Radar Systems International

MARCONI

No. 27

New Aid to Repeatable Accuracy

The new NATO 155mm SP70 howitzer is to be supplied with the latest electronic plane conversion (EPC) equipment developed by the Control and Simulation Division of Marconi Radar under the terms of an advance quantity production contract. With long range indirect fire weapons such as the FH70 and other towed and self-propelled howitzers Marconi can supply a computer-based plane conversion equipment.

This EPC data is used for gun laying in conjunction with the target data generated by a central computer such as FACE which is then displayed by AWDATS at the gun position. The Electronic Plane Conversion System has been developed by Marconi in conjunction with the Royal Armament Research and Development Establishment and gives to indirect fire artillery a hitherto undreamt of degree of accuracy.

Microprocessor Based

This plane conversion system was designed originally for the SP70 Howitzer but can also be fitted to field howitzers and other guns. The system can also be used with self-propelled rocket launcher systems. The EPC system is based on a microprocessor which does away with the need for a mechanical cross-levelled sight by automatically converting the earth-plane target co-ordinates into data for the particular gun. An accuracy is thus achieved which is much greater than that obtained by the use of optical mechanical systems. The equipment also reduces the possiblity of human errors being introduced into the gun laying procedures.

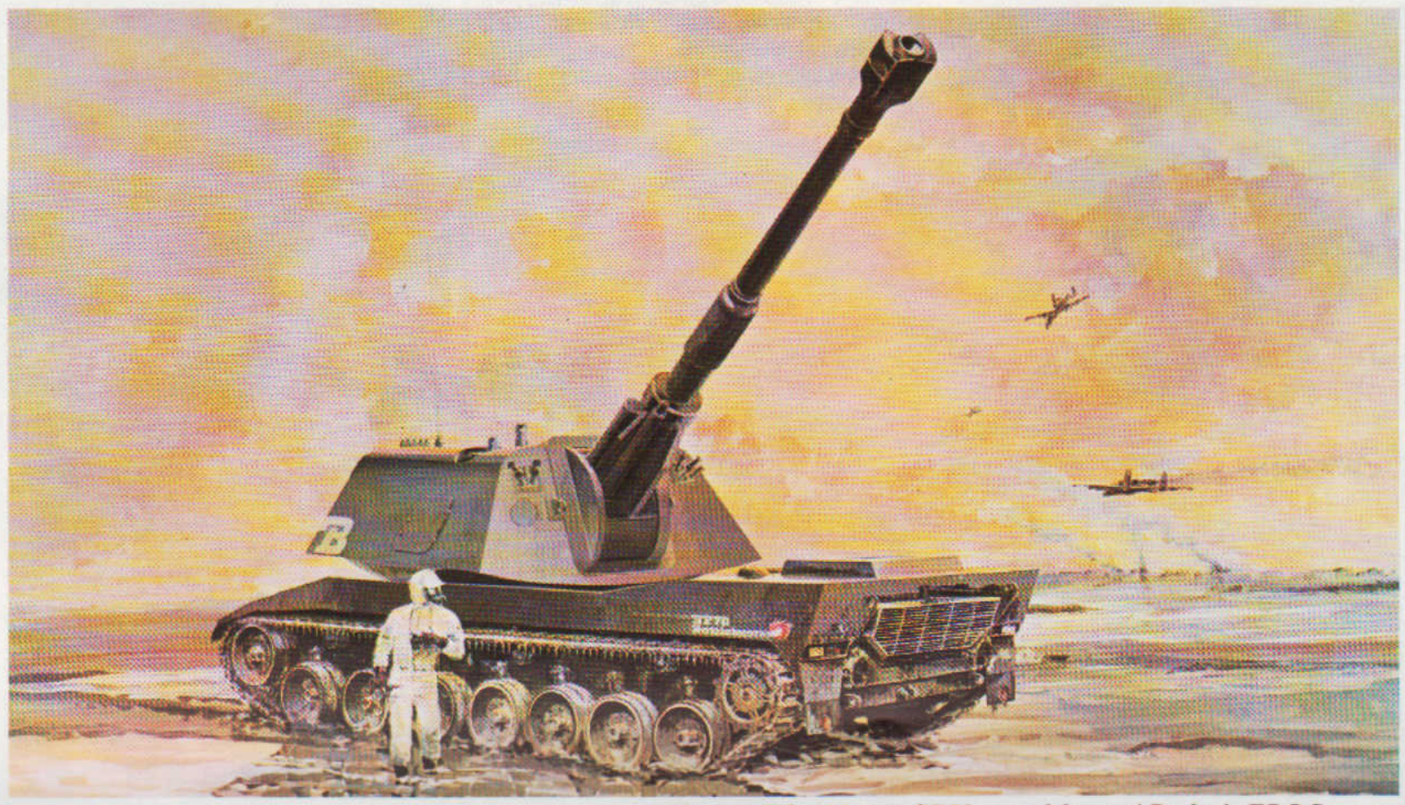
The central fire direction computer relays target information in the form of earth co-ordinates to the weapon by means of an automatic data transfer equipment such as AWDATS.

Input Information Converted to Weapon Data

The inputs from the rugged weapon platform tilt sensors and the sight and gun/launcher attitude encoders are converted by the microprocessor from earth plane target information into corrected weapon plane data. This data is then displayed on a control panel adjacent to the gun layer's sight. Illuminated displays give the layer precise instructions as to how to lay the weapon in order to engage the selected target accurately, firing from a tilted gun platform. The control panel shows a correct lay when the panel indicates a null display.

The laying of the gun upon receiving initial fire orders, or relaying between rounds is carried out more swiftly than with the previous mechanical systems.

The Marconi EPC system follows established equipment design practices and therefore, because of its compact modular construction, it may be adapted to any indirect fire weapon system. Because EPC system is a flexible system, there is considerable scope for development in conjunction with future semi-automatic gun laying systems.



The NATO 155 mm SP70 uses Marconi Radar's EPC System.

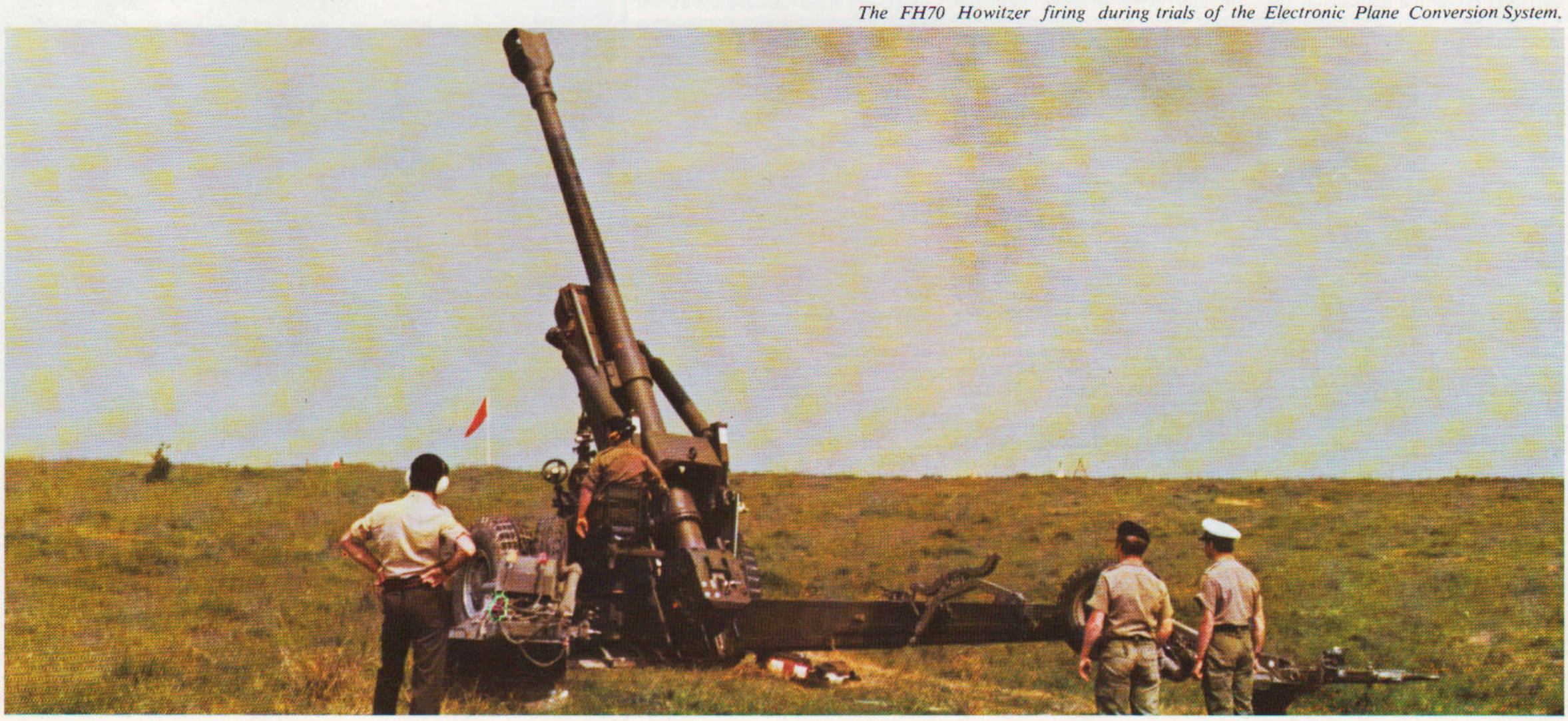
The EPC System fitted to an FH70 Howitzer.

Queen's Award for Marconi Radar

It was announced on the 21st April, HM The Queen's birthday, that Marconi Radar had gained the Queen's Award for Export Achievement.

The award acknowledges the great success of Marconi Radar in the fiercely competitive export markets of the world. In the past three years the company has almost trebled its export sales. Marconi Radar's achievement has been largely in the export of air traffic control systems and in air defence and naval radar systems. Also, the overseas sales of electronics control and monitoring equipment, together with simulation and military systems, account for a large proportion of this dramatic increase in the total exports figure from Marconi Radar. Mr. John Sutherland, the Managing Director of Marconi Radar, expressed his delight at this clear recognition of the company's achievements and his pride in the efforts of the many Marconi Radar people throughout the country who all helped to win this award.

The FH70 Howitzer firing during trials of the Electronic Plane Conversion System.



Fire Control and Power Drives for Light Turrets

Apart from the Control and Simulation Division's expertise in the development and supply of fire control systems for main battle tanks, the fitting of such equipment to lighter fighting vehicles such as Scorpion, Fox, etc, has not been neglected by the company. The system is based on the same Marconi Computer Unit EC 600 used in heavier tanks. Ballistic calculations are performed by this microprocessor-based computer and the target range is derived from a laser range finder within the gunner's periscope sight. An aiming point can be injected into the eyepiece of this sight, the position of the aiming point being determined by the computer. The target range is also presented in the field of view. The system is ideal for ranges up to approximately 2000 metres. Programming of the equipment for use with a 76mm or 90mm gun, or any other gun and ammunition type, presents no difficulty. The system is easy to use and in operation it reduces the reaction time significantly before a first round is fired. An increased hit probability is also achieved with this fire control system, both against static and mobile targets.

Power Drives

Lightly armoured reconnaissance vehicles such as the Scorpion and Fox often have to react quickly in the performance of their duties. This is best accomplished by the gunner, if he uses a power traverse, to lay the gun on the target with the least possible delay. Obviously the slightest delay in this situation reduces the chances of success in any engagement. As an extension of their work in the continuing development of power drives in the turrets of main battle tanks, Marconi have recently developed power drives for lightly armoured fighting vehicles.

This equipment is compact and is easily installed in turrets of Scorpion, Fox and similar vehicles. Marconi power drive systems are supplied to provide power traverse alone, or as an alternative two-axis systems are available giving control of the gun in both elevation and traverse. If the gun is of 90mm calibre the two-axis system is preferable, particularly if a fire control system is also fitted. A traverse system comprises the motor-gearbox mechanical assembly, the control amplifier, also the commander's and gunner's controllers. In the traverse gearbox motor unit a high speed 28 volt d.c. servo motor drives through an epicyclic gear and worm drive to an output gear meshing with the main turret traverse gear. The hand drive is quickly disengaged when power drive is used by a locking mechanism which has a quick release facility. The Marconi Radar power drive provides fast slewing with smooth slow speed tracking combined with overall solid-state reliability.

A Scorpion Light Tank at speed.

Marconi Solid-State Gun Control Drives

The ability of a moving tank's gun to remain aimed on target over rough ground depends not only on its sensitive Gun Stabilization System but also on an efficient power drive to the turret's electric servo motors. The Control and Simulation Division of Marconi Radar have for a period of years been working on various solid-state power drive units to replace rotary amplifiers such as metadynes. Units using high-current output transistors able to deliver up to 500 amp. to the motors have been constructed.

With an increase in the power-to-weight ratio of new tanks and their improved suspension, higher cross-country speeds are becoming more common. At the same time, tank designers expect the suppliers of the Gun Stabilization System to improve its pointing accuracy and this in turn means that more powerful drives for gun control systems are now needed. Recently, the trend has been for the price of power semiconductors to reduce significantly and consequently solid-state gun control systems are becoming competitive with rotary power amplifiers such as metadynes. Because of the significant advantages of solid-state drives in the areas of servo performance, far higher electrical efficiency, lower maintenance costs and quieter operation, many armed forces are expected to change over to this form of power drive for armoured vehicles. Several countries are considering solid-state power drives in their tanks, in some instances to replace hydraulic systems, as there is a much lower fire risk after battle damage with all-electric systems. The much improved servo performance which these solid-state drives can achieve means that they are now being designed into new tanks.

After investigation and due consideration of the available design options, Marconi developed a system which takes in the vehicle 28 volt d.c. supply and converts it to a supply in the region of 180 to 200 volts d.c.

This high voltage supply is controlled by two separate power transistor bridges to supply current to the traverse and elevation servo motors, at currents up to 200 amps peak per motor.

The solid-state drive is a two-axis unit which can control both the traverse and elevation system in a battle tank turret. The high efficiency of the solid-state drive is a distinct advantage in reducing the drain on the vehicle's electrical system. This is an important consideration as ever-increasing demands are being made on the vehicle's power supply, the heaviest of which is to power the turret and gun servos. The performance of the servo system is enhanced by a much faster response and a more accurate control is also exerted over the output current to the servo motor which allows Marconi engineers to improve the design of the signal processing and feedback loops of the system.

Tank Gun Goes to Sea

The well-proven combination of the ROF 105mm tank gun and Marconi Radar's fire control equipment and gun control equipment have been brought together again for use in patrol vessels and similar craft.

The problem of ship's motion is basically the same as that of a tank moving over undulating ground and rate gyroscopes mounted at the gun are used to stabilize it effectively.

The conception of further developing this highly accurate surface-to-surface weapon system originated in the Admiralty Surface Weapons Establishment. The MoD Sales Organization offer the Autonomous 105mm Patrol Gun as a reliable yet low-cost solution to arming small patrol craft. Two men in the gun mounting are all that are necessary to operate and fire the gun. The mild-steel turret, as well as housing the two-man gun crew, contains the entire weapon system, including the fire control equipment and as many as 30 rounds of ammunition. A fixed ammunition is used, being fired electrically, obturation is achieved with a full length brass cartridge. The 105mm gun is orthodox in design with a rifled barrel and a horizontal sliding breech. A product of the Royal Ordnance Factory at Nottingham, the 105mm gun is the main armament for the Centurion and Vickers Main Battle tank, also the West German Leopard and Swiss PZ61 tanks. The gun is also in service with the armies of Argentina, Australia, Belgium, Canada, Denmark etc.

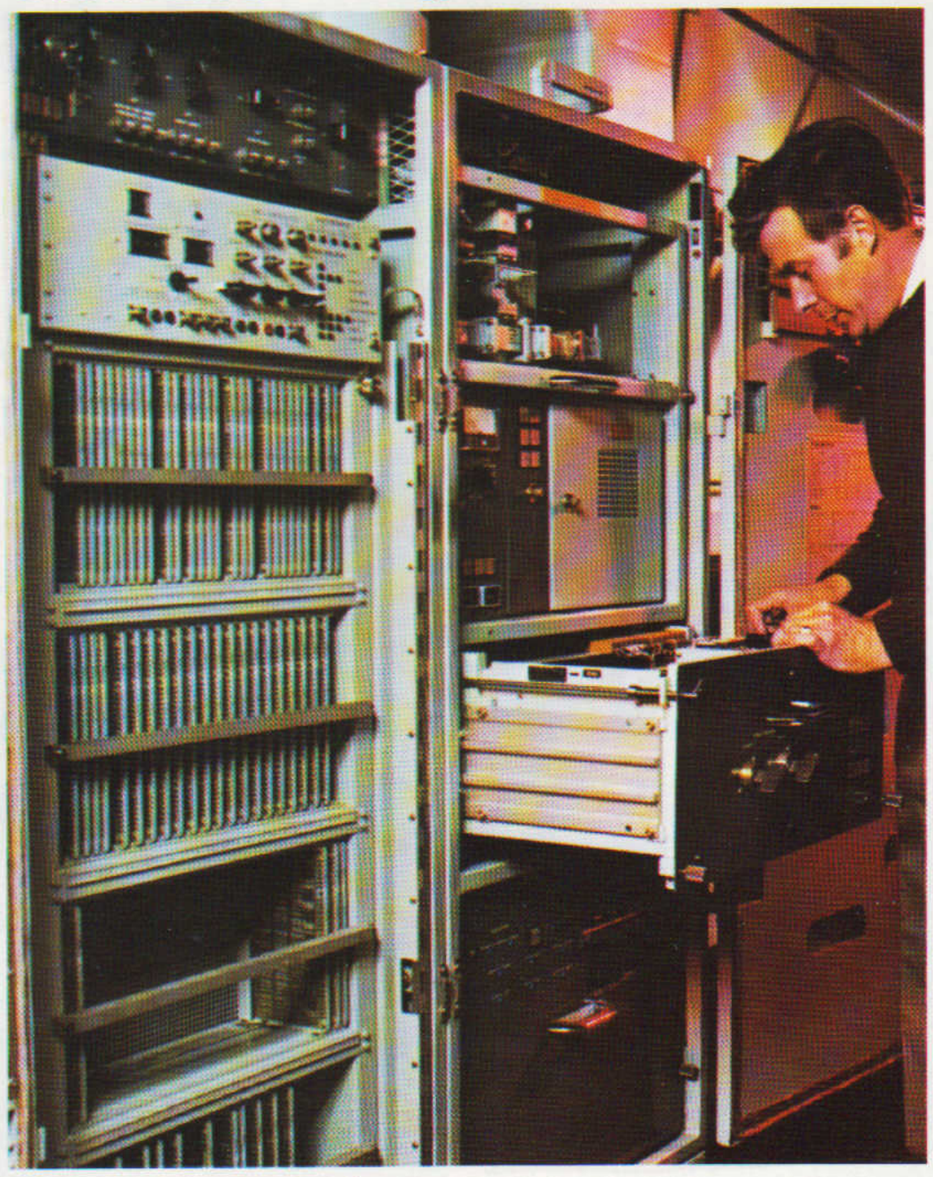
The complete autonomous gun package is designed so that it is commissioned at the factory and then readily installed in vessels, from 35 metres and longer, with a minimum of ship's fitting involved.

Marconi Radar have been engaged in the research and development of weapon control systems for over 35 years. The two Marconi systems, Gun Control and Fire Control are both incorporated in this advanced adaptation of tank gun control technology developed by Marconi Radar at Leicester.

Greater accuracy with high engagement speeds are the design aims of the Autonomous 105mm Patrol Gun System. The performance of guns up to 3 inches with a remote optical director gave a hit probability of just over 0.2 at 4km. The 105mm system described here, had a hit probability of just under 0.8 for the same range and target conditions. These conclusions were the result of a computer-based mathematical model investigation.

A wide variety of ammunition, within and out of NATO, is available for the 105mm gun.

S800 Radar — Big Demand



The ST858 Transmitter Receiver.

Current orders for the Marconi Series 800 radar are in excess of £40M.

Since the most successful operation of the specialized 800 series tracking radar at the Royal Artillery firing range at Larkhill, a similar range instrumentation radar has been installed at West Freugh in Scotland. This radar, the ST858 was specially developed to provide information in the form of tracking data on the flight of missiles, projectiles and aircraft including free-falling objects, such as store drops, etc.

The accuracy, speed and reliability of the ST858 instrumentation radar has given to investigators a powerful aid in the analysis of free-falling and propelled objects. The capability of the ST858 in providing such data, so readily, has greatly impressed first-time observers of this equipment. The ST858 is being fully utilized at both of these establishments. It is able to track projectiles as small as 20mm diameter and lock onto them at a range of 320 metres. The maximum unambiguous tracking range in MTI is 24km and in the non-MTI mode is 80km. Much interest has been shown by some overseas customers in acquiring this radar. The Larkhill and West Freugh installations are housed in permanent buildings but the ST858 is also designed for mobile use, being supplied in an air-conditioned cabin with an optional Marconi Avionics TV camera if required. Other radars in the S800 series include the ST850 tracking radar which has been designed to integrate with ground-to-air missile systems. Marconi Radar have for many years been able to supply very advanced weapon radar systems for both land and sea defence. These include surveillance and tracking radars for the detection of and fire control against hostile aircraft and surface targets.

The Control Console of the ST858

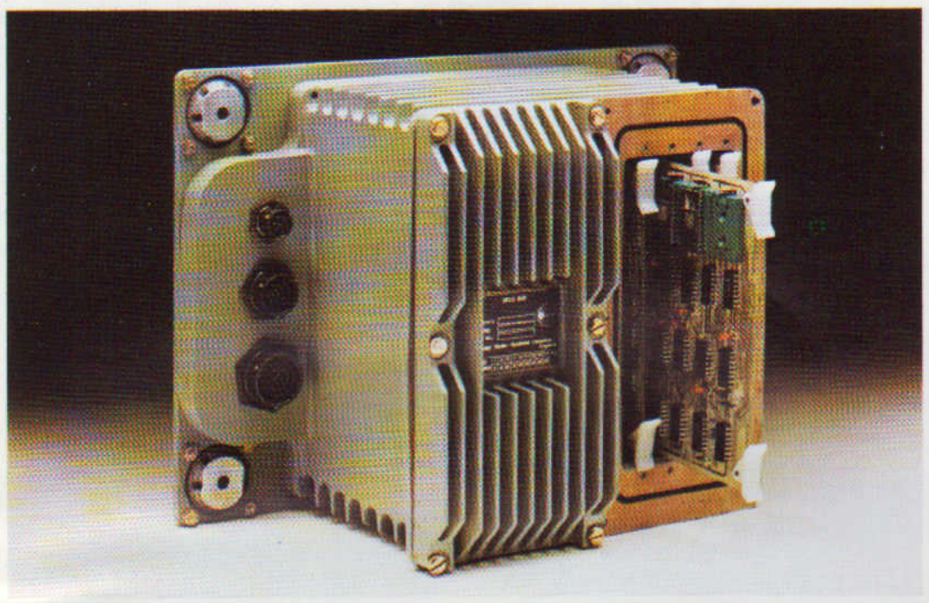
SFCS 600 is a First Time Hit!

The Marconi SFCS 600 Fire Control System, designed by the Control and Simulation Division of Marconi Radar, increases the first time hit probability by improving the data relevant to those factors necessary for the accurate aiming and rapid firing of a tank gun. The probability of achieving a hit with the first shot against either a moving or static target depends on several factors. Information is fed into a computer which solves the ballistic equation and generates an aiming point in the eyepiece of the gunner's sight. This enables the gunner to engage the target accurately and with the minimum of delay. Much experience using SFCS 600 has been obtained by Marconi in numerous firing trials in many countries. The SFCS 600 system is not confined only to being fitted into new tanks but can also be used in retrofit programmes on older tanks. It can, for example, be fitted into T54, T55, T59 and T62 tanks, also in M41, M47, M48, M60, Centurion and Vijayanta, as well as Vickers Mk 1 and 3 and the Valiant. It is also readily adapted for use in more lightly armoured vehicles, one example being the Scorpion CVRT.

Despite the advanced technology of the SFCS 600 Fire Control System, the operation of the equipment is very simple in use. Tank crews new to SFCS 600 have in the trials tank always been able to familiarize themselves extremely quickly with the system and become adept in its operation, having had only a previous session of instruction in the classroom on the use of the equipment. The simplicity of the system lies in the fact that a single aiming point is presented to the gunner in his eyepiece after he has acquired the target and ranged it with the laser rangefinder. The computer processes the input data to provide the necessary aim-offs and the gunner then brings the aiming point onto the centre of the target and fires. The operating sequence for the tank gunner using the SFCS 600 system is illustrated by the sequence in Figs. 1 to 4. These show the generation of the aiming point in the gunner's field of view and the addition of lead angles, before firing.

The range of the target is obtained by a laser range finder mounted in the gunner's sight. The control panel is mounted adjacent to the tank commander for the selection of ammunition type and other inputs can be made manually if, for example, a sensor becomes defective. The SFCS 600 Fire Control System is designed to British Military specification standards and uses components approved by NATO.

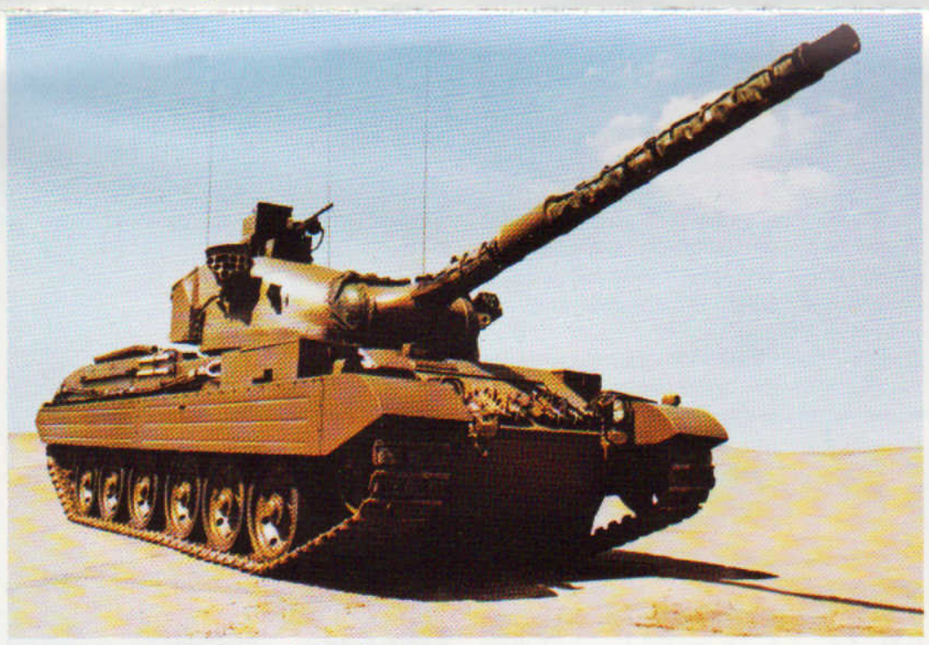
The Commander's Control Panel (CP1522)



The EC 600 Computer Unit

An American M60 Tank

A Wind Sensor

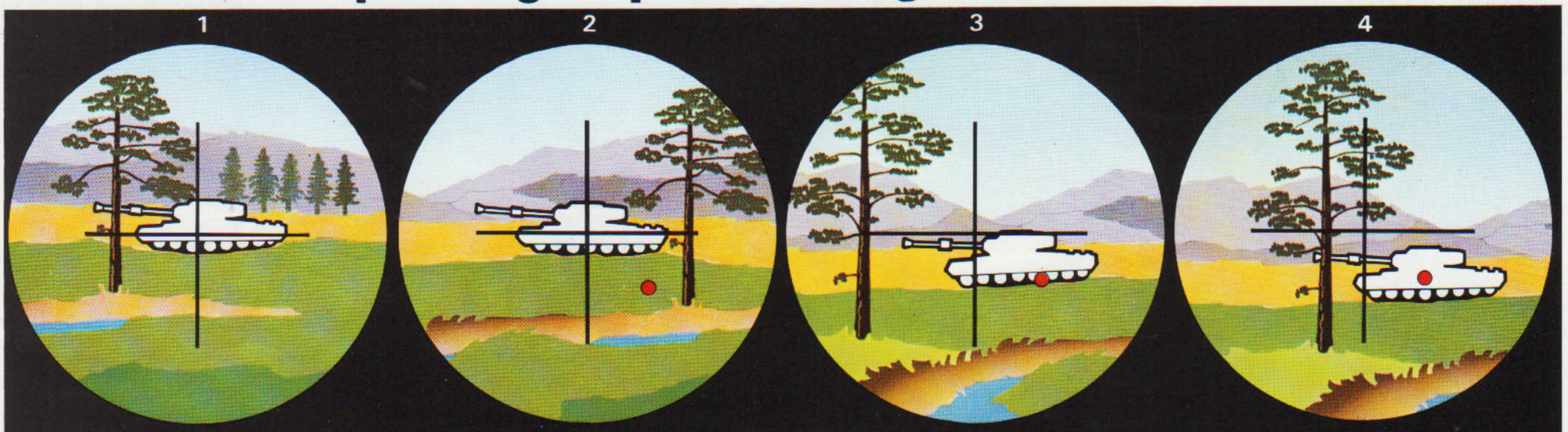


The Vickers Mk 3b Battle Tank

The Avimo LV2 Gunner's Laser Sight

A line of T62 Tanks on the move

The Gunner's Operating Sequence Using SFCS 600



Gunner acquires the 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.

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.

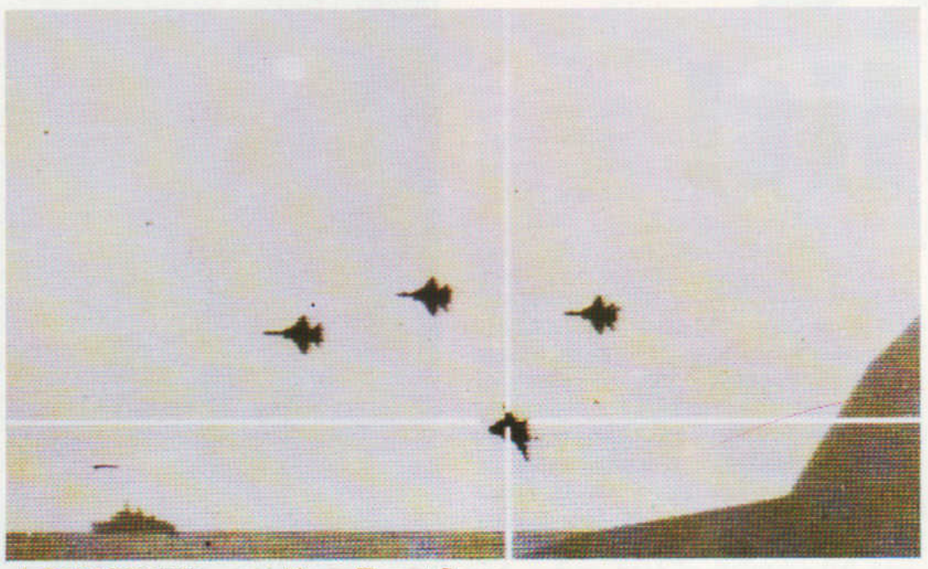
After calculating the lead and superelevation angles, the computer also generates signals which can be fed into the gun servo loops. These cause the gun to move to bring the aiming point and target into alignment.

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

TEPIGEN Trainer for Tank Crews

The application of the now well established TEPIGEN (television picture generator) simulator, of Marconi Radar, to tank crew training, is being studied at the company's Control and Simulation Division in Leicester. This new application would provide the tank crew for the first time with a trainer that would interact realistically with the scene under observation. This work, to provide a tank-crew trainer, follows naturally from the experience of Marconi Radar in the provision of naval trainers and ship handling simulators.

A TEPIGEN trainer recently delivered has highlighted the remarkable economies of modern training systems in the greater utilization of the time of highly skilled instructors. The Versatile Multi Aimer Trainer enables a single instructor to control simultaneously a group of eight trainees each at their own individual student console. Although all the students are presented with an identical tactical situation, individual operators are enabled to practise target tracking and weapon guidance, quite independently of other students.



A TEPIGEN Weapon Aimer Target Scene

A read-out at the instructor's console permits each student's performance to be monitored for immediate assessment. The TEPIGEN visual scene is presented in a variety of ways whether using optical sighting devices or a directly viewed CCTV display. Facilities at the instructor's console are provided so that the library of training exercises can be constantly expanded and changed. Realistic attack profiles and situations can be prepared and the trainee has no chance of familiarising himself with the exercises to be presented to him.

TEPIGEN Applications

Simulators cannot be identical in all respects with their original nor is it important that they should be. The degrees of fidelity which it is worthwhile striving for, and paying for, depends on the type of learning to be imparted. A considerable amount of investigation has gone into assessing the transfer of training from a simulator to the real operation. If the right action cues have been incorporated in the simulator, the transfer is made without any setback. In this case the student's total learning time will be much shorter than if he had picked up his training wholly 'on the job', because of the very high initial learning rates typical of simulators. Bad simulation on the other hand, can result in a 'negative transfer' leaving the student at a disadvantage in dealing with the real operation. At a time when training simulators are becoming increasingly important, because of the heavy costs and high risks from learning on the job. CGI is seen as a means of raising the quality (the transfer coefficient) of simulation.

One of the eight versatile Multi Aimer Trainer Consoles

Marconi can support the visual element in simulation with an extensive experience of other techniques. Equipment it has supplied covers the simulation of radar displays, alpha numeric displays, controls, indicators, communications and sound effects.

NEW Mobile Electronic Warfare System

View of the S373 ECM vehicle deployed

Marconi Radar's Type S373 ECM System is a multi-band electronic warfare system incorporating high power jamming facilities. The ECM vehicle functions as a jamming source autonomously using its own surveillance system for the detection, location and analysis of emitters. The S373 ECM vehicle can also investigate the ground-to-ground effectiveness of jamming or be used to observe the performance of radars operating under a wide range of jamming conditions. The S373 is ideal for the training of radar operations under ECM conditions. The ECM equipment is in a one-ton container mounted behind the antenna system on a flat bed vehicle such as a four-ton Bedford truck. When deployed, the antenna, which is enclosed in a fibreglass radome, is elevated to its operating position by means of a hydraulic jacking system.

The Antenna System

The antennas comprise two horn-fed parabolic dish reflectors. The antennas are driven by slab torque motors which combine high torque with low inertia, and as direct drive is used no gear boxes are required. This arrangement permits a wide range of scan speeds to be obtained with precise position control. The antennas can be made to turn at any speed between 1 and 200 revolutions per minute. The scan is variable from 5° to 180°, the position control provides an accuracy of better than a tenth of a degree. The angle of elevation for each antenna may be set to any position from -5° to +8° by means of electrical actuators controlled from within the cabin. Both the antenna scan speed and positions in azimuth and elevation are displayed on the operator's control panel.

The Transmitter System

Each band has an independent high power TWT transmitter feeding its own antenna. The transmitters are self-contained, each having a digitally controlled v.f.o., a driver stage and modulation system with an output amplifier stage.

The Receiver System

A scanning superhet receiver with associated frequency counter, radar signal analyser and displays are provided which allows the equipment to operate in an autonomous role. When used with an associated ESM system, the built-in receiver allows the ECM operator to identify and acquire any emission to which he is directed and subsequently to monitor and report an observed change in characteristics.

During surveillance the antenna operates in a step scan mode and in each position the receiver sweeps over a preset frequency band. When a signal is detected above a preset level, the sweep is automatically stopped and the frequency, pulse width and PRF are measured and stored. Search is then resumed automatically. Data held in the store can be displayed on a VDU as required.

The azimuth bearing of an emitter is obtained by the antenna scanning continuously with the receiver tuned to the emitter frequency. The bearing is extracted automatically as the antenna scans the emitter and it is then added to the stored data and appears on the VDU.

The output of the receiver during the scan can be displayed on an oscilloscope against azimuth. This allows manual measurement of emitter bearing and the presence of sidelobe reception to be detected so that the true emitter bearing can be established. Side-lobe reception in the automatic mode can be eliminated by raising the detection threshold until only main beam signals are allowed through.

Radio and teleprinter equipment provides communications with the EW control centres and Command HQ using voice and digital data links. Incoming teleprinter messages will be displayed on the operator's VDU but 'hard copy' versions of all incoming and outgoing messages are also available.

The cabin incorporates two standard air-conditioning units which are used for both equipment cooling and maintaining an equable environment for personnel.

The vehicle operates from a single phase, 220 to 240V, 50Hz primary power supply. Power consumption is about 18kVA with full air-conditioning load.

Marconi Radar and Canadian Marconi Produce a New Radar

The new Marconi Radar Type 1819 is a surveillance radar developed jointly by Marconi Radar and the Canadian Marconi Company, and is a recent example of the continuing historical links between these two great companies.

The Type 1819 radar is an extremely adaptable S band equipment capable of rapidly detecting air targets and clearly locating surface vessels and aircraft when used in a coast-watching role. This compact and rugged radar is available in either a static or a mobile version, the mobile version is capable of rapid deployment. All the equipment comprises well-proven units and the design ensures high reliability and easy maintenance. The 1819 radar provides excellent low cover with a high data rate. Other features are frequency selection and excellent subclutter visibility.

Inside cabin view of Transmitter/Receiver Cabinet, Display Unit and Signal Processor Cabinet

A selection of display and data handling equipment can be supplied for use with Radar Type 1819, ranging from a rotating coil 12-inch (30cm) display to a computer controlled 16-inch (40cm) synthetic display with track marking and target allocation facilities and both rate-aided and limited area auto-track target tracking capability.

The magnetron transmitter can be switched by the operator to any one of six pre-set frequencies within the frequency band 2.0 to 3.1GHz, and two different pulse repetition rates are available giving maximum unambiguous ranges of 90 nautical miles (166 kilometres) or 45 nautical miles (83 kilometres).

Digital MTI signal processing is available to the maximum range in both modes, but the shorter pulse and higher PRF provide improved clutter rejection in the shorter range mode (typically better than 30dB cancellation of stationary land clutter). A logarithmic amplifier non-MTI channel is provided in addition to the MTI channel, both being fitted with constant false alarm rate (CFAR) circuits and pulse repetition frequency discrimination (PRFD) circuits to eliminate the effects of non-synchronous interfering signals.

Selection of MTI or non-MTI channel output for display is pre-set by the operator on a range basis. Comprehensive built-in monitoring is provided, including facilities for measuring receiver noise figure and testing the correct operation of the MTI processor.

The low sidelobe antenna is designed to provide good low angle performance combined with low overall weight.

Rotation rate is 15 r.p.m. and the elevation beamwidth is 7°, or optionally 30°. Detection ranges in excess of 40 nautical miles (75 kilometres) are expected on low flying aircraft.

In the mobile version, the lightweight antenna is easily removed for stowage within the cabin.

A view of the Radar Type 1819