

Radar Systems International

MARCONI

No. 23

Complete Trials Success for Precision Radar Tracker



ST858 antenna installed at Larkhill.

Range Instrumentation Radar for RAE

A specialized version of the versatile Marconi S800 Series tracking radars has been developed as a precision tracker designed to provide accurate data on the trajectory or flight path of missiles or airborne objects.

Since being delivered to the Royal Aircraft Establishment for installation at the Royal Artillery range at Larkhill, this radar has proved capable of producing tracking data on a wide range of ballistic experiments with a speed and accuracy well beyond the expectations of the operators.

A major feature of this radar, ST858, is the ability, when locked on to an aircraft, to instantaneously change to a small object leaving the aircraft and lock on to the new target and track it, recording and displaying information on range and movement. This enables complete tracking of aircraft, missiles, store-drops, ejector seats, etc.

Another important feature is the ability to track targets carrying a transponder, this facility widens considerably the range of uses to which this specialized radar can be put.

It is capable of tracking projectiles with calibres down to 20mm, will lock on at a range of 320m and



Control console of the ST858. The PPI in the foreground displays tracks, the A scope shows the target signal and the TV monitor above is locked on to the radar boresight.

provide precise data on trajectory and drift. Maximum unambiguous tracking range in MT1 mode is 24km, in the non-MT1 mode, the range is 80km.

This equipment is permanently installed, but it is designed to be supplied in an air-conditioned cabin capable of being towed or loaded on a truck.

Another Overseas Order for Radar Enhanced Tigercat

Tigercat

High speed, low level attack aircraft can operate day or night in all weathers and defence against such an intrusion requires immediate reaction and accuracy from ground based weapons.

The well proven Tigercat ground based missile, along with the naval version, Seacat, is in service in all parts of the world in this vital defence role. Many customers, both in the UK and overseas, are aware that the full potential of this missile can only be realized by the addition of the automatic tracking radar and the latest order for this version of the well-known 800 Series comes from overseas.

Radar Operation

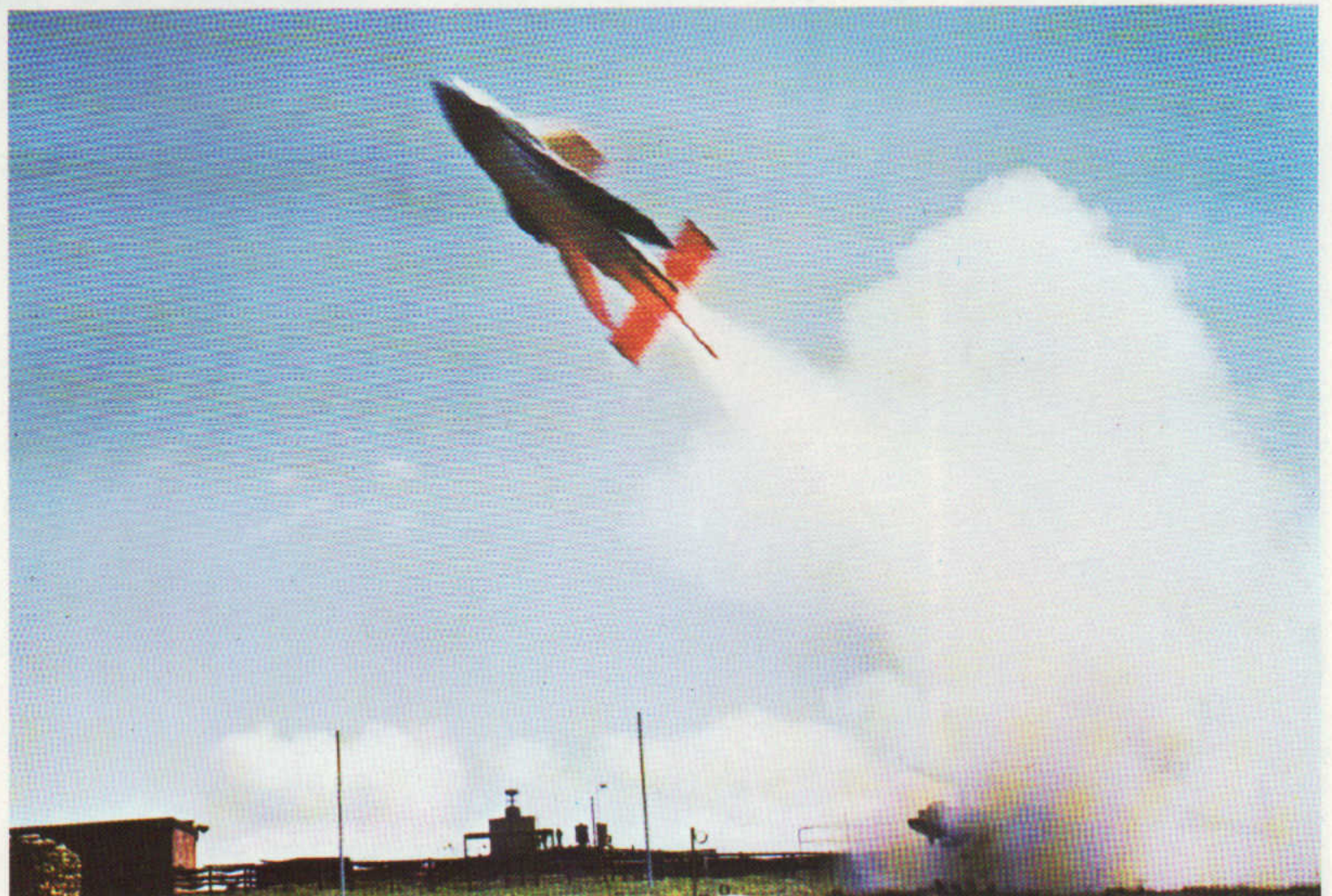
The addition of a tracking radar to this potent weapon system provides dark fire capability which continues

the excellent performance into the hours of darkness and the automatic tracking facility greatly improves its performance. Carrying a trio of missiles, each with an explosive warhead and fuzes covering a large triggering zone, the launchers release each missile under the control of a tracking radar which guides it along the sight line to impact.

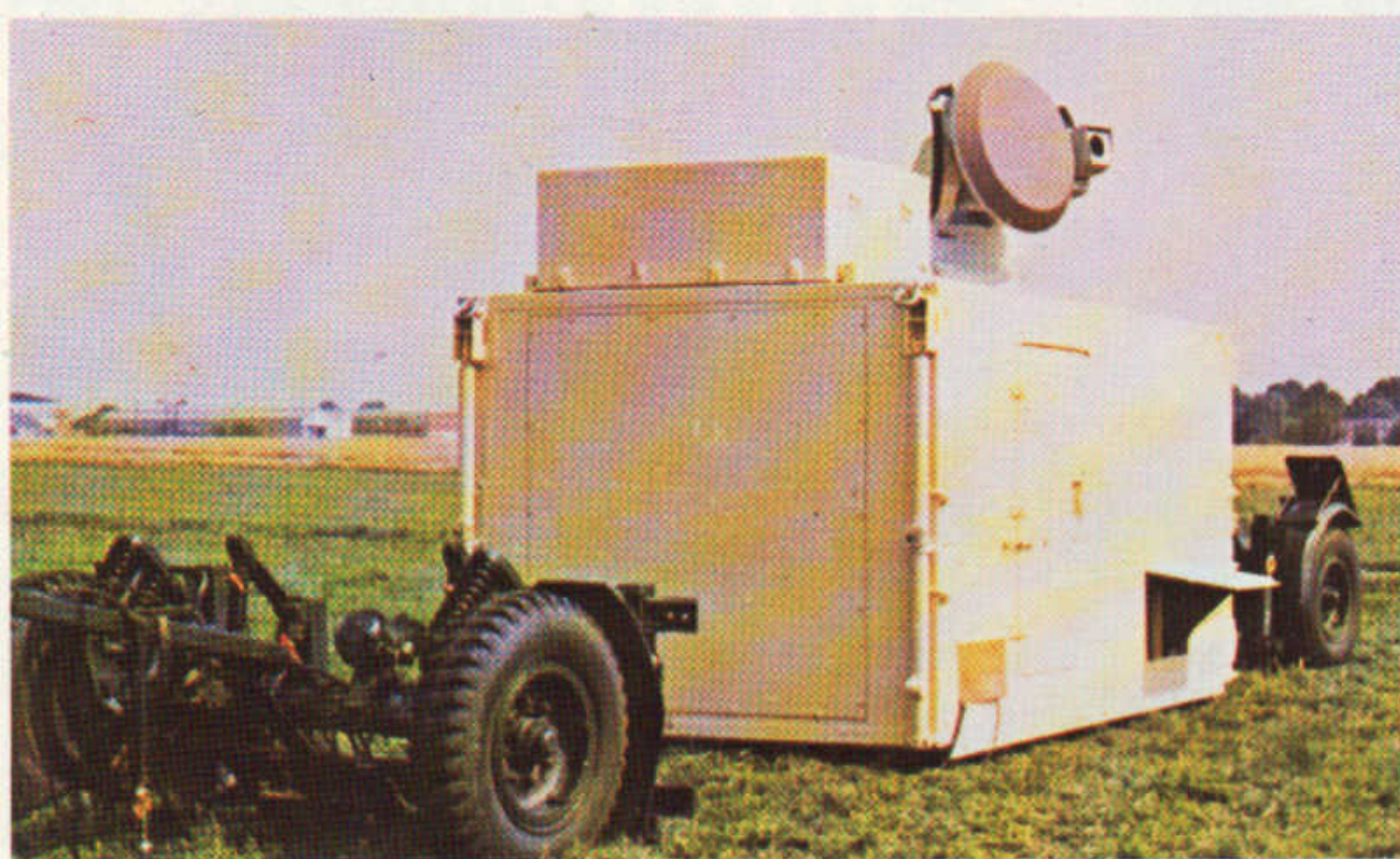
The approaching target can be detected at over 20km away in daylight or dark and the missile can be launched within nine or ten seconds against a Mach 1 low-level attack. The system has pulse-radars with doppler processing for surveillance and tracking with a television camera for automatic gathering to the target sightline.

Fire Control Unit

This is an ST850 fully automatic



The performance of the Tigercat ground-to-air missile is enhanced by the use of the ST850 automatic tracking radar.



The Fire Control Unit and the Command Post cabins are air-conditioned and fully transportable.

tracking radar, a television system and weapon control consoles. All equipment is housed in a mobile air-conditioned cabin. The initial target data is normally derived from a surveillance radar, but the ST850 is capable of providing excellent low cover surveillance. One Fire Control Unit can be allocated to a group of Tigercat launchers.

Command Post

A larger cabin equipped with a surveillance radar and extended display console serving as the site commanders H.Q. From this console targets are allocated to up to four Fire Control Units or optical directors. Each Fire Control Unit can operate independently, using information on the overall air

picture.

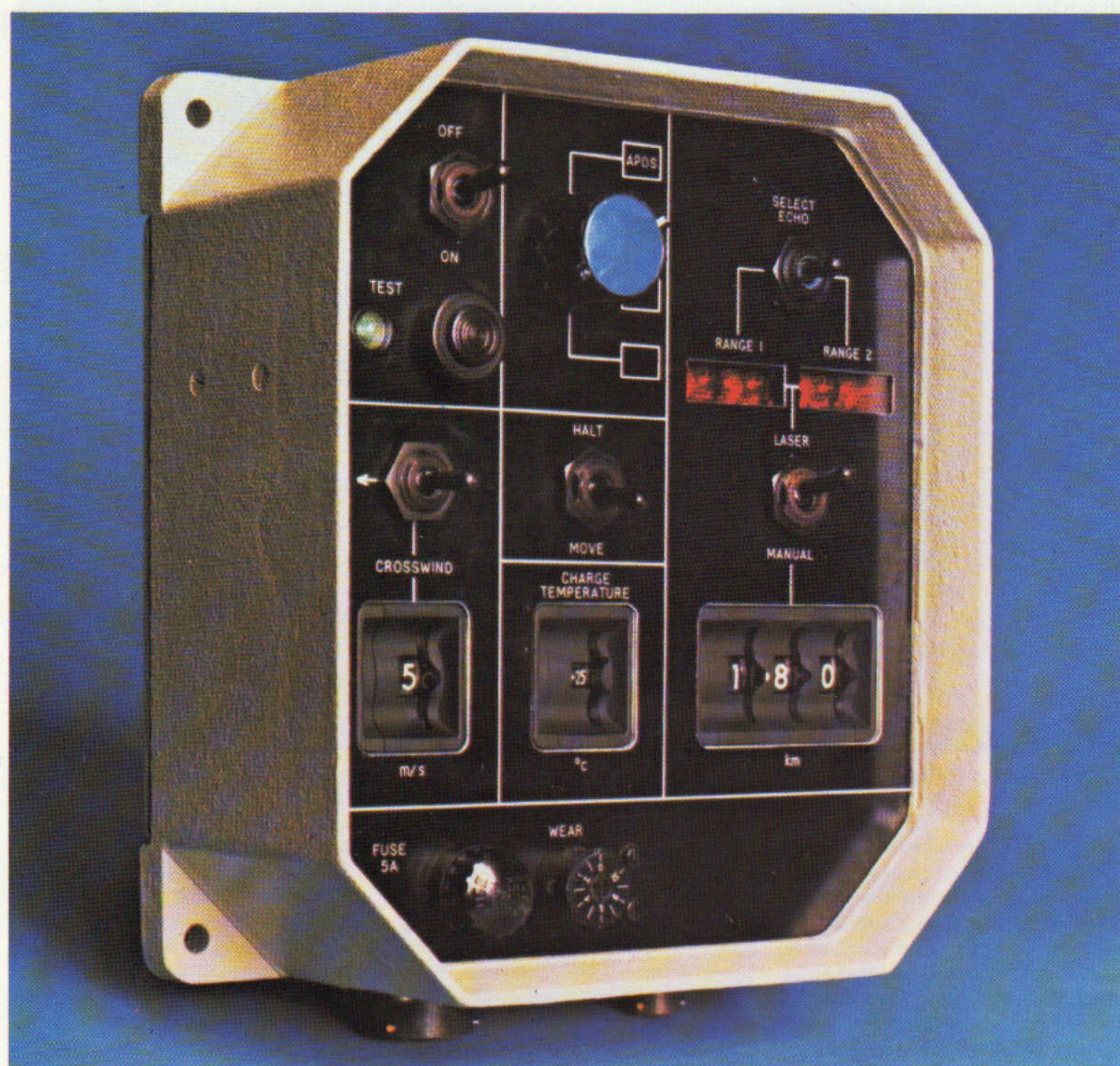
The Tigercat weapon system is in service with the Royal Air Force Regiment and many overseas defence forces. The missile has proved its reliability and superior performance at long or short ranges and will continue in service, together with the naval version, Seacat, well into the 1990s.

The Marconi SFCS 600 Fire



Vickers battle tank at Lullworth firing range.

The Aim is a First Time Hit



The Marconi SFCS 600 Fire Control System for tanks provides the gunner with a computerized system which calculates the parameters affecting the true aiming point to achieve a first time hit in the shortest time.

The units of the system have been carefully designed to permit fitting into a wide range of battle tanks and enables existing tanks to be readily up-dated by a simple retrofit program. The small physical size of the units of the system allows great flexibility in the location and fitting with a minimum demand for space in the turret.

Minimum Cost Maximum Performance

The philosophy throughout the design and development stages has been to provide the maximum first round hit probability combined with minimum cost; this has been achieved by identifying the major causes of aiming error and effectively reducing these whilst retaining the low cost objective.

The success of the system has been clearly demonstrated at a number of firing trials using stationary and moving targets with an extremely high percentage of first round hits at all ranges.

In answer to the wide interest that has been shown in this versatile, cost-effective system, a film has been made to enable enquirers from UK or overseas to see the remarkable performance of this system in action.

Operation System Test and Preparation

The Fire Control System is switched on. Upon pressing the TEST button a spot of light appears in the sight and the system is ready.

The Laser Rangefinder is switched on and fired at a suitable target and the range display in the eyepiece is checked. If correct, the LASER/MANUAL switch is set to LASER and the RANGE GATE control is checked against the target.

Set CROSSWIND and AIR DENSITY switches to AUTO (if sensors are fitted).

Set in the charge temperature read off from ammunition stowage thermometer.

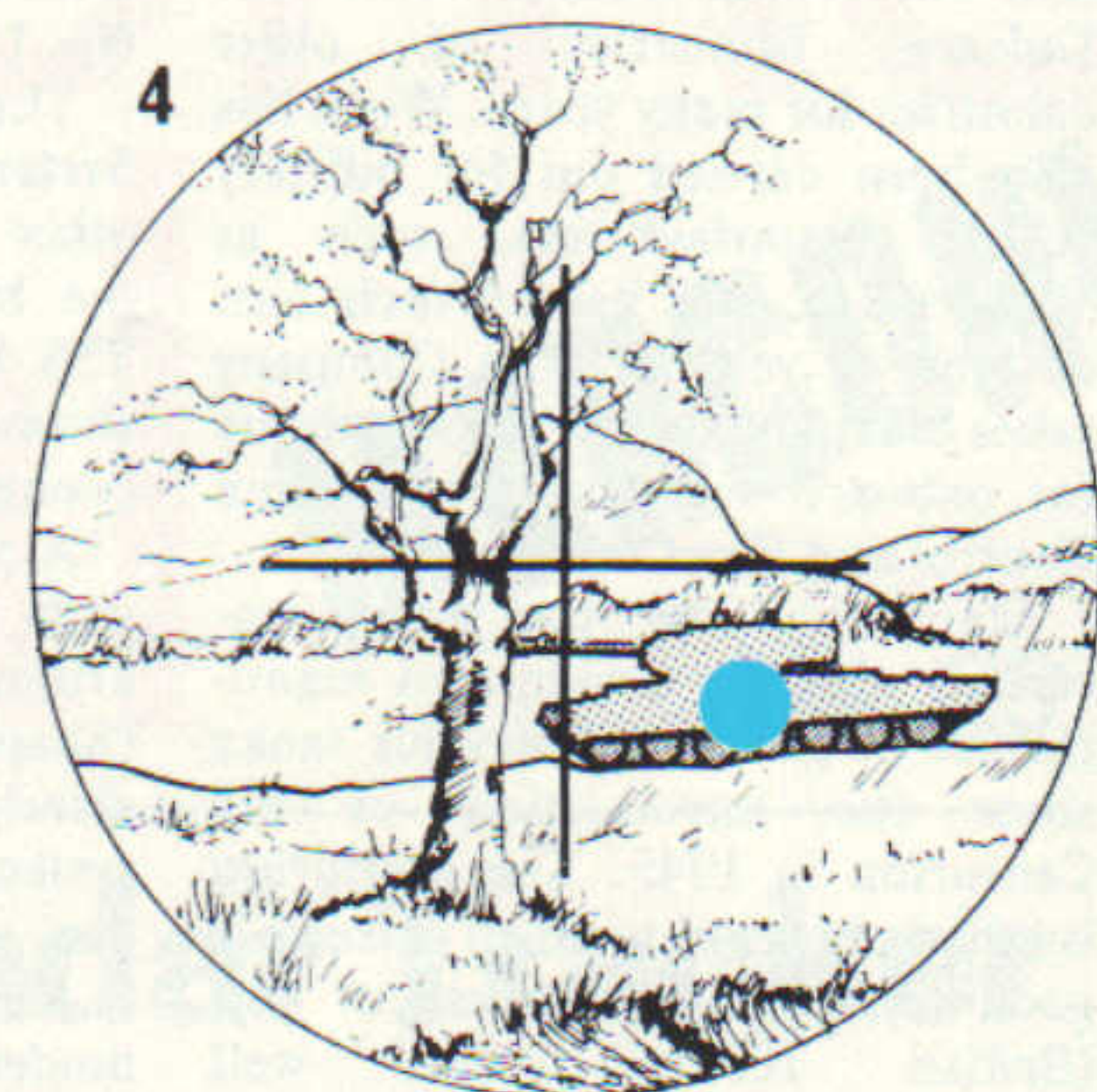
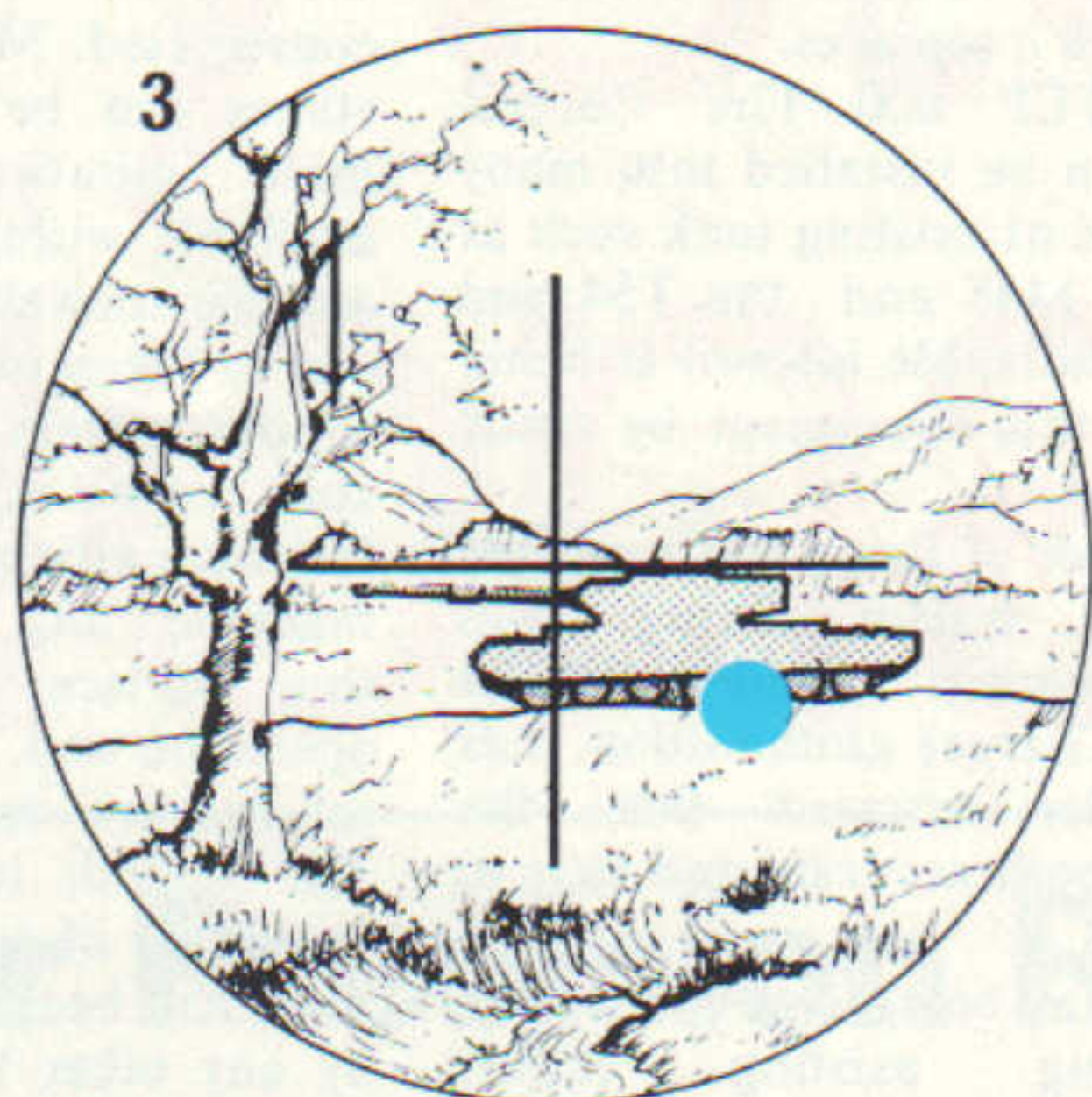
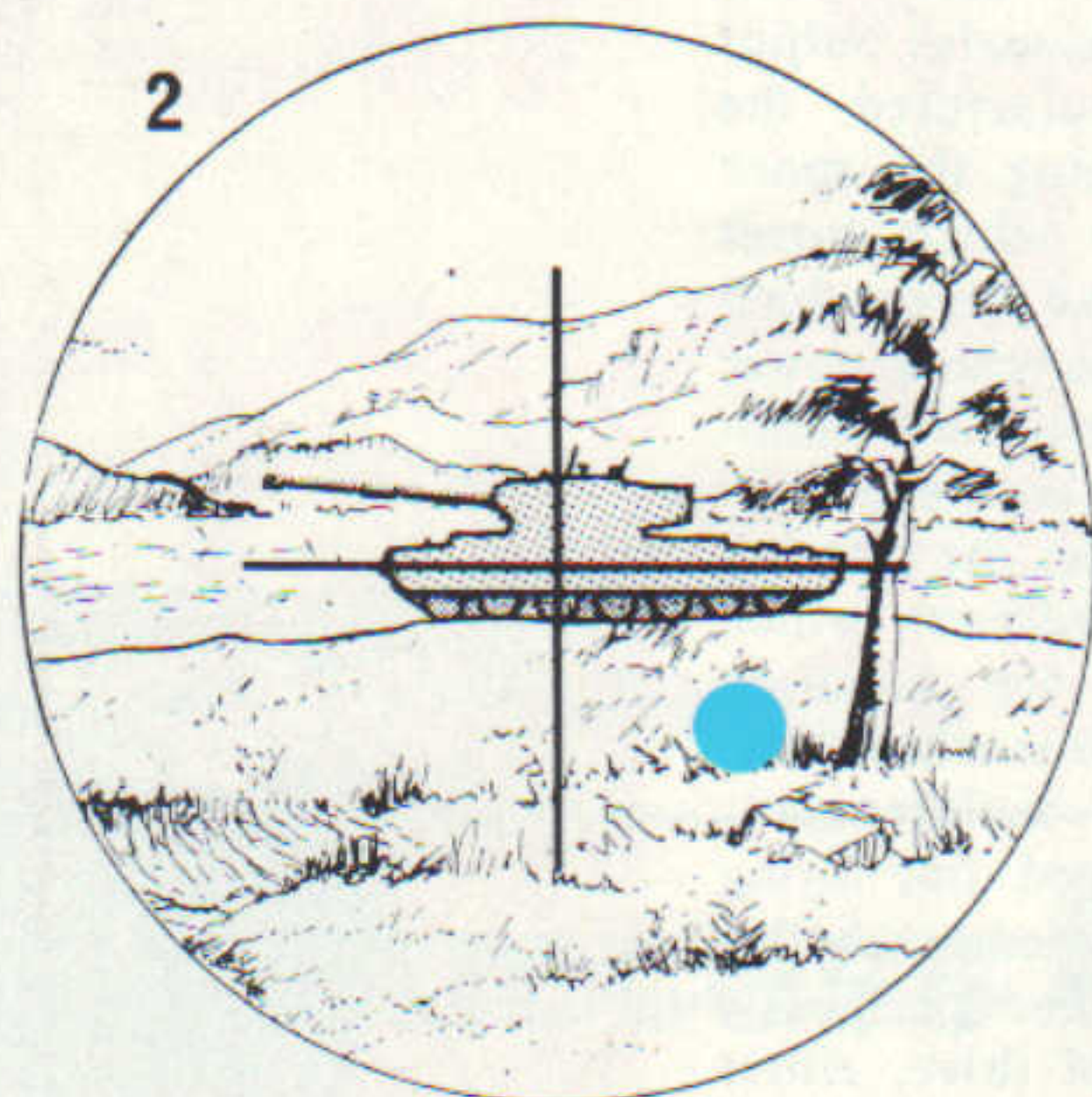
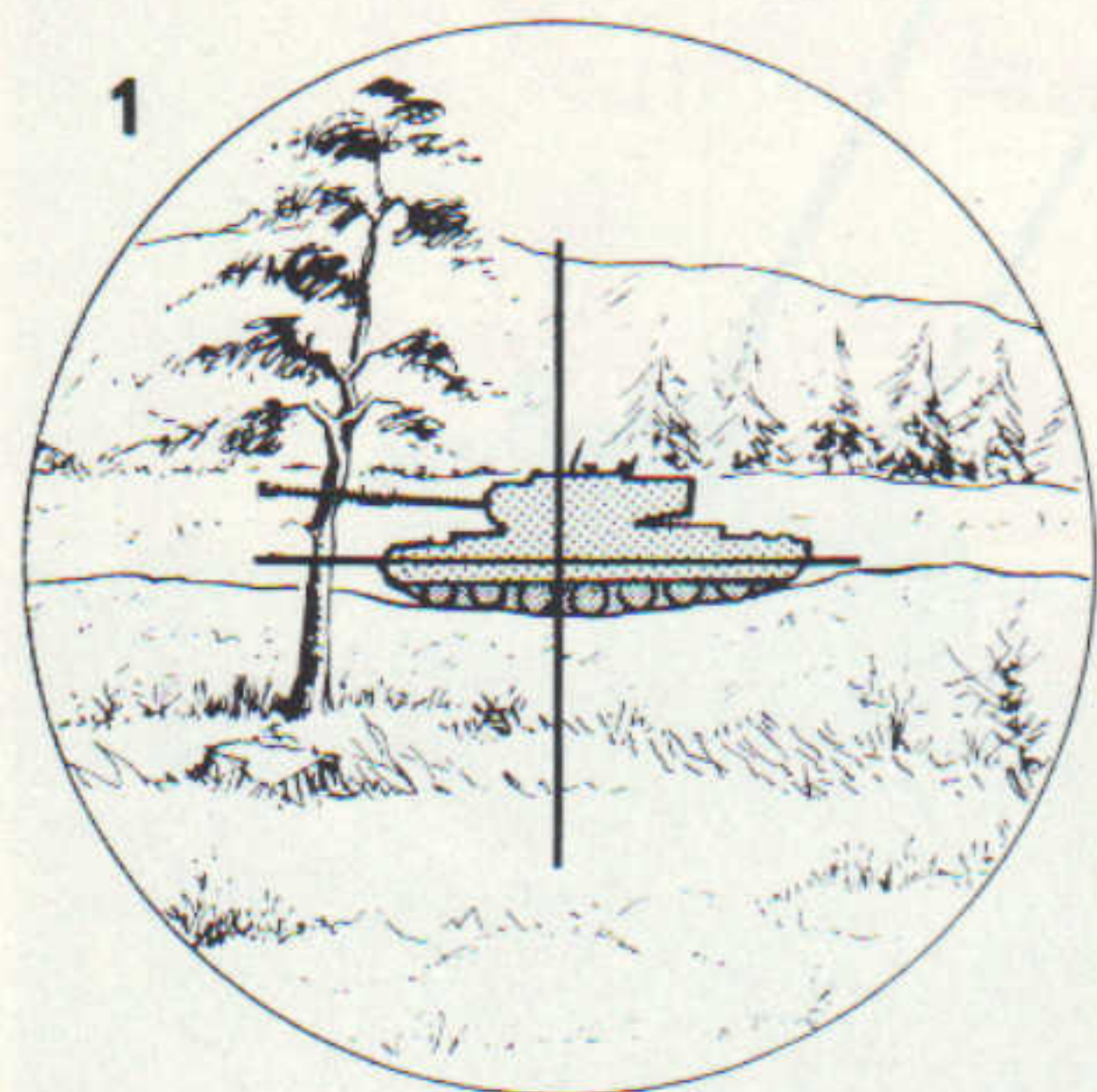
Set AMMUNITION SELECT switch to type of ammunition to be used. The system is now tested and ready for firing.



Control Panel CP1522.

Tilt Sensor Unit TS1341.

Control System for Tanks



1 Gunner acquires target and begins to track. When tracking smoothly, the laser button is pressed. This informs the computer that the tracking sequence has started. At the end of the tracking sequence the laser button is released and the laser is fired.

2 The computer calculates the lead and superelevation angles. An aiming point is generated and appears in the gunner's field of view offset by the calculated amounts.

3 After calculating the lead and superelevation angles, the computer

also generates signals which are fed into the gun servo loops. These cause the gun to move to bring the aiming point and target into alignment.

4 Aim-off sequence is complete. The gunner corrects the final lay to bring the aiming mark accurately onto the target centre and the gun is fired.

Great interest was shown during firing trials by UK and overseas visitors.

Firing Sequence

On instruction from the tank Commander to engage a target, the required ammunition is selected, the gunner aligns his sights on target and presses the laser firing switch. The computer now starts operating and the gunner follows the target (if moving) for about 1.5 seconds, or as long as required. Providing the target is centred on the crosswires at start and end of tracking, the computer will calculate the correct lead angle. With a stationary target the Laser Fire switch may be pressed and released immediately. A light spot in the sight moves away from the target to an off-centre position. This is the correct aiming mark to allow for range, target speed and all other meteorological and ballistic factors.

This light spot in the sight is brought onto the target and the gun fired. Against stationary targets a typical reaction time of 5 seconds is achieved with very short crew training. With moving targets reaction time is also greatly reduced.

Computer

The compact, rugged digital computer carries out the calculations for gun alignment by sampling the input data and correlating these

with information stored in the memory. The output is used to produce the offset aiming mark in the gunners sight.

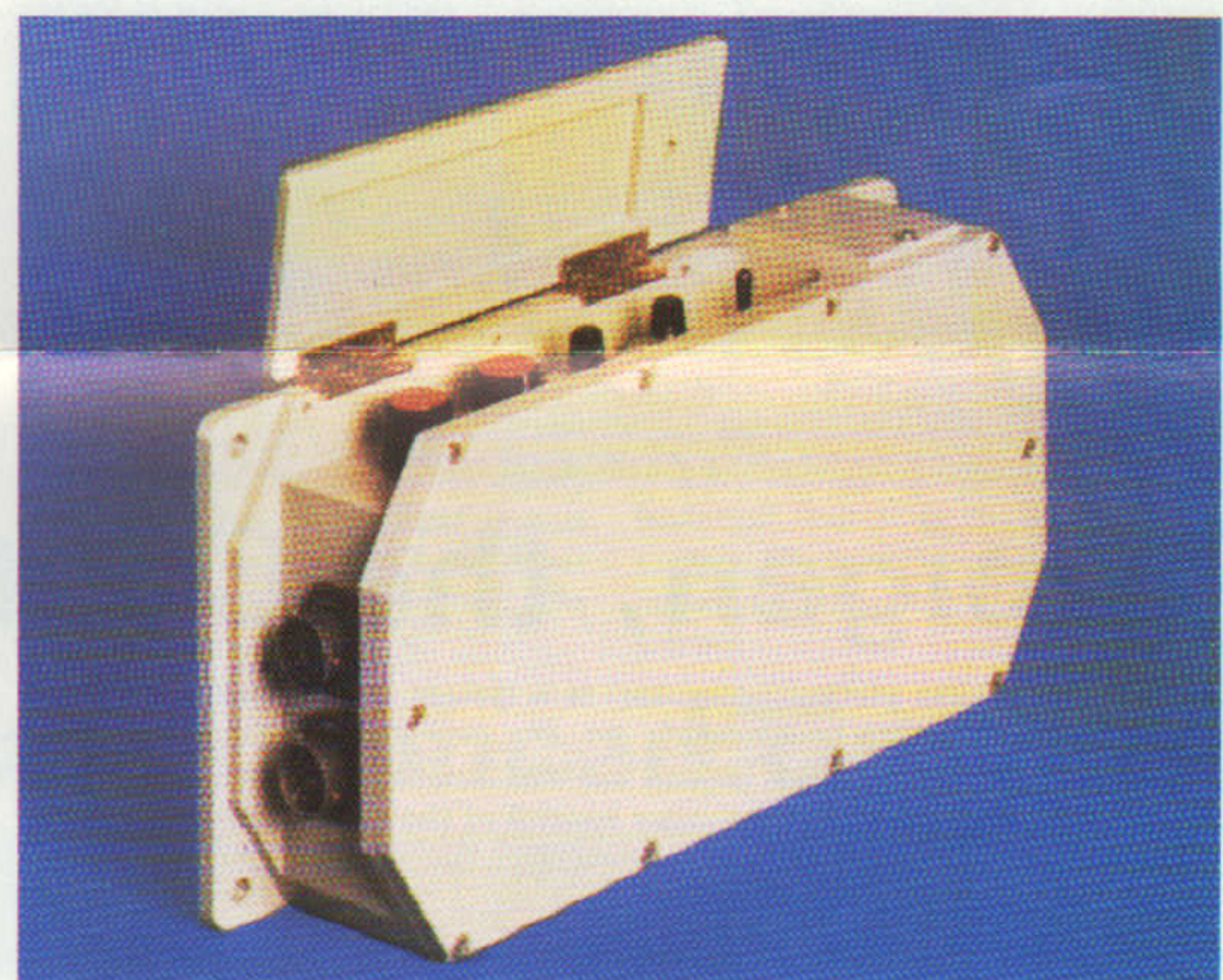
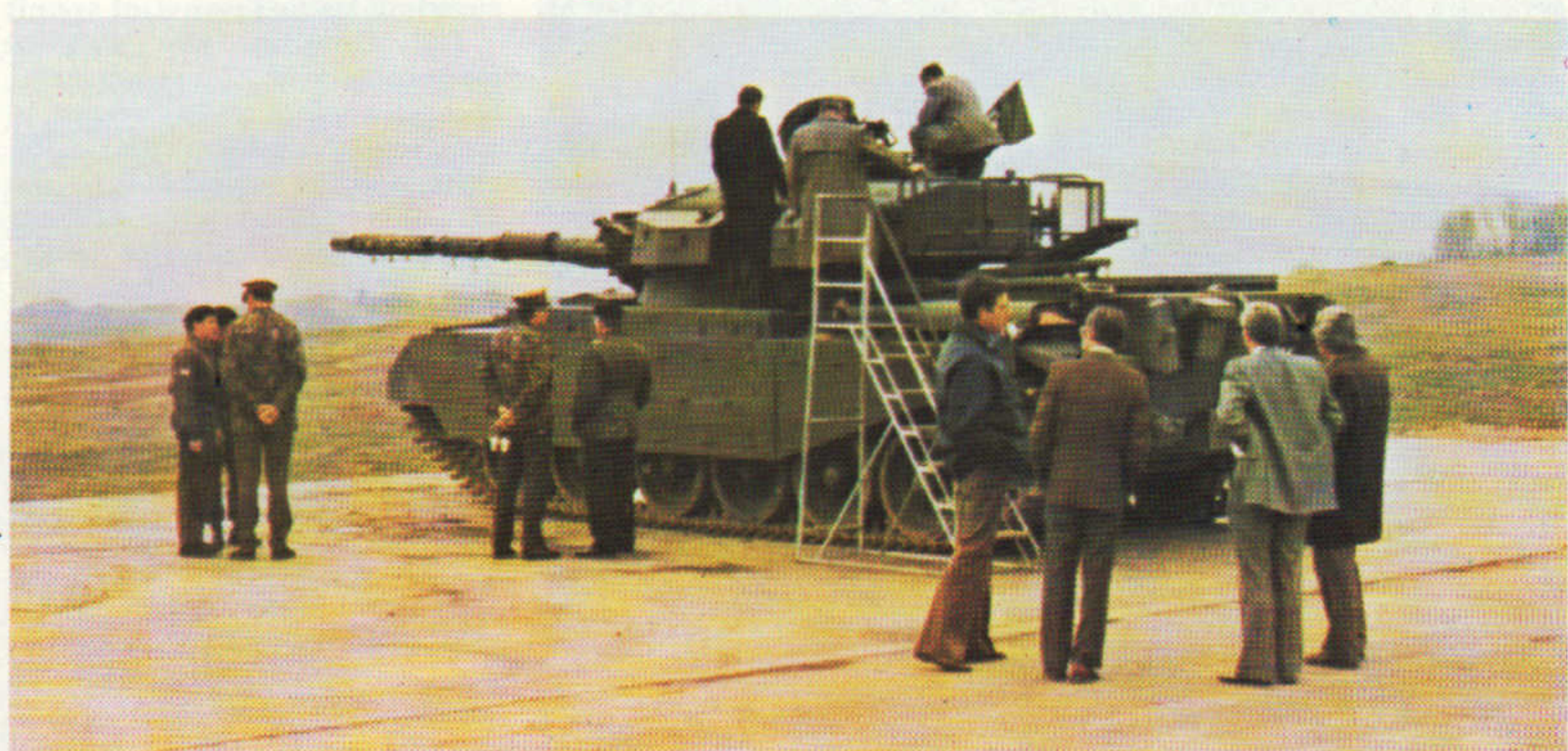
Sensors

Certain data is put into the control panel, such as ammunition type, charge temperature and periodic adjustments for barrel wear.

However, a number of sensors are available, which are designed to be incorporated in the system, although manual inputs are still provided on the control panel if sensors are not required or in the case of damage or other incapacity. These are the crosswind and air density sensors set outside the hull of the tank.

Other sensors are an integral part of the system, such as the tilt sensor on the trunnion of the gun carriage and the pick-offs which analyse the rate of gun elevation and traverse.

The SFCS 600 system is particularly suited to battle tanks such as the Centurion, M47, M48 and the T54 and T55. The equipment is designed to British Military standards and uses NATO approved components.



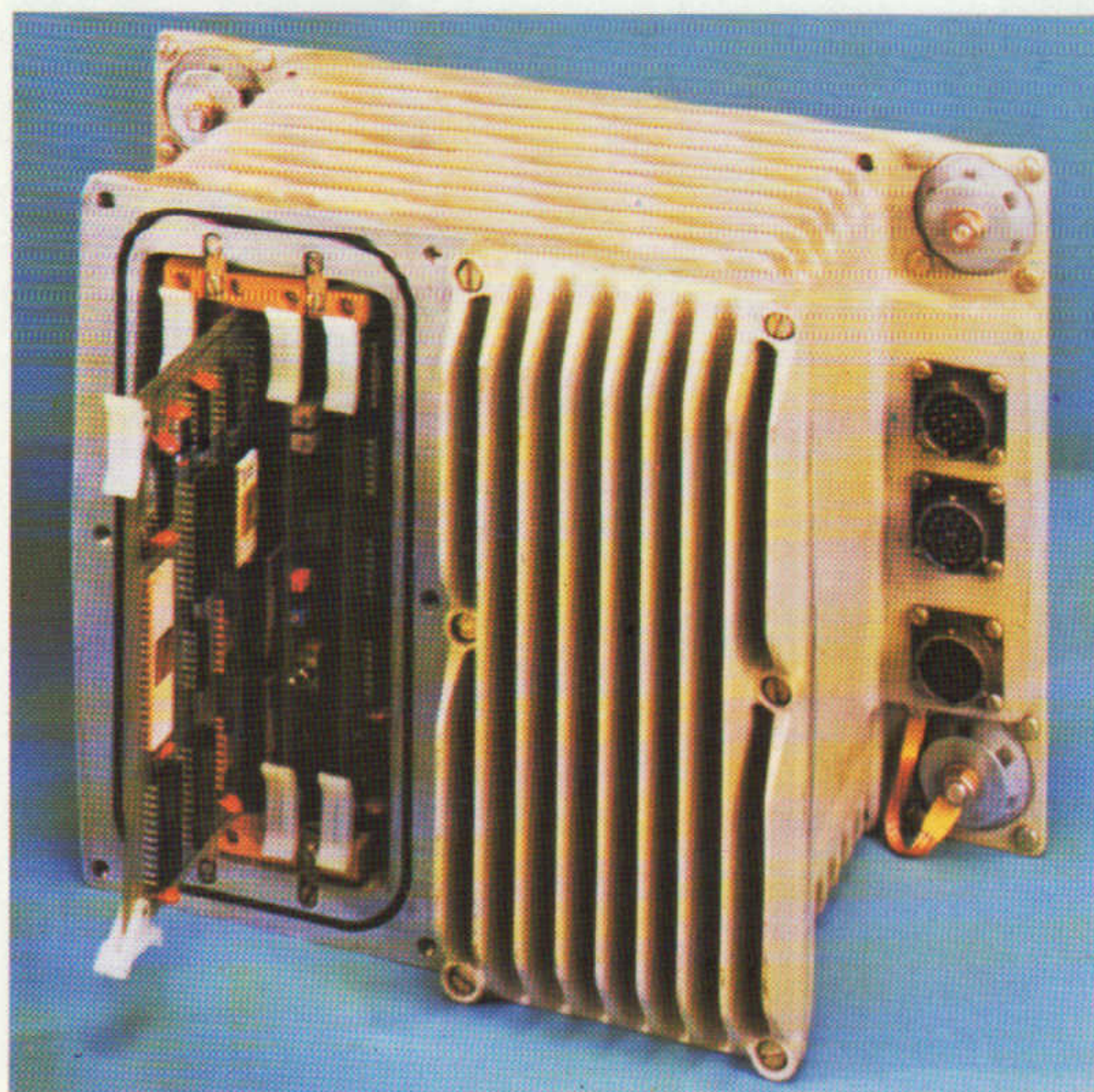
Spot Injection Unit SP1521.

Marconi Gun Control and Stabilization Systems

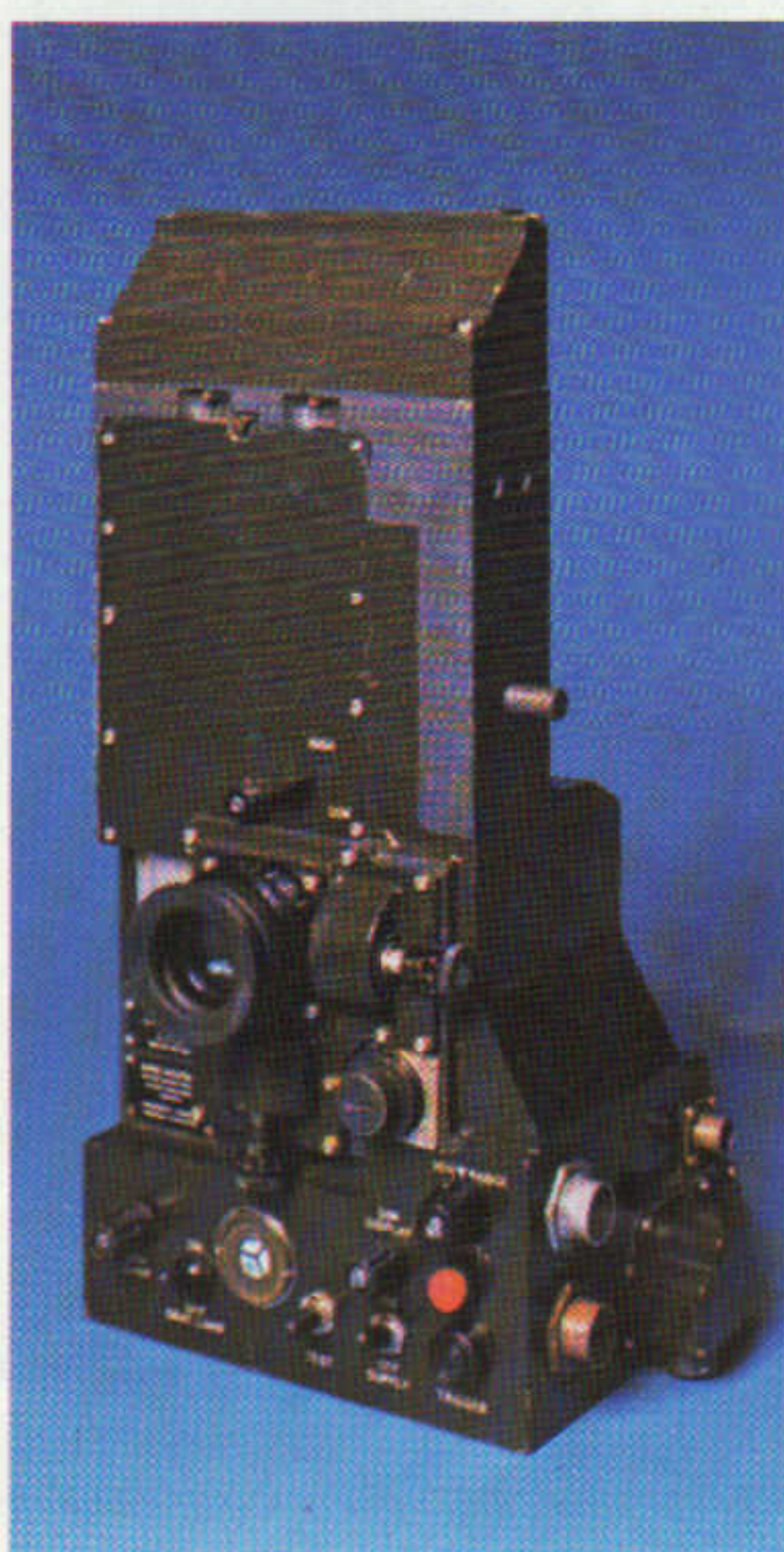
These systems are now standard equipment on new Centurion tanks. The equipments are designed to give the tank gunner the ability to maintain the gun aiming point on the target whilst the tank is on the move. Gyroscopic units detect every motion of the tank as it travels across the roughest terrain and transmit signals to the gun servo controls, keeping the gun aligned on the target in spite of the tank's motion. When fitting to existing

tanks, the condition of electrical and mechanical equipment must be in reasonable working order, and Marconi engineers will advise upon the performance to be expected from the tank when the Gun Control and Stabilization system is fitted.

This system will give any Centurion, however old, a better performance and, together with SFCS 600, will bring it to modern front line standards at a reasonable cost.



Computer EC600 with half lid removed and programme card half withdrawn shows ease of programme change for differing ammunition types.



The SFCS 600 Fire Control System will interface with a number of Laser Range Finder Gunner's Sights. Shown above is the Ericsson sight; below, the Avimo LV2, both typical sights for the Centurion tank.



A film being made which is available showing the successful demonstration of the SFCS 600 and Gun Control and Stabilization system.

Technology in the Service of the Army

Marconi Radar has worked on Army projects with the British MoD and in collaboration with the Defence Ministries of other countries for many years. Work has also been carried out for military vehicle manufacturers, such as Vickers Ltd., for use on their own designs of vehicle. The Company takes complete design responsibility for onboard systems such as Gun Control and Fire Control.

Marconi Radar has been concerned with the design and manufacture of gun stabilizers for tanks since the introduction of the Centurion in 1945. The Centurion is still considered to be an extremely good tank, with an excellent gun (British 105mm) and well armoured. In consequence many Centurion owners are carrying out a complete retrofit programme in which the vehicle automotive performance would be improved by installing a diesel engine. The Marconi fully transistorized Gun Control and Stabilization system is offered as part of this programme. This produces an excellent stabilization accuracy when the vehicle is

moving cross-country and has many other advantages over the thermionic gun control system FV/GCE No. 1 which it replaces.

The SFCF 600 Fire Control System can be installed into many other types of existing tank such as the M47, M48 and the T54 and T55. Considerable interest is being shown in this equipment by many countries.

A number of firing trials carried with this system, firing both armour-piercing and HESH (Shaped Charge) ammunition, has clearly demonstrated that the system is both accurate and easy to use.

As well as being concerned with modernizing existing tanks, Marconi Radar also undertakes Design Study and Development work for new vehicles.

In the area of self-propelled weapons such as howitzers and rocket launchers, there are two main areas of activity. Being control systems specialists, the first concern is to lay the weapon accurately and smoothly against data supplied from elsewhere. On new weapons,

solid-state electric power servos capable of delivering up to 20kW to the servo motors have been constructed. More powerful output stages can be manufactured, the main limitations being the space available within the vehicle turret and the allowable peak power which can be taken from the vehicle power supply system. These new solid-state control systems are electrically far more efficient than the rotating machine sets (metadynes) which they replace; they are quiet in operation and, unlike machine sets, require no regular maintenance. The smooth low-speed fine-laying capability of such systems is better than has been achieved previously by any other type of drive, either electric or hydraulic.

The Company also supplies plane-conversion equipment. Because a self-propelled weapon is not levelled before firing, the attitude of the vehicle hull on the ground must be taken into account; that is, target co-ordinates designated in map co-ordinates (earth reference) must be converted to vehicle co-ordinates before the weapon can be laid. This conversion is carried out by on-board instrumentation generally similar in its principle of operation to the central computer of a tank fire control equipment.

Another area where similar principles are employed to advantage is in anti-aircraft defence. To fire accurately against a fast moving aircraft requires similar onboard equipment to a tank fire control system. The rate of computation must be high and the accuracy of computation is also required to be precise. It will be appreciated that because of the aircraft speed, little time is available for a gun crew to react after the target is seen. The computer will also demand large angular offsets between the gunner's line of sight and the gun axis when firing commences, so that the target



The Falcon twin 30mm self-propelled anti-aircraft gun is equipped with a Marconi weapon control system.

and shells arrive at the same point in space simultaneously. In consequence, the anti-aircraft fire control problem is considerably more difficult than the anti-armour case, where the target speed is low.

In the total system approach, the problems of equipment maintenance and logistic support are not neglected.

Equipment designed for use by Armies in vehicles such as battle tanks and S.P. guns must be extremely rugged and reliable. Marconi equipment is designed and packaged with this in mind. The equipment must also be easy to calibrate and repair, by the rapid replacement of a system sub-unit or printed circuit card. Many equipments also contain in-built test circuits for use during calibration and fault-finding. In consequence, the system time-to-repair is minimised.

Even so, modern fighting vehicles are becoming so complex that there is now a move towards checking all vehicle sub-systems automatically so that the vehicle commander will

be informed immediately by the maintenance crews whether his vehicle is serviceable or not, and if not, which vehicle sub-system is faulty.

Automatic monitoring equipment is offered whereby all significant parameters are checked continuously, for not only the electronic control systems must be monitored but also such items as main engine lubricating oil pressure and temperature, radiator cooling water, radio receive/transmit performance etc. The vehicle commander can also be given an indication of which parameters are moving towards their limits of acceptable performance; that is, he can be informed that a fault is likely to occur soon in a particular area.

The examples given above are presented as typical equipments for Army use, but there are many others and the Company makes a considerable investment of private venture funds into this area to improve techniques and to increase this field of activity by extending the product range.



Tepigen, the Cost-effective Training System

Tepigen (television picture generator) is a system of producing television pictures directly from a computer.

Because the scenes and objects on the television screen, and their movements, are under the complete control of the stored programs in the computer and the commands of the operator, the pictures can portray any scene or any action, real or imaginary.

Such a powerful and flexible tool provides an advanced training aid which can be programmed to provide the visual and sound element of any scenario, either military or civilian.

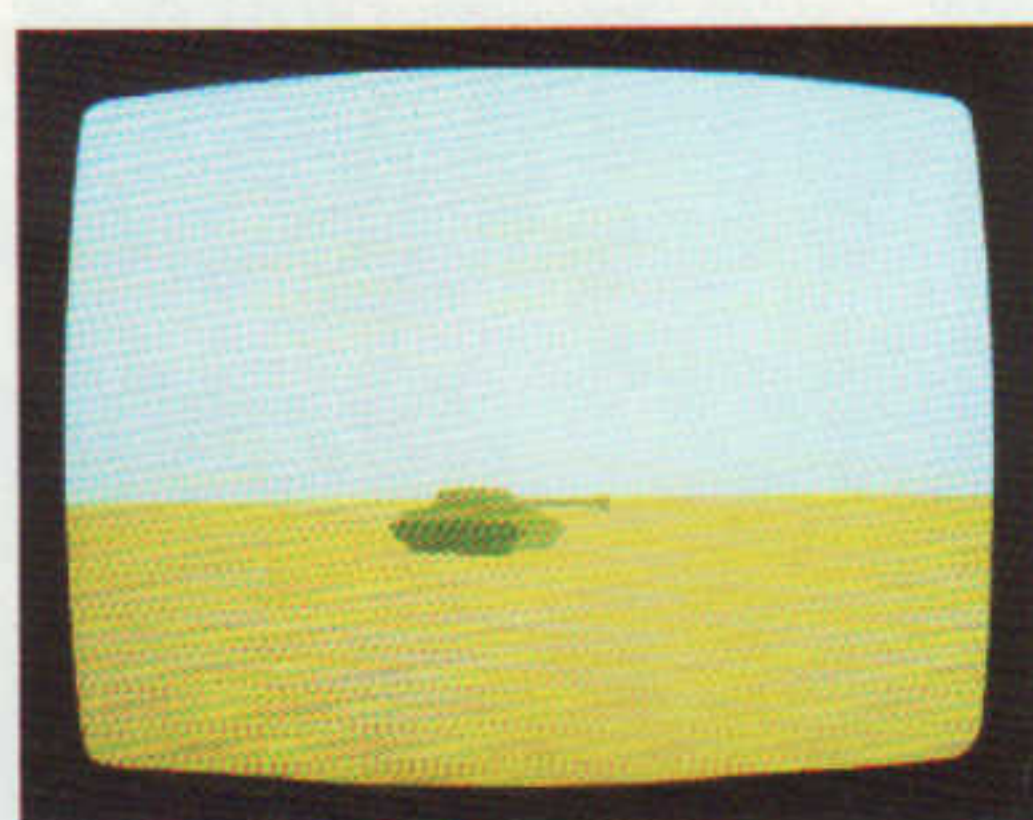
Military training is normally an expensive and time-consuming exercise which is, however, a vital necessity if personnel are to be taught the use of standard weapons and equipment, introduced to new ones, given intermediate refresher courses or even test tactics and

action on land, at sea or in the air. The range of possibilities is almost limitless, and the system is already in use for the training of gunners, missile aimers, ship handling etc.

Recent orders include a gun aimer trainer for the Royal Malaysian Navy to train personnel in the operation of anti-aircraft and anti-ship weapons.

The trainer comprises a rolling platform to simulate the deck motion of a ship, a Bofors 40mm L70 naval gun, two visual displays for the gun layers and an Exercise Controller's console. Two Marconi Locus 16 computers are used, one in the TEPIGEN picture generator and a second as the exercise control computer.

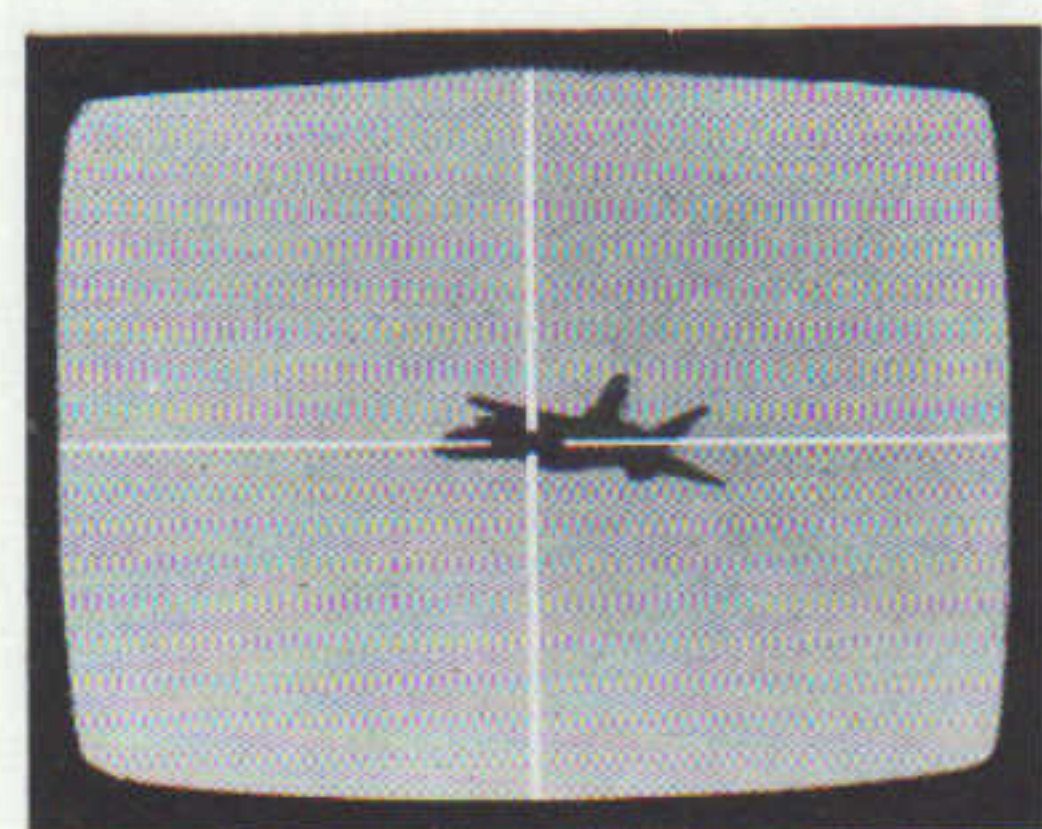
Gun layers are trained in their normal position on the Bofors gun and the view seen through the gun-sights is produced on television displays. The visual presentation of the graticule, the targets, the



scenery and atmospheric effects on this display, generated entirely by computer, is composed instantly from mathematical models held in the computer memory. This scene changes with the observer's view and the effects of poor visibility sun, cloud and different light levels corresponding to the time of day. A repertoire of attack sequences involving up to four fully manoeuvrable targets is prepared. As these sequences are easily changed and the types of target, such as aircraft, helicopters or ships can be varied, there is no question of a trainee becoming familiar with one particular exercise.

The system also includes computer generated sound. This is of considerable importance since operators rely on changes in electronic and gearbox sounds to confirm the response of the weapon to their control.

Control of an exercise is achieved by means of a comprehensive control console which enables the instructor to monitor and assess the performance of the student and provides overall command of the simulator. When an exercise is not being run the instructor's console can be used for the preparation of models for future exercises.



theories. The use of real weapons, ammunition and personnel for these purposes is limited by availability, time and cost — all these limitations are immediately overcome by the use of computer generated imagery. The scenes and actions are entirely realistic and put the trainee right in a battle environment, the sounds and actions reinforce this reality and every action taken by the trainee produces an equally genuine and realistic reaction on the screen in front of him.

Each program is specially devised through co-operation between Marconi engineers and relevant experts to simulate any scene or

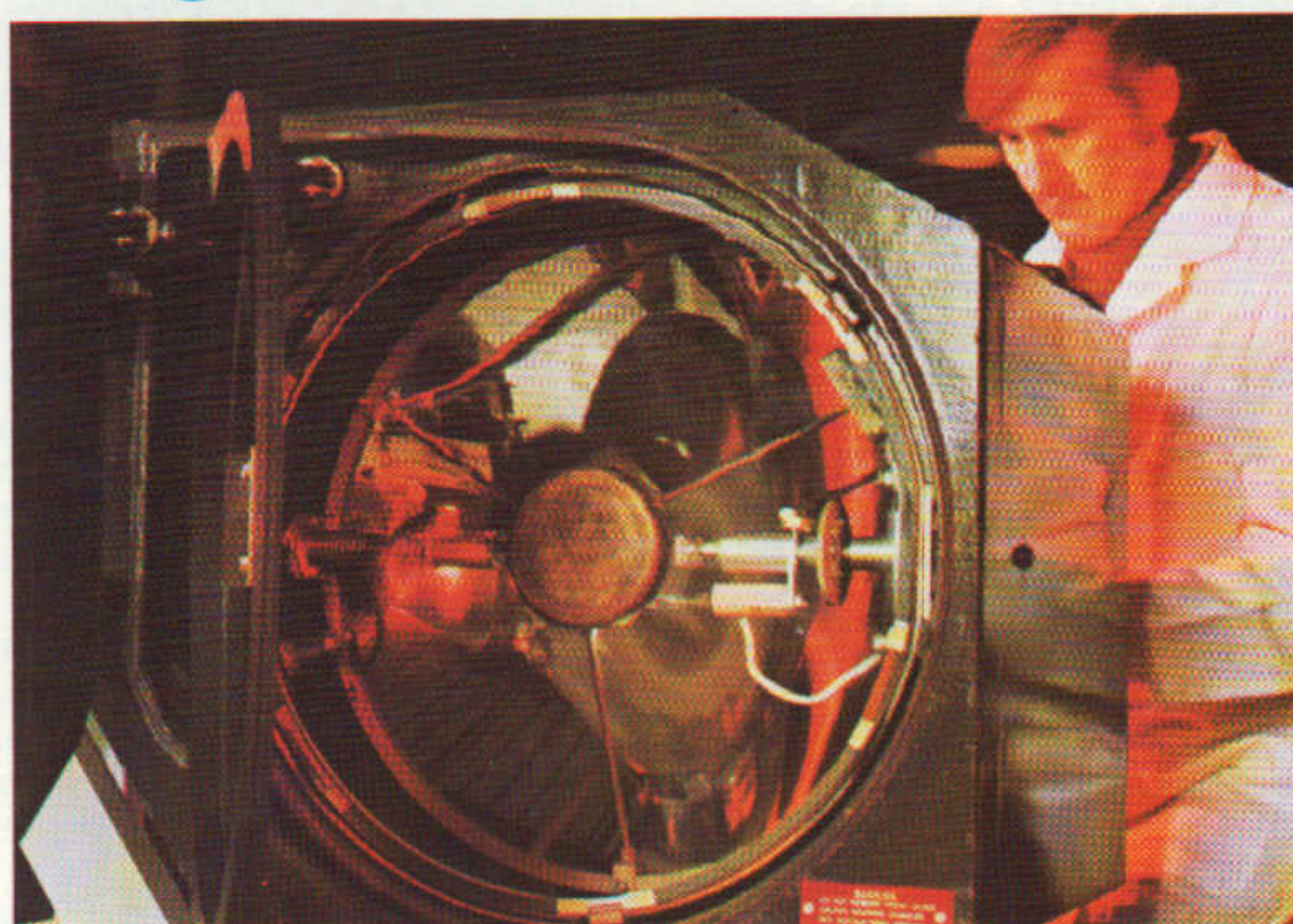
Current work on TEPIGEN at Marconi Radar includes a contract from MoD (PE) to manufacture a system for the ashore training of naval missile aimers.

Research and development contracts are also on hand for other applications, e.g. for ship handling from the department of Industry, for flight simulation from MoD

(RAF), and for assessment by the Royal Armament Research and Development Establishment (RARDE).

Studies are currently being carried out to analyse and evaluate a tank crew trainer utilizing TEPIGEN to provide an advanced, cost-effective and realistic training environment for tank crews.

Target Illumination for Tanks



2500 of these servo-controlled searchlights have been delivered for use on Chieftain battle tanks. This

rugged target illuminator has a 1000 yd white or infra-red beam and withstands the shock of gunfire.

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