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ANTITANK MISSILES NIGHT FIRING FROM AEROSPATIALE HELICOPTER

G. de WINTER

AEROSPATIALE, FRANCE

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G. de WINTER - AEROSPATIALE, FRANCE

1 - NIGHT FIGHTING REQUIREMENT FOR THE HELICOPTERS EQUIPED WITH THE ANTITANK MISSILES

GENERAL

The tank, which has been for a long time the shock unit for the ground forces, is now capable of moving and fighting at night.

It is acknowleged that one of the most effective weapons which gives a decisive advantage is the Antitank Helicopter.

A good example is given by Aerospatiale's Dauphin armed with Euromissile's Hot system. The 4,000 m range capability allows to fire the missile while remaining out of range of the gun. The helicopter provides the antitank weapon with mobility and versatility.

Since the advent of the thermal imager (thermal camera), which is a purely passive detection device, it has been possible to equip the antitank helicopters with such devices and to perform night firings under the better conditions of discretion.

1.1 - Recall of the HOT missile operation

It is a 2rd Generation Antitank missile system. The gunner only has to aim the sight at the target, and the flying missile is automatically maintained on the line of sight.

The missile includes a two stage motor which propels it a high speed. Missile control by jet deflectors provides a high manoeuvrability at any range. The war-head is a shaped charge, capable of piercing up to 800 mm of armour. Its range is up to 4,000 m ; its accurary, a few ten centimetres. The missile is launched from a tube in which it is placed as soon it is manufactured.

The firing installation includes essentially a sighting system with a reticle ; it is harmonized with a goniometer which determines the angular error between the missile and the line of sight, by receiving the IR signal sent by the missile's non modulated tracer.
An electronic unit generates the correcting signals sent to the missile via the guidance wires.

(See figure 1)

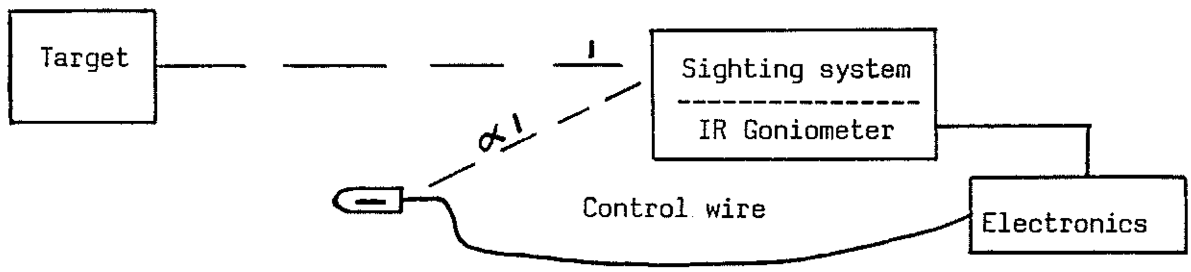


FIGURE 1

1.2 - Specific problems, in connection with night firing

The sensor used for night sighting should :

- have a very good resolution, in order to be capable of seeing a particular point on the target (e.g. the turret base),
- have a very accurate and steady reticle, readily adjustable, and easily collimated with the goniometer,
- not be blinded by the missile tracer, which involves :
  - . Selections of wave length for the imaging sensor
  - . A high dynamics of the detectors

. A geometry of the detector arrays, leading to avoid cross-modulation

1.3 - Characteristics of the vision system

The night firing and observation mission requires a number of characteristics to be determined :

- Target detection capability : the target is located as a characteristic point not belonging to the landscape.
- Target recognition : this is the fact of distinguishing the vehicle type (Jeep, truck, tracked or wheeled vehicle ...).
- Target identification : this is the possibility of indicating the name of the vehicle (AMX 10, Chieftain ... tank).

The ranges at which the vision system is capable of detecting, recognizing and identifying the target do not depend only on its own characteristics, but also :

. on the target characteristics : dimensions, contrast,

. on the atmosphere transmission conditions (relative humidity, visual distance ...),

. on the observer (visual acuity, familiarization, training...).

2 - SELECTION OF A SENSOR

For night firing and observation, the 10 μ thermal imagers were chosen.

Advantages :

- It is a passive system, consequently a discreet system. No emission nor radiation which could cause it to be detected.

- The selected wavelength corresponds with the maximum of energy radiated by the landscape (about 300°K).

- The energy radiated by the tracer, which is maximum in the IR goniometer wave length, is notably reduced in the 10 μ band.

Disadvantages :

- The materials that present a transparency to the 10 μ radiations are rare and expensive (germanium and znse) ; their variation of index as a function of temperature is significant.

- Moreover, the wave length that is used requires, owing to diffraction problems, large diameter optical systems amounting to about 20 centimetres.

- The detectors must be cooled at 70°K.

Thermal imagers operation principle

Functional breakdown

Let's recall first that in the 10 μ band no sensitive surfaces equivalent to the vidicon are available.

Thermal imagers use then elementary detectors grouped in parallel or in series parallel, associated with a scanning system.

Depending on the level of the financial position or the level of technology attained, one places a higher or a lower number of detectors : 55 in France, 180 in the U.S.

They also include :

- An optical system with one or several fields.

- The preamplifiers of the detectors, and possibly the delay lines.

- A cooling system for the detectors based on one of the following principles :

  . Gas expansion in open circuit (Joule Thomson method), or

  . in closed circuit. The system includes then a compressor (Stirling cycle).

- An image reproduction system based on demultiplexing, which can be either mechanical (using the scanning system) or electronic.

- A display system which can be :

  . a "direct vision" system using L.E.D.'s.

  . by means of a C.R.T.

- A symbol generator allowing to introduce "inlays" in the display, and more particularly the cross hairs.

3 - SELECTION OF A PLATFORM

To fulfill the observation and firing mission, the thermal imager must be coupled with other sensors and be installed on a swivelling platform.

In order to eliminate the effect of the vibrations caused by the carrier, stabilization means are required.

Two methods can be employed :

- Stabilization of the platform itself, to the required accuracy.

Advantages :

Full uncoupling between the vehicle and the sensors. The sensors are just attached to the platform.

This is the so-called "inertial" solution, which is better for natural stability and minimizes the work of the driving elements (torque motors).

Disadvantages :

The core of the platform must always be in a trirectangular "canonical" position (rotation axes perpendicular to the line of sight, whatever the orientation of the platform may be).

The platform should have three to four axes, which leads to a higher difficulty of design specially when the platform includes a direct optical channel which must go through the gimbals of the platform.

- 2 level-stabilization

. The first level of stabilization is provided by the platform. The stabilization can be then of about 1 milliradian.

. The second level is the fine stabilization and is provided in the optical path of the sensor itself, e.g. by means of a mirror controlled by the stabilization residual value as detected by the gyroscope carried by the platform.

Advantage :

Simpler platform design.

Disadvantages :

The fact that the sensor takes a part in the stabilization sets problem of the electrical boundary between the sensor and the platform (gyroscope), which creates maintenance problems. Moreover, the gyroscope does not work as a zero reading instrument, which can induce scale factor stability problems.

4 - NIGHT ANTITANK ACTION

4.1 - Firing of the HOT missile from the DAUPHIN helicopter, VENUS system

In order to carry out the antitank action at night, the day firing system must be filled with an equipment designed to solve the problems in connection with the piloting of the helicopter and the setting to work of the weapon at night.

The Dauphin helicopter has, in addition to its rapidity and manoeuvrability, a carriage capability which allows it to be equiped for night flying and firing.

a) Piloting of the helicopter

The pilot is provided with image intensifier binoculars of the micro-channels type, enabling him to perceive the outside world.

b) HOT armament

- HOT/Dauphin standard firing installation (day time installation type).

The sight and the goniometer are gathered into a sight-localizer assembly installed on the cabin roof. The sight is filled with a stabilized mirror which makes the sighting quality independent of the carrier vibrations.

The optical part, with two magnifying powers, allows both ground observation and fine target tracking. The optical head can rotate by $\pm$ 120° with respect to the sight axis so as to allow observation on a wide front and firing during the evasive manoeuvres.

The eyepiece is located at the end of a telescopic arm and the operator directs the sight using a control stick.

Aiming assistance devices facilitate the aiming control whatever the helicopter motions may be.

The guidance electronics boxes are installed in the cargo compartment. A steering indicator is available to the pilot to enable him to steer the helicopter when a missile is to be fired.

The missile rounds are 8 in number, arranged in two faired pods that are attached to the ends of the multi-purpose weapons pylon. The launchers are slaved in elevation to the sighting optical unit.

c) Night firing installation (VENUS)

This is a "kit" designed to complement the day firing installation and which includes essentially :

- a stabilized platform located in the helicopter "nose", including :
  . a thermal imager

. a localizer

. a collimator

- An harmonization prism, outside the platform.

- A C.R.T. display unit, the image of which can be projected into the day sight eyepiece.

- The electronics boxes.

- The control unit.

- The cooling system.

d) Setting to work of the installation

The gunner uses the stick that is intended, in the day installation, to rotate the sight mirror.

On "night" position (control unit), the platform is controlled direct by the stick and the image from the C.R.T. appears in the sight.

The mirror in the day sight reproduces the platform position.

On "day" position at the control unit, the mirror of the day sight is controlled direct by the stick, and the platform reproduces the mirror position.

It is then possible any time during day-time observation to see the visible image or the "10 μ" image.

Depending on the case, the angle output given by the gonio of the day sight or by the one of the stabilized platform is transmitted to the firing unit and is turned into commands to the missile.

e) Characteristics of the main items

I - Stabilized platform

The platform is of the "2 stage stabilization" type.

The reference is given by a gyroscope. The platform deviations with respect to that reference are transmitted to the elevation and bearing torque motors of the platform.

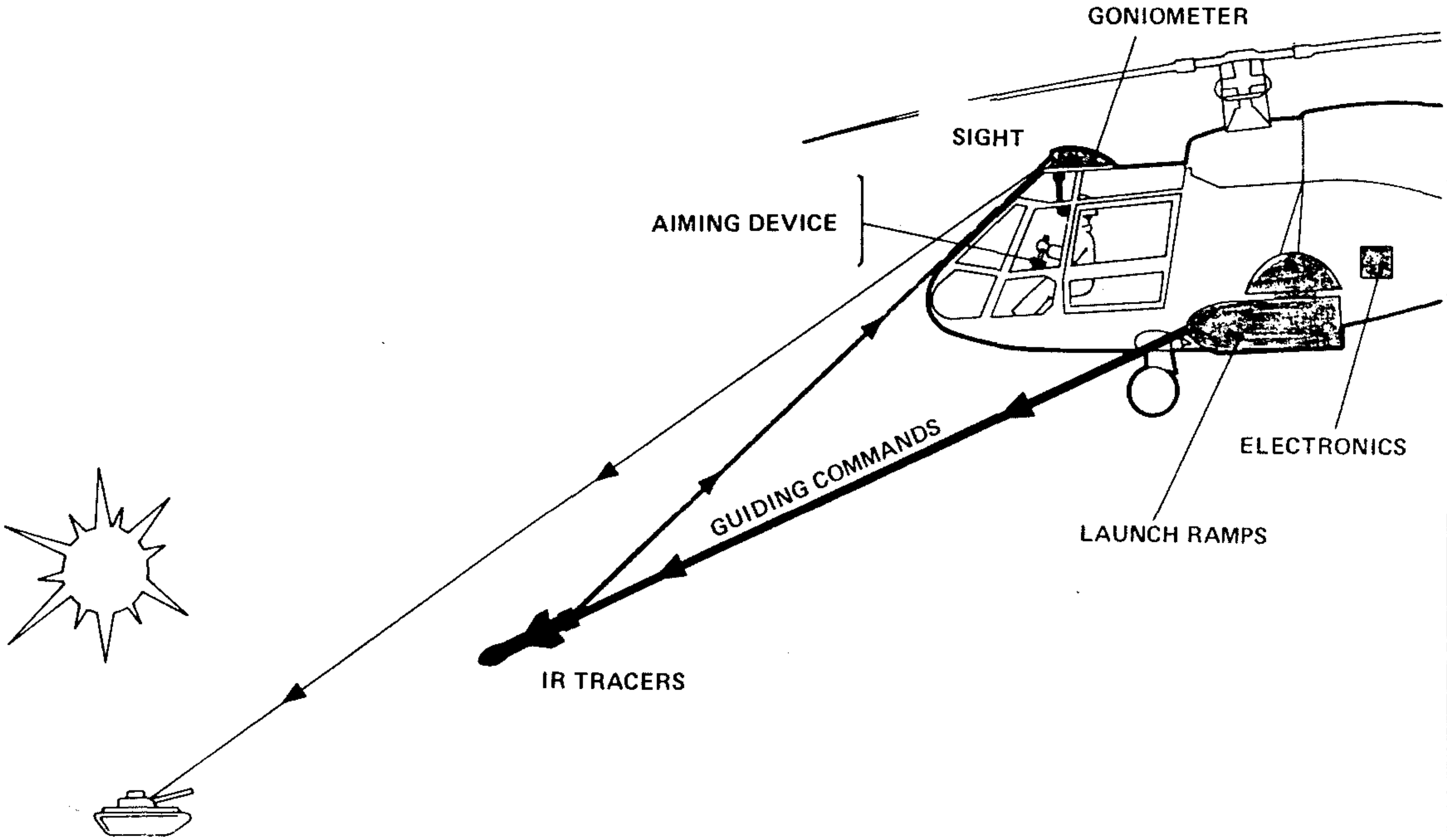
The residual error signal is sent to the secondary stabilization systems in the sensors.

In the thermal imager there is a stabilization mirror located on the optical path, after the lens. In front of the goniometer there is a diasporameter.

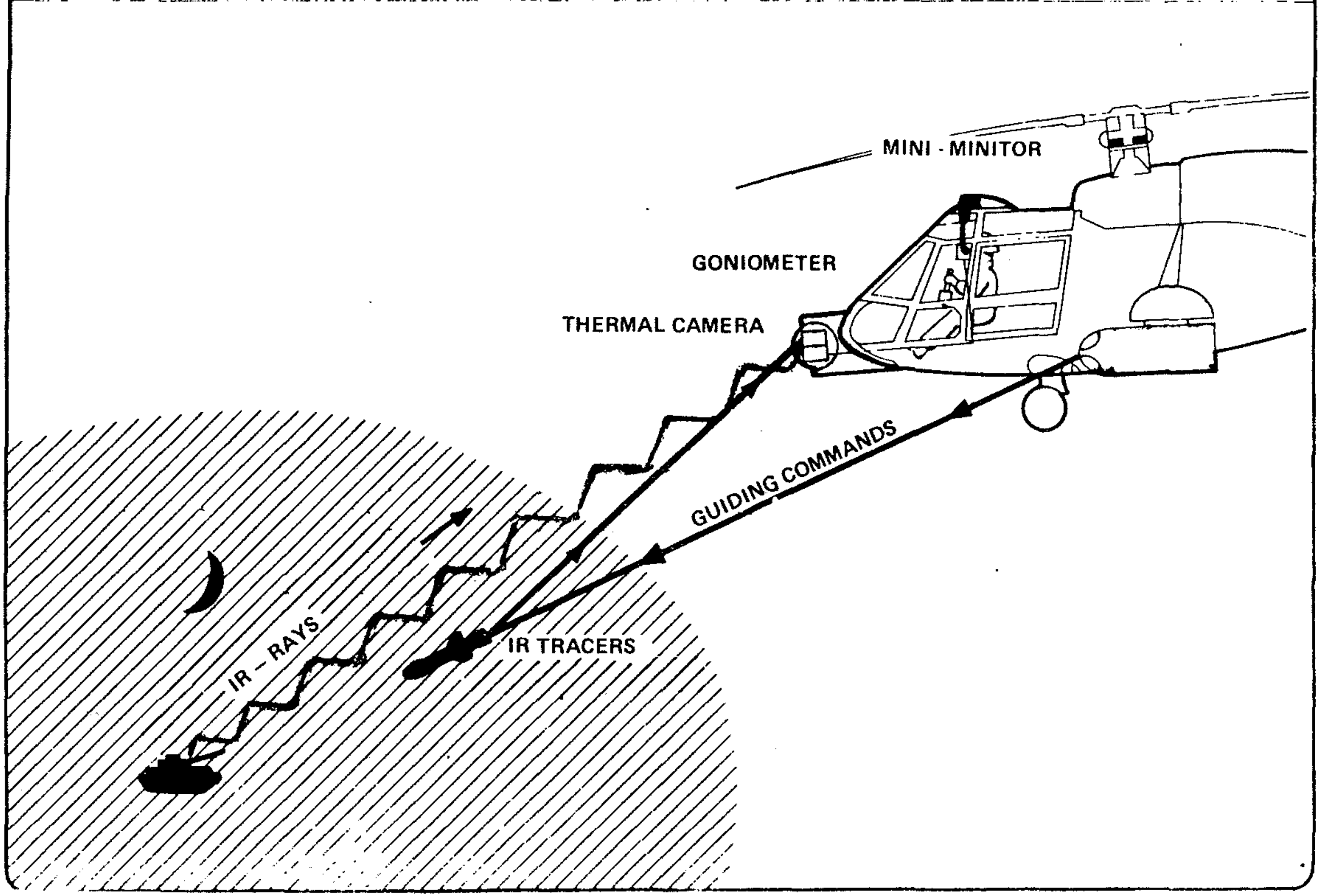
Training of the platform : the pilot, using the stick, sends precession orders to the gyroscopes.

HOT

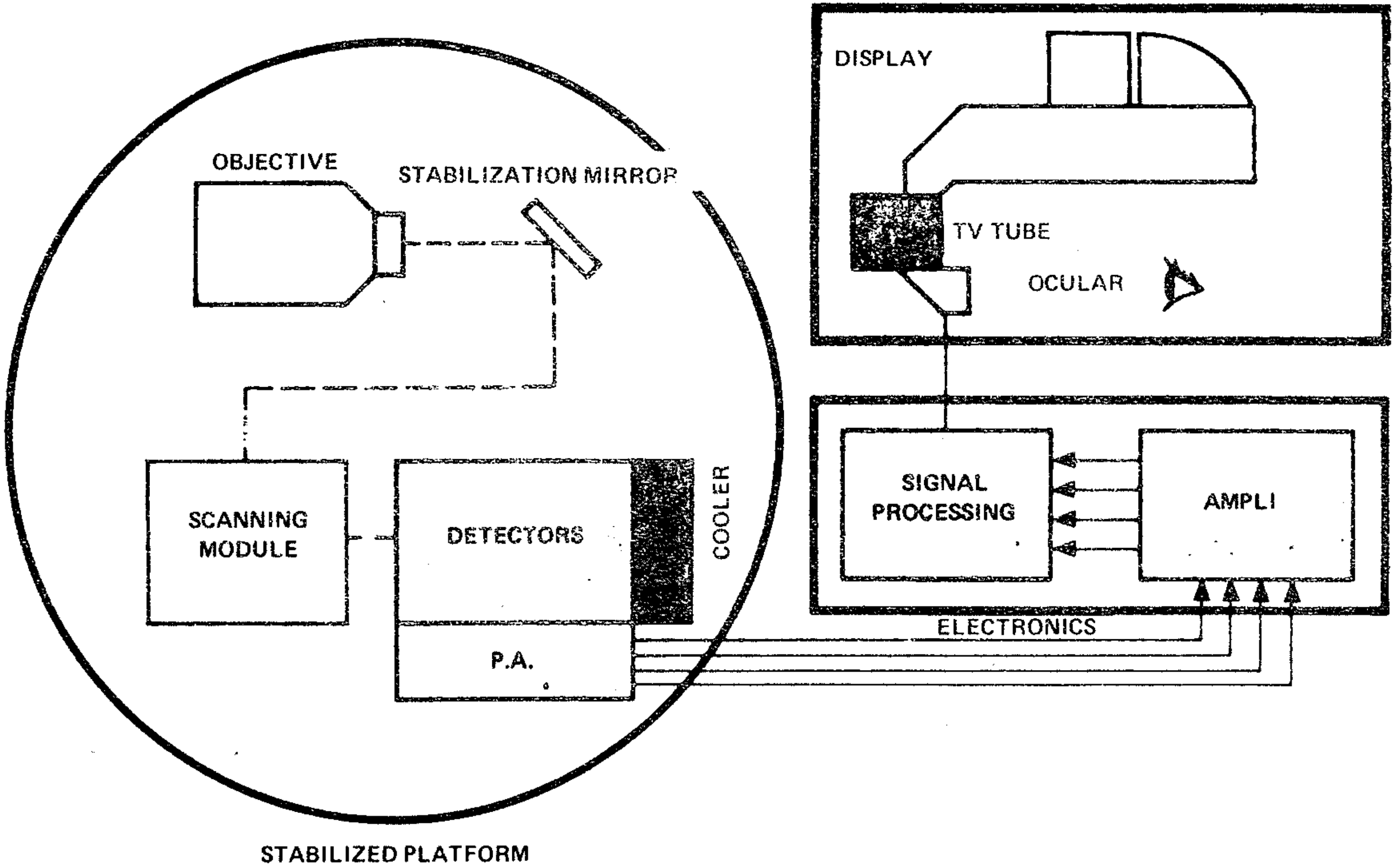
GUIDANCE PRINCIP – DAY FIRING



HOT GUIDANCE PRINCIP – NIGHT FIRING **VENUS**



HOT THERMAL CAMERA – BLOCK DIAGRAM **VENUS**



- Platform diameter : 600 mm
- Weight : 90 Kg
- Travel :
  . yaw : ± 110°
  . pitch : 20° up
    30° down
- Max. speed :
  . yaw : 1 rad/sec
  . pitch : 0.5 rad/sec
- Min. speed on both axes : 0.2 mil/sec

II - Thermal imager (T.I.)

It has two fields :

- large field (target detection) : 5.7° x 8.2°
- small field : 1.9° x 2.7°

Series parallel type scanning :

- number of detectors : 42 (7 x 6)

Thermal imager capability : 25 images/sec

Input pupil dia. : 150 mm

T.I. weight : 17.5 Kg

NOTE :

There is an electronic magnifying system at the level of the display to increase the thermal imager efficiency.

III - Cooling system

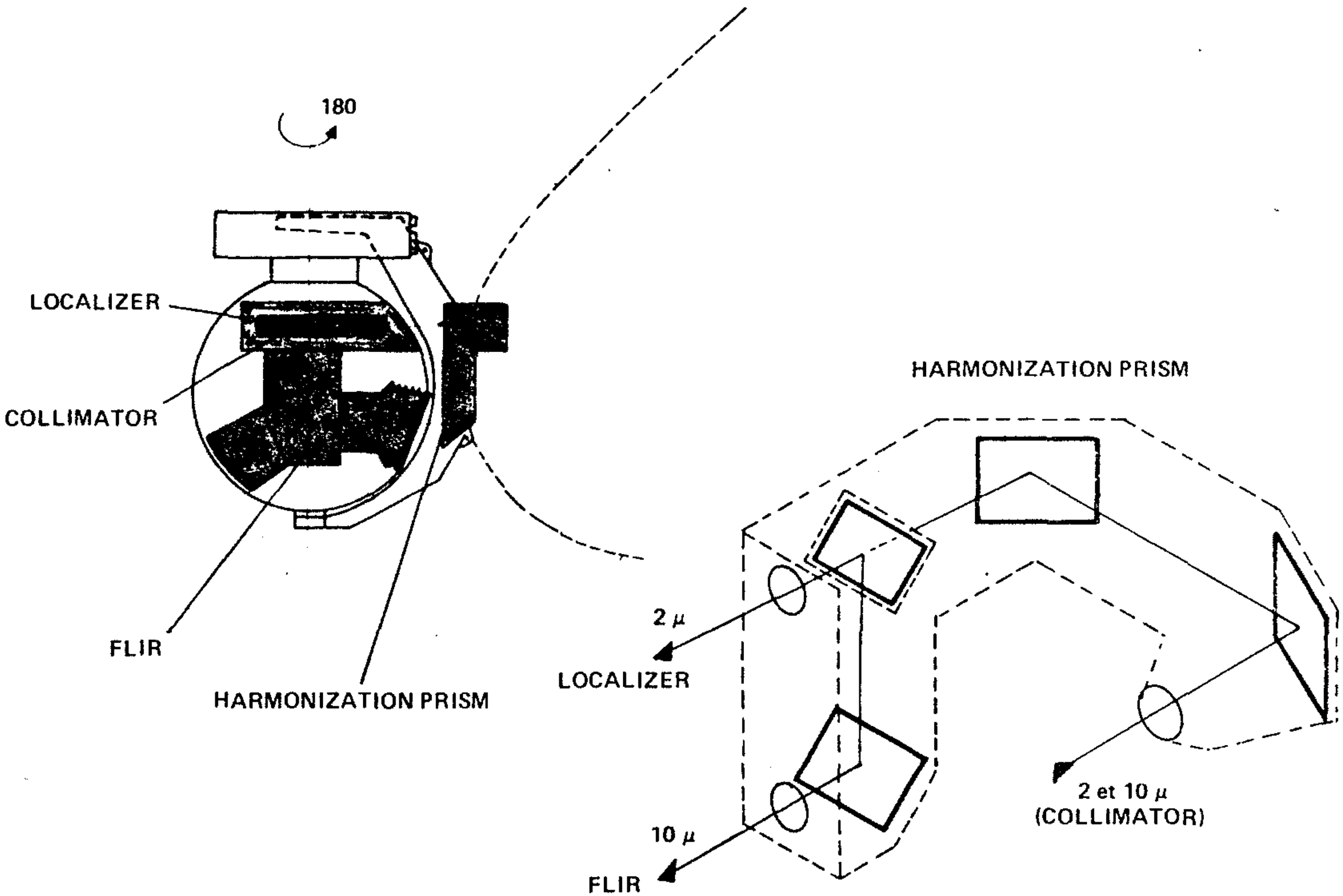
Cooling is achieved by Joule Thomson effect. The corresponding gas bottles are placed in the helicopter cargo compartment.

IV - Harmonization

Taking into account the very good behaviour required from the parallelism between the T.I. axis and the gonio axis, an in-flight harmonization device has been installed.

12.4.12

HOT HARMONIZATION **VENUS**



The platform includes a 2.2 μ and 10 μ emission collimator the beam of which is transmitted to the thermal imager and to the goniometer via a prism located behind the platform. *For that purpose the platform is rotated by 180° in order to face the trihedron.*

The T.I. is harmonized by adjustment of the crosswires (reticle).

The gonio harmonization is achieved by reducing to zero the residual angle error.

V - Performance data

NATO type targets	: 2.30 m x 2.30 m
ΔT/background	: + 2°C
ΔT/details	: + 5°C
Detection of the targets	: 4600 m on the average
Recognition	: 4200 m on the average

Firing results

Firing in various configurations :

- Stationary or moving target
- Helicopter : hovering
  forward flight (0 to 150 km/h)
  crossing flight

Firing to the HOT missile max. range

Results of the experiment (till April 1982) :

32 missiles launched
29 missiles corrects
25 target hits

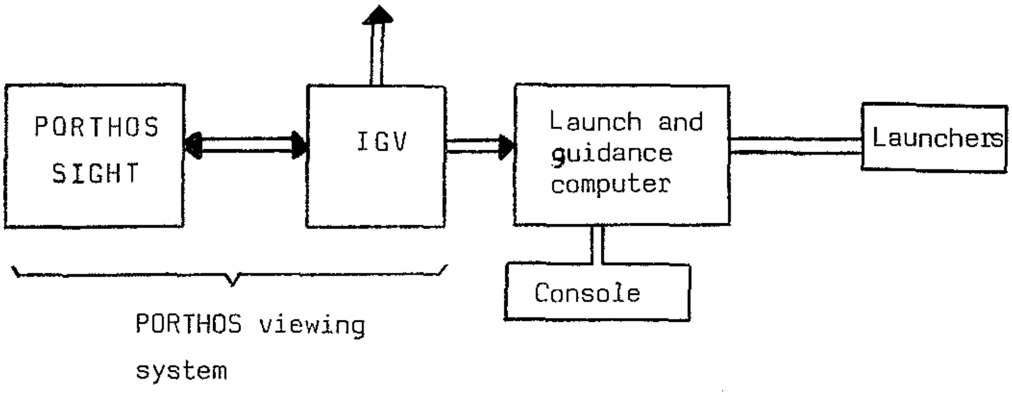
4.2 - Firing of the HOT missile from the HAC/PAH2 helicopter - PORTHOS system

The Franco-German helicopter HAC/PAH2 should be capable of firing the HOT antitank missiles.

The corresponding equipment has the day/night capability.

All the sensors that are necessary for the antitank mission are gathered on a platform called the PORTHOS sight.

The PORTHOS viewing system is connected on the one hand to the rest of the helicopter weapon system and on the other hand to the launch and guidance assembly which includes, in addition to the missile guidance computer, the two elevation trainable launchers carrying 4 HOT missiles each.



Definition of the PORTHOS sight

Location	: helicopter roof
Deflection	: yaw ± 120° pitch ± 25°
Stabilization	: 2 stages
Harmonization	: internal device

Sensors

Thermal imager	3 fields
TV camera	2 fields
Direct optical channel	2 fields
HOT localizer	2 fields
Laser rangefinder	

Main uses

- General and detailed observation at day and night.
- Distance measurement.
- Night piloting assitance.
- Gunner-helicopter pilot link.
- Coupling with the helicopter navigation system.

Besides, the system has the automatic target tracking capability owing to the processing of the signals from the various sensors.

Characteristics of the T.I.

In the french version it is based on elements of the SMT modular thermal system.

Image display is provided by a C.R.T. in which a very stable crosswires has been introduced.

Fine stabilization can be achieved :

- either by a mirror inserted after the lens,
- or in a semi-automatic way by modulating the scanning of the video frame.

The 3 fields of the T.I. are :

- large field : 5.4 x 8.1°
- small field : 1.8 x 2.7°
- control field : 30 x 45°

T.I. harmonization

It can be done in any position of the sight (internal harmonization).

5 - POTENTIAL APPLICATIONS OF THE PORTHOS SIGHT

The applications of the PORTHOS sight that can be envisioned for subsequent developments could be :

. installations as a mast mounted sight

. firing of air to air missiles

. firing of 3rd generation antitank missiles

Installation as a mast mounted sight

The modular design of the PORTHOS sight and the fact that the harmonization device is fully incorporated into the sight make it possible to convert it into a mast sight without any fundamental change. This however would require the suppression of the direct optical channel.

Firing of Air to Air missiles

The PORTHOS sight includes all the sensors allowing acquisition of helicopter type air targets, either by detection by the gunner himself or by indication by the pilot through his helmet sight. The platform is then rotated and can supply the missile seeker with the data that will allow it to acquire the target before the firing or possibly during missile flight.

Moreover, and in so far as the harmonization problem would be settled, the PORTHOS sight could provide data allowing gun firing.

Firing of 3rd generation antitank missiles

In the present state of considerations concerning the 3rd generation antitank missile, it is planned to develop a"Fire and Forget" type missile fitted with a seeker.

The design of the PORTHOS sight make it possible to arrange the sensors so as to make them suited to the performances of that missile.

An appropriate processing of the signals delivered by the sensors and more particularly the thermal imager should allow to make a correlation with the image seen by the seeker and to designate the target to the missile with a high accuracy.

6 - CONCLUSION

With development of the VENUS system, with the study of the PORTHOS viewing system ("visionics"), essentially evolutive, and having solved the specific problems of night firing, SNIAS has gained the means for providing the present and future helicopters with the day-night antitank capability.