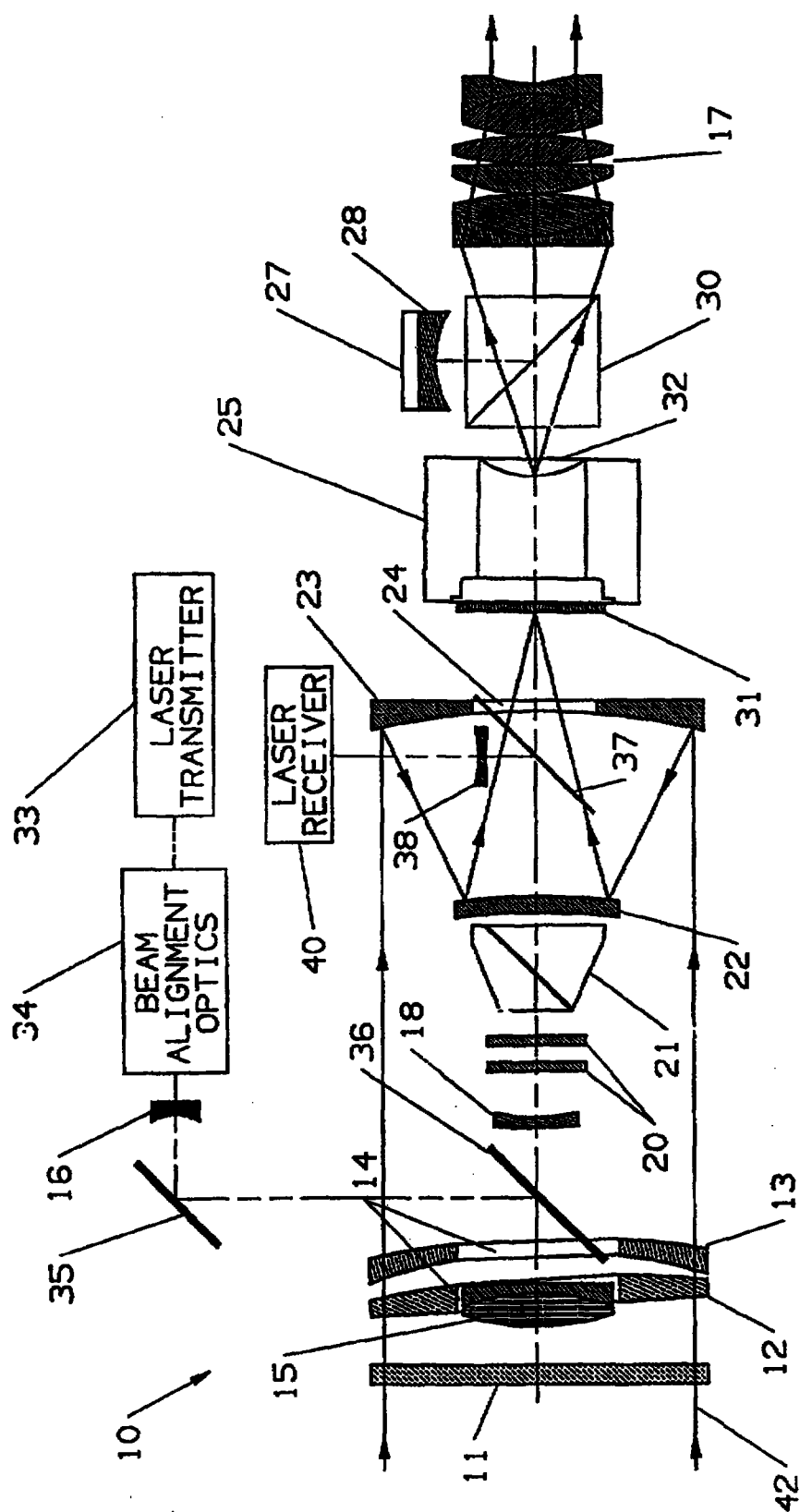


FIGURE 3

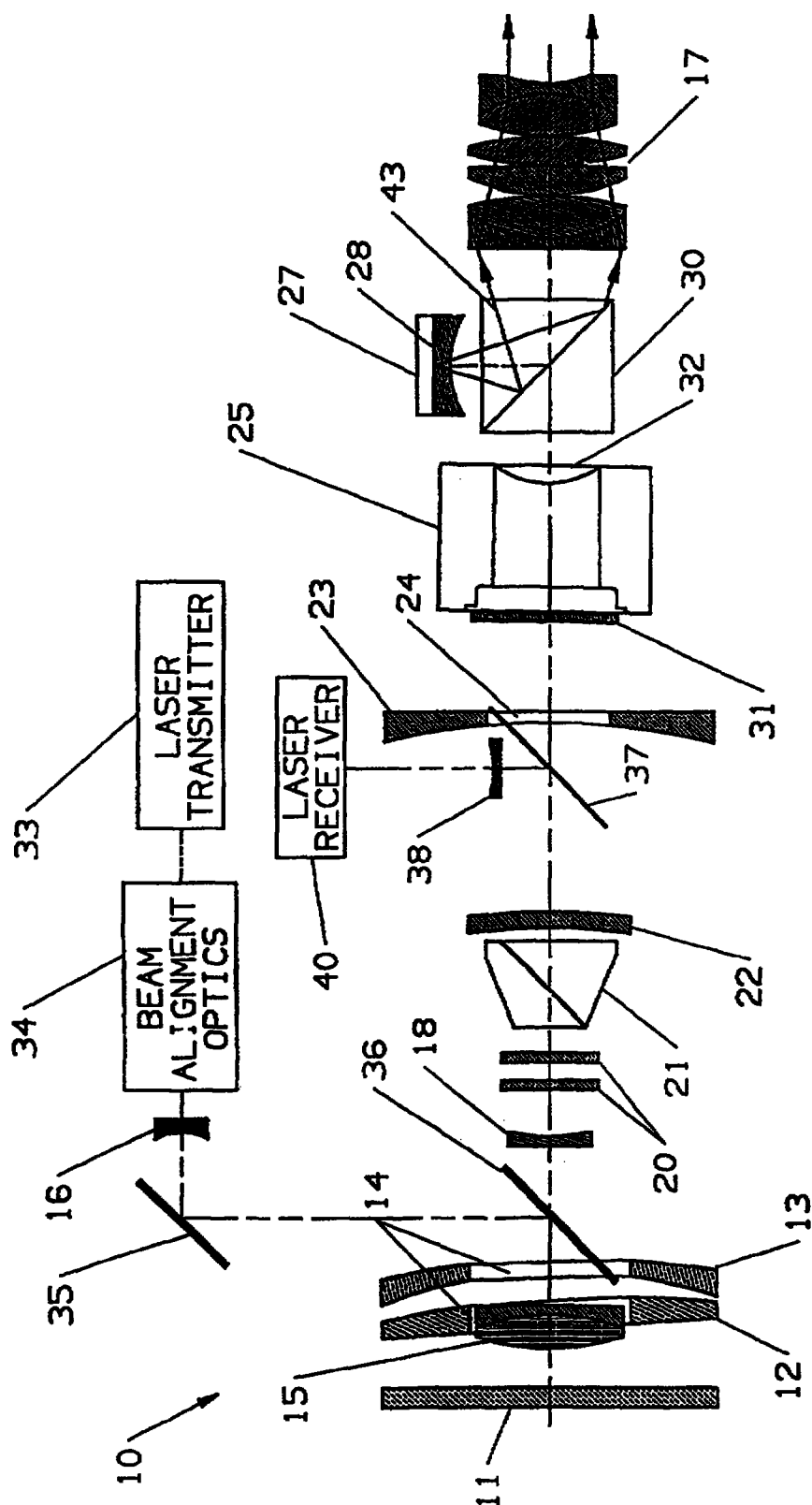


FIGURE 4

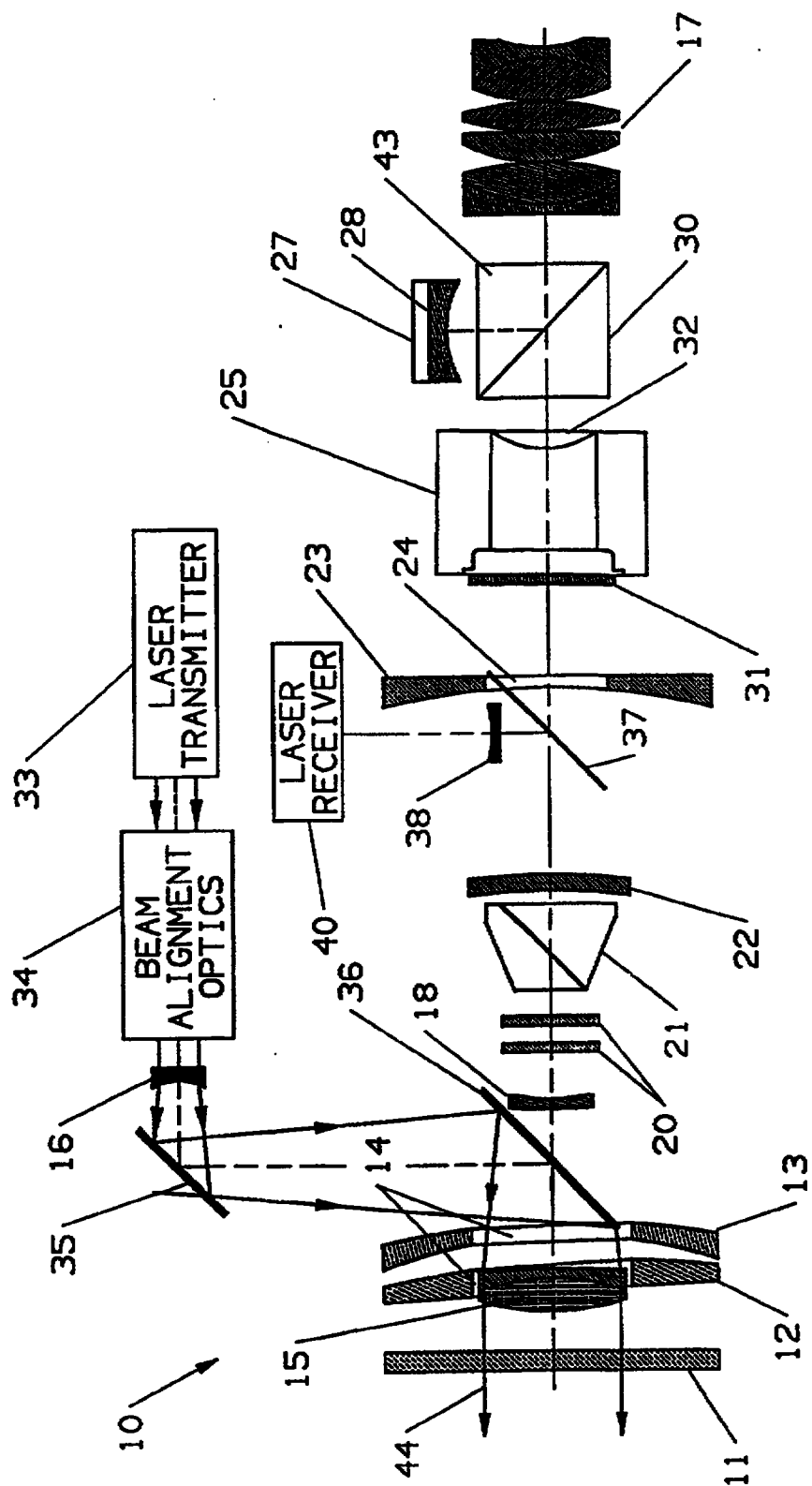


FIGURE 5

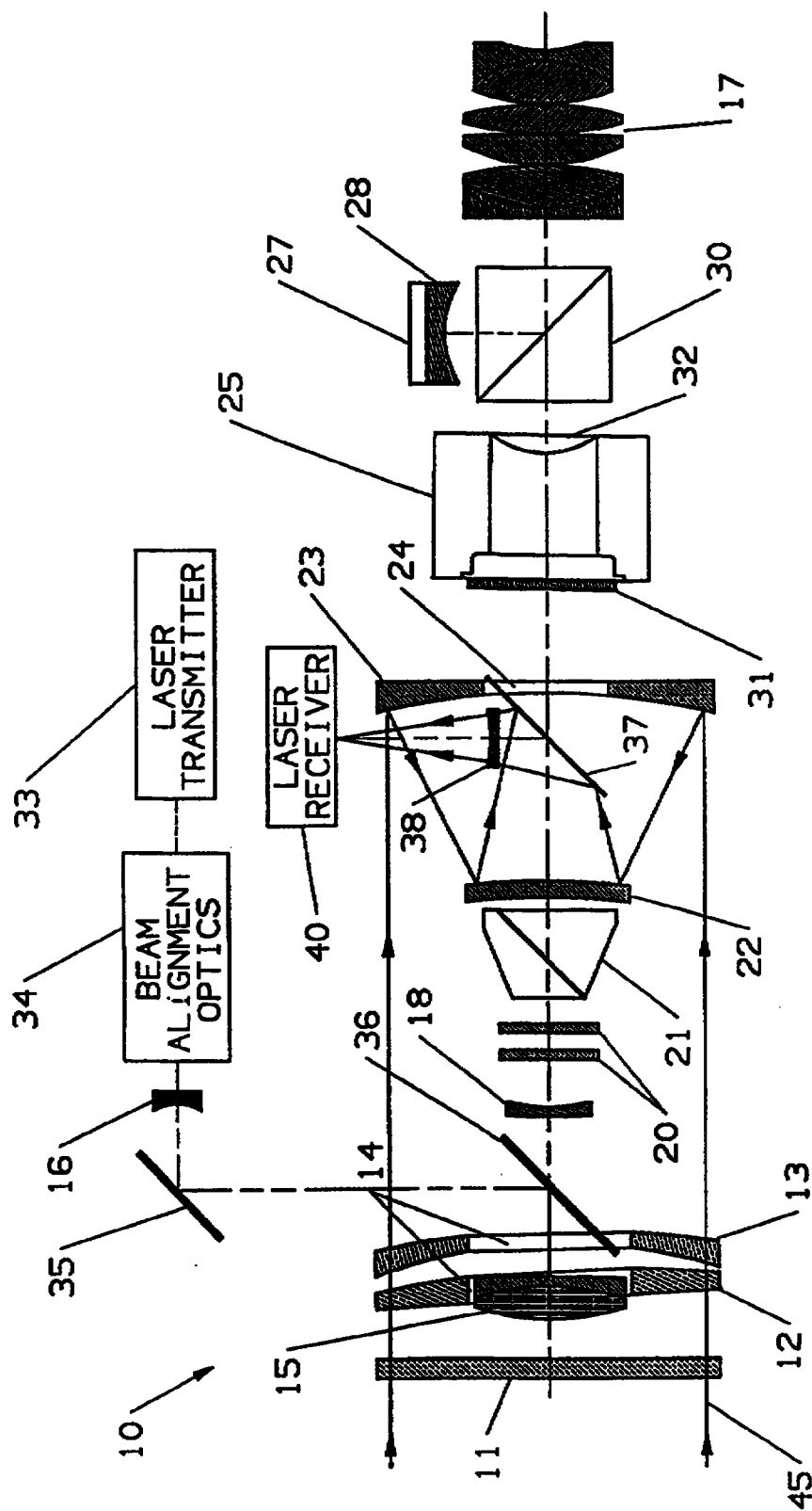


FIGURE 6

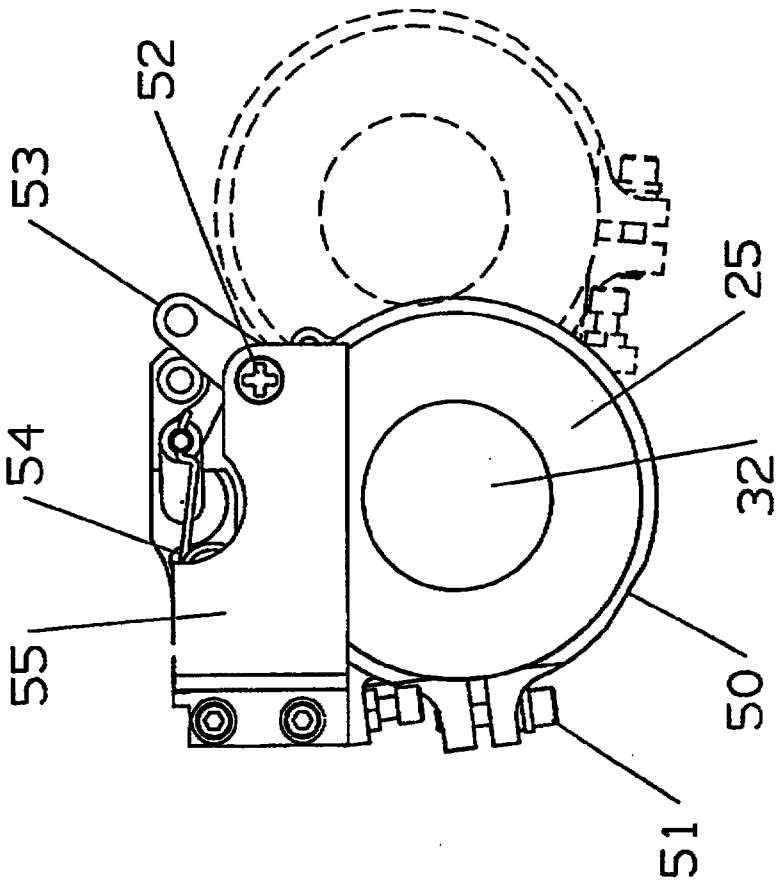


FIGURE 7

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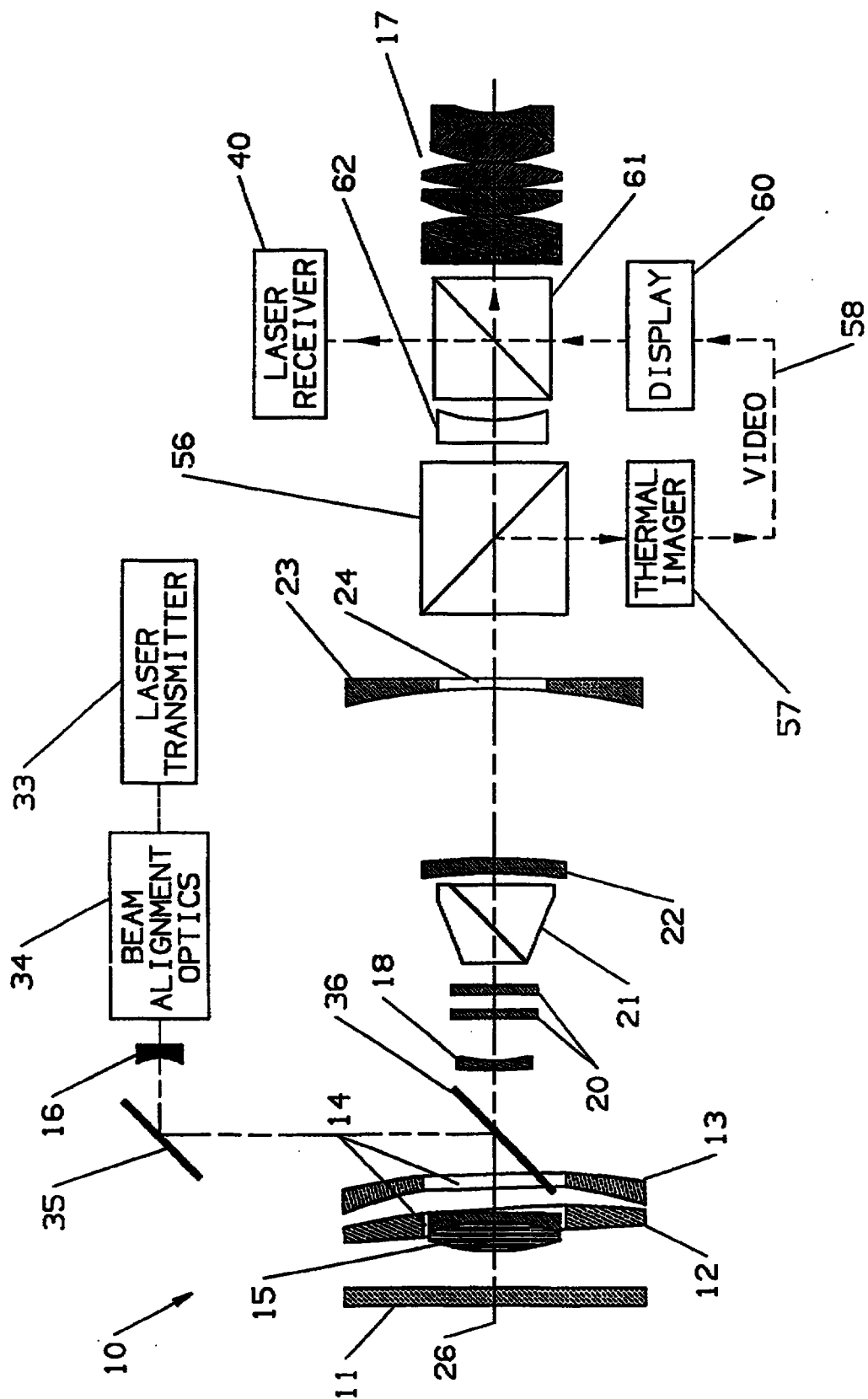


FIGURE 8

CLAIMS:

We claim:

- 1 1. An integrated day and night sighting system
- 2 (10) comprising:
- 3 a daylight optical system having daylight optics
- 4 for collecting and focusing visible light from an
- 5 objective lens (15) onto an eyepiece lens assembly
- 6 (17) in a daylight light path between said objective
- 7 lens (15) and said eyepiece lens assembly (11);
- 8 a night light corrector lens (12,13) mounted
- 9 adjacent said daylight objective lens (15), said night
- 10 correction lens (12,13) including a pair of tilted
- 11 lens elements to compensate for astigmatism;
- 12 an image converter (25) for night light use and
- 13 being movably supported for movement into and out of
- 14 the daylight light path between a daylight position
- 15 out of the light path and a night light position in
- 16 the light path, said image converter (25) being
- 17 positioned for said eyepiece lens assembly (17) to
- 18 focus thereon when said image converter (25) is in
- 19 said light path;
- 20 a night reticle display (27) positioned between
- 21 said image converter (25) and said eyepiece lens
- 22 assembly (17);
- 23 a night light primary mirror (22) positioned to
- 24 reflect light from said night light corrector lens
- 25 (12,13); and
- 26 a night light secondary mirror (22) positioned to
- 27 receive light from said night primary objective mirror
- 28 (23) and to focus the light onto said image converter
- 29 (22) when said image converter (27) is in a night
- 30 light position, whereby an integrated night and day
- 31 light optical system (10) is provided in a compact
- 32 packaging.



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- 1 2. An integrated day and night sighting system
- 2 (10) in accordance with claim 1 in which said night
- 3 light secondary mirror (22) is positioned in said
- 4 light path and is coated to pass visible light
- 5 therethrough and to reflect infrared light.



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1 3. An integrated day and night sighting system
2 (10) in accordance with claim 2 in which said image
3 converter (25) is an image intensifier.

1 4. An integrated day and night sighting system
2 (10) in accordance with claim 1 in which said day
3 objective lens (15) and said night light corrector
4 lenses (12,13) are mounted together with said night
5 light corrector lens (12,13) mounted coaxial of said
6 day objective lens (15).

1 5. An integrated day and night sighting system
2 (10) in accordance with claim 3 in which said night
3 secondary mirror (22) has a curvature for focusing
4 infrared light onto an image plane between the primary
5 objective mirror (23) and the daylight objective focal
6 plane so that the image plane coincides with the input
7 surface of said image intensifier (25) when the image
8 intensifier is in the night light position.

1 6. An integrated day and night sighting system
2 (10) in accordance with claim 5 including a day risley
3 lens (20) mounted in said optical path between said
4 daylight objective and said eyepiece lens assembly
5 (17).

1 7. An integrated day and night sighting system
2 (10) in accordance with claim 6 including a daylight
3 negative lens (18) mounted in said optical path
4 between said daylight objective lens (15) and said
5 eyepiece lens assembly (17).

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1 8. Cancelled

1 9. An integrated day and night sighting system
2 (10) in accordance with claim 7 in which said night
3 reticle display (27) includes a beamsplitter (30)
4 positioned in front of said eyepiece lens assembly
5 (17) for directing said reticle display (27) onto said
6 eyepiece lens assembly (17).

1 10. An integrated day and night sighting system
2 (10) in accordance with claim 1 including:
3 a laser (33) positioned for directing a laser
4 beam through said daylight objective lens (15); and
5 a rangefinder receiver (40) for receiving
6 reflected laser light received by said sighting
7 system, whereby a laser rangefinder is formed in a
8 compact design with a day and night light sight.

1 11. A laser rangefinder system (10) in
2 accordance with claim 10 including a laser
3 beamsplitter (36) for directing said laser beam
4 through said daylight objective lens (15).

1 12. A laser rangefinder system (10) in
2 accordance with claim 11 including a receiver
3 beamsplitter (37) for directing light being received
4 by said integrated day and night sighting system (10)
5 onto a rangefinder receiver (40).

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1 13. Cancelled

1 14. An integrated day and night sighting system
2 (10) in accordance with claim 1 in which said night
3 light corrector lens (12,13) is a pair of tilted lens
4 elements (12,13).

1 15. An integrated day and night sighting system
2 (10) in accordance with claim 14 in which said day
3 objective lens (15) has a pair of larger night
4 corrector lenses (12,13) mounted coaxially thereto
5 whereby the day objective lens (15) directs light
6 through an opening (14) in said night corrector lens
7 (12,13).

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1 16. An integrated day and night rangefinder
2 system (10) comprising:
3 a daylight objective lens (15);
4 a night corrector lens (12,13) coaxially mounted
5 to said daylight objective lens (15);
6 an eyepiece lens assembly (17);
7 an image converter (25) for night light use and
8 being mounted to receive infrared light thereon, said
9 image converter (25) being positioned for said
10 eyepiece lens assembly (17) to focus thereon;
11 a laser (33);
12 a laser beamsplitter (36) for receiving a laser
13 beam from said laser (33) thereon and directing said
14 beam through said day objective lens (15);
15 a night objective mirror (23) positioned to
16 reflect night light from said night corrector lens
17 (12,13);
18 a night secondary mirror (22) positioned to
19 receive light from said night objective mirror (23)
20 and to focus the night light onto said image
21 intensifier (25); and
22 a receiver beamsplitter (37) positioned in said
23 light path, said receiver beamsplitter (37) directing
24 received light to a rangefinder receiver (40),
25 whereby an integrated rangefinder system (40) is
26 provided in a compact design with a night and day
27 light sight.

1 17. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 in which said
3 night corrector lens (12,13) is tilted to compensate
4 for astigmatism.



1 18. An integrated day and night rangefinder
2 system (10) in accordance with claim 17 in which said
3 night correction lens (12,13) includes a pair of
4 tilted lens elements.

1 19. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 in which a
3 night secondary mirror (22) is positioned in said
4 light path to pass visible light and to reflect
5 infrared light.

1 20. An integrated day and night rangefinder
2 system (10) in accordance with claim 19 in which said
3 image converter (25) is an image intensifier.

1 21. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 including a
3 reticle display (27).

1 22. An integrated day and night rangefinder
2 system (10) in accordance with claim 21 in which said
3 receiver beamsplitter (30) is positioned for directing
4 the image of said reticle display (27) onto said
5 eyepiece assembly (17).

1 23. An integrated day and night rangefinder
2 system (10) in accordance with claim 16 including
3 visible light optics (18,20) located between said day
4 objective lens (15) and said eyepiece lens assembly
5 (17) for focusing daylight onto said eyepiece lens
6 assembly.



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1 24. An integrated day and night rangefinder
2 system (10) in accordance with claim 23 including a
3 day light image erecting prism (21).

1 25. An integrated day and night rangefinder
2 system (10) in accordance with claim 21 including a
3 beamsplitter (30) positioned between said image
4 intensifier (25) and said eyepiece lens assembly (17)
5 for directing said reticle display into said eyepiece
6 lens assembly (17).

1 26. An integrated day and night sighting system
2 (10) in accordance with claim 16 in which said night
3 corrector lens (12,13) is coaxially mounted to said
4 day objective lens (15) whereby the day objective lens
5 (15) directs light through an opening (14) in said
6 night corrector lens (12,13) and said night corrector
7 lens (12,13) directs infrared light received around
8 said day objective lens (15).

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1 27. Cancelled

1 28. Cancelled

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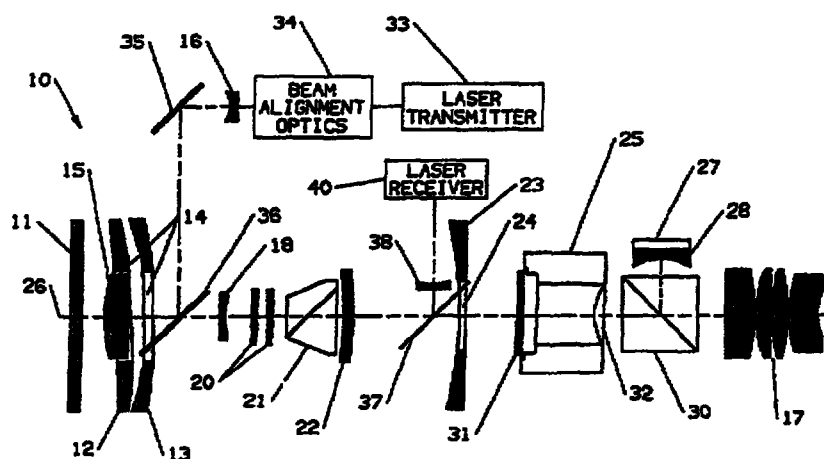
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(21) International Application Number: PCT/US96/13403 (22) International Filing Date: 21 August 1996 (21.08.96) (30) Priority Data: 08/529,330 18 September 1995 (18.09.95) US (71) Applicant: LITTON SYSTEMS, INC. [US/US]; 21240 Burbank Boulevard, Woodland Hills, CA 91367 (US). (72) Inventors: ANDERSON, J., Richard; 518 Savona Court, Altamonte Springs, FL 32701 (US). JONES, Larry, G.; 1355 Luther Way, Lawrenceville, GA 30243 (US). SHAFER, David; 56 Drake Lane, Fairfield, CT 06430 (US). GIBSON, James, E.; 150 Stoney Ridge Drive, Longwood, FL 32750 (US). (74) Agent: HOBBY, William, M., III; Hobby & Beusse, Suite 375, 157 E. New England Avenue, Winter Park, FL 32789 (US).	(81) Designated States: AU, CA, IL, JP, SG, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>	

(54) Title: DAY AND NIGHT SIGHTING SYSTEM



(57) Abstract

An integrated day and night sighting system (10) and a laser rangefinder apparatus includes a daylight objective lens (15) having a night light corrector lens (12, 13) mounted adjacent to and coaxially with the daylight objective lens (15) and having an eyepiece lens (17). An image converter module (25) may be an image intensifier for night light use and is movably supported for movement between a daylight position out of the light path and a night light position in the light path (Figure 7). The image converter (25) is positioned to focus the night light optics thereon and for the eyepiece lens (17) to view the image intensifier screen (32). A night primary objective mirror (23) is positioned to reflect light from the night objective lens (12, 13) and a night secondary mirror (22) is positioned to receive light from the primary objective mirror (23) and to focus the night light onto the image converter (25) when the image converter (25) is in the night light position.