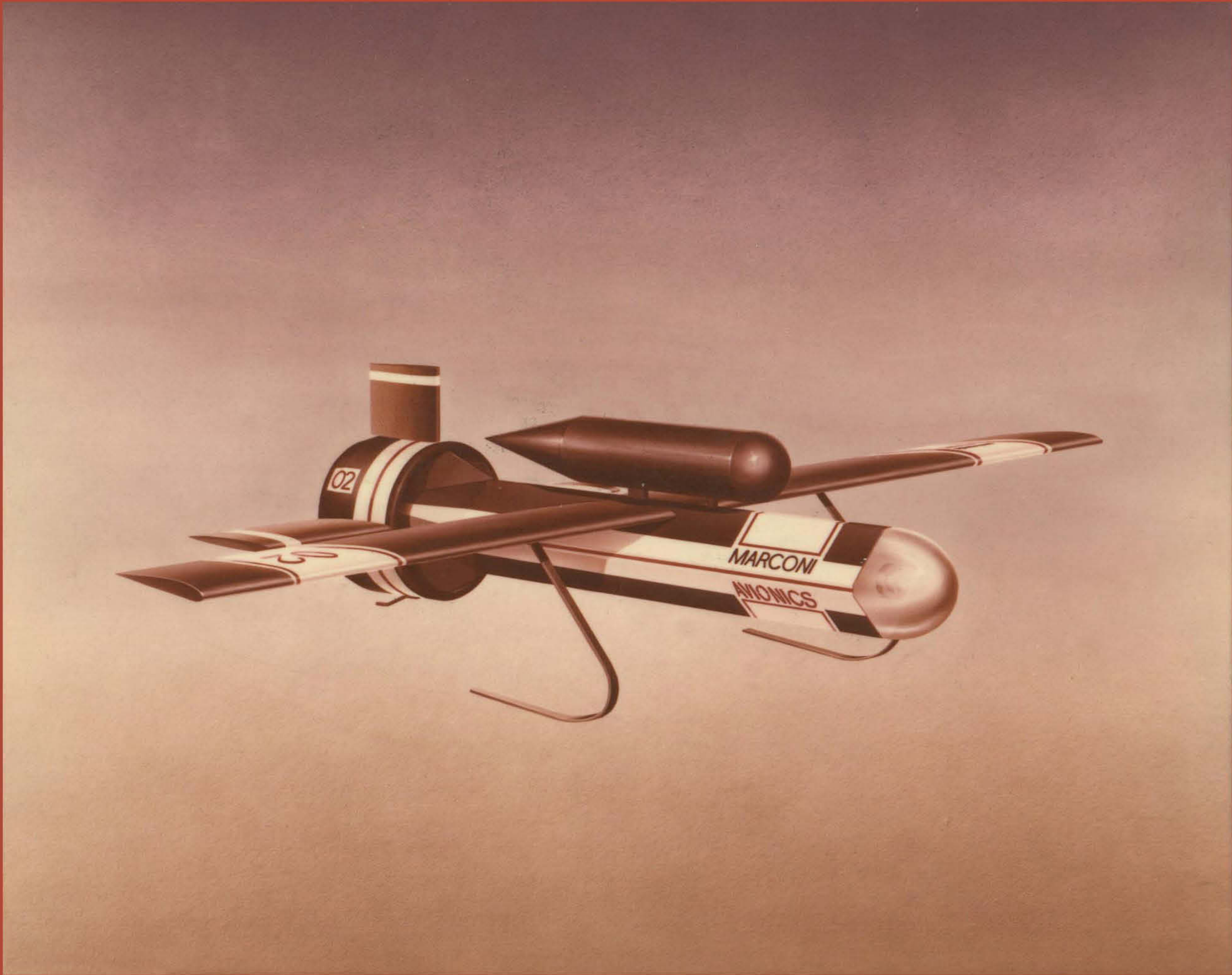
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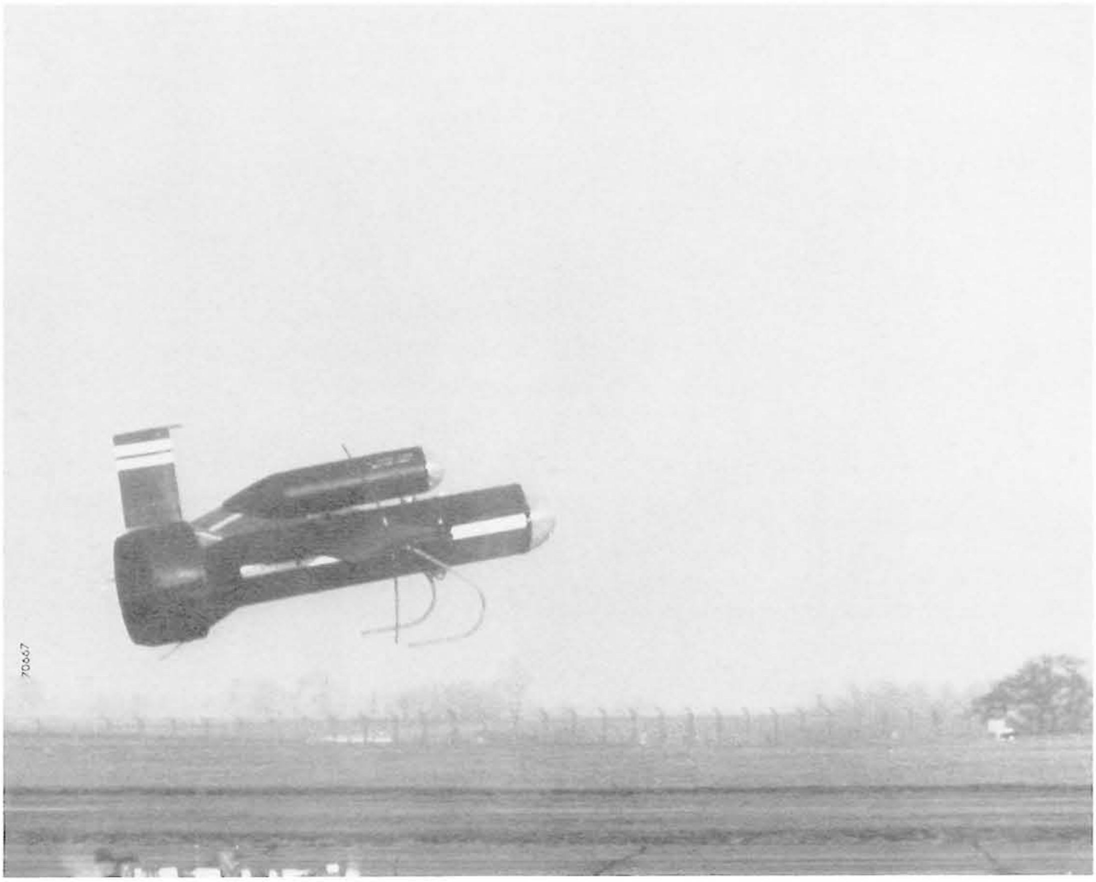
MARCONI
AVIONICS

MACHAN

Unmanned Aircraft Flight Research Facility



MACHAN is the air-vehicle component of an unmanned aircraft flight research facility being set up jointly by the Ministry of Defence (PE) and Marconi Avionics. The project, which covers development and production of both the aircraft and the ground station, is intended to support a wide range of experimental flying programmes covering both payload trials and flight guidance system development.

Flight Automation Research Laboratory

MACHAN
An Unmanned Aircraft Flight Research Facility

Prime Contractor	–	MARCONI AVIONICS (ROCHESTER) FLIGHT AUTOMATION RESEARCH LABORATORY
Main Sub-Contractors	–	CRANFIELD INSTITUTE OF TECHNOLOGY for Airframe, Power Plant and Digital Flight Control System.
	–	MARCONI AVIONICS (BASILDON) ELECTRO-OPTIC SURVEILLANCE DIVISION for Radio Links and Surveillance Payload.

Leading Particulars of Aircraft (Preliminary)

Wingspan	3.66m	12ft
Length	2.13m	7ft
Max Level Speed	59m/s	115kt
Cruising Speed	33m/s	64kt
Endurance at cruising speed	2 hours	
Gross Take-off weight	80kg	175lb
Payload	15kg	33lb

Engine	–	Weslake 18 HP with external electric starting
Launch	–	Radio controlled trolley or pneumatic launcher
Recovery	–	Normally – By conventional landing In emergency – By parachute

Baseline Equipment Fit

PCM Command Link
Digital flight control system driving dc surface actuators
3-axis rate gyro pack
16 channel telemetry on 449MHz

For further details, see FARL Report No. 262/1194.

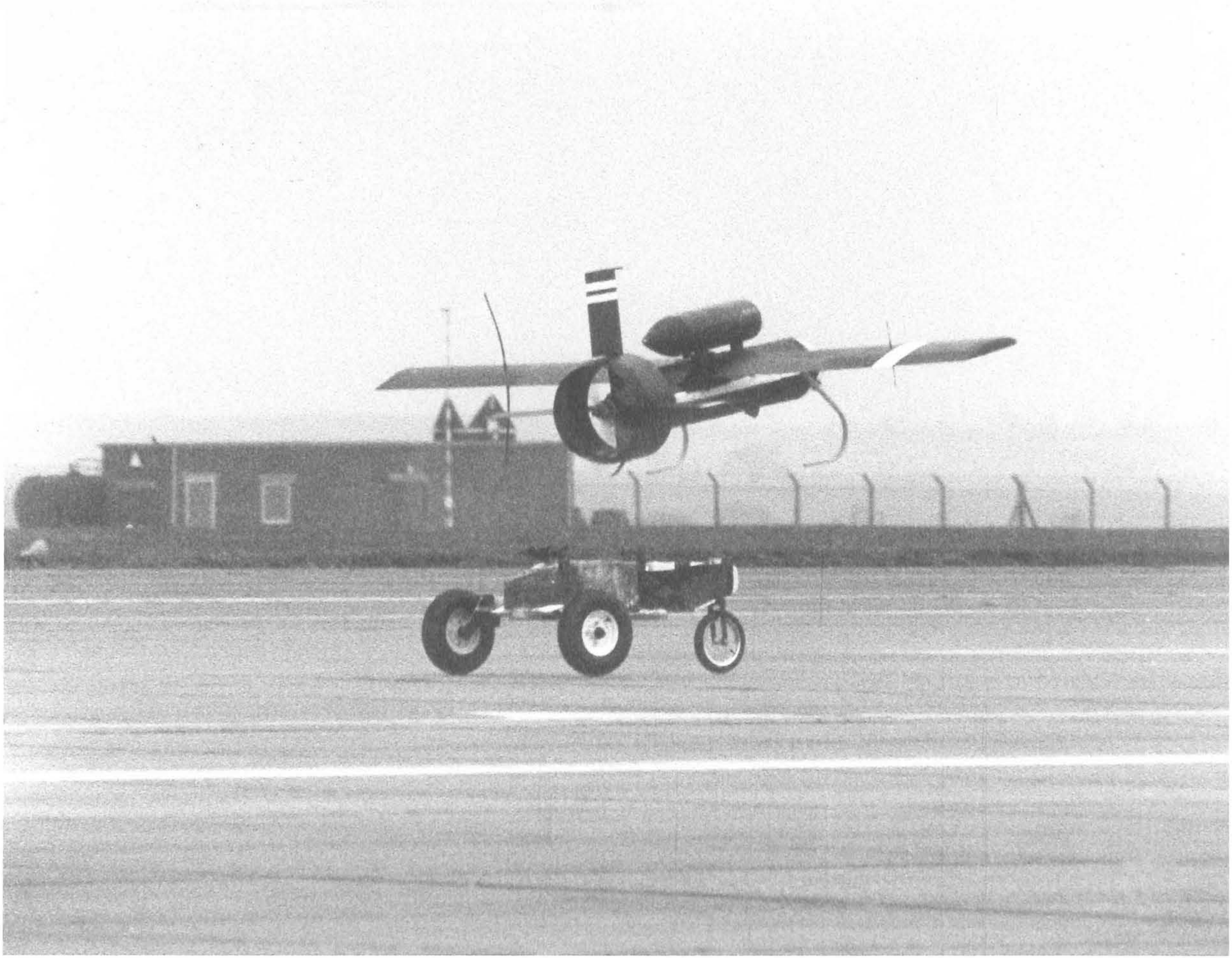
Marconi Avionics Limited

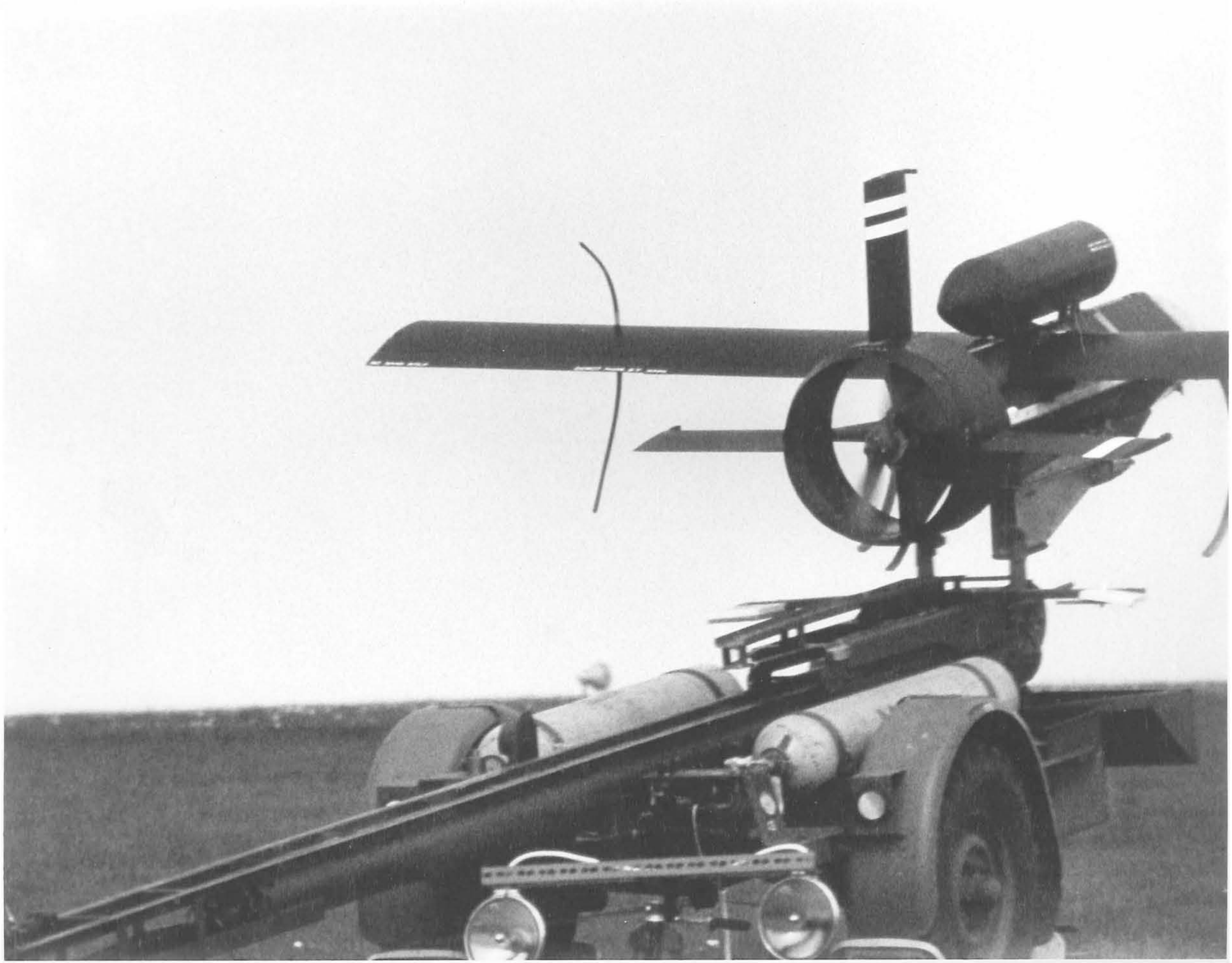
Airport Works Rochester Kent England
Telephone: Medway (0634) 44433
Telex: 965884

Flight Automation Research Laboratory

MARCONI AVIONICS

A GEC-Marconi Electronics Company



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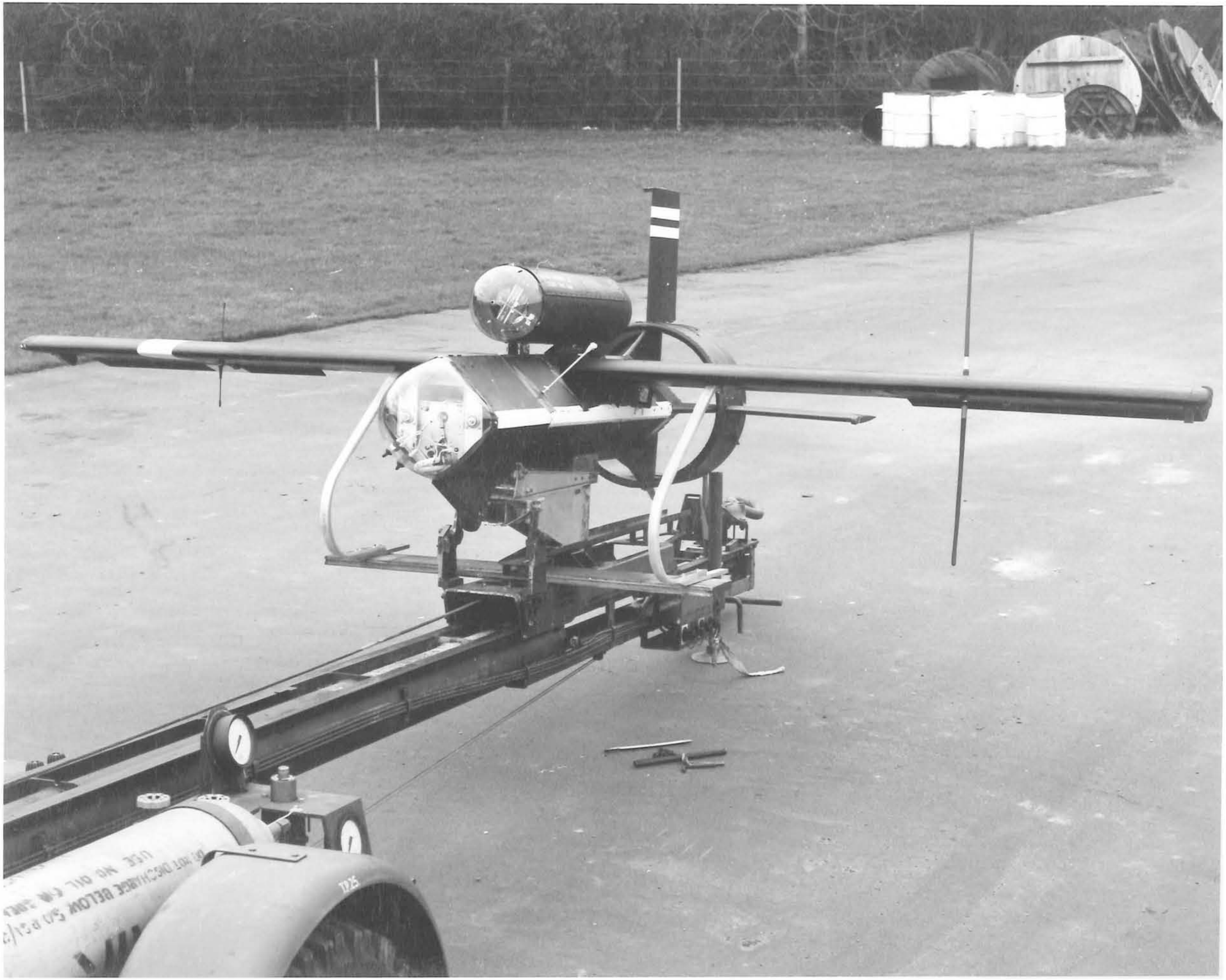


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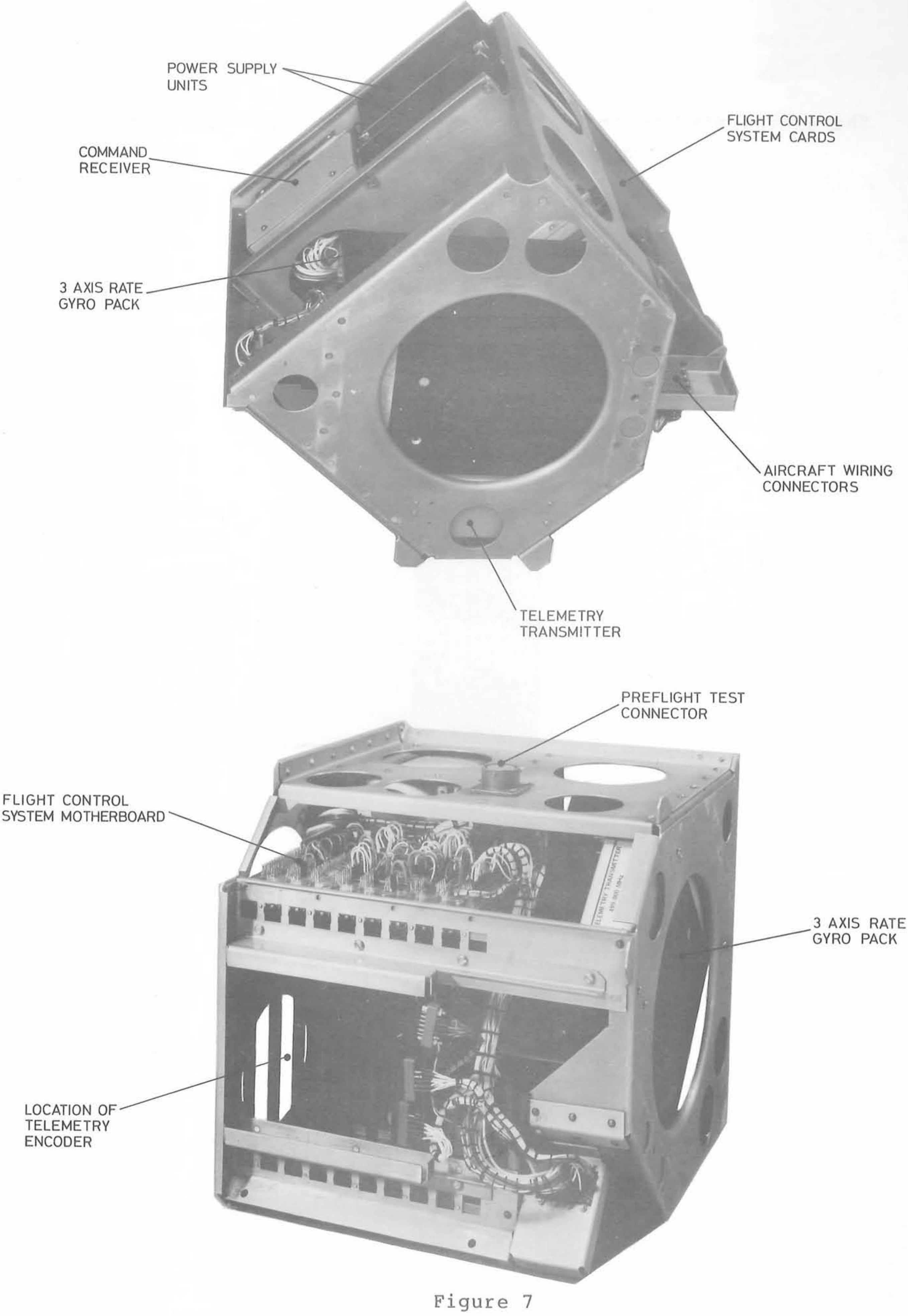
POWER SUPPLY
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LOCATION OF
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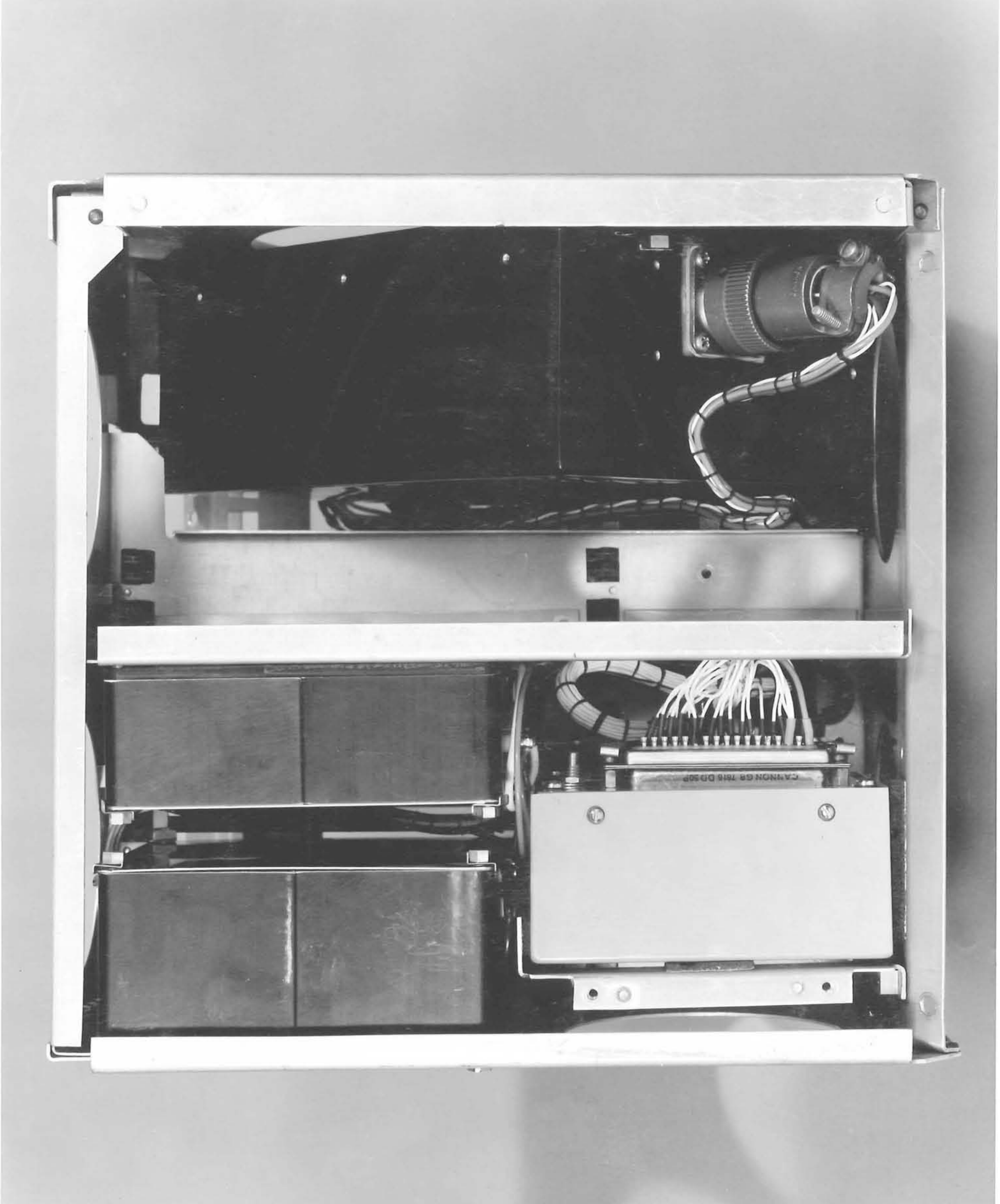
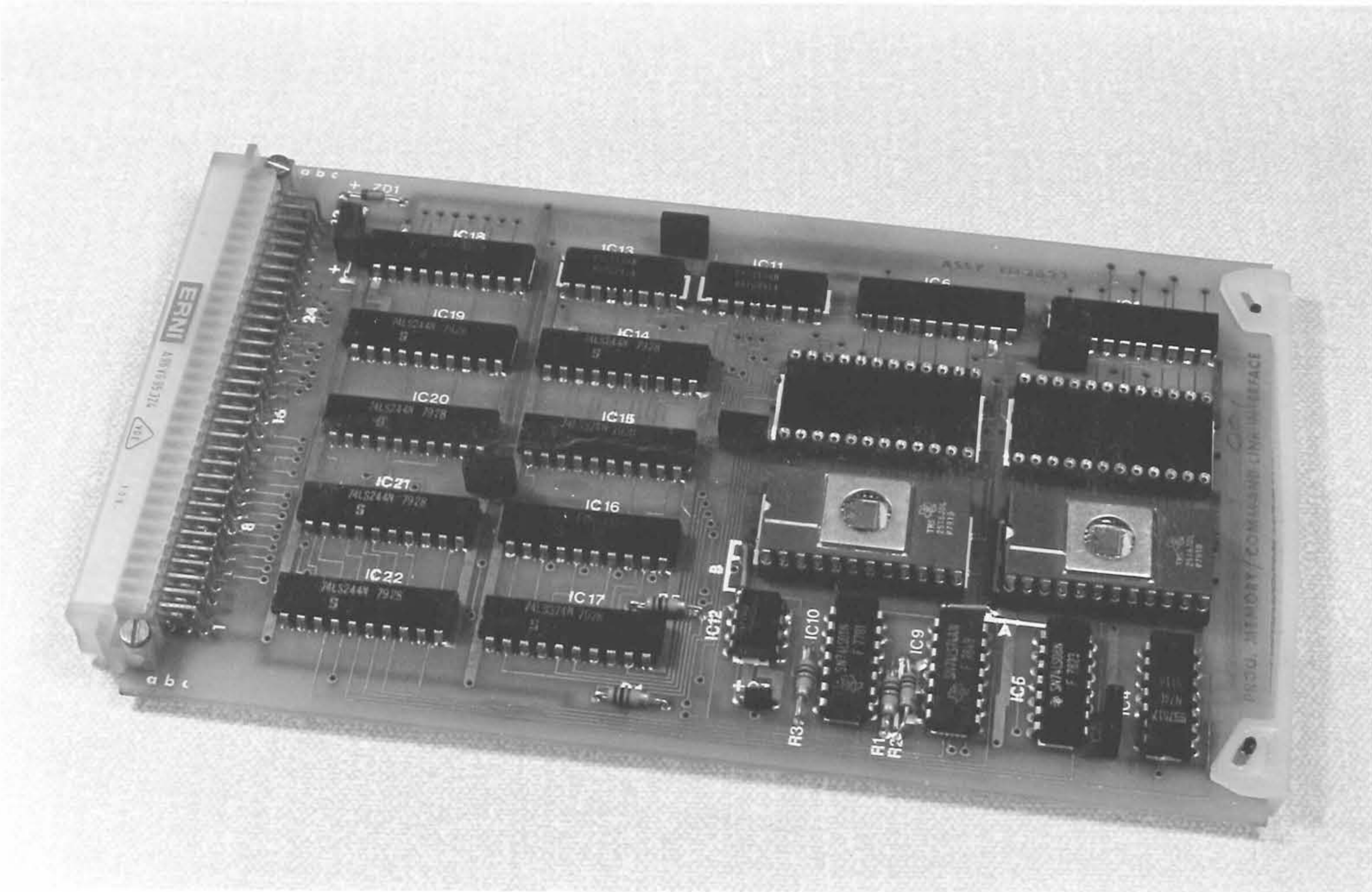
Figure 7

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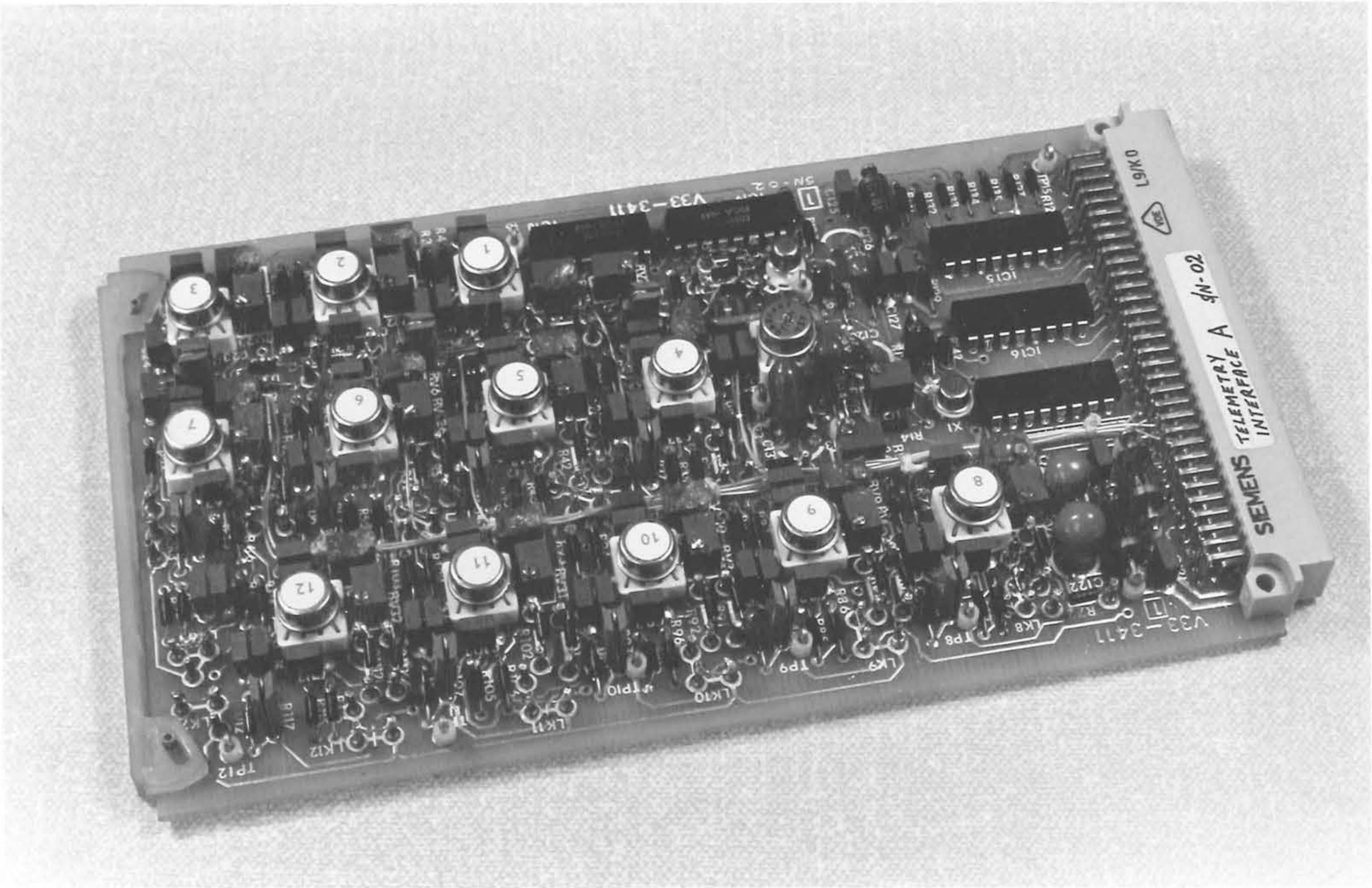
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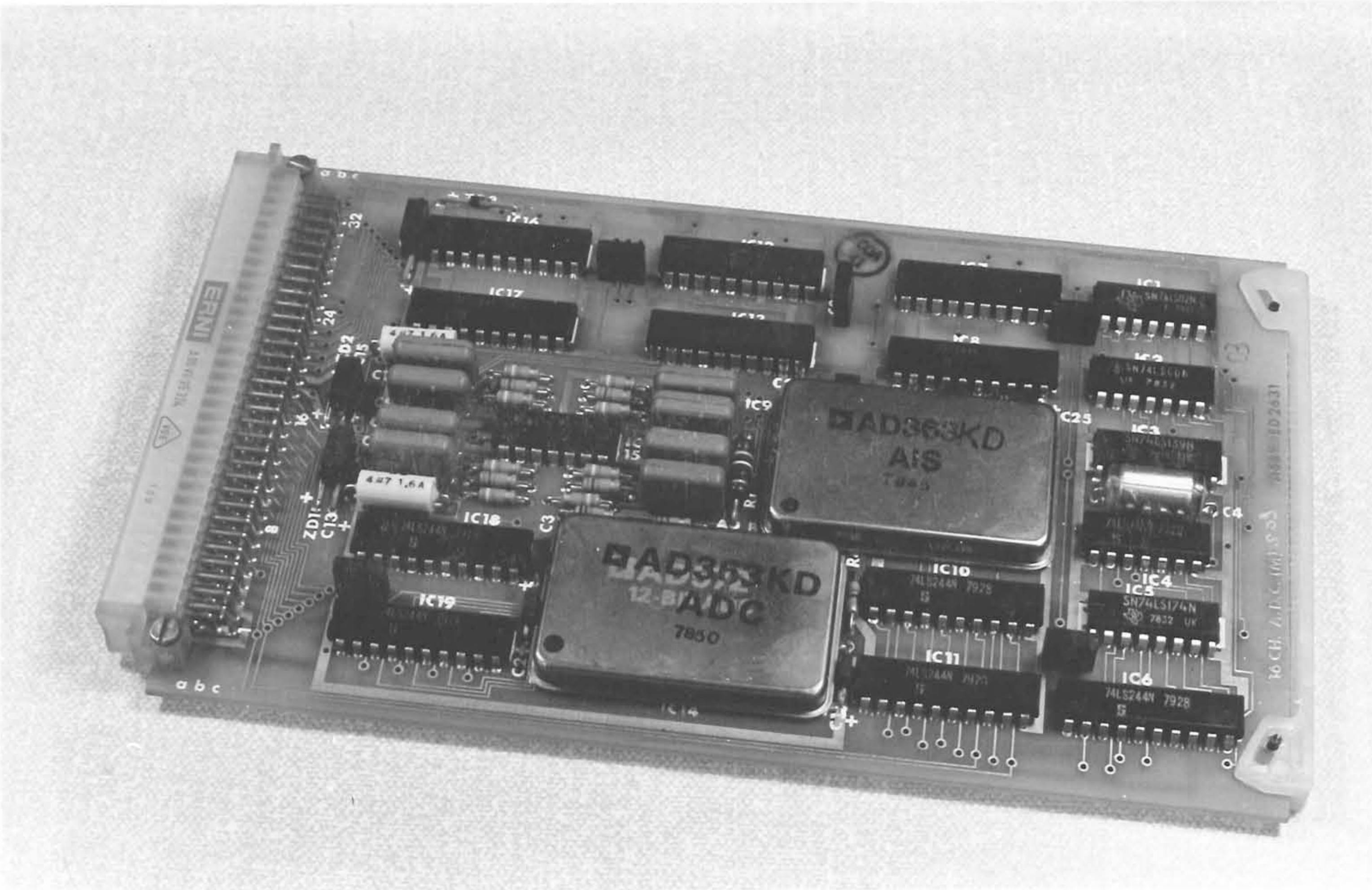

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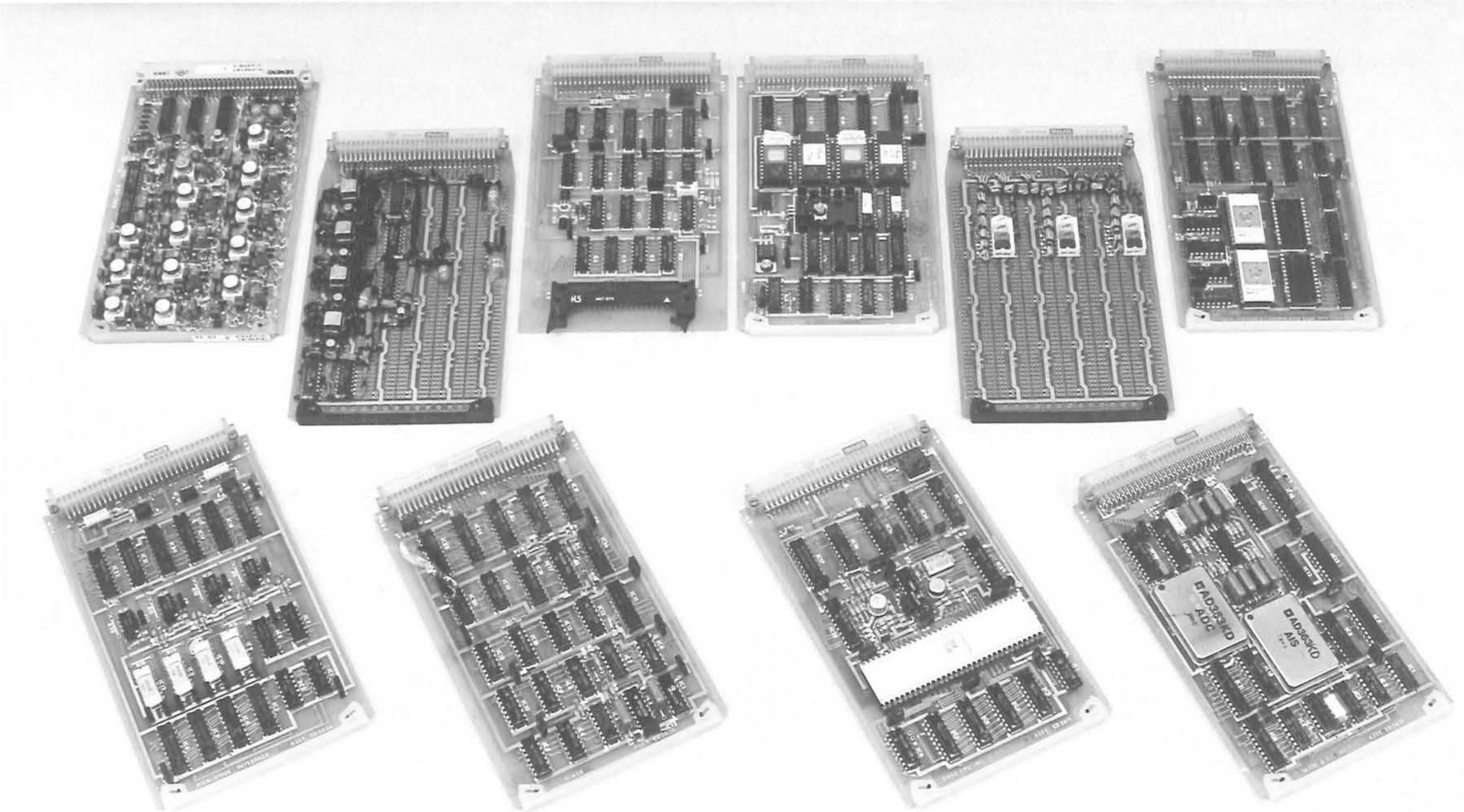
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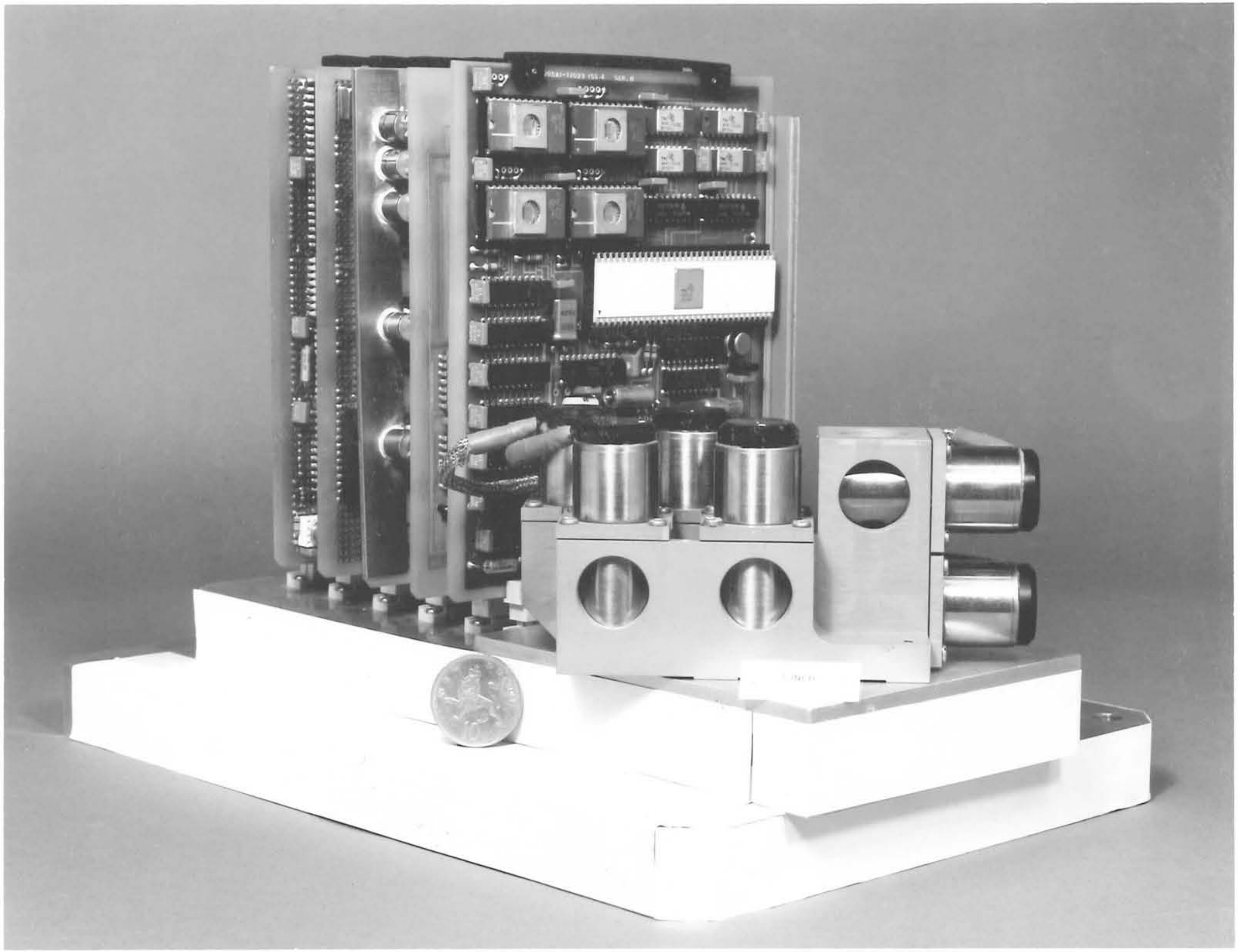

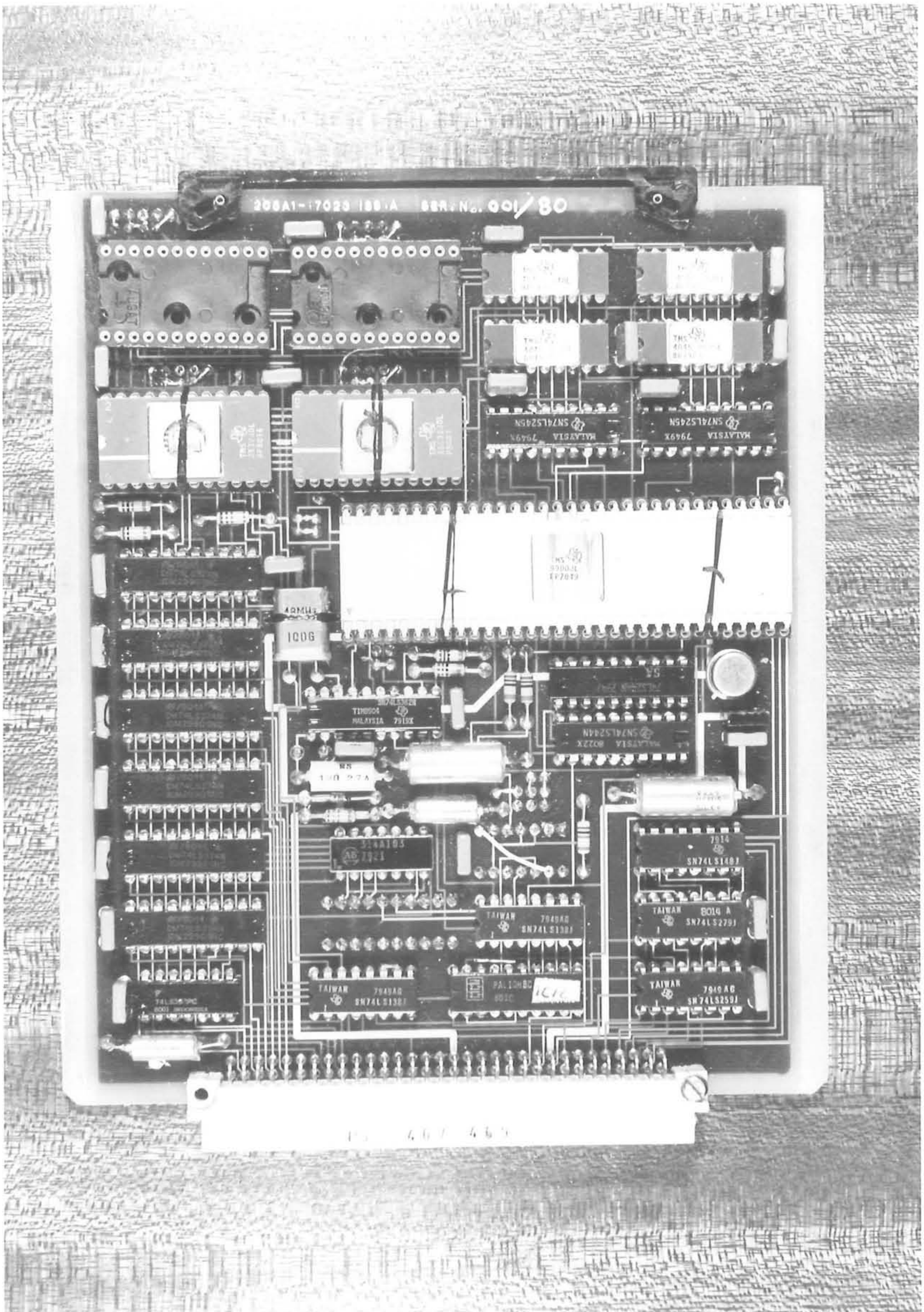

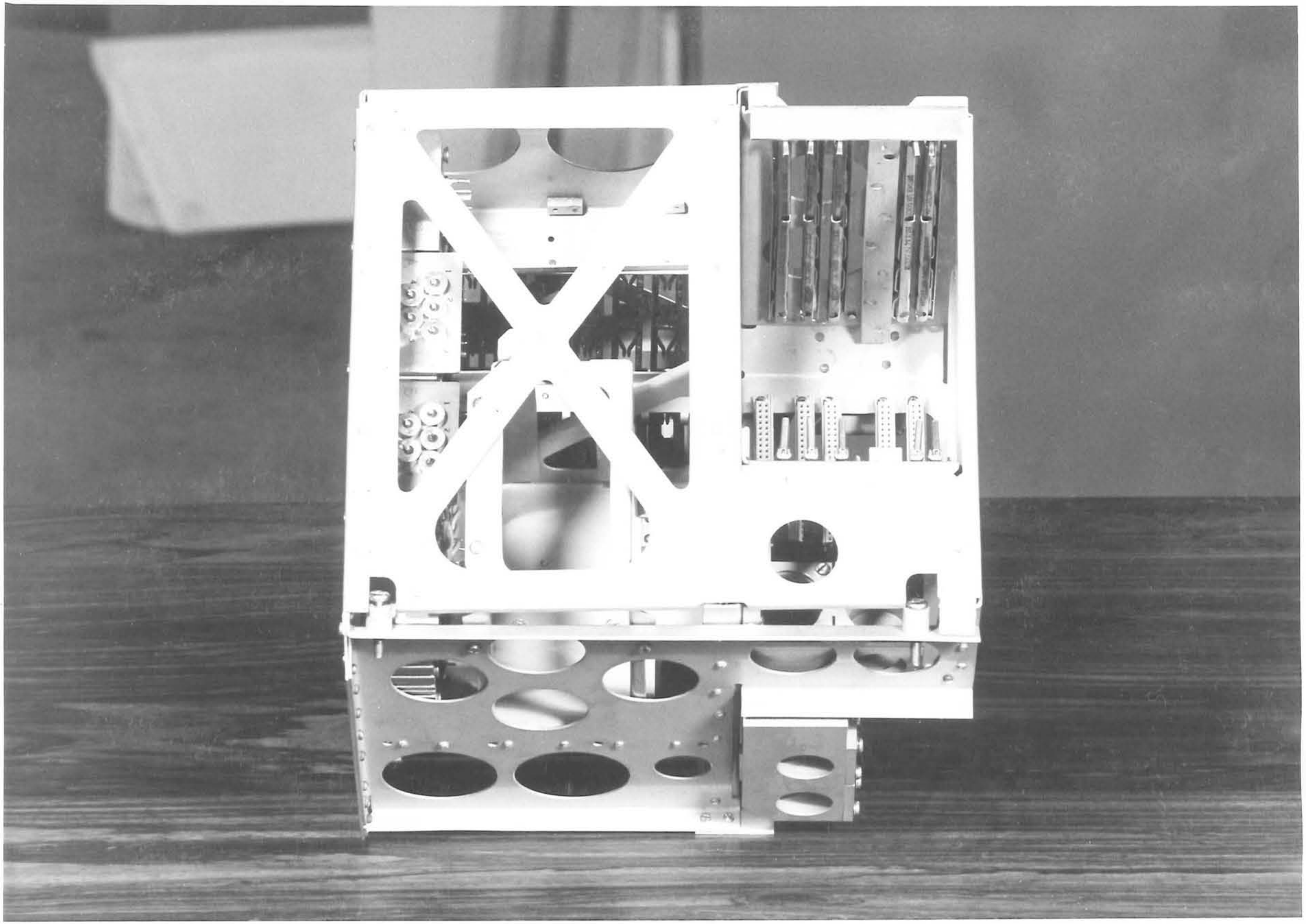

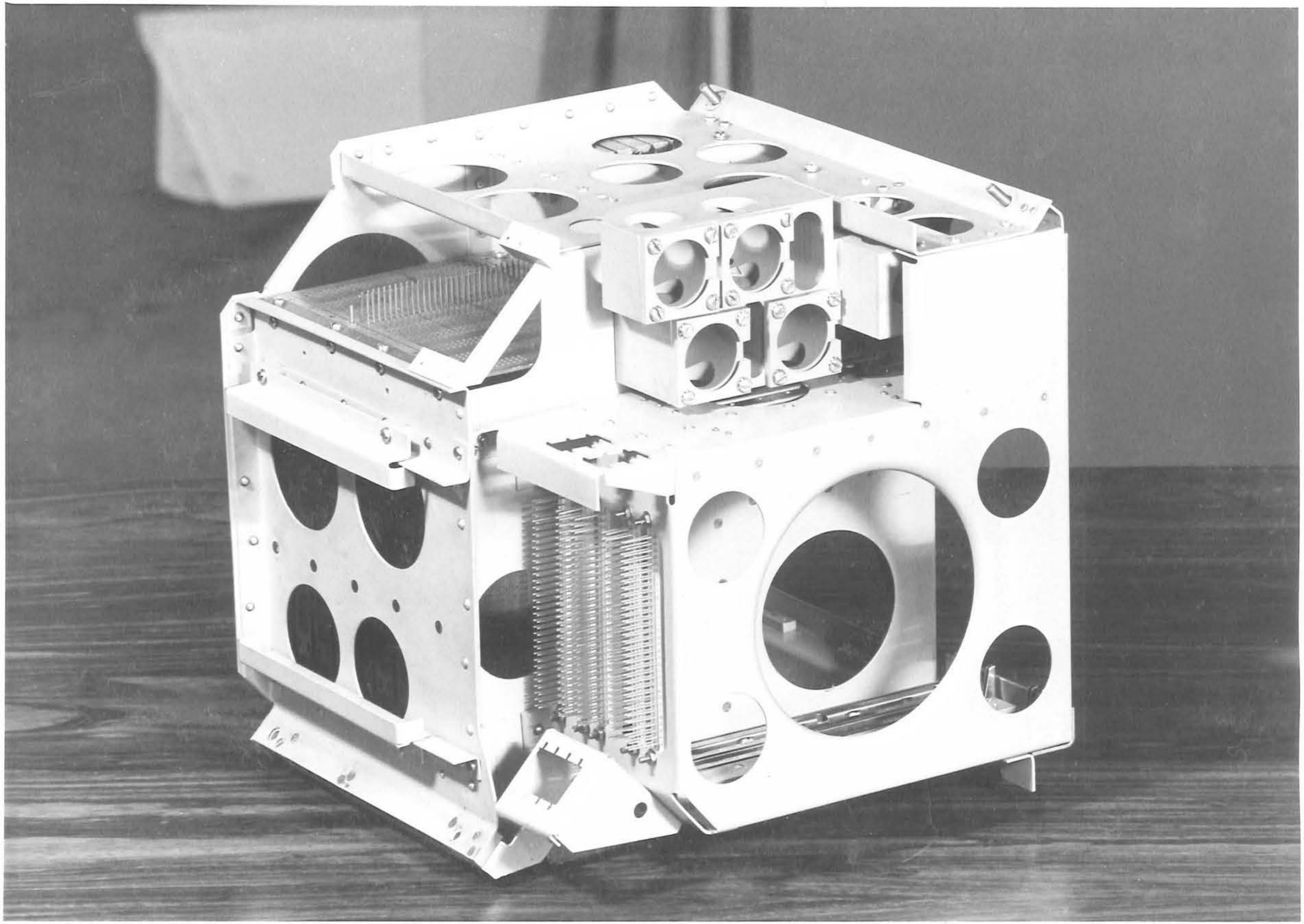

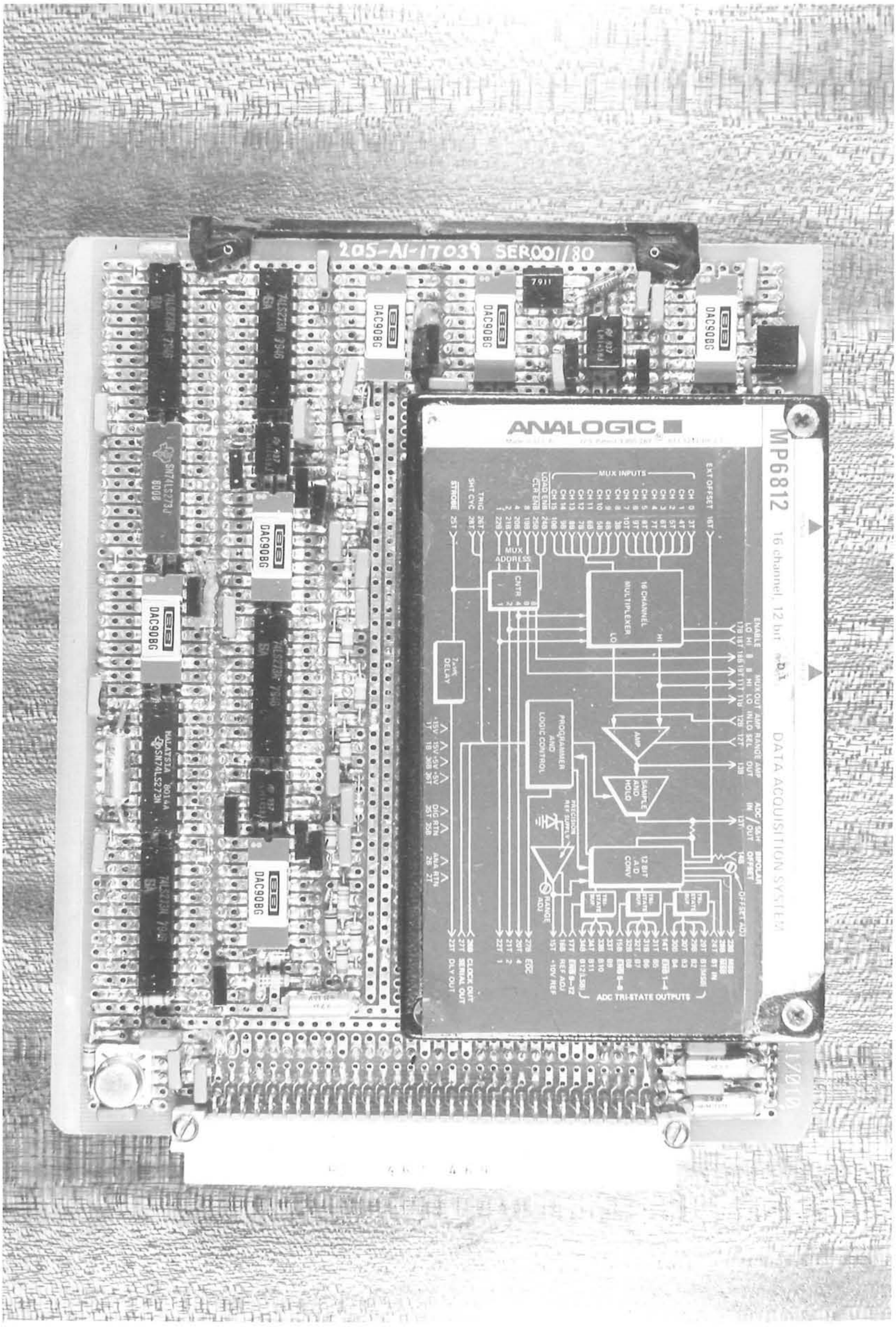
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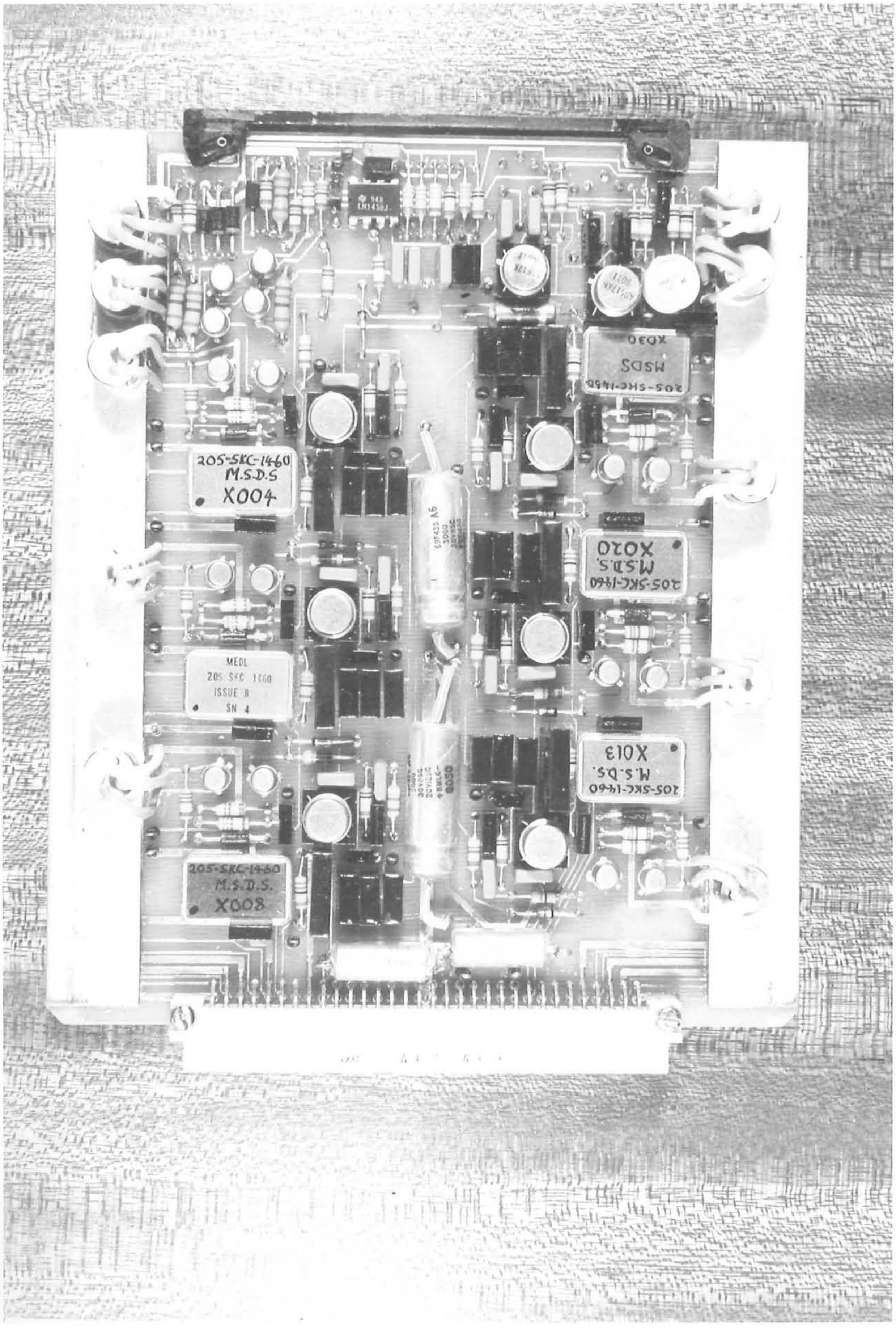
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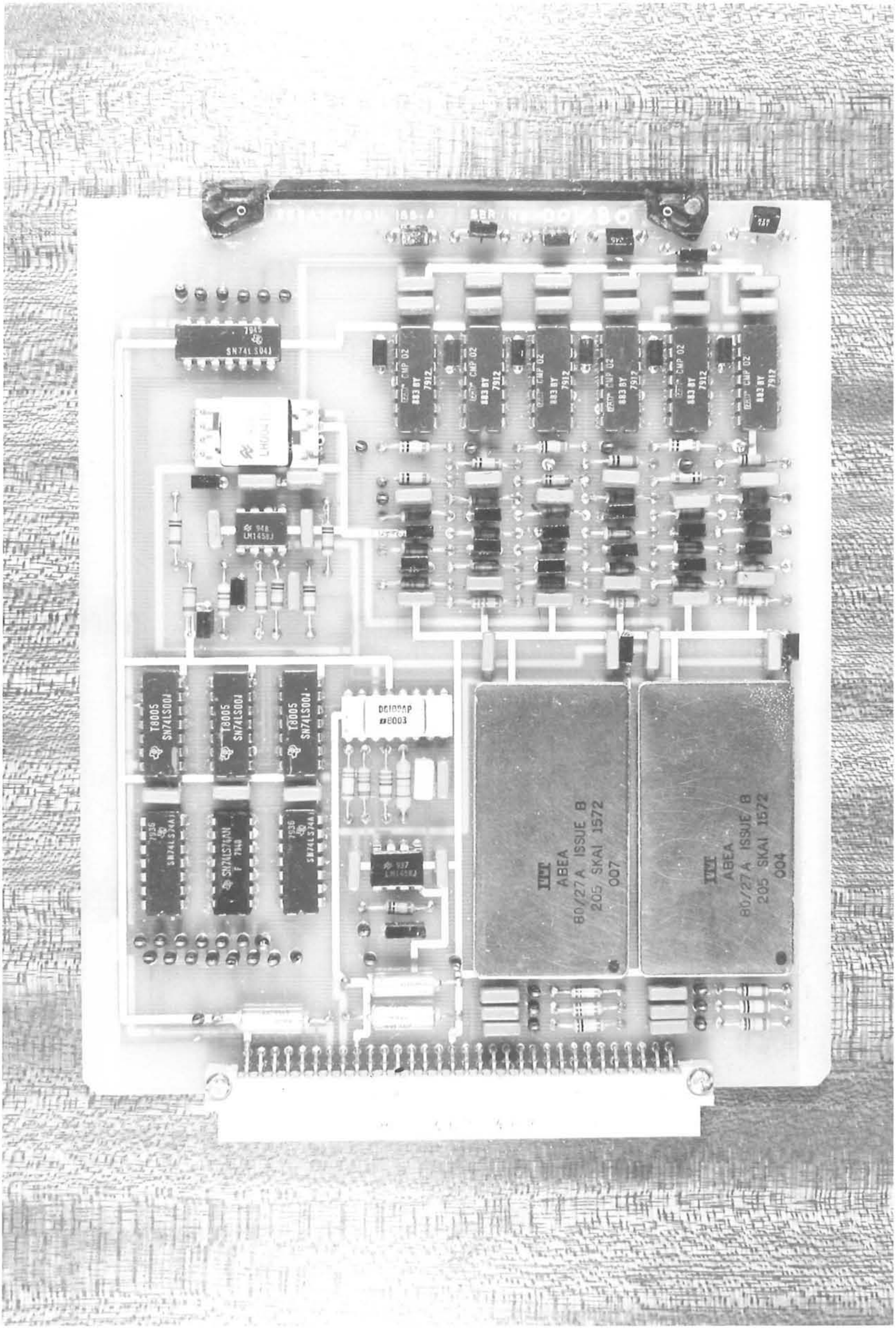
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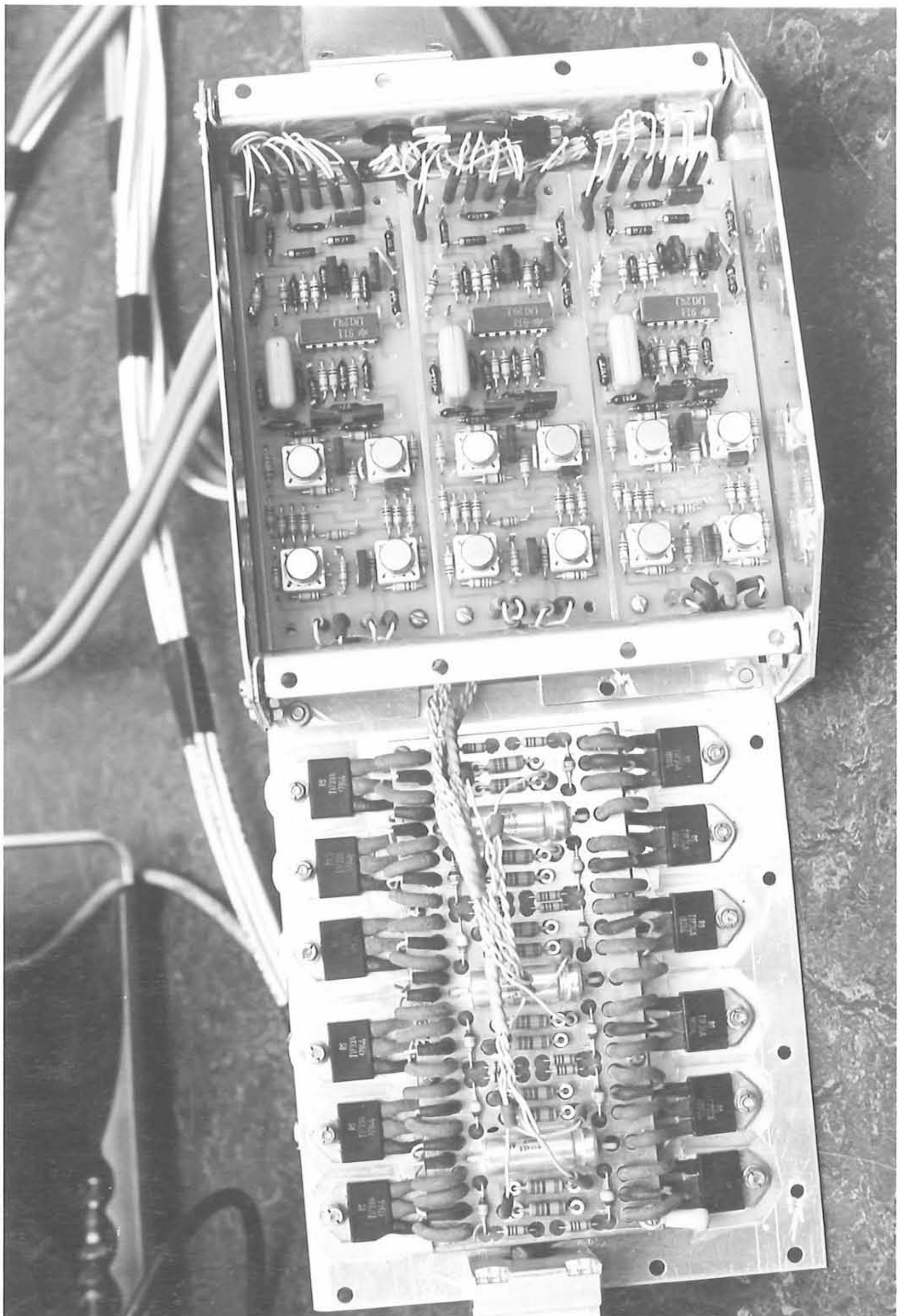
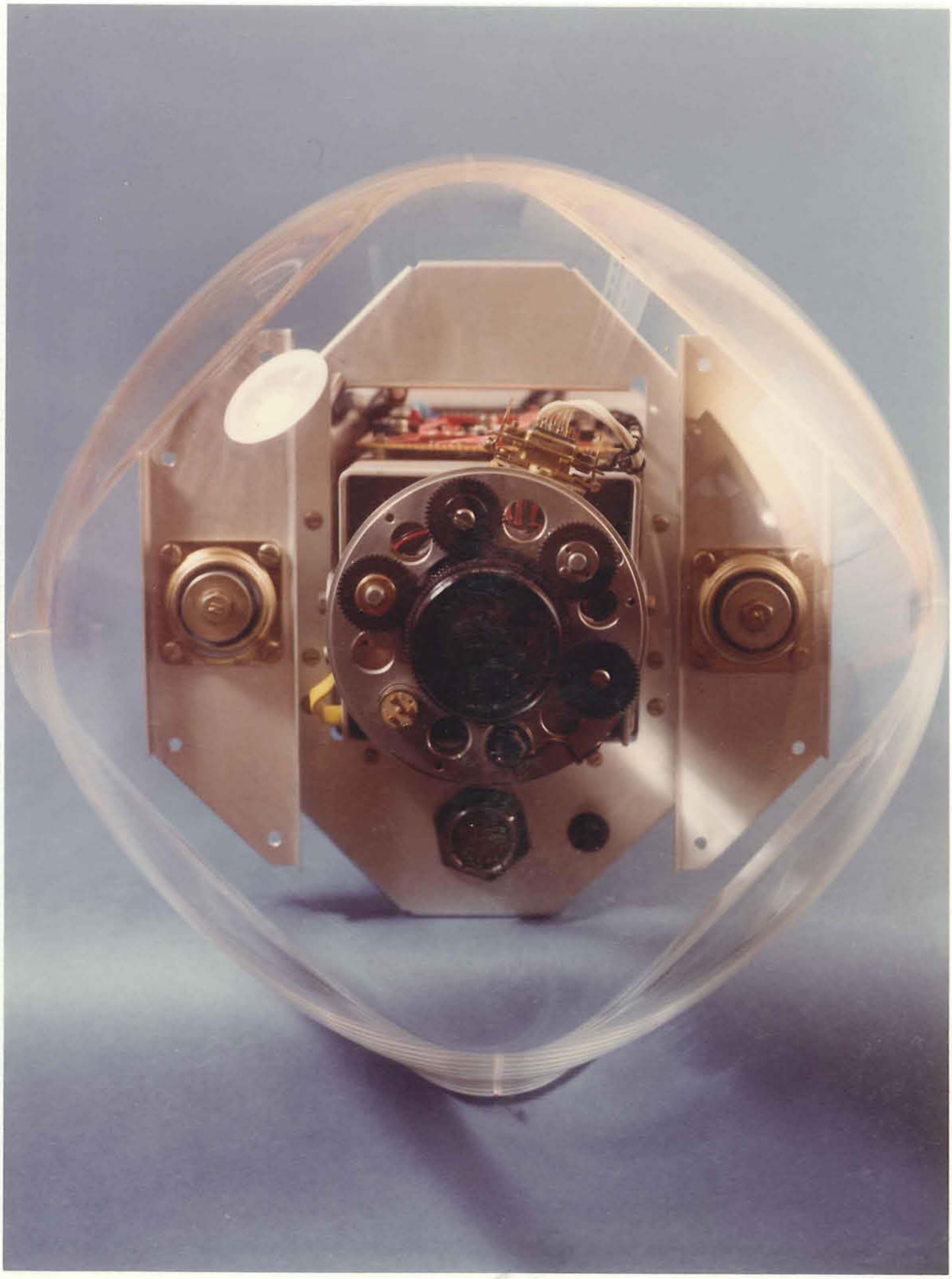
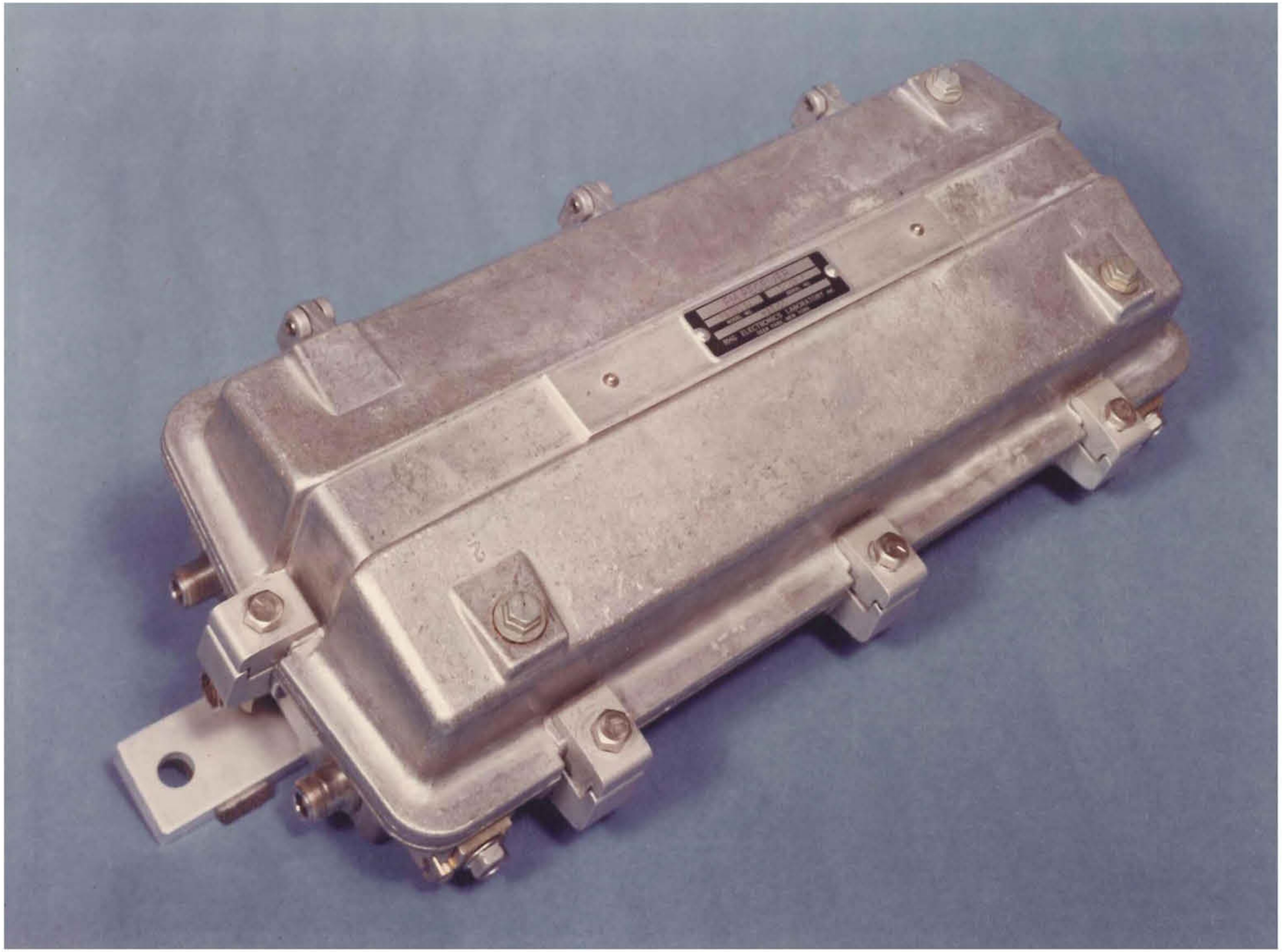
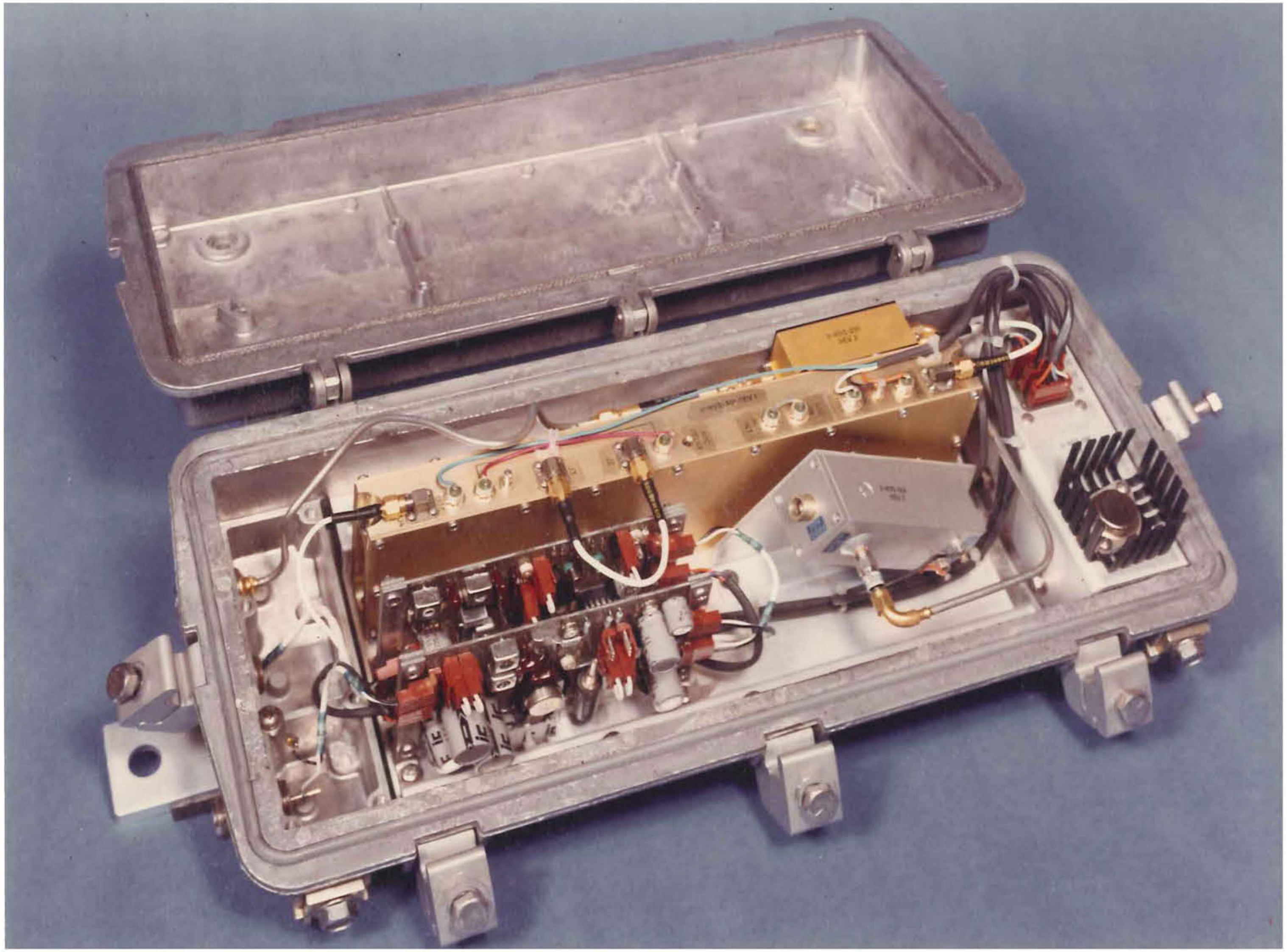
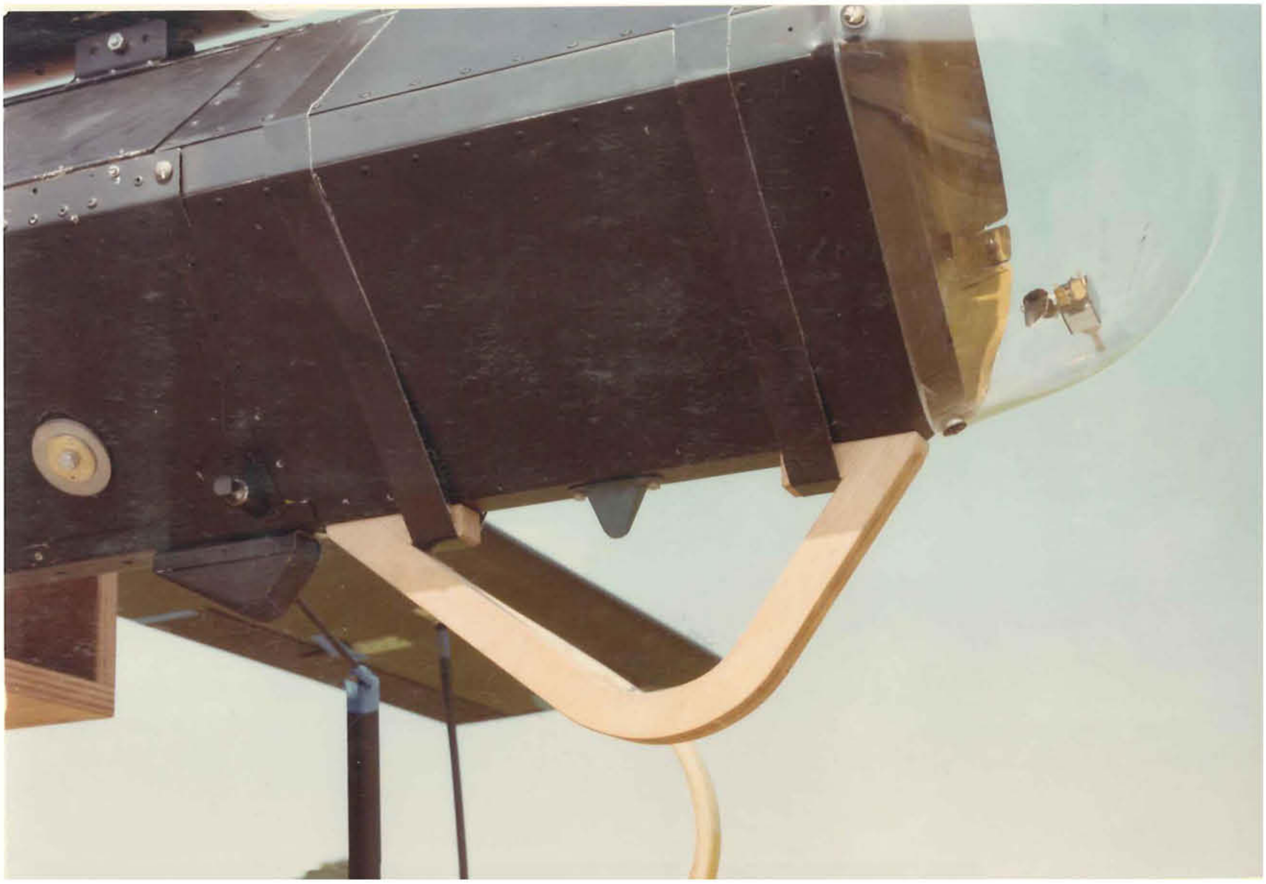
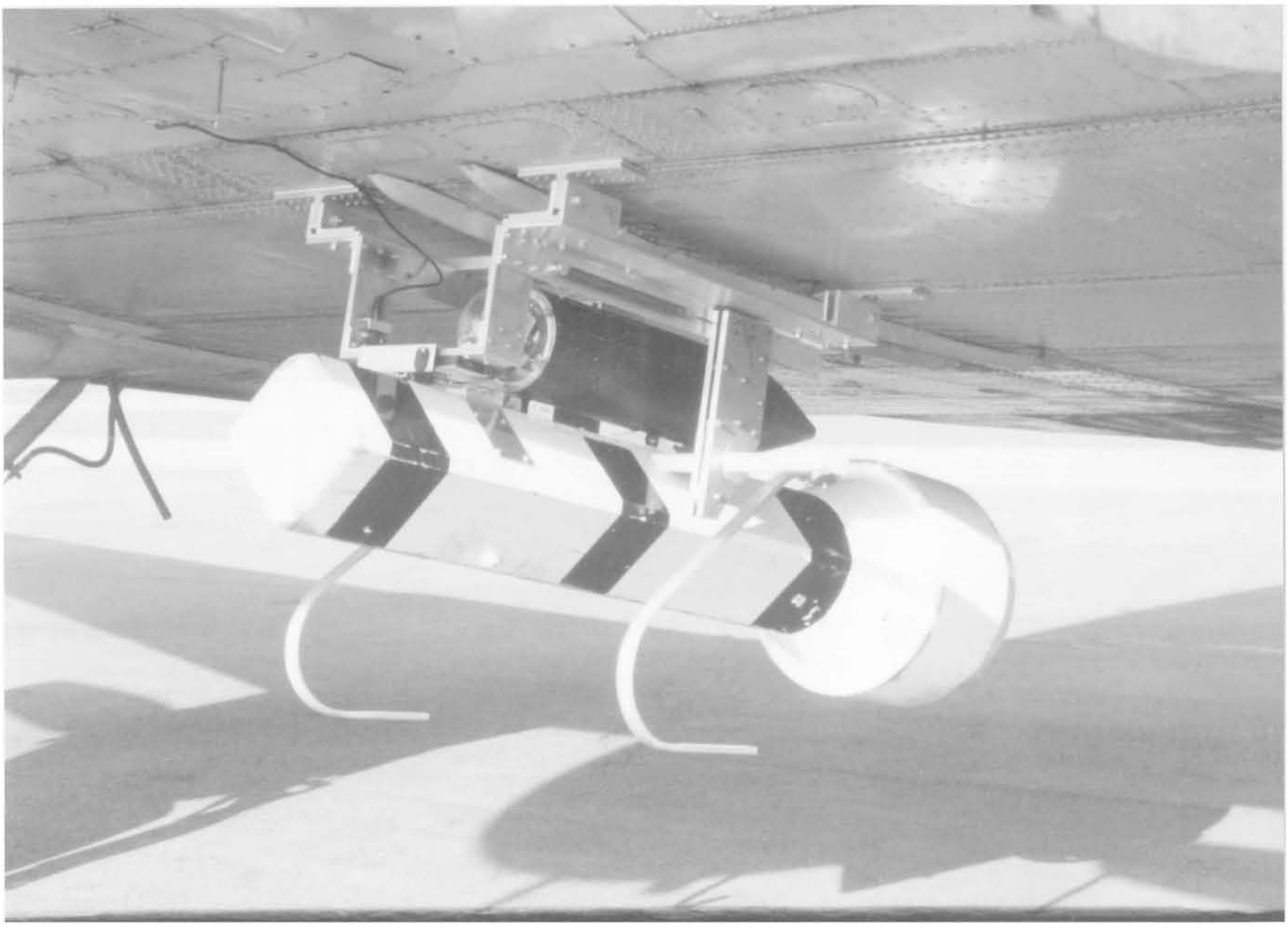













G-ALWC

T Hamill BSc CEng MIERE
Marconi Avionics

Designing the MACHAN unmanned aircraft

Aircraft that can fly without a pilot on board have a variety of uses, mostly of a military nature. One of the most advanced automatic planes is the Machan, whose development has been supported by the Ministry of Defence (Procurement Executive).

T. Hamill is the Engineering Manager of the Flight Automation Research Laboratory, Marconi Avionics.

The idea of using unmanned aircraft for both civil and military tasks is by no means new. The first unmanned aircraft were used in about 1916, during World War I, as aerial targets and for interception and ground attack. Since those early days, unmanned aircraft have had mixed fortunes except in their role as aerial targets. The last couple of years has seen a major upturn of interest, however, brought about by the dramatic increase in microelectronics capabilities and a similar increase in the roles that these aircraft can perform.

Given the concept of an unmanned aircraft, used in applications where manned aircraft would be inappropriate, one would like to capitalise on the pilot's absence and have less equipment which would mean less weight. Until recently, these savings could not be made. A human pilot has a prodigious ability to process information and take appropriate action; and replacing this human ability with electronic substitutes required in the past a mass of equipment that cancelled out most if not all of the potential savings. Only recently has equipment become small and light enough to realise the benefits.

The early aircraft were either very simply pre-programmed to carry out a simple flight plan or heavily dependent on a radio link with the ground for control and guidance. The rapid development of electronic counter-measures in modern warfare has required this dependence on the ground to be reduced as much as possible, thus placing even greater demands on the airborne equipment. Fortunately, large-scale integration (and now VLSI) has led to the manufacture of avionics equipment, with the necessary capability, to be made at low weight and small volume; and at modest cost. The cost is especially important since all unmanned aircraft have to be cheap and most are regarded as expendable.

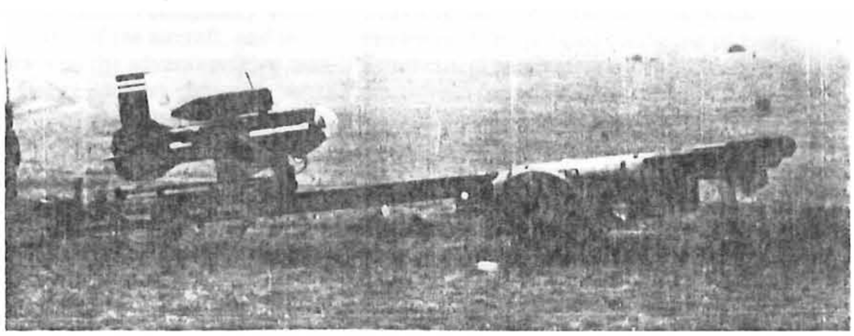
The Machan unmanned aircraft system represents one of this new breed of unmanned aircraft. Its avionics are more sophisticated, in some aspects, than those carried by some of the front-line manned aircraft in squadron service with the RAF today. It is an experimental aircraft first and foremost, aimed at providing data on a number of different flying and operating techniques and payload capabilities. The principal application is the modern battlefield. Civil uses are more demanding in terms of safety and are therefore only likely to receive wide acceptance when the military uses have provided the large accumulation of operating experience necessary to establish confidence.

Before examining the electronics in detail, it is worth considering the airframe in which the electronics have to function, as it has quite an influence on the design. Indeed, one thing which emerges from the work being done on unmanned aircraft is the need to relate all the facets of its production.

A class of its own

The aircraft has a wingspan of 12 feet and is 7 feet long. These dimensions tend to suggest that it is little bigger than the larger radio-controlled models. It is the weight, 190lbs, which clearly indicates that this aircraft is in a very different class. Its construction employs a range of materials and techniques. The fuselage itself is constructed of sheet metal because it requires little tooling, is appropriate to small numbers, and provides a benign electro-magnetic environment for the contained equipment. It also provides a stable ground plane for the diverse antennae mounted on the aircraft, preventing the unwanted disturbance of aerial patterns by changes of installation. These considerations all arise from the experimental role of the aircraft and are clearly much less applicable to a volume production of an aircraft which is functioning well and immutably defined. Accordingly, various schemes for composite fuselages to meet different operational requirements have been produced but not, so far, flown.

That is not to say that composite materials are unused in the aircraft; they are used extensively in the aerodynamic surfaces. The wing comprises an alloy spar with foam sections which have been hot-wire cut to provide the aerofoil shape. The whole is then skinned with glass fibre to produce a smooth and very robust structure. The control surfaces and duct fins are similarly constructed. A different foam technique is used in the propeller duct which is made up of a double skin with a foam 'sandwich' filling. In this case, the foam is generated in situ by a local mixing of the appropriate chemicals. The transparent dome on the nose of the main fuselage and the parachute pod, the skids, and several other smaller parts use a range of composites in their construction.



The Machan aircraft on the pneumatic launcher just before a flight at the Royal Aircraft Establishment, Larkhill. The plane accelerates to about 60mph in under a quarter of a second (photograph: RAE).

The aircraft is controlled by means of five control surfaces, three identical tail surfaces and conventional ailerons on the wings. A number of control strategies are possible with these surfaces since they can all be driven independently. The conventional strategy is to use the two horizontal tail surfaces as an all-flying tailplane and the rudder and ailerons for yaw and roll control respectively. However, the rudder can be used to provide roll acceleration and the tail surfaces used differentially to control roll. This flexibility is another reflection of the experimental functions which the aircraft performs.

Fearsome acceleration

The power unit is a Weslake, air-cooled two-stroke engine of about 18 horsepower. It is mounted just aft of the wing and drives a ducted, two-blade, wooden fan. The aircraft is launched from a Short's pneumatic catapult that can accelerate it to 60 mph in well under ¼ of a second. This fearsome acceleration is provided by a unit which can be towed behind a small truck. The aircraft has also been launched from a radio-controlled trolley propelled solely by the aircraft's own thrust but this technique requires a long, prepared runway and therefore limits severely the choice of the operating site.

The Machan can be recovered by a parachute which is mounted in the pod above the fuselage, or by a conventional landing. Again, the latter technique requires a prepared site which does pose operating restrictions.

It can be seen that the avionic equipment design is significantly impacted by choices made in the operation and airframe design.

a. It must withstand the high levels of vibration associated with two-stroke, synchronous firing engines.

b. It must withstand the very rapid acceleration from the pneumatic launcher.

c. It must withstand a high shock on landing.

d. It must be flexible to take advantage of the choices of operating and control modes of the airframe.

Not surprisingly, a digital solution was chosen for the flight control system which is based on the ubiquitous microprocessor; in this case, a Texas 9900. The microprocessor, together with most of the permanent avionics fit, is located behind the variable payload in a separate bay. The units are mounted together in a very light metal assembly which allows the whole fit to be exchanged as a single unit.

The digital approach to the requirement for flight controls provides several advantages, some of which are particularly relevant to a trials aircraft while others have a more general application. It is easy to change the control laws, both to evaluate the minimum complexity which allows adequate control of the aircraft, and to determine quantitatively the advantages that may accrue from using more complex control schemes. These changes in control law are made by changes in software only and may be implemented with great visibility and, hence, safety.

A change of gain in the control loops can be made in flight by transmitting actual gain values to the aircraft from the ground station. If this facility is used, the ability to return instantaneously to a pre-programmed set of values held in the aircraft is provided as a safety feature. Changes of control law in flight are always accomplished by commanding the selection between two, fixed blocks of programme, and never by an in-flight modification to the programme.

Another advantage of digital implementation was recognised at the design stage although the extent of the benefit was not appreciated until flight trials were under way. The power of the digital computer may be directed to system test, both at the preparatory stages and as an immediate preflight test. A checkout of the processor, the store (both fixed and volatile), the input and output interfaces, the control surface deflections, the r.f. links for command and telemetry, etc, can be made in a matter of seconds on the flight line. The implications of this ability for an operational aircraft are obvious.

The most important sensor functions on the aircraft are those for airmass and body motion. Airspeed is measured by a simple hot wire anemometer and height by a solid-state pressure transducer. Two variations on motion sensing are available; for simple flying tasks, a three axis rate gyro pack provides outputs for autostabilisation modes. The gyros used in this configuration are GRH4s, more usually found in missiles. For more demanding functions, where it is necessary to know body attitude as well as the rotational rates, a 'strapdown' attitude and heading reference system is used.[3, 4]

Strapdown and gimbals

The term 'strapdown' is used to distinguish this type of system from the possibly more familiar type of gimballed system. In the latter, a stabilised platform is kept level with respect to inertial space by means of gyroscopes mounted on the platform itself. Accelerometers, also mounted on the platform, measure the local vertical to help provide long-term levelling of the platform. The attitude of the vehicle in space is obtained by measuring the angles of the platform gimbals. In the strapdown system, the sensors are in fixed alignment with respect to the aircraft axes: they are literally 'strapped down'. The integration of the angular rates provides an angle output, but since the relationship between aircraft body axes and inertial space is continuously varying, so a continuously varying axis transformation must be applied to refer all the measurements back to inertial space. Three pairs of sensors, a gyro and an accelerometer (the G1-G6 and APG6) are mounted in mutually orthogonal axes. The sensed parameters are processed in the aircraft system's second 16-bit microprocessor which is also a Texas 9900.

Because the processing is basically an integration procedure, its accuracy is affected by iteration rate and word length. The sixteen bit implementation is necessary to reduce adequately the errors caused by rounding off. There are various means of representing the attitude, each based on a different means of integrating the body angular rates. Machan's particular implementation is based on the use of Euler Symmetrical parameters which have certain advantages over direction cosines or Euler angle transformation techniques. There is no singularity at pitch angles of $\pm 90°$; and transcendental functions are eliminated from most calculations, thereby speeding up the processing task.

The calculated vertical is corrected in the long term, and established at start-up, by reference to the accelerometer data. This measure of the local vertical is, however, influenced in the short term by vehicle manoeuvres and so a suitably long time constant has to be used in filtering this data into that obtained from the gyros. The most serious error would be the displacement of the sensed vertical from the true vertical during a turn (when centrepetal acceleration is experienced). In this system, an approximation to the centrepetal acceleration is calculated by using the airspeed and the turn rate from the gyros; a technique not possible using simple vertical gyros.

The use of a separate microprocessor for the functions of flight control and attitude sensing is not a reflection on the limitations of the processors available. One processor capable of both functions certainly represents a feasible implementation, but there are certain advantages to functional partitioning (and hence software partitioning) between distributed processing elements, particularly when the aircraft in question is involved in a trials environment and the individual functions are continually subject to review. The ability to change one function without affecting others saves time in re-clearing the system for flight, and the modularity of the system is a great help in keeping it maintained. In fact, this functional partitioning is carried one step further, in that the navigation function is performed in a third 9900 processor; only, in this case, the processor is in the ground station. More will be said of this when the means of communication between the aircraft and the ground station have been discussed.

Avoiding interference

The commands from the ground to the aircraft are passed over a VHF radio link using pulse code modulation techniques. The aim is to achieve a high level of immunity from spurious information picked up from potentially interferring sources. Of the data transmitted, two-thirds is for the identification and validation of the remaining one-third which represents the 'real' messages. A telemetry system operating in the UHF band relays information back to the ground, including the sensor data appropriate to providing a navigation function remotely and housekeeping data used to determine how the various aircraft systems are performing.

The aircraft also carries a system for assessing hazards which, independently of the onboard computers, controls the functions of parachute deployment, engine cut-out and parachute jettison. This system will put the plane into a recovery sequence if commanded to do so, or if radio contact with the ground is lost, or if the radio messages from the ground fail their validity checks, or if any failure in the flight control system is detected. Parts of this hazard system are duplicated for additional safety.

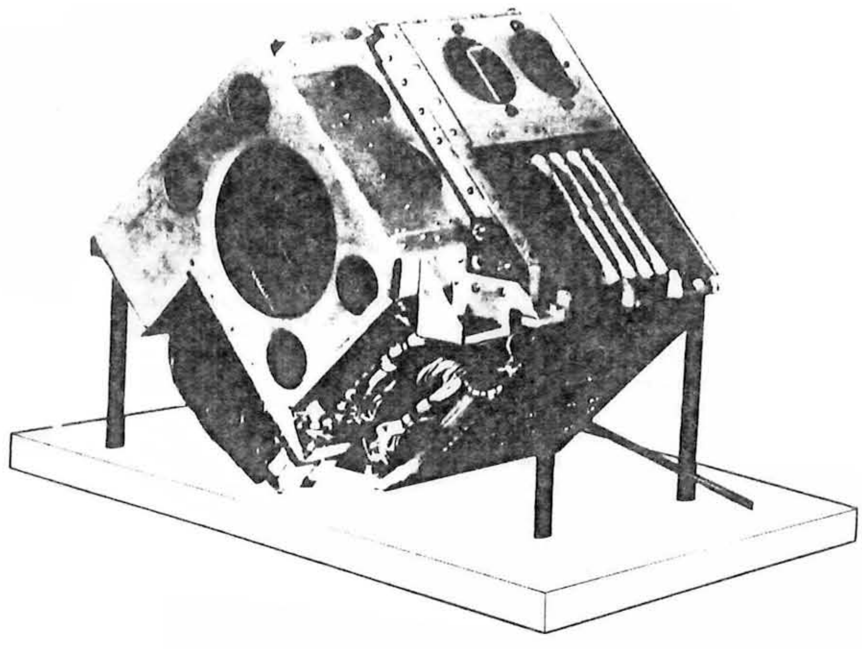
Last in this list of aircraft systems which fall outside the terms of the payload is the Cinderella of most aircraft, the electrical system. The Machan has been standardised on a single 28 volt d.c. supply from an engine-driven alternator and a central regulator/conditioner unit for a number of reasons. First, it allows an easy choice of battery support, which is necessary to ensure the recovery of the aircraft in the event of a generator failure. Second, a wide choice of standard equipment, including power generation modules, is available for 28V systems. Third, it simplifies the provision of ground power.

The ground station

The major element of the ground station is a two-man console. The first position is for the air-vehicle controller and has all the prime aircraft controls, autopilot functions, etc, as well as a display which can be used for viewing a TV sensor image received from the aircraft, a synthetic instrument display, or an overlay presentation of both types of imagery simultaneously. The second position could loosely be described as the 'experiment' seat. The functions to be performed by the occupant of this position would vary according to the type of trial being flown and the payload carried. A similar cathode ray tube to that provided for the pilot is available for sensor display, etc, and access to the centre console is equally possible from both positions.

The unit houses the third Texas 9900 processor mentioned earlier. It provides the autopilot functions and is the basis for a number of navigational experiments. The basic autopilot functions are built around the standard 'hold' and 'acquire' modes for each of three parameters; namely height, heading and airspeed. Three digital LED displays are provided to display either the current state of these parameters or their demanded values. The datum values are set by potentiometers mounted on the autopilot control panel, which occupies the space between the two TV displays. The functions of additional controls are software designated in a fashion appropriate to the trial being performed. For example, an autopilot mode which causes the aircraft to execute a procedure turn would be useful if the aircraft were being used to calibrate airfield approach aids. Such a mode would be entered using one of the software driven function switches.

The autopilot computer operates by receiving data on the aircraft's state from the telemetry system, together with demanded states from the autopilot control panel. The necessary control surface and throttle activity is computed and then transmitted to the aircraft via the normal command link, instead of (or mixed with) inputs from the pilot. The benefits of this ground-based autopilot function are twofold. Firstly, the software and the usefulness of control modes can be assessed without changing the aircraft software. This, in turn, implies that the ground station autopilot may be disengaged, returning the aircraft to a previously defined state. This ability significantly eases the problems of qualifying the aircraft for flight. The corollary to this is that, since the autopilot based on the ground station and the aircraft's own flight control computer are software compatible,

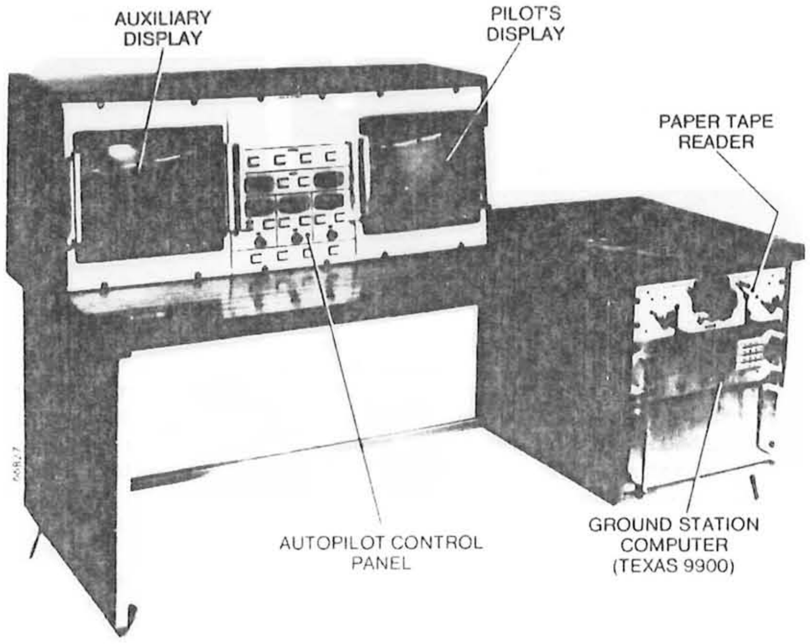


The Machan avionics includes a digital flight control system, a digital strapdown attitude and reference system, and several radio links.

software proven on the ground may be transferred to the aircraft to provide increased on-board capability with high confidence.

The second advantage of having an outer loop closure mechanism on the ground is that functions may be evaluated experimentally without producing specialised airborne hardware. Many techniques (particularly in the area of navigation) could be evaluated on the ground without the significant hardware development programmes that otherwise would have to be conducted before the technique's operational effectiveness could be proven.

The software for the ground station computer is written in an hierarchical, modular fashion, each level operating on a menu of simpler functions from the next level down. For example,



The console of the ground station has dual TV displays, a 16-bit microcomputer, autopilot controls and a radar display.

the bottom level would contain the three hold and acquire modes for heading, height and airspeed. The next level up would allow straight legs and constant rate turns to be flown using a constant rate of change of heading into heading acquire. Racetrack patterns would be operated by the third level, calling on straight legs and turns, and the uppermost level would represent complete flight plans. This structure is ideally suited to the developmental nature of the programme and for implementing the ordered transference of control capability from the ground station to the air vehicle computing facilities.

Another function performed by the ground station computer is the conversion and display of data from the range radar. Data can be displayed as range/bearing from the radar and from the ground station, or in any other reference frame. For gimballed optical sensor payloads, the ground station computer can receive gimbal angles via the telemetry, and then display the range and bearing of the centre of the sensor's field of view (a useful feature in target designation).

The experimental programme and payloads

The programme is currently directed towards demonstrating the various capabilities required for a battlefield surveillance mission. The activities fall broadly into three categories:

- The evaluation of suitable sensors.
- Navigation, guidance and control techniques.
- The general evaluation of components and systems under realistic operating conditions.

Mention has already been made of the way in which the special environmental conditions impact on the design of the onboard equipment. A further characterisation of this environment, both by general experience and by specific experimentation, is essential if the equipment is to fulfill its required functions reliably, without being over-specified, over-engineered and therefore over-priced. A determination of the vibration characteristics is an important example of this type of work; it is equally important to allow these aircraft to be handled by unskilled personnel, thereby revealing their shortcomings for field use.

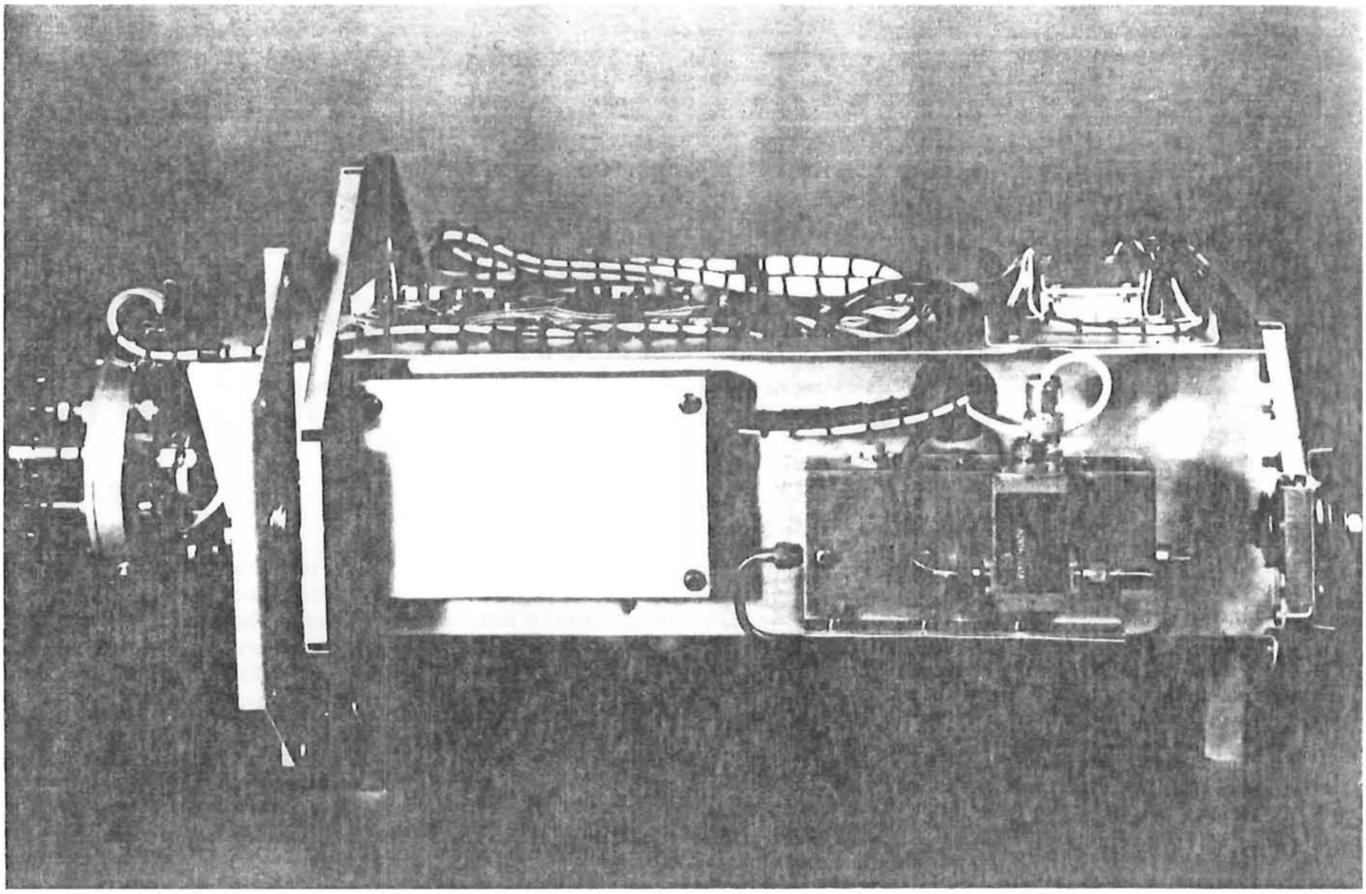
The navigation experiments are obviously applicable to many roles and not simply to surveillance. However, the intended mode of use does, in many ways, define the boundary conditions within which the navigation function must be performed. Take the example of autonomy. There is an obvious trade-off between depending on radio instructions from the ground, (which makes the system detectable and so vulnerable to countermeasures) and making the aircraft fully self-contained by using sophisticated autonomous navigation techniques, and thereby increasing its unit cost. If the surveillance role demands that images are transmitted in real time at intervals back to the ground station, then radio silence has already been broken and totally autonomous navigation may be inappropriate.

Similarly, the way in which the target is best viewed dictates which flight control mode is required. Should the aircraft overfly the object of interest several times from different directions; should it orbit the target; or should it view the target from an orbit displaced from the overhead? Do you compensate for wind drift to allow exactly the same pattern to be flown repeatedly or allow some variation in the pattern to make effective countermeasures more difficult? Such questions can be answered only by experiment and experience.

Dead reckoning

Once the navigation facilities have been defined, the means of achieving the required accuracy must be investigated. The starting point is to use dead reckoning based on three figures: heading (from the 'strapped-down' attitude and heading reference unit); airspeed; and an estimate of wind vector. But dead reckoning on this basis alone is unlikely to provide an adequate, long-term, performance because of the variable nature of the wind and the poor quality of the estimate of wind vector. The situation can be improved in two ways and, in practice, both may be used.

The first is to measure groundspeed directly by using a Doppler velocity reference. This eliminates errors due to wind drift but the errors in the velocity and heading may still be unacceptable in some applications. It is worth remembering that the error in heading will grow with time, being a function mainly of gyro drift, whereas the error in distance flown is a function of that distance. The way in which a man flying an aircraft corrects his navigation by reference to a compass airspeed indicator and his watch is by 'position fixing'. He simply looks out of the window and consults his map. He can estimate corrections to compensate for errors in heading and wind vector or, if he knows the ground



speed, for heading error only. Position fixing in an unmanned aircraft can be performed in a variety of ways. It is possible to use a TV sensor to look at the ground and then having the operator refer to his map but this technique has limitations and other, more automated means are usually required.

Matching the scene observed by an imaging sensor to a specially stored map is obviously one way of achieving the fixes and this technique is actually used in the homing phase by some American Cruise missiles. Various radio fixing techniques are available. A radar can be used, for example, to give the range and bearing of the aircraft from the surveyed position of the ground station but, in an operational situation, a conventional search radar is very vulnerable to detection. Radio links with very narrow beams can be used to provide information on bearings and, if the received pulse is retransmitted by a transponder in the aircraft, the time taken to receive the transponded pulse back at the ground can provide a measure of the range. These techniques, using monopulse links, have been demonstrated in remotely-piloted aircraft. Position fixes can also be obtained using radio beacons; either the OMEGA VLF system or the Global Positioning satellite system. Much has already been written about techniques in which the sensed terrain height is compared with a specially prepared contour map stored in the on-board computer, and from a comparison of the two the position of the aircraft can be deduced. Many variations on this and related techniques have been proposed and it is their experimental evaluation with a realistic air vehicle which is seen as one of the longer term aims of the Machan programme.

The sensors for a surveillance mission can be extremely diverse, depending on whether the surveillance is 'visual' or electronic. The Machen programme, as currently envisaged, falls into the former category. It starts in the visible spectrum, with a daylight-only TV system and may be extended according to the results obtained with this most basic of imaging sensors and the results of other work being conducted in parallel. The options would include extending the range of operating conditions, such as low-light TV, infra-red sensors and millimetric sensors; or changing operational constraints such as a move to line-scane sensors (visual or infra-red) with a view to reducing the bandwidth required of the data link, or stereoscopic sensors, aimed at improving the performance of the image interpreter.

One other important aspect of these payload trials will be the operating frequency of the data link. In general, it has to be in the order of several gigahertz, both from considerations of bandwidth and to fit in with other frequency allocations. The first TV payload has a link operating in 'S' band and, although most trials are likely to be conducted at lower frequency, this unit has been chosen to help demonstrate and quantify the penalties of moving up the electromagnetic spectrum.

As with a great many earlier technologies, the development of unmanned aircraft has been driven primarily by a military requirement. However, the civilian uses are beginning to come to light and, given the pace of development of microelectronics, the capabilities and safety of these aircraft must grow. It will undoubtedly be many years before they become a common sight. In fact, one of the ranges on which such aircraft are operated coincides with one of the highest concentrations of UFO sightings in the UK. However, our children will probably pay them no more heed than we pay to a passing jumbo jet. It is our responsibility to ensure that the undoubted potential of these aircraft is not restricted by our lack of imagination.

An example of a payload. The TV system has a remote zoom, focus and iris.

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Race on to build robot spotter plane for army

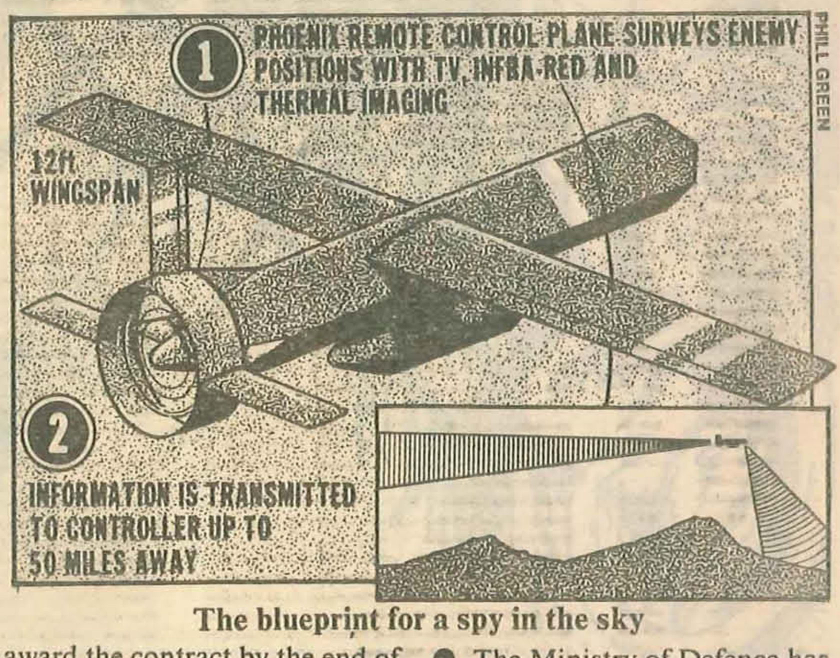
by James Adams
Defence Correspondent

DESIGNS have been submitted to the Ministry of Defence for an unmanned spotter plane, codenamed Phoenix, that will revolutionise the way Britain's forces fight on the non-nuclear battlefield. Two groups are competing for the £100m contract to produce it for the army.

The Phoenix – officially described as a Remotely Piloted Vehicle, or RPV – is designed to replace ground reconnaissance patrols in identifying behind-the-lines targets, beyond the immediate battle area. Its sensors will be able to pick up details of troops and equipment below the plane and relay a picture back to a controller, sitting in front of a TV screen, who can then direct an attack on the targets with pinpoint accuracy.

"The British army is convinced that anything that goes forward of the front line, whether on foot or in the air, will be shot to bits", explains a scientist familiar with the Phoenix project. "They need something that will give them 'real time' intelligence and not cost lives."

After a three-year study into RPV technology, final designs were submitted last Friday by two contending consortia led by Ferranti and Marconi. These will be followed up by formal bids in September and the defence ministry is expected to award the contract by the end of the year.



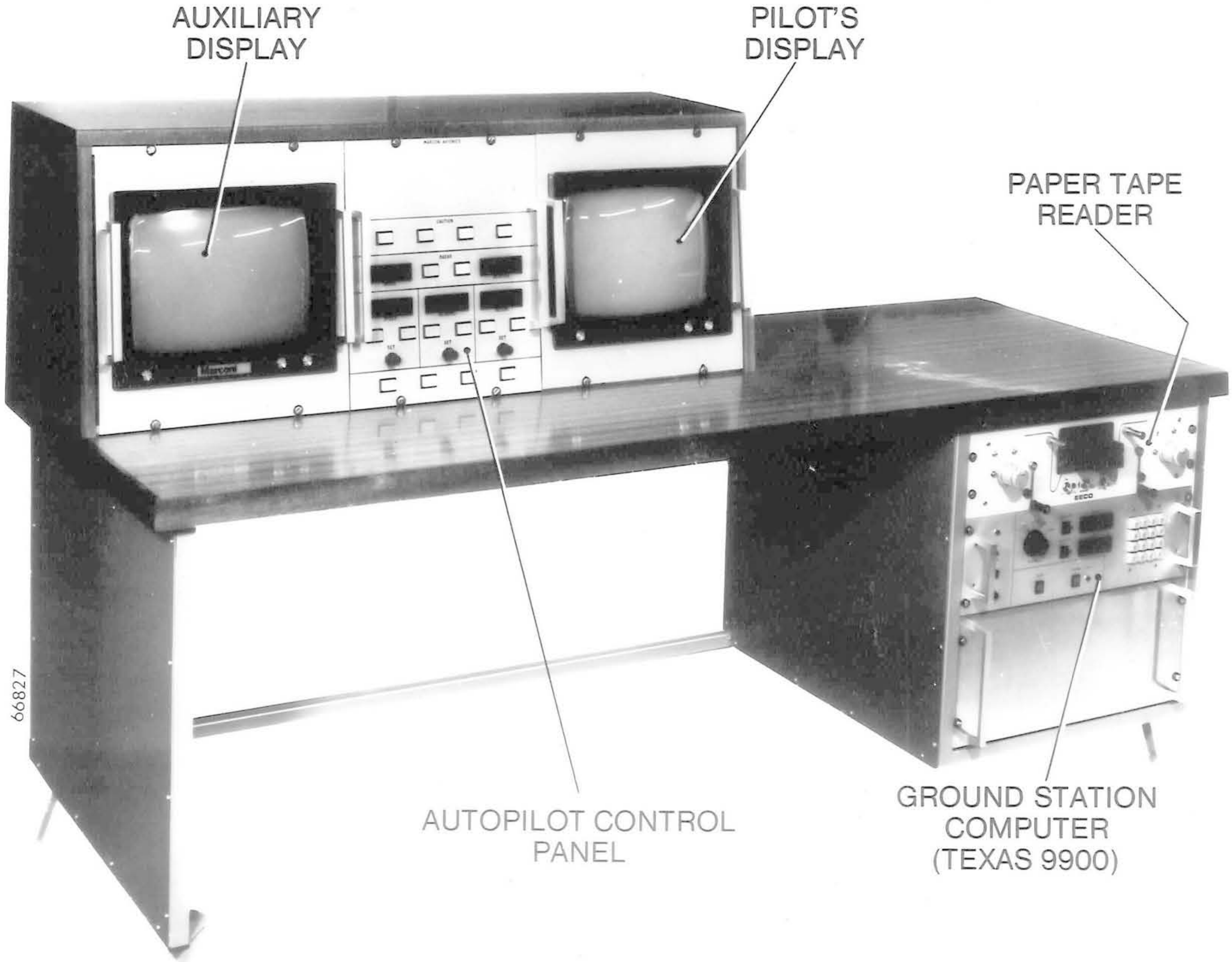
The blueprint for a spy in the sky

Although details remain highly classified, it is known that there are some characteristics common to both designs:

- The Phoenix, with a 12ft wingspan, will have a cruising time of five hours, at speeds varying between 55 mph and 150 mph.
- It will be launched by catapult and recovered by parachute, which will be housed on the plane's belly so that, in landing, the aircraft will invert thus protecting the sensors.
- The sensor package will comprise both infra-red and thermal-imaging systems which can relay 'real time' information back to a control vehicle. The sensors lock on to different heat sources and can distinguish between a tank, truck or troop-carrying vehicle.
- The Ministry of Defence has specified that the sensor package must be removable, to facilitate its rescue (if need be) or its replacement by an electronic reconnaisance or jamming unit.
- The fuselage will be diamond-shaped, which considerably reduces its radar signature.

Britain was once a pioneer in the field of RPVs but, since 1978, development has largely been left to other countries, particularly Israel. In the 1982 war in Lebanon, the Israelis deployed two types of RPV, the Scout and the Mastiff, to spot and direct fire on Syrian SAM missile sites and to monitor troop movements.

The Israeli army believes the RPVs saved many lives and considerably improved the effectiveness of its artillery fire.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PILOT'S DISPLAY
PAPER TAPE READER
AUTOPILOT CONTROL PANEL
GROUND STATION COMPUTER (TEXAS 9900)
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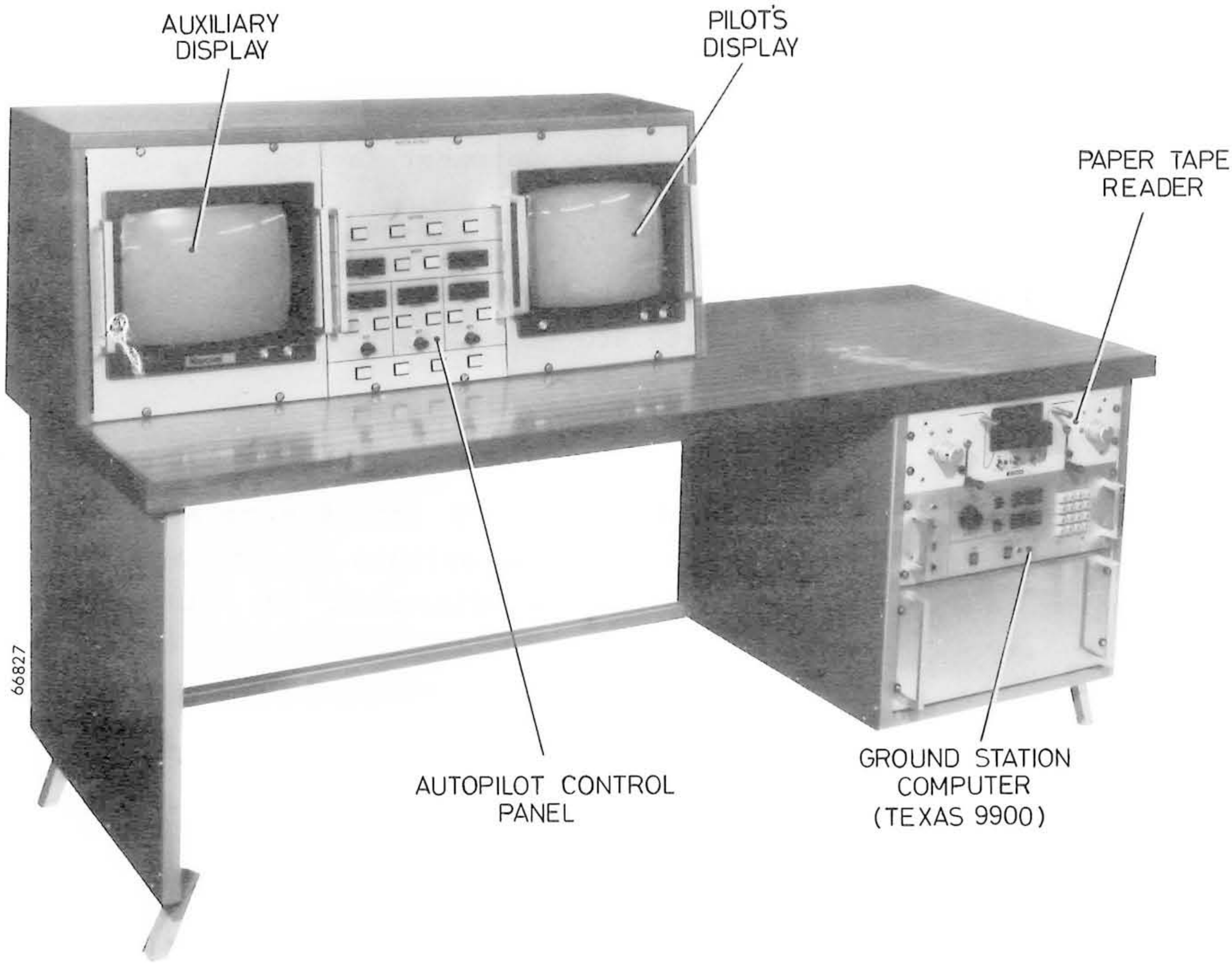
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Figure 8

INTELLATE AUTOMATIC TESTING

INTELLATE is an acronym of **INTELL**igent **A**utomatic **T**est **E**quipment. The concept is based on building up an "Expert" data base which stores details of equipment faults and symptoms, which are then accessed and compared with the defective equipment data to arrive at the most likely diagnosis of the fault(s). An analogy can be made to computerised medical diagnosis - the aim is really to try to computerise the processes, techniques and skills that an experienced crew chief uses in diagnosing and rectifying equipment faults.

The engineering maintainance branch of the RAF is very keen to investigate the possibilities and anticipate that substantial savings in maintainance costs are possible.

Fig. 9 is a block diagram showing the system concepts.

The ability to access the MIL-STD-1553B Data Bus to ascertain the operational condition of all the avionic systems and sub-systems **in flight** offers a new dimension in diagnostic capability.