MARCONI INSTRUMENTS

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Standard Signal Generator . . . TYPE TF 144H

by J. BALDING

This article is complementary to the one by J. M. Parkyn which appeared in Instrumentation *Vol. 7 No. 8. It describes in greater detail some of the mechanical design features of this new instrument, and also some general aspects of the mechanical engineering of signal generators.*

DESIGN CONSIDERATIONS

From the very beginning of the design stage of TF 144H it was obvious that the new instrument would have to incorporate all the desirable features of its predecessors, which had made them so popular. The extent of this popularity can perhaps best be judged by the fact that the original design, created some 26 years ago, had been in continuous production ever since, with only very minor modifications.

The outstanding feature of the previous instruments in this series was the rugged simplicity of the overall design which imparted the high order of reliability proved under arduous conditions of service with the armed forces.

Other good features were accessibility and consequent ease of servicing, good frequency discrimination and simplicity of operation.

DESIGN DETAILS

The R.F. Unit

Once a broad overall specification of the new signal generator had been decided upon, the starting point of the design was the heart of the instrument, the r.f. unit.

Frequency stability was a prime requirement, and this was approached primarily from two angles. Firstly, the provision of a rigid base or plate to maintain the correct relationship between the various components, and secondly, the prevention of a large temperature rise, or variations, inside the r.f. unit.

Instead of the more usual box or frame type of R.F. Box casting, a simple cast plate of aluminium alloy was decided upon. This requires much less machining and is easier to drill as all the holes lie in the same plane. This plate is mounted vertically behind the front panel, and is spaced off from it by substantial steel pillars to give clearance for the various drives, etc., mounted on the front face. All the larger components are mounted on the rear of this plate, *i.e.* the tuning gang, attenuators, filter box and the fixed contacts which engage with the coil turret.

The three valves — r.f. oscillator, a.l.c. and crystal oscillator — together with their associated components are mounted on a separate chassis secured to the top of the cast plate at right-angles to it. Thus the r.f. unit is divided into two separate units for assembly purposes, one being of a mainly mechanical nature, and the other, the valve deck, consisting mainly of wiring and small

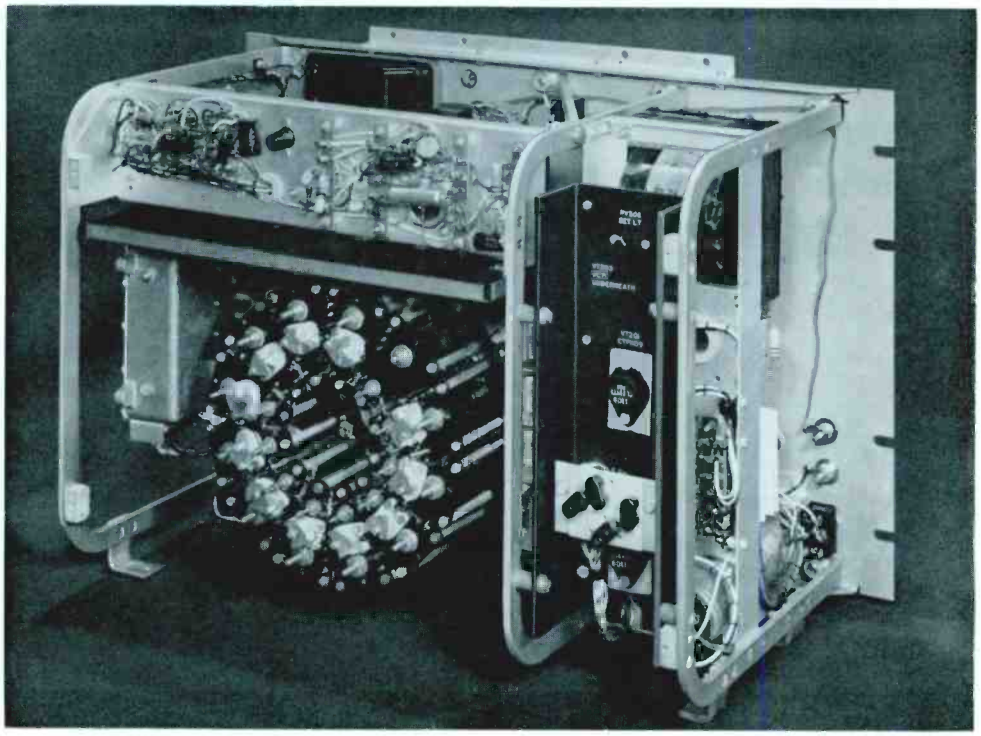
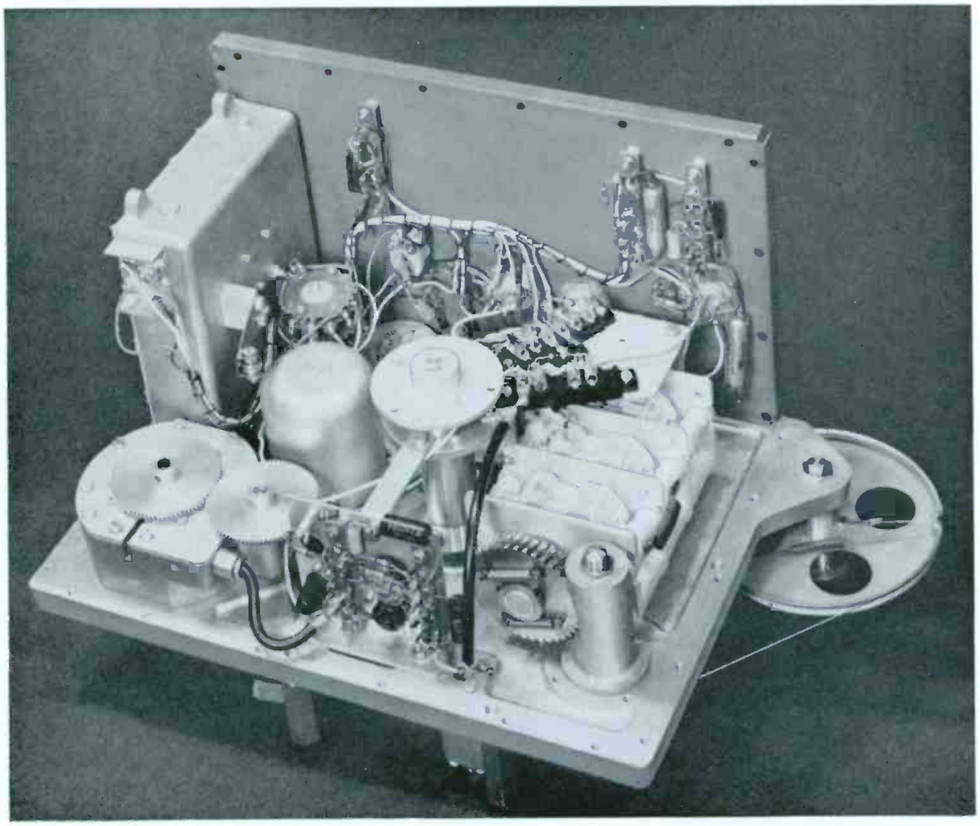
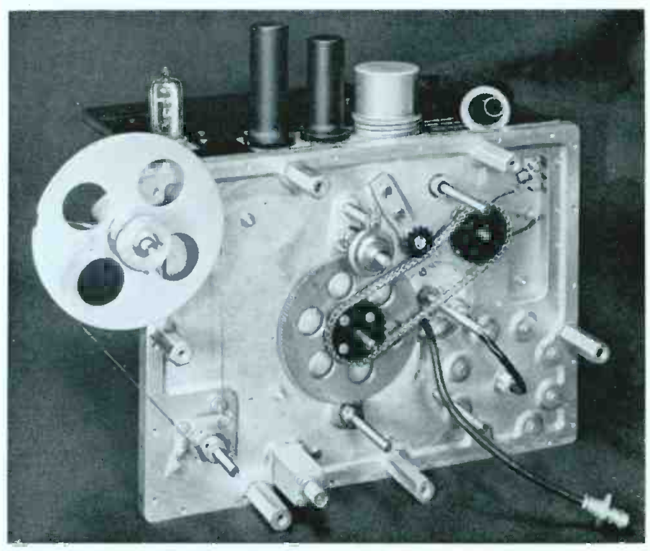


Fig. 1
Rear view of TF 144H, with R.F. Box cover removed, showing the open, accessible layout of the various sub-units





Figs. 2 and 3
Rear and front views of R.F. Box, with coil turret removed. The basic construction and simple drive spindle arrangements can be clearly seen

soldered components. This means that specialized operators can not only work on the two units independently but also at the same time.

In order to keep the temperature in the R.F. Box within reasonable limits the valves are mounted externally in special heat dissipating screening cans, only the pins of the valve holders projecting into the inside of the unit. These special cans consist of a copper tube, closed at the top end, inside which there is a stocking of tinned copper braid designed to fit closely around the glass envelope of the valve. This braid is secured at the base of the tube by a spinning operation, and a threaded bush is forced in to enable the can to be screwed onto the valve holder. Thus the heat is conducted away from the valve by the braid, and radiated partly by the outer copper tube, and partly by the chassis, which is in intimate contact with the tube adjacent to the valve holder, and acts as an effective heat sink.

The relative positioning of the main tuning capacitor, oscillator valve and coil turret contacts was given considerable thought, not only from the usual angle of endeavouring to keep the length of the inter-connecting leads to a minimum but also in trying to bring out the various control spindles in logical positions on the front panel without resorting to complicated drive mechanisms. Both these aims have been met. The coil for the highest frequency range (30-72 Mc/s) consists of three turns, showing that most of the inductance is where it can be closely controlled—on the turret mounted coil former—and not in the connecting leads.

The tuning capacitor driving spindle projects directly through to the front panel, the only gearing being on the turret driving spindle. This was included to give a lighter action to the range change control, which is geared down 6:1, giving half a turn of the control knob between ranges.

Coil Turret

In the interests of frequency stability the coil formers for the tuned windings have been made as large as possible—$\frac{3}{4}$ inch diameter—consistent with accommodating twelve complete units on the $7\frac{1}{4}$ inch diameter turret disc.

The turret disc is a bakelite moulding $\frac{3}{8}$ inch thick and is mounted in a vertical plane directly behind the tuning capacitor with the contacts facing forwards. These contacts are elliptical in section to mate easily with the butterfly type fixed contacts secured to the cast plate. They are made of a solid silver alloy and are held in correct alignment by moulded recesses in the turret disc. The outer periphery of the disc has twelve vee notches moulded in to act as locations for the roller indexing mechanism.

The individual coils are placed axially around the turret and are mounted on twelve segment-shaped plates each supported parallel to the disc by three aluminium alloy pillars which are slightly longer than the coil formers. The plates are also of bakelite with soldering pins moulded in. These serve to terminate the coil windings, and support associated components on one side, and provide anchoring points for the short leads which connect with the turret contacts on the other.

This arrangement allows the individual coil units to be easily removed as complete assemblies, a feature which greatly facilitates production, testing and servicing.

Tuning Capacitor

The main tuning capacitor is a specially designed three-gang unit with a ceramic spindle running in large-diameter ball races, and ceramic side bars and stator supports. All the metal parts are of brass heavily silver plated, and the temperature coefficient is very low.

This capacitor is mounted with its spindle vertical, and is secured firmly to the base casting by short steel pillars adjacent to the driving gear at the lower end, the upper end being flexibly mounted to allow for the differing expansion coefficients of the aluminium alloy base casting and the ceramic parts of the capacitor. Rotation of the capacitor is effected by a rigidly mounted stainless steel worm gear, driven directly by the front panel tuning knob, which meshes with a bronze wheel mounted on the rotor spindle close to the lower bearing.

The worm wheel is a fully throated design of generous proportions (20 diametral pitch) and is split laterally across its centre, the two halves being spring-loaded together to reduce the backlash to a low figure.

The comparatively low ratio of 8:1 for this main tuning drive was chosen to give rapid travel from end to end of a range without undue loss of discrimination. Each range is divided into approximately 400 divisions by the four-turn 100-division dial secured to the tuning knob, the total backlash in the system amounting to less than 1 part in 3000. The main frequency dial is driven directly from the worm spindle by a simple wire drive, each range covering 180° of the $7\frac{1}{2}$ inch diameter dial.

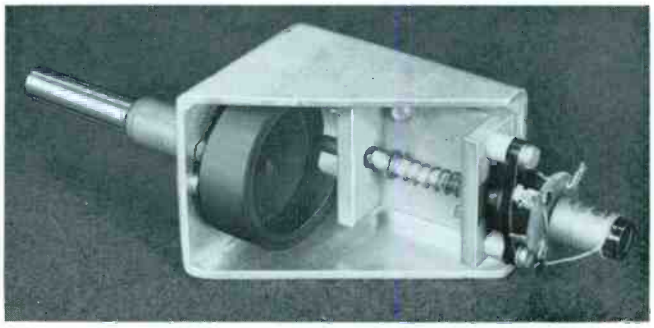


Fig. 5. The incremental frequency control unit

Fine Tuning

For the greater frequency discrimination required by modern narrow bandwidth receivers an improved type of incremental frequency control* was developed for this instrument. This consists of a small permeability tuned inductor coupled via a special auto transformer across part of the main tuned winding of the oscillator coil.

The front panel control operates a face cam via a 6:1 ratio ball drive. Spring-loaded against this cam is a

* Prov. Patent 6806/60

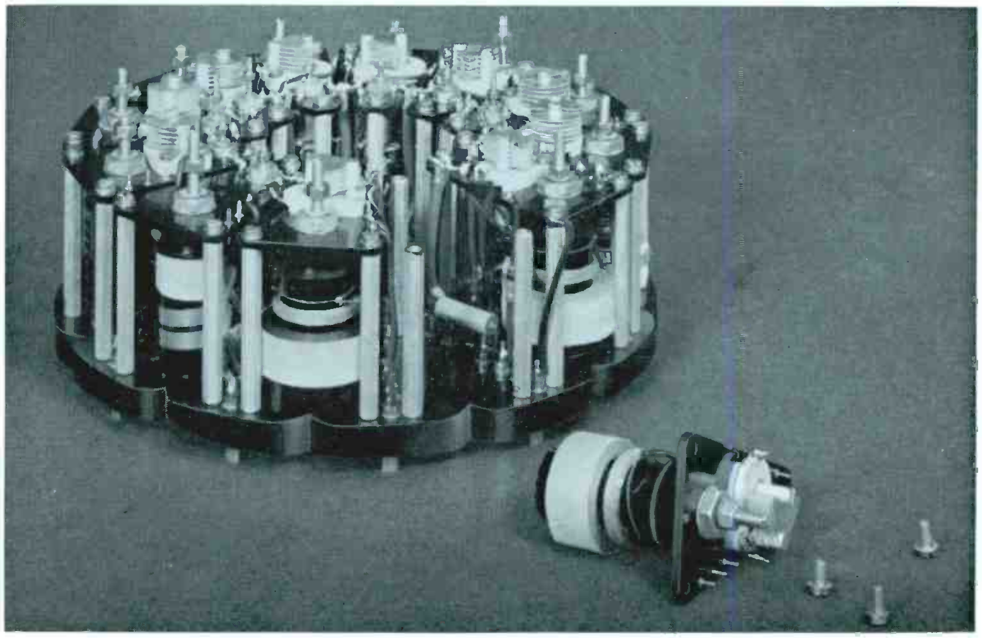


Fig. 4
The coil turret assembly, showing how individual coil units are easily removed

ceramic spindle which carries the iron dust core at the opposite end. The spindle is ground to very fine limits, and slides in two accurately reamed holes to ensure that very small reversals of the face cam result in purely axial and not lateral movements of the spindle. For 320° rotation of the incremental dial, the core has $\frac{1}{4}$ inch of linear motion which, in conjunction with the ratios of the various inductors and transformer, gives a total cover of 1 % of the frequency indicated on the main tuning dial.

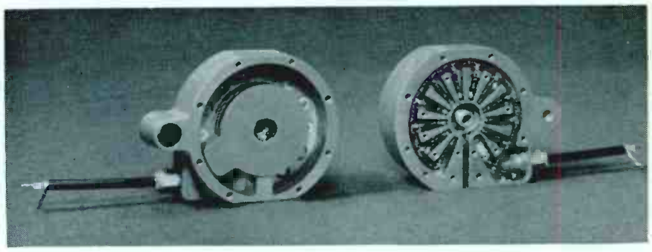


Fig. 7. Front and rear views of the coarse step attenuator

Filters

The various supplies to the R.F. Box pass through a series of r.f. filters which are housed in an aluminium alloy filter box. The box, together with the coarse attenuator body and index head, are pressure die castings. This process was chosen in preference to sand or gravity die methods because the vast saving in machining costs more than offsets the increased cost of the dies. It is also possible to reduce the wall thickness of the castings, resulting in lighter components and maximum use of available space. Pressure die castings can also be produced with much greater accuracy, and the nature of the process ensures that the metal is homogeneous and free from blow holes and concealed cavities.

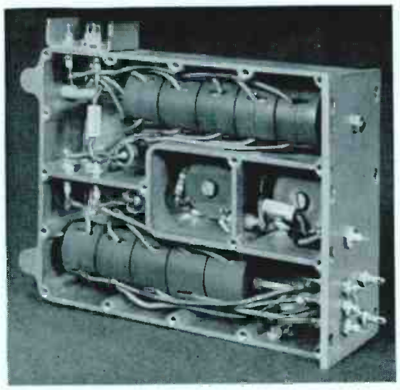


Fig. 6
The filter box assembly. This unit houses six double-section filters and associated components in a space only $5\frac{1}{2} \times 4\frac{1}{2} \times 1$ in.

Attenuators

Both the coarse and fine attenuators are part of the R.F. Box assembly. This is a new departure in signal generator design and overcomes one of the major difficulties usually encountered when the attenuators are separated from the main r.f. unit, namely that of obtaining a low resistance earth bond between them.

The output from the oscillator valve is fed first into the coarse attenuator by a lead inside the R.F. Box. The output from the wiper arm is then transferred via a double screened coaxial lead external to the R.F. Box to the fine attenuator which is mounted inside the R.F. Box with its connecting sockets accessible from the front of the base plate. The output from the fine attenuator is then taken via another double screened lead to the output socket on the front panel

As previously mentioned, the coarse attenuator body is an aluminium alloy pressure die casting, and careful attention has been paid to the screening of the resistors forming the individual π sections, and the provision of separate earth points for each 'rung' resistor of the ladder network. A $\frac{1}{8}$ inch wide radial slot, $\frac{3}{8}$ inch deep, runs outwards from the centre of the attenuator, and serves to reduce the flow of earth currents between the high potential and low potential ends of the ladder. The contacts are of solid silver alloy fitted in P.T.F.E. inserts recessed into the centre wall which separates the resistors from the wiper arm assembly. These contacts have a very low capacitance to earth, in the order of 0·3 $\mu\mu$F.

The rotor arm is screened by an aluminium alloy cover, the outside of which is formed with axial grooves, to provide an index location in conjunction with a spring-loaded ball fitted into the main body casting.

The rotor assembly is mounted on the centre spindle which is moulded in an insulating material to prevent coupling between the rotor section and the stray fields inside the R.F. Box. The output lead is secured firmly to the base casting as it passes through and picks up with the rotor arm via a pin which fits into a specially formed plunged hole in the centre of the rotor.

Since the fine attenuator deals with much smaller differences in power levels, an orthodox wafer switch was found adequate for switching the series and parallel resistors of the ladder network. Nevertheless, great care has been taken to keep all lead lengths as short and direct as possible, and the main earth path is a $\frac{3}{16}$ inch thick aluminium disc, which also carries the wafer switch, and is secured to the attenuator case as close as possible to the R.F. Box base casting

Power Supplies, L.T. Stabilizer and Modulator Oscillator

The rest of the instrument is composed mechanically of three units, the power supply, l.t. stabilizer and modulator oscillator chassis. These are mounted on three rectangular section steel support rails of U formation, the open ends being secured to the top and bottom of the front panel. These rails also carry the eight fixing blocks to which the case is attached.

Power Supplies

The power supply chassis is mounted vertically on the left-hand side of the instrument at the side of the R.F. Box between two of the supporting rails, and carries the mains transformer, l.t. and h.t. rectifiers and smoothing capacitors. It is arranged with the open side towards the rear of the instrument, for ease of access.

L.T. Stabilizer
The l.t. stabilizer unit is mounted directly behind the power unit, and consists simply of a U-section aluminium alloy strip $\frac{1}{8}$ inch thick to form a suitable heat sink for the transistors. It also carries the mains voltage selector panel which is accessible by removing a cover plate on the rear of the case. The unit is arranged so that by removing the top pair of the four fixing pillars, it can be swung downwards to allow access to the power unit chassis.

Modulator Oscillator
The modulator oscillator and h.t. stabilizer components are mounted on a horizontal chassis above the R.F. Box. Here again the open side faces rearwards and all components are readily accessible. Great care was taken in the layout of all these units to ensure that the majority of the components were placed on the same side of the various chassis for ease of assembly and servicing. The use of grommets was also kept to a minimum, and in the few places they are used are of generous size to enable the cable forms to pass through easily.

Front Panel Layout
The basic arrangement of the controls presented on the front panel follows the now familiar pattern, with the main frequency dial, tuning controls and input arrangements to the left, and the attenuators and output sockets to the right, with the carrier and modulation level controls and monitoring meter above them.

The main tuning control is placed low down on the panel so that the operator's wrist may rest on the bench to give a steadying effect to the hand when making fine adjustments. The range change control is conveniently situated adjacent to the tuning control, and operates the R.F. Box coil turret via a 6:1 reduction gear for ease of operation. The turret is continuously rotatable, *i.e.* there are no stops at the extreme ends of the frequency coverage.

The main frequency dial is protected by a shallow Perspex cover, which also houses the cursor. A small knob near the centre of this cover enables the cursor to be adjusted accurately with respect to the dial by using the crystal check points, the locations of which are conveniently indicated on the centre of the dial cover.

To make the fullest use of the available front panel area, two dials, the range indicator and coarse attenuator, have been placed behind the panel and are viewed through small moulded escutcheons.

Rack Mounting Facilities
The overall size of the front panel is 19 inches wide by $12\frac{3}{16}$ inches deep, and is provided with slots at the edges, of suitable size and spacing to enable mounting in a standard rack frame. When specified for rack mounting, a dust cover is provided in place of the case, and panel handles are fitted to protect the controls and enable convenient handling.

Battery Operation
It was decided to retain the battery operation facility of the previous instrument in this series, to maintain the versatility under field conditions.

This has been achieved very simply. Both the power supply leads, battery and mains, for the proprietary versions terminate at the front panel with 12-way sockets,

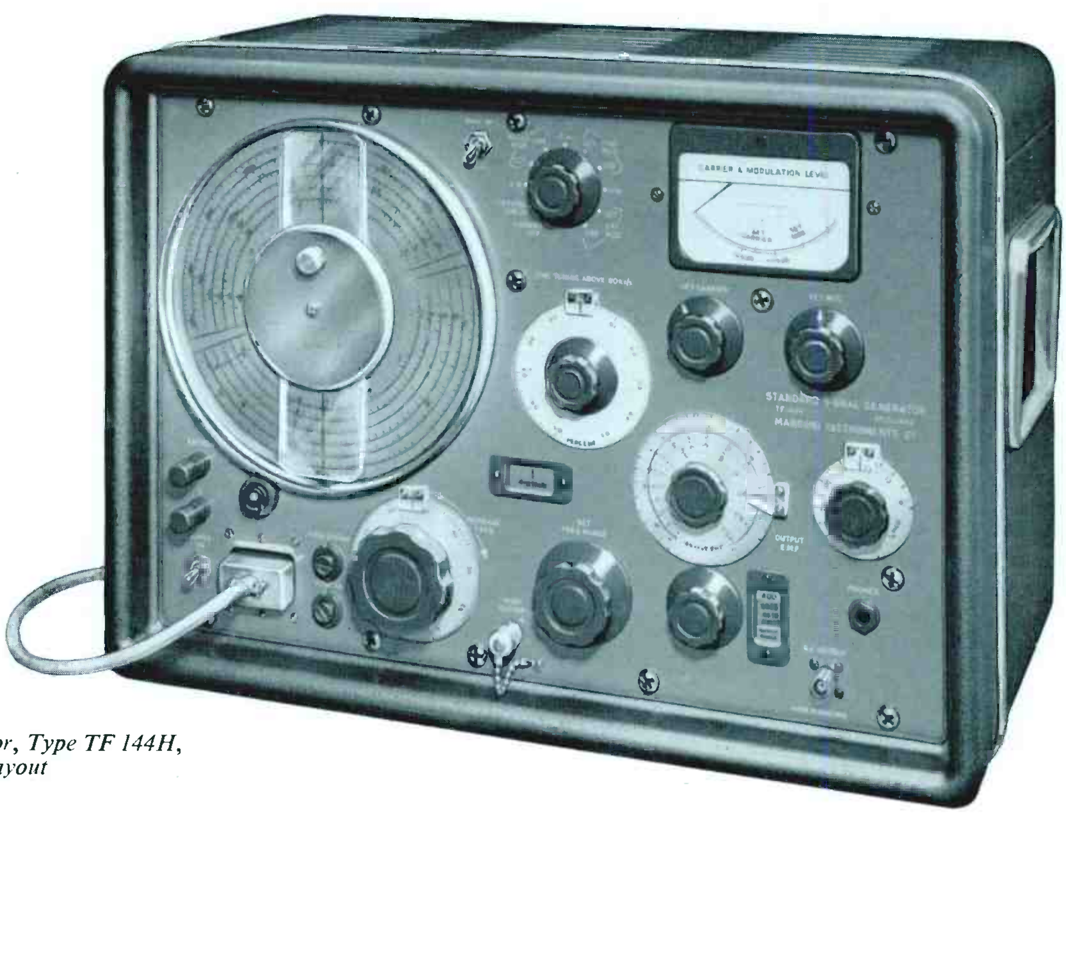


Fig. 8
Standard Signal Generator, Type TF 144H, showing the front panel layout

which mate with a 12-way plug recessed behind the panel. The wiring of this plug and the battery lead socket is so arranged that the internal stabilizing and power supply circuits are disconnected, and the battery h.t. and l.t. supplies are fed in via the same switch as the mains supply.

Proprietary and Service Versions

Either the cased or rack mounting versions are available to proprietary or service specifications. In all instances the component construction and finishes of the basic instruments are identical, the only differences being in the meter, power supply leads and the accessories provided

Meters

To meet the stringent Services specification, the standard 3×4 inch rectangular meter is replaced by a round hermetically sealed unit. This is mounted behind a plate which fits exactly into the panel cut-out provided for the standard meter and the two units are directly interchangeable.

Mains Supply

For the Services versions a supply adaptor, TM 6263, is screwed to the front panel. This converts the recessed 12-way plug into a Plessey Mk. IV socket suitable for the standard Services mains lead. It may be easily removed to enable the battery lead to be used.

Protection

The Services cased versions are also fitted with a lid which completely covers the front panel to protect the controls during transit and storage

These features have all been arranged so that any instrument can be converted to a particular type quickly and simply.

The extent to which the outstanding features of the previous instruments in this series have been included and improved upon in this new version can be seen by comparing the relative specifications. Although designed primarily as a proprietary instrument, TF 144H has passed the Services acceptance tests and has been designated GENERATOR, SIGNAL CT 452.

STANDARDIZATION OF CRYSTAL CALIBRATORS TF 1374 & TF 1374/1

An alternative method suggested by a reader—

Sir,—In *Marconi Instrumentation* for June, Mr. E. Isaacs describes the method of standardization of Crystal Calibrators using a CR.100 receiver and a separate a.g.c. voltmeter.

I would like to point out that a war surplus receiver of Marconi manufacture is, from my experience, probably the ideal for this. This is the R.1155A which is equipped with 'magic eye' tuning indication. By adjusting the signal from the crystal to be approximately equal to that from Droitwich, the eye can be made to open and close in accordance with the beats. The advantage is that the magic eye will respond to a note below audibility but still of a considerably higher frequency than any pointer type meter can follow, thus the crystal can be trimmed through a stage in which the eye is fluttering to one in which the opening and closing takes place over a period of several seconds.

I felt that after reading Mr. Isaacs' article, I could not resist pointing out the advantages of this old type receiver.

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