

MODULAR VISUALIZATION DEVICES

The field of the invention is that of display devices for troops, notably for infantry, designed to improve their capacity to advance and to shoot on their daytime and night-time missions.

A modern infantryman must be capable of accomplishing various types of missions and these various missions require various types of display systems.

In the daytime, when taking aim with his weapon, he may become a potential target. In order to overcome this drawback, a video camera, that can for example be a CCD (Charge Coupled Device) camera, is mounted on the barrel of the weapon. This camera is coupled to a first monocular display device placed in front of one of his eyes. This device allows the soldier to take aim at the target from an offset position, and consequently to shoot while, at the same time, remaining protected.

At night, in order to facilitate his advance, the infantryman must be in possession of night-vision systems called light intensifier systems. These can be either monocular systems, in other words disposed in front of one eye, the second eye remaining free, or binocular systems, in other words disposed in front of both eyes.

During a mission comprising a large number of movement sequences, the use of a monocular device allows the soldier to maintain a wide field of vision in the eye without the monocular device. Thus, he can move forward more easily by maintaining a clear perception of the terrain, obstacles on the ground and tree branches situated in his immediate environment, in other words within a perimeter typically less than 5 metres. Maintaining a wide field of vision also allows the soldier to be vigilant for possible aggression from the sides. Display devices with light intensifier

supply an intensified image having, by design, a much higher luminance than the ambient light. Consequently, when the soldier lifts up his monocular display device, a certain time is required before the eye that was
5 observing the intensified image adapts to low levels of light. The free eye that is already adapted to the darkness allows the soldier to reduce his time to adapt to the darkness.

On the other hand, night-vision binoculars are
10 better adapted to missions comprising a large number of observation sequences. Binocular vision allows a higher visual comfort in the observation of the remote environment, typically of the order of 100 m.

Consequently, in order to best ensure the
15 success of the various missions of the infantryman, several display devices are required. Currently, the display systems most frequently used are either image-intensified night-vision binoculars or helmet displays. However, none of these various systems can be used to
20 carry out all the daytime and night-time missions as they are defined above and, in addition, these are generally costly and bulky systems.

The subject of the invention is a modular system essentially comprising a first monocular device
25 specifically dedicated to daytime missions, a second monocular module specifically dedicated to night-time applications, the combination of the two modules forming a binocular display device. Indeed, this modular equipment has clear advantages provided by the
30 following features:

- monocular night vision useful for movement at night with one eye free of any device;
- binocular night vision useful for long-duration night-time observation with an excellent
35 visual comfort;
- monocular offset targeting useful for shooting while, at the same time, remaining protected;

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- binocular offset vision useful for long-duration observation while, at the same time, remaining protected.

It should be noted that this modular arrangement allows the soldier to only carry on his helmet the module that is useful for the current mission which spares him from carrying an additional weight on his helmet when he only needs to use a single monocular display device.

More precisely, one subject of the invention is a first monocular display device comprising a mechanical body, an image source, relay optics and an eyepiece, the image from the image source being collimated by the relay optics and the eyepiece towards the eye of an observer, characterized in that the relay optics comprise a semi-reflecting plane prism, that the display device comprises a retractable protective shutter disposed in front of the said semi-reflecting prism and that the mechanical body comprises mechanical coupling means designed to attach a second display device onto the said monocular display device.

Another subject of the invention is a monocular display device comprising a mechanical body, an image source, relay optics and an eyepiece, the image from the image source being collimated by the relay optics and the eyepiece towards the eye of an observer, characterized in that the display device comprises a retractable plane mirror disposed within the relay optics and that the mechanical body comprises mechanical coupling means designed to attach a second display device onto the said monocular display device.

Finally, a further subject of the invention is a modular binocular display device comprising a first monocular display device placed in front of one of the eyes of an observer and a second monocular display device placed in front of the other eye of the said observer, the first device comprising a first mechanical body, a first image source, first relay

optics and a first eyepiece, the second device comprising a second mechanical body, a second image source, second relay optics and a second eyepiece, characterized in that:

- 5 • the first relay optics comprise a semi-reflecting plane prism,
- the optical power of the assembly formed by the first relay optics and the first eyepiece is identical to the optical power of the assembly formed
- 10 by the second relay optics and the second eyepiece;
- the first display device comprises a retractable protective shutter that can be disposed in front of the said semi-reflecting prism,
- the first mechanical body comprises first
- 15 mechanical coupling means,
- the second display device comprises a retractable plane mirror that can be disposed in the second relay optics,
- the second mechanical body also comprises
- 20 second mechanical coupling means designed to couple with the first mechanical coupling means such that the first monocular display device can be either rigidly linked with, or detached from, the second monocular display device,
- 25 • when the first display device is rigidly attached to the second display device, the protective shutter is retracted in front of the semi-reflecting prism; the plane mirror is also retracted, the semi-reflecting prism occupies the position of the plane
- 30 mirror before the retraction of the said plane mirror, the images from the first and from the second image sources are transmitted through the first and second relay optics and the first and second eyepieces by reflection off and transmission through the semi-
- 35 reflecting prism towards both eyes of the observer.

The invention will be better understood and other advantages will become apparent upon reading the

description that follows, presented as a non-limiting example and with reference to the appended figures, in which :

- Figure 1 shows a first monocular device
5 according to the invention;
- Figure 2 shows the said first monocular device attached to a helmet;
- Figure 3 shows a second monocular device according to the invention;
- 10 • Figure 4 shows the said second monocular device attached to a helmet;
- Figure 5 shows a binocular device according to the invention;
- Figure 6 shows the said binocular device
15 attached to a helmet.

The binocular assembly 1 is composed of two monocular modules 2 and 3. Consequently, each module must be able to operate in both an autonomous manner
20 and also in a coupled manner when the two display modules are united so as to form just a single binocular display device. These various modes of operation are only made possible by the use of a semi-reflecting prism 23 disposed in one of the two
25 monocular devices allowing the mixing of the images coming from the first and second display device.

In Figures 1, 3 and 5, the following drawing conventions have been adopted: the mechanical bodies 27 and 37 are depicted using fine lines, the image sources
30 and the optical systems using bold lines, the path of the light rays through the various optical elements by the dashed arrows and the detachable parts also using dashed lines.

35 Figure 1 shows a first monocular device 2 according to the invention comprising the said semi-reflecting prism 23. In Figure 1, the device operates in an autonomous manner. It essentially comprises:

- A first mechanical body 27 depicted using fine lines in the figure;

- A first image source 21 disposed inside this body 27;

5 • A first optical assembly essentially comprising first relay optics 22, a first eyepiece 24 and the semi-reflecting prism 23.

The image source 21 can be a small-sized imager with dimensions typically of the order of a centimetre
10 which is also referred to as a 'micro-display'. An LCD matrix, lit by a light source that can, for example, be formed by light-emitting diodes, can be used for this micro-display. This imager delivers, for example, images and targeting information coming from a camera
15 mounted on the soldier's weapon.

This image is focussed into an intermediate image by first relay optics 22 in the focal plane of a first eyepiece. The relay optics are conventionally composed of various sets of optics 221 and 222
20 comprising optical lenses. A semi-reflecting prism 23 is disposed within these relay optics. This prism is a thin plane prism and is used in reflecting mode. Its coefficient of reflection is around 50 percent such that it can also be used in transmission mode without
25 favouring one optical path over the other. It should be noted that, in this configuration, half the luminous power is lost by transmission through the semi-reflecting prism. However, in order to compensate for this loss of power, the imager only needs to have a
30 higher luminance such that the final luminance seen by the soldier is adequate, which does not pose a technical problem.

From the intermediate image, the first eyepiece 24 forms a collimated image at infinity seen by the
35 observer. The exit pupil of the eyepiece is superimposed on the pupil of the eye of the soldier. The depth of field of this eyepiece is large enough for

targeting comfort. The eyepiece can be fitted with a focussing adjustment.

At least one plane angled mirror 25 allows the optical assembly to be folded back into a space of reduced thickness.

The first mechanical body 27 provides several functions which are the support of the various elements of the system and their protection against attack from the external environment which can be particularly severe for an infantryman on a mission. It also carries coupling means allowing the said device to be coupled to a second display device. These means are not shown in Figure 1.

The said display device also comprises a retractable protective shutter 26 that is disposed in front of the semi-reflecting prism 23 when the said device 2 is used in an autonomous manner. This opaque shutter ensures the mechanical protection of the semi-reflecting prism and, at the same time, prevents any stray light from penetrating inside the relay optics. The protective shutter 26 may be independent from the first mechanical body, as shown in Figure 1, or may be rigidly attached to the said body 27. In this case, in the retracted position, it fits into a housing disposed in the mechanical body and designed for this purpose.

The first mechanical body 27 may also comprise means for attaching it to the helmet of the soldier, as is indicated in Figure 2 where the device is shown mounted onto a helmet 4. In this case, the helmet comprises a mechanical mounting bracket 5 designed to attach the monocular display device 2. These attachment means comprise mechanical parts allowing the device to be installed either over the right eye or over the left eye of the soldier. They may also comprise adjustment means that allow the eyepiece exit pupil to be best positioned in the pupil of the eye of the soldier. The device therefore allows an offset aim to be taken which is useful for shooting while, at the same time, leaving

the other eye free, thus allowing the maximum safety of the soldier to be guaranteed when shooting.

Figure 3 shows a second monocular device 3 according to the invention comprising a retractable mirror 33, where the said second device can be coupled to a first display device 2. In Figure 3, the said second device operates in an autonomous manner. It essentially comprises:

- A second mechanical body 37 depicted in the figure using fine lines;
- A second image source 31 disposed within this body 37;
- A second optical assembly essentially comprising second relay optics 32, a second eyepiece 34 and the retractable mirror 33.

The image source 31 delivers intensified images of the external surroundings. It essentially comprises an upstream wide-angle object lens 311 and a light intensifier 312. The upstream lens 311 forms an image of the external surroundings on the photosensitive surface of the intensifier that delivers an intensified image of it on its rear face. When the intensifier does not have an image inverter device, the intensified image is naturally inverted with respect to the initial image coming from the photosensitive surface. The optical combination comprising relay optics 32, the angled mirrors 35 and the eyepiece 34 is arranged such that the final collimated image has the same orientation as the image from the external surroundings. It is not therefore necessary for the intensifier to have an image inverter device. The upstream wide-angle object lens 311 is fitted with a focussing mechanism.

This intensified image is focussed into an intermediate image by second relay optics 32 in the focal plane of a second eyepiece 34. The relay optics 32 are conventionally composed of various sets of optics 321 and 322 comprising optical lenses. A plane

retractable mirror 33 is disposed within these relay optics. The protective mirror may be independent of the second mechanical body 37 or be rigidly attached to the said body. In this case, in the retracted position, it
5 fits into a housing disposed in the mechanical body and designed for this purpose. In this latter arrangement, the mirror is constantly protected from the outside whether it is in the retracted position or not.

From the intermediate image, the second
10 eyepiece 34 forms a collimated image at infinity seen by the observer. The exit pupil of the eyepiece is superimposed on the pupil of the eye of the soldier. The depth of field of this eyepiece is large enough for targeting comfort. The eyepiece 34 can also be fitted
15 with a focussing adjustment.

Plane angled mirrors 35 allow the optical assembly to be folded back into a space of reduced thickness.

The second mechanical body 37 provides several
20 functions which are the support of the various elements of the system and their protection against attack from the external environment which can be particularly severe for an infantryman on a mission. It also carries coupling means allowing the said device to be coupled
25 to the first display device. These means are not shown in Figure 3.

The second mechanical body 37 may also comprise means for attaching it to the helmet of the soldier, as is indicated in Figure 4 where the device is shown
30 mounted onto a helmet 4. In this case, the helmet comprises a mechanical mounting bracket 5 designed to attach the monocular display device 2. These attachment means comprise mechanical parts allowing the device to be installed either over the right eye or over the left
35 eye of the soldier. They may also comprise adjustment means that allow the eyepiece exit pupil to be best positioned in the pupil of the eye of the soldier. The device therefore allows an intensified view of the

external surroundings to be delivered to one eye, while the other eye remains free.

Figure 5 shows the first and the second display devices when they are assembled by their coupling means to form a binocular device 1. In this case, the protective shutter 26 is retracted in front of the semi-reflecting prism 23 and the plane mirror 33 is also retracted.

For the binocular device 1 to operate correctly, three optical conditions must be met:

- The optical power of the assembly formed by the first relay optics 22 and the first eyepiece 24 must be identical to the optical power of the assembly formed by the second relay optics 32 and the second eyepiece 34;

- The semi-reflecting prism of the first device must occupy exactly the same position that the mirror of the second device occupies before it is retracted;

- The distance separating the two eyepieces must also be approximately equal to the inter-pupil distance, which is approximately 65 millimetres.

The images from the first and of the second image sources are transmitted through the first and second relay optics and the first and second eyepieces by reflection off and transmission through the semi-reflecting prism towards both eyes of the observer. Consequently, in order to ensure correct binocular vision, the transmitted images must be of identical angular size and, consequently, the optical powers of the first optical assembly and of the second optical assembly must be equal.

When the intensifier tube 312 of the second image source is switched on, the equipment then allows binocular night vision that is useful for long-duration night observation with an excellent visual comfort. The first image source can also be switched on and display information in simple symbolic form which will be seen by both eyes superimposed with the intensified image.

The whole of the binocular device can be mounted onto the soldier's helmet 4 by the attachment means for the first and second monocular display devices, as indicated in Figure 6.

CLAIMS

1. Modular binocular display device (1) comprising a first monocular display device (2) placed
5 in front of one of the eyes of an observer and a second monocular display device (3) placed in front of the other eye of the said observer, the first device (2) comprising a first mechanical body (27), a first image source (21), first relay optics (22) and a first
10 eyepiece (24), the second device comprising a second mechanical body (37), a second image source (31), second relay optics (32) and a second eyepiece (34), characterized in that:

- the first relay optics (22) comprises a
15 semi-reflecting plane prism (23);

- the optical power of the assembly formed by the first relay optics (22) and the first eyepiece (24) is identical to the optical power of the assembly formed by the second relay optics (32) and the second
20 eyepiece (34);

- the first display device (2) comprises a retractable protective shutter (26) capable of being disposed in front of the said semi-reflecting prism (23);

- the first mechanical body (27) comprises first mechanical coupling means;

- the second display device comprises a retractable plane mirror (33) capable of being disposed in the second relay optics (32);

- the second mechanical body (37) also
30 comprises second mechanical coupling means designed to be coupled with the first mechanical coupling means in such a manner as to rigidly attach or detach the first monocular display device (2) to/from the second
35 monocular display device (3);

- when the first display device is rigidly attached to the second display device, the protective shutter (26) is retracted in front of the semi-

reflecting prism (23); the plane mirror (33) is also retracted, the semi-reflecting prism (23) occupies the position of the plane mirror (33) before the retraction of the said mirror (33), the images from the first and
5 from the second image sources are transmitted through the first and second relay optics and the first and second eyepieces by reflection off and transmission through the semi-reflecting prism (23) towards both eyes of the observer;

- 10 • when the first display device operates in an autonomous manner, the retractable protective shutter is disposed in front of the semi-reflecting prism (23);
- when the second display device operates in an autonomous manner, the retractable plane mirror is
15 disposed in the second relay optics (32).

2. Binocular display device according to Claim 1, characterized in that at least one of the image sources (21, 31) is a matrix imager, in particular an
20 LCD imager.

3. Binocular display device according to either of Claims 1 and 2, characterized in that at least one of the image sources (21, 31) is formed by a focussing
25 object lens (311) and by a light intensifier (312).

4. Monocular or binocular display device according to one of Claims 1 to 3, characterized in that at least one of the mechanical bodies (27, 37)
30 comprises attachment means.