

MARCONI INSTRUMENTATION

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Analogues and Digits

A VALVE VOLTMETER, a counter/frequency meter, and a spectrum analyser—the subjects of the three main articles in this issue—have little in common, least of all as regards readout. One uses a moving-coil meter, one a digital display, and one a cathode-ray tube. Each represents a different form of readout, which is the method of indicating the quantity being measured by the instrument.

Readout in electronic instrumentation, like computers, comes in two categories—analogue and digital. Analogue readouts represent electrical quantities in terms of something physically measurable; for example, voltage may be represented by deflection of a meter pointer, frequency by angular position of a dial, and time by horizontal displacement of an oscilloscope beam. Digital readouts represent these same electrical quantities as a direct numerical display.

Analogue readout is far more widely used, and the moving-coil meter is probably the most familiar type for a passive instrument such as a valve voltmeter. Although simple and inexpensive, an industrial meter is limited to about 1% in accuracy and needs a certain amount of skill and care in reading; it may give rise to parallax error although this can be eliminated by a mirror scale. On the credit side, however, it can be calibrated to match any non-linear characteristic in the measuring system, and is particularly suitable for indicating maxima and minima in dynamic measurements such as are involved in adjusting a tuned circuit to resonance.

Digital readout is a relative newcomer to electronic instrumentation and gives a positive foolproof display. It is easier to read, especially in poor light, and lends itself to automatic range selection and decimal point positioning—all features which cut measurement time and greatly reduce human error and fatigue. It is capable of much higher accuracy and resolution, and permits slave operation of data recorders. On the other hand it is bulky and expensive, involves much more complex circuitry, and is inferior to the analogue readout for observing the nature of changes in the quantity to be measured. Furthermore, digital techniques are not applicable to all problems of measurement. Digital voltmeters, for example, are not practical for a.c. measurements much above 10 kc/s so the conventional rectifier type with moving-coil meter readout, such as the TF 1041C, is the obvious choice for economical and reliable r.f. measurement.

Counters, however, are concerned with a very different measurement problem—the recording of a discrete number of phenomena rather than an infinitesimally variable quantity. This leads naturally to digital measuring techniques and hence to digital presentation of the answer. Binary counters used for this purpose have merely to distinguish between the presence or absence of, say, pulse signals being counted and are 100% accurate. It is a logical development to extend this extremely accurate system to the measurement of frequency, which is simply a question of counting the number of pulses or sinewaves occurring in a second or other known period. Here the accuracy is limited only by that of the crystal-controlled timing period and an inherent ambiguity of ± 1 count in the digital display; the overall figure, typically a few parts in 10^7 or 10^8 , is therefore much higher than that of any analogue system of comparable complexity and cost. But, as with voltmeters, the application of digital measurement techniques is limited: above about 10 Mc/s a heterodyne system is required to reduce higher frequencies to a frequency within the measurement capability of the counter.

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Big Ben: the best known example of a familiar form of positional analogue read-out. The use of Roman numerals may add character and dignity to the calibration, but it is fortunate that the Arabs invented a numbering system more suitable for digital read-out devices.

photograph by The Times

In frequency converters such as the TF 1434 Range Extension Unit, which is available as an accessory for the TF 1417 Counter, the beat frequency is switched to the nearest multiple of 10 Mc/s below the unknown frequency which is indicated approximately by a preselector tuning dial. Since the local oscillator is controlled by the Counter's crystal standard and the simple dial type readout has only got to measure to the nearest 10 Mc/s, the full accuracy of the digital system is maintained.

The digital readout for counters can take several alternative forms of which the two commonest are the decade column and the in-line type. In the former, vertical columns of numbers 0 to 9 represent units, tens, hundreds, etc., and the appropriate number in each column is illuminated by a neon lamp. Compared with in-line readout, the column display takes up a large amount of panel space and is less convenient for most readings because of the irregular vertical arrangement of the digits; however, this irregularity has a compensating advantage of representing a positional analogue of the reading. This shows at a glance the approximate value of the answer without reading the figures, and makes it

easier to watch trends such as rates of change in successive readings. Hence the column type of display really combines the advantages of both digital and analogue readout.

The in-line display is compact and therefore more suitable for a small transistorized counter such as the TF 1417. It is also a more sophisticated readout since

it is the nearest approach to a printed record; the eye does not have to search up and down for the digits and there is less likelihood of failing to notice the illuminated decimal point.

Perhaps the most elegant type of analogue readout is the cathode-ray tube which can be used to give a two-dimensional representation of an electrical quantity, turning abstractions like amplitude- or frequency-modulation into concrete form. The undulating picture we have of amplitude modulation is as it appears on the amplitude/time representation of an oscilloscope; the c.r.t. readout on the Spectrum Analyser, OA 1094A, however, depicts amplitude against frequency and brings Fourier analysis and Bessel functions to life in the examination of modulated signals.

There is no universally best type of readout for all instruments. The clear, mathematical efficiency of digital may be more in keeping with this age of computers and data processing; but analogue with its versatility and closer relationship to the quantity being measured is the only answer to most requirements of readout in instrumentation.

J.R.H.



Vacuum Tube Voltmeter

TYPE TF 1041C

by E. C. CRAWFORD,
Graduate I.E.E.

A description is given of a valve voltmeter with full-scale sensitivities varying from 300 mV a.c. and d.c. to 300 volts a.c. and 1,000 volts d.c. The power supplies to the valve heaters and to the h.t. line are electronically stabilized using the latest techniques, thus realizing reading stability of the first class for an instrument of this type.

TF 1041C IS THE LATEST of a series which has been progressively developed over six years with improvements in specification and performance at each stage of development.

TF 1041, the original model, described in *Instrumentation* in June, 1955, had a maximum sensitivity of 1V full scale and a frequency response up to 700 Mc/s.

TF 1041A had similar sensitivity but with a new diode probe, giving a frequency response extended to 1,000 Mc/s.

TF 1041B had sensitivity increased to 300 mV full scale and yet a further probe design extending the h.f. response to 1,500 Mc/s.

TF 1041C has similar performance to TF 1041B but has improved l.t. regulation in addition to electronically stabilized h.t.

It may be asked why it is necessary to progress a design in small jumps instead of getting the final design the first time. The reasons are various. First of all is the fact that the latest components were not available, and performance is directly related to these. Secondly the aim is always to produce the best economic design, the one that gives most people the best value related to their needs in terms of specification. Another reason is that a change in design gives users ideas that lead to suggestions to the designers via the commercial department, and these lead in turn to better specifications.

It is not difficult to design a one-purpose instrument with a very restricted range of application which can, over such a range, have an exceedingly good specification; but the traditional valve voltmeter is intended to be a maid of all work and to do its best in several different jobs.

Because the basic valve voltmeter is of a traditional design it is worth considering at every stage of development if the best circuit is being used.

IS THERE A BEST CIRCUIT?

A variety of valve circuit arrangements for a valve voltmeter have been proposed and used at various times by different manufacturers and designers, and some experiments were carried out during the development of TF 1041C to see if any one had advantages over the others for insensitivity to power supply changes in terms of zero stability.

To do this test properly identical valves were used in all the different circuits tested, one particular valve always occupying the position of input valve where applicable. The tests per circuit arrangement were two-fold. First a test for zero stability in terms of equivalent input signal when the h.t. was varied by a certain percentage, and secondly the same thing with the h.t. stabilized but with the heater supply to the input valve alone varied by a small fixed amount.

Preliminary observations had already made it obvious that with symmetrical push-pull valve arrangements heater variation effect was due to a differential in the behaviour of individual cathodes, and so it was decided that the best policy to follow for clearest observations was to ensure that this differential was exactly the same in every test, hence the heater supply to one valve only was varied.

The circuits fell into three groups: (1) a straightforward d.c. amplifier with no feedback; (2) various forms of d.c. amplifier with feedback applied in different ways, including the familiar cathode follower type as well as that used in TF 1041B and C; (3) cascade arrangements of valves where one valve is used as the load for another.

The h.t. tests quickly eliminated any circuit which was not symmetrical in the push-pull sense. It is in practice not easy to find two matched valves when working under identical conditions. It is extremely unlikely that dissimilar operating conditions can lead to a balanced performance.

The worst case is of course the balancing of a valve with its dynamic anode impedance against a fixed resistance unless other precautions are taken which were outside the scope of these particular experiments.

It was obviously important that if the indicating meter is connected between taps on two networks of resistors and valves, each network being connected across the same varying h.t. rail, then the networks must at least be nominally identical. They can rarely be actually identical because of the small variations in the construction of valves in the same batch.

The effect of l.t. heater supply variation was carried out under conditions already outlined above. Care was also taken to ensure that the affected valve always had the same anode-cathode voltage and current. The results

showed that no circuit had any advantage over any of the others. No matter how much or how little feedback, the relative shift in zero or meter reading in terms of equivalent signal input for the same deflection was always the same.

This behaviour is in some respects akin to the noise factor of an input stage which, in theory anyway, is unaffected by feedback.

It may also be explained in terms of an extra bias potential developed inside the valve by the change in cathode temperature and which in a circuit would be represented by a generator (battery) in the cathode lead from the affected valve. On this basis it may be shown by circuit analysis that the experimental results obtained might have been anticipated on paper once the basic parameters had been found experimentally.

The overall conclusions were then as follows:

- (a) there is no 'wonder' circuit which automatically gives discrimination against power supply variations;
- (b) anyone's claim to the contrary not based upon controlled experiments must be treated with some scepticism;
- (c) that asymmetrical arrangements should be avoided, and
- (d) that better stability can only be achieved by proper isolation of the major variant—the mains power supply.

THE TF 1041C VALVE AMPLIFIER CIRCUIT

The experiments outlined above made it obvious that a balanced or push-pull circuit should be used supported by well regulated h.t. and l.t. supplies. As the minimum full scale deflection on a.c. was to be 300 mV and at such a level the efficiency of the diode rectifier is so low that only 230 mV d.c. is available from it, the valve amplifier had to have sufficient gain so that a standard meter could be driven to full scale with suitable loading resistors also included for stability.

It is always extremely desirable that the accuracy is relatively independent of valve selection. This virtue is obtained by high loop gain and a lot of negative feedback.

The circuit which best realized the requirements is shown schematically in Fig. 1. Each half of the push-pull circuit consists of a valve amplifier and cathode follower

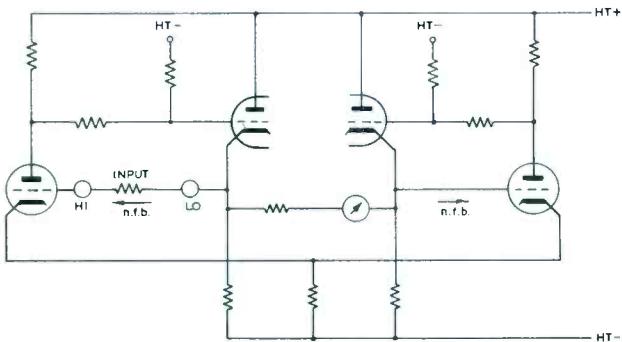
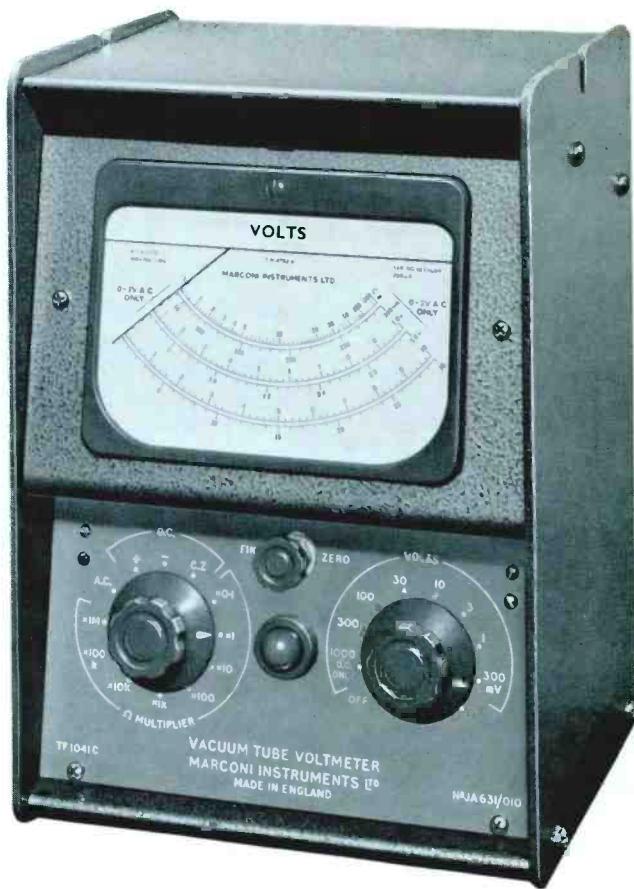


Fig. 1. Schematic diagram of TF 1041C valve amplifier circuit



Vacuum Tube Voltmeter, Type TF 1041C

with 100% overall negative feedback. It can be seen that the push-pull halves are coupled together by a resistor common to the two amplifier valves.

The negative feedback path on each side is between the cathode of the cathode follower (the output point) and the grid of the associated amplifier. In the left-hand half this negative feedback path is actually via the input signal source paralleled by the input grid leak. As the grid resistance of the amplifier is virtually infinite the high resistance of the feedback path has no significance.

The feedback reduces the combined output resistance of the two cathode followers to about 80Ω . It is found that this output resistance, which forms some 10% of the meter resistance on the most sensitive range, is hardly affected by valve replacement, so that the accuracy is not susceptible to long term drift due to valve aging.

To take care of dissimilarities in the valve characteristics there are three zero controls. One is a coarse preset which is the major adjustment, and is set during manufacture so that the external user controls are in the middle of their useful range. The second control has a range of approximately ± 400 mV; experience has shown that the operating characteristics of the amplifier valves may drift by half that amount even after prolonged pre-aging.

As this control is slightly too coarse for use on the most sensitive range an extra-fine one is added to allow

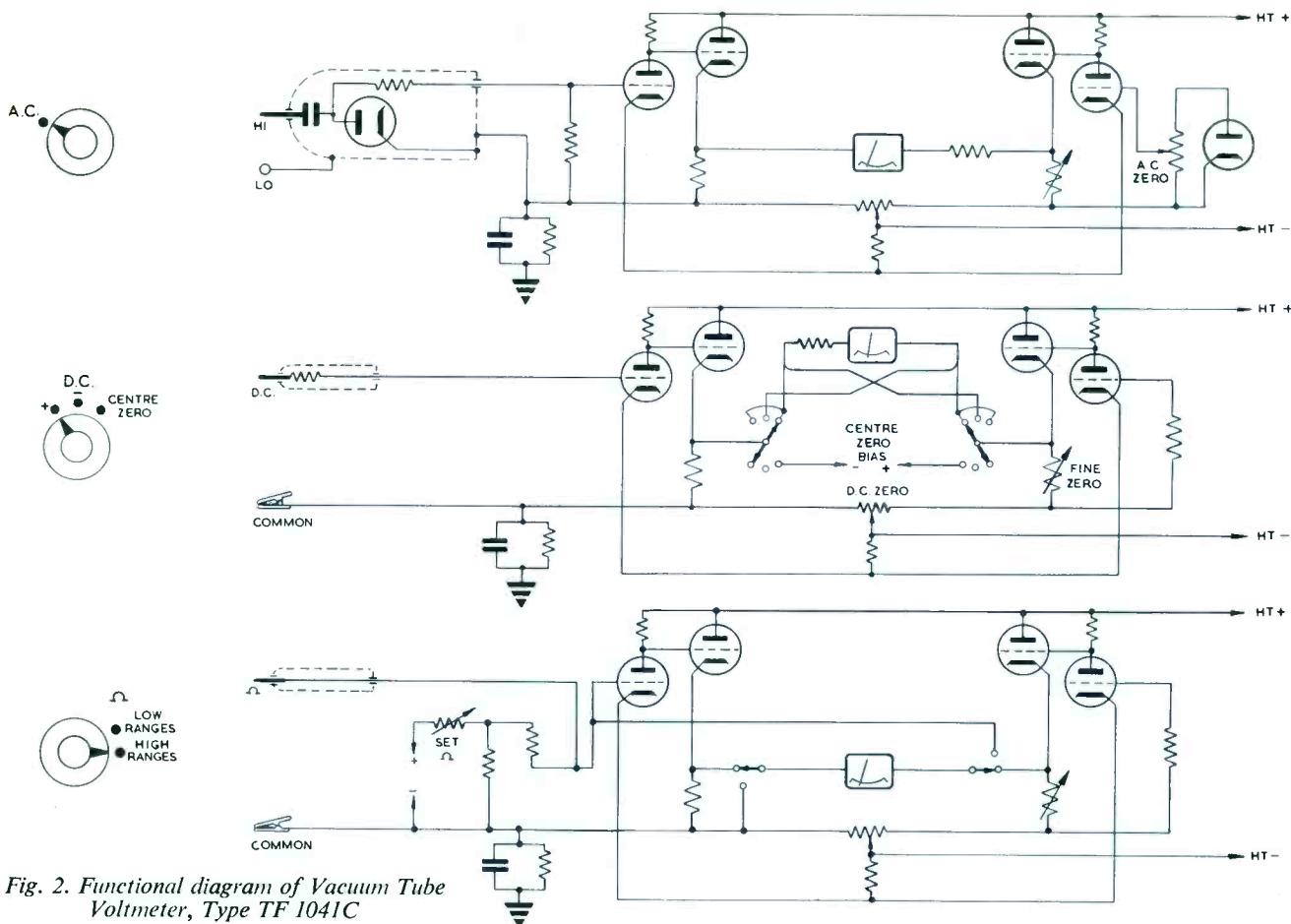


Fig. 2. Functional diagram of Vacuum Tube Voltmeter, Type TF 1041C

exact hair line setting on the most sensitive ranges, which is otherwise precluded by the resolution of the normal zero control.

D.C. MEASUREMENTS

The HI terminal is brought out on a screened antimicrophonic lead to a slim cigar-shaped probe which has an isolating $1\text{ M}\Omega$ stopper built in to it at the measuring end. This permits d.c. measurements on r.f. circuits without particularly upsetting tuning characteristics. As the same probe is used for the measurement of resistance, provision is made for short circuiting this resistor by a small built-in slide switch labelled 'V' and ' Ω '.

The LO connection is made by a separate lead terminated by a bulldog clip. This is connected to true earth by a $50\text{ M}\Omega$ resistor and a $0.01\text{ }\mu\text{F}$ ceramic capacitor. This is the only circuit earth in the instrument, thus permitting differential voltages to be measured between points at 350 volts or so to true earth.

Because of the high input resistance between HI and LO of $100\text{ M}\Omega$, particular care is taken to guard against leaks from the chassis onto the HI connection, particularly in view of the differential measurement possibilities just mentioned.

All the insulating materials for the wiring and switches have been chosen to give the lowest possible leakage under all climatic conditions.

Leaks onto other parts of the circuit from earth can occasionally be significant. One source is via the bakelite knob of the set zero controls and the user's hands. To prevent this small effect the insulation of the knob is perfected by polythene caps.

A.C. MEASUREMENTS

All a.c. measurements are made using the a.c. diode probe which contains a thermionic diode, a blocking capacitor and an isolating resistor. These function as a peak detector so that the capacitor develops a charge approximately equal in potential to the positive excursion relative to earth of the measured waveform.

This d.c. potential is switched into the valve bridge circuit which amplifies it in terms of power to give a meter reading. The appropriate meter scale is labelled a.c. volts and the figures indicate the r.m.s. value on the assumption that a pure sine wave is being measured. Of the two possible alternative indications, r.m.s. (assuming sine wave) or positive peak (assuming nothing), it is generally considered that the r.m.s. value is most generally useful. It can, however, be misleading to uninformed users, but these points are made clear in the Handbook.

The input time constant of the probe is sufficiently long to enable accurate measurements down to 20 c/s, at which frequency there is a reading error of about 5%. It is really impracticable to use a higher value capacitor to extend

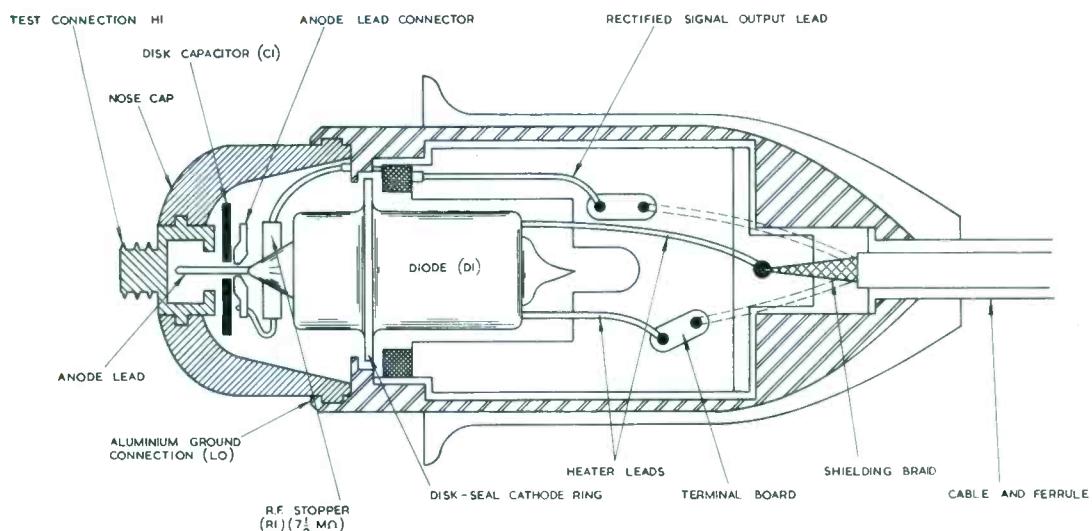
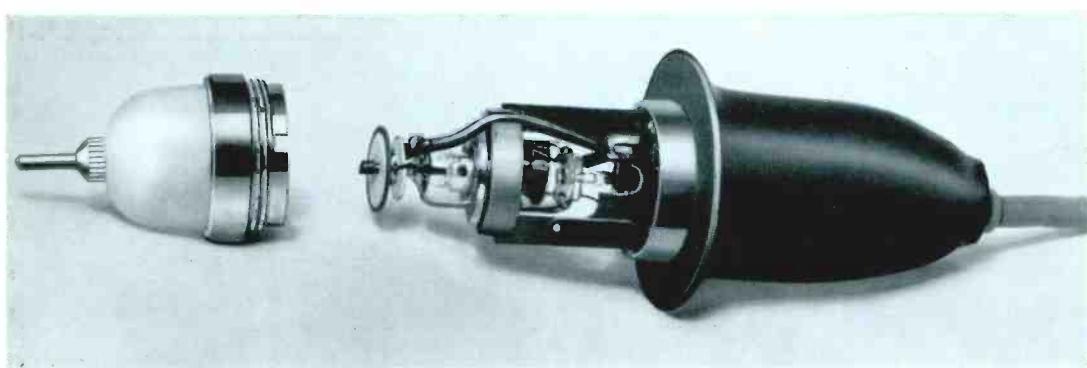


Fig. 3.
A.C. Probe



the range into the sub-audio region without sacrifice of the h.f. properties of the probe.

Due to the probe's unique design, the series inductance and stray capacitance has been kept to an absolute minimum; the frequency response thereby extends to beyond 1,000 Mc/s, being only about +3 dB in error at 1,500 Mc/s if carefully connected so that external inductance is virtually zero.

In the usual arrangement the external contact, the blocking capacitor, the anode connector and the anode lead are all physically in series, and the maximum normal +3 dB frequency which is controlled by the series resonance of the input inductance and valve capacitance is about 1,000 Mc/s. If Fig. 3 is examined it can be seen that the anode connector of the diode valve penetrates the isolating capacitor C1 and is very nearly at the same level as the external contact connector. The inductance could hardly be reduced further than this. It is this minimizing of the inductance which gives this new probe an advantage of several hundred megacycles extended frequency coverage compared with its early predecessors.

To go with the a.c. probe there are several optional accessories available. Two of these are a coaxial type 'grounding' sleeve and a coaxial line 'T' connector. These are mentioned here to draw attention to the vital necessity of maintaining a really short and direct earth connection

when making accurate measurements at frequencies in excess of a few megacycles.

The maximum a.c. voltage which may be directly measured with the a.c. probe is that equivalent in peak value to 300V r.m.s. at low frequencies. At higher frequencies the maximum value falls off because of the diode rating. In the event of higher r.f. voltages than 300 r.m.s. requiring to be measured, there is also available a capacitor type attenuator which is effective from about 10 kc/s up to v.h.f.

The lowest full scale a.c. range is 300 mV (as for d.c.). At this level the rectification efficiency of the diode is beginning to drop off seriously as Fig. 4 shows. At 300 mV the available d.c. output is only 230 mV; this is the lowest full scale signal which virtually determined the valve bridge circuit design.

At the lower end of the scale the first calibration mark is 25 mV. This is practically the lowest level at which a thermionic diode will work. Below this level crystal diode probes are more useful because of the absence of the standing d.c. which all thermionic diodes produce. They are, however, extremely prone to damage by surges and have not in general the convenience of the thermionic diode to wide band (audio to u.h.f.) measurement together with its ability to withstand electric shocks without the use of a series of attenuator heads.

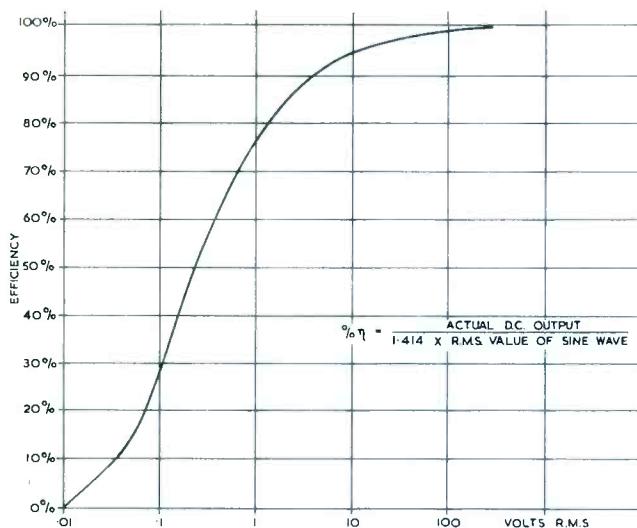


Fig. 4. Rectification efficiency of probe detector.

RESISTANCE MEASUREMENTS

The principle used is that of the ordinary multimeter—a source of e.m.f., a standard resistance and a voltmeter. With open circuit leads (*i.e.* at $R=\infty$), the voltmeter reads full scale, having been set by the SET OHMS control. When the measured resistance is equal to the selected standard the meter reads half scale, and so on. Every scale reads from 0 to ∞ , but maximum accuracy on each range is only obtained around the scale centre. The resistance standards therefore progress in decades from 1 ohm up to 10 M Ω , giving 20 m Ω and 500 M Ω as the extreme calibrated scale marks.

So that the lower values of resistance may be sensibly measured, the leads are arranged for four terminal measurements. The common lead and the DC/ Ω probe both contain two conductors. One in each is the current

lead, the others convey the p.d. across the unknown to the voltmeter.

The source of e.m.f. for all the ohms measurements is from a separate rectified supply direct from the transformer.

The same supply is also available at a position marked C.Z. (Centre Zero), which enables the meter pointer to be offset to mid-scale on any d.c. range. This is a facility occasionally required, for example, during the alignment of discriminators in f.m. receivers and is just one of the many features that go to make the TF 1041C a versatile easy-to-use instrument. Examination of the specification shows, however, that performance has not been sacrificed to versatility.

THE REGULATED SUPPLIES

These are of conventional design although unusual in their use in this type of valve voltmeter. As suggested earlier, it is quite feasible to build less sensitive and discriminating valve voltmeters without any h.t. or l.t. regulation at all, depending upon the relative similarity of valve characteristics to make the added complication of stabilized supplies superfluous.

The regulation obtained is a 10 to 1 improvement over no regulation for a $\pm 10\%$ mains supply variation. As is usual, the final limitations are set by the dissipation of the series regulator at maximum and by lack of volts at minimum.

A double triode amplifier/series valve is used for the h.t. with a neon tube for reference.

For the l.t. regulation a power transistor controls the 1.2 amps at 6.3 volts for the five valves of the voltmeter circuit. Its reference is a zener diode connected to its base via an intermediate power transistor.

REFERENCE

Ratcliffe, P. M.; A new Vacuum Tube Voltmeter, Type TF 1041, *Marconi Instrumentation*, 5, 42 (June, 1955).

ABRIDGED SPECIFICATION

A.C. Measurements

RANGE: 25 mV to 300 volts in seven ranges. Full-scale deflections: 300 mV, 1, 3, 10, 30, 100 and 300 volts.

ACCURACY: 1, 3, 30, and 100 V ranges: $\pm 2\%$ of f.s.d. ± 10 mV. Other ranges: $\pm 3\%$ of f.s.d. ± 10 mV.

FREQUENCY RESPONSE: Typical characteristic, relative to response at 1 kc/s, is flat to within -0.5 dB at 20 c/s, ± 0.2 dB from 50 c/s to 500 Mc/s, +1 dB at 1,000 Mc/s, +3 dB at 1,500 Mc/s.

INPUT CONDITIONS: Shunt capacitance: approx. 1.5 $\mu\mu$ F. Resistance: greater than 5 M Ω at 1 kc/s, greater than 500 k Ω at 10 Mc/s, and approx. 150 k Ω at 100 Mc/s.

D.C. Measurements

RANGE: 10 mV to 1,000 volts in eight ranges. Full-scale deflections: 300 mV, 1, 3, 10, 30, 100, 300, and 1,000 volts, positive or negative. Centre-zero facility on all ranges.

ACCURACY: $\pm 2\%$ of f.s.d. ± 10 mV, except for inputs greater than 100 volts when the accuracy is $\pm 3\%$ of f.s.d.

INPUT CONDITIONS: Resistance: 100 M Ω , plus 1 M Ω isolating resistor in probe. Capacitance to ground: approx. 2 $\mu\mu$ F.

Meter zero

A mains supply variation of 10% causes a deflection change of less than 20 mV at f.s.d. on all a.c. ranges and 10 mV on all d.c. ranges.

Resistance measurements

RANGE: 0.02 ohm to 500 M Ω in eight ranges. Full-scale deflections: 50 ohms, 500 ohms, 5 k Ω , 50 k Ω , 500 k Ω , 5 M Ω , 50 M Ω , and 500 M Ω .

Speeding Communications. Telex has now been installed at Marconi Instruments Ltd., St. Albans, London, Leamington Spa and Harrogate. The numbers are shown on the back cover.



Counter/Frequency Meter . . .

TYPE TF 1417

by D. W. BISSET,
Graduate I.E.E.

The article describes a completely new and highly versatile frequency/time measuring equipment with a 7-decade in-line readout. The instrument is of modular construction and employs solid-state circuitry throughout. A novel feature is the use of 'and' and 'or' gate logic which makes the instrument readily adaptable to remote control of the principle functions. The maximum count rate is greater than 10 Mc/s and time measurements as short as 0.2 μ sec may be made. The instrument is of rugged construction and its small size makes it particularly suitable for general laboratory use.

OVER RECENT YEARS there has been an ever-increasing use made of counting techniques in many aspects of electronic measurement. Counting methods applied to give direct measurement of frequency and time are today commonplace, due mainly to the inherent high accuracy combined with simplicity of operation which are characteristics of counter type equipments. Furthermore, an instrument having comprehensive facilities for the measurement of frequency and time can readily be used for applications embracing a wide range of phenomena having either electrical or non-electrical parameters, by the use of suitable converters, transducers, etc., such as to present these parameters as electrical signals falling within the frequency and voltage range of the counter. Heterodyning techniques can be used to extend the range of direct frequency measurement, as described in the article on the TF 1434—page 86.

DESIGN CONSIDERATIONS

Inherent in a counter type instrument is a relatively large amount of circuitry which, using thermionic valve techniques, presents the designer with formidable problems of physical size, weight, and high supply power consumption with the associated problem of temperature rise. In addition, at high counting speeds where circuit impedances are perforce low, the thermionic valve falls considerably short of the ideal switching element, and circuit elaborations such as voltage excursion limit clamps must be introduced.

Transistors have provided a near perfect solution to the problems of counting to speeds over 10 Mc/s; this is because of their small size and low power consumption and, in particular, their excellent on/off impedance ratio when used as switching elements even in high speed circuits. This latter characteristic renders the counting stages relatively insensitive to changes in value of the other circuit elements and supply rail levels, and indeed of the transistors themselves.

COUNTER/FREQUENCY METER TF 1417

This is a completely new instrument in the Marconi range of frequency/time measuring equipments. The instrument is fully transistorized and is highly versatile, having pro-

vision for many operational modes in this field of measurement. The equipment features high reliability, high accuracy, small size with light weight, ease of operation, and has a clear 7-digit in-line readout using transistor-driven gas-filled numeral tubes, which dispense with the need for any moving parts or relay contacts.

Sampling is automatic, but provision for 'manual' operation by means of a reset switch is included. Display time is continuously variable up to 5 seconds and is independent of sampling time. Each of the three input channels (essentially INPUT, START and STOP) is provided with a step attenuator and trigger level control, enabling a wide range of input levels to be applied directly without risk of damage to the instrument. The additional slope selection switches on the 'run' and 'stop' input circuits enable the gate to be operated on either +ve or -ve going edges of applied pulses.

The FUNCTION front panel control sets up the instrument to perform any one of the following measurements:

1. Straight or totalizing counting.
2. Externally applied events during externally applied time interval.
3. Frequency ratio of two applied signals.
4. Frequency measurement.
5. Time interval measurement.
6. Period measurement.

A further position of the FUNCTION switch enables a check to be made on the correct working of the time base and counting circuitry, the instrument 'measuring' a 10 Mc/s signal derived from the internal frequency standard.

The wide range of gate times and timing units is selected by a common front panel control, and is derived from a 1 Mc/s oven-controlled crystal oscillator, driving cascaded decade dividing units, which require no setting up or subsequent adjustment.

The readout is readily interpreted by means of an automatically positioned decimal point, presenting the answer in units of Mc/s, kc/s, c/s, sec, msec or μ sec, as appropriate to the particular measurement.

AUXILIARY FACILITIES

Sockets on the rear panel make available rectangular pulse outputs at frequencies from 0.1 c/s to 10 Mc/s in



*Fig. 1
Counter/Frequency Meter
Type TF 1417*

decade steps. A further connector carries binary coded decimal outputs corresponding to the particular count displayed (four lines per digit), together with a print command signal coinciding with the beginning of the display period. This connector also carries provision for inhibiting the counter gate until the end of the printer cycle.

As an optional facility, an additional socket at the rear can make possible the remote operation of function and time base controls by the application of a direct voltage to the connections appropriate to the particular measurements being made. This facility lends itself to the inclusion of the instrument in systems where several measurement functions are required of one counter equipment.

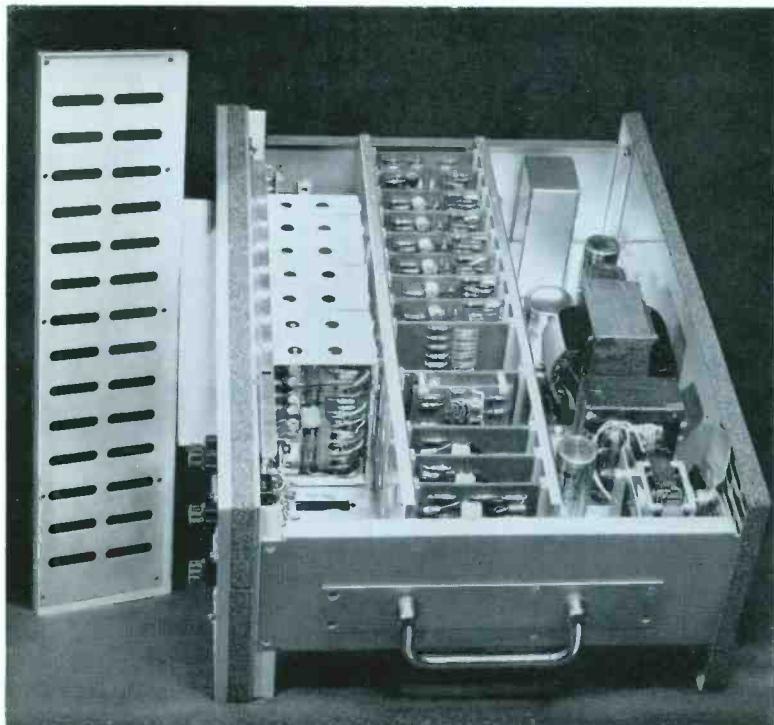
GENERAL LAYOUT

Fig. 1 is a general view of the instrument showing the front panel controls and in-line readout. The layout clearly associates each input channel with its corresponding socket, slope selector switch and attenuator with concentric trigger level control. The numeral tubes projecting through the front panel are protected by a shield, which includes a red tinted filter to reduce reflected light to a minimum and at the same time improve contrast.

In Fig. 2 the case and top cover have been removed, showing the rigidly mounted plug-in modules, which take the form of printed board assemblies. The seven counting decades, with their associated numeral tubes, occupy the space immediately behind the front panel.

Behind these are a further 13 circuit boards comprising the 1 Mc/s oscillator and frequency multiplier unit, seven decade divider units, two boards carrying the counter control and time base switching facilities, and three amplifier/trigger units, each associated with its corresponding input socket and attenuator.

Along the rear of the single flat chassis is the stabilized power supply, the plug-in crystal oven, and a blower motor. The last, which has to deal with a circuit dissipation of only 50W, ensures that the temperature within the case remains virtually at ambient. The blower action is to draw



*Fig. 2
The case and top cover removed*

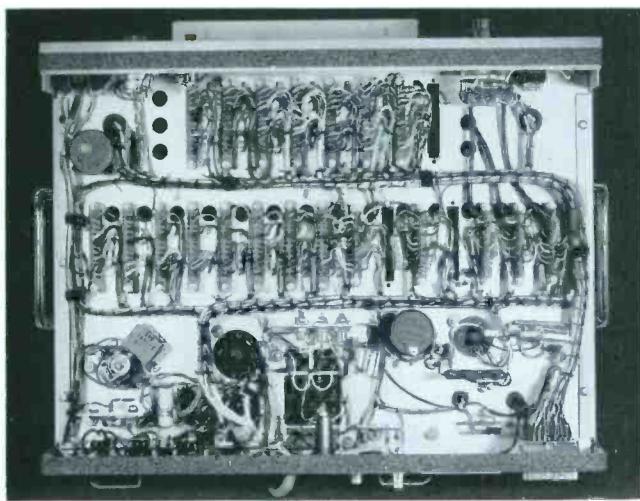


Fig. 3. Underside view

air up through holes on the underside of the case, through perforations on the main chassis, and discharge it through a grill in the rear panel.

The underside view of Fig. 3 emphasizes the basic simplicity of the mechanical design, with the resulting ease of access to the various plug-in unit sockets. Supply voltage tappings are provided for 40 to 60 c/s supplies in the voltage ranges 100 to 150 and 200 to 250 volts. The supply input circuit is protected by a fuse accessible from the rear of the instrument.

DECADE COUNTING UNITS

Only three decade counting unit types are used in the instrument; these have speeds of 10 Mc/s, 1 Mc/s and 250 kc/s. The 1 Mc/s and 250 kc/s units are common to both time base dividers and six of the seven counting decades. In the latter application, the decade board is mounted in a metal frame assembly which carries a

second board providing the necessary decoding and drive to the plug-in numeral tube on the front edge.

Fig. 4a is the complete module, while Fig. 4b is an exploded view showing the numeral tube drive board and the interconnecting leads. Without the numeral tube, the whole assembly measures only $4\frac{1}{4}$ in. high, $3\frac{1}{2}$ in. deep and 1 in. wide.

BLOCK DIAGRAM

Before consideration of this, it is necessary to make reference to a novel feature of the instrument's circuitry which is that, apart from the input step attenuators, all switching is performed by the use of 'and' and 'or' gate logic techniques. Thus, the FUNCTION and FREQUENCY/TIME controls switch by applying a direct voltage to the appropriate circuit gates, so that the signal switching proper is actually performed on the plug-in modules.

Fig. 5 illustrates the technique as applied to selecting a particular output from the time base dividers. The divider outputs are d.c. coupled and swing between 0V and -11V levels. The diagram shows the condition with 100 kc/s selected. -11V is applied to R1 by means of the front panel control. MR2 conducts, and transistor VT1 is turned on by potentiometer R1, MR2, R2 and R3 which is returned to +5.6V. This is only true when the 100 kc/s input is in the -11V condition and MR1 is biased off by the voltage drop across R1. When the drive swings to 0V, MR1 conducts, bringing the junction of MR1, MR2 to near 0V potential. This, in turn, results in potentiometer R2, R3 turning off VT1, and this condition remains until the input waveform level returns to -11V. The output pulse differs from the selected input only in that the mark/space durations are reversed. To ensure satisfactory switching of VT1, R1 must be high in relation to the 100 kc/s source impedance, and low relative to R3. This switching method gives the combined advantages of minimizing the amount of wiring in the instrument

Fig. 4a. The complete module

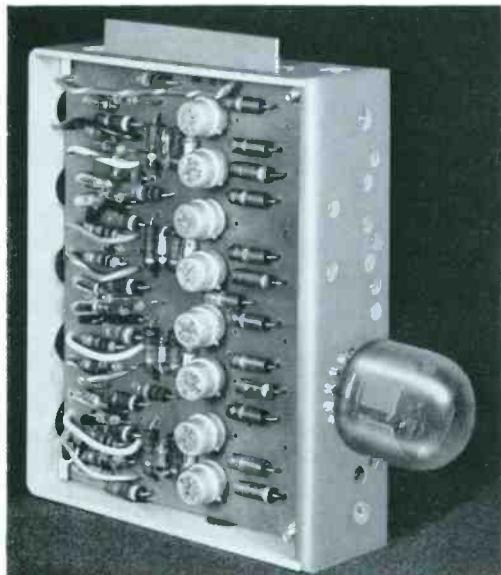
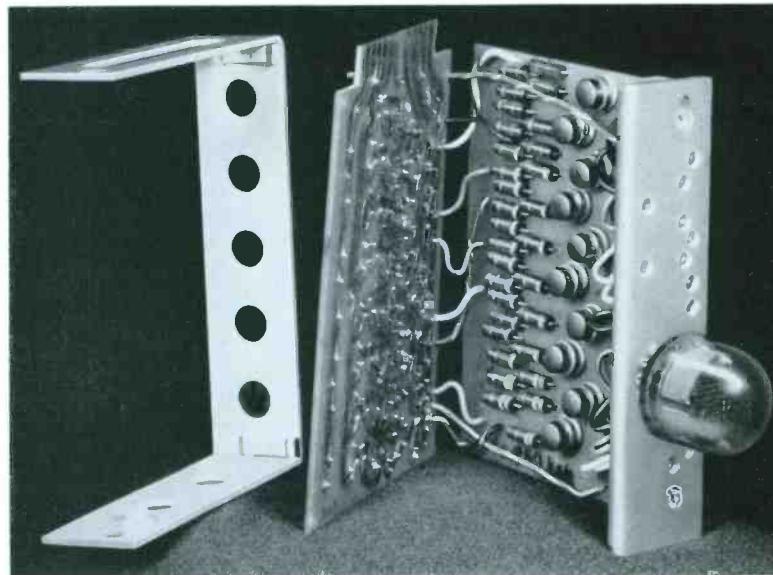


Fig. 4b. An exploded view



which actually carries pulse signals, and offering a ready means of remote control.

Fig. 6 is a simplified block diagram of the instrument, intended to indicate the various stages and outline how they are interconnected to perform the various measurement functions.

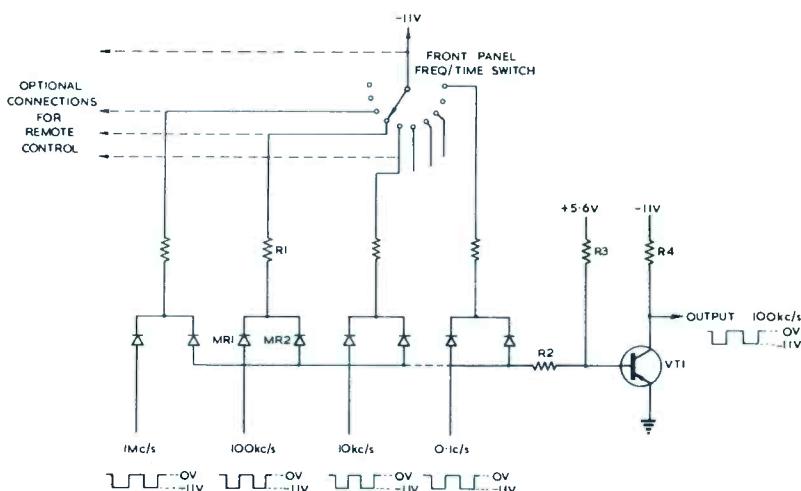
The three inputs, A, B and C, are each coupled via step attenuators to their associated amplifier and trigger units referred to as input, start and stop amplifiers respectively. All three amplifiers are essentially the same in that each has an input amplifier transistor directly coupled to a fast Schmitt trigger. The trigger outputs are routed via 'and' and 'or' gates to a further amplifier transistor, so that the particular output fed to further stages of the counter can be selected by the function control. The output stage of

For most measurements other than time interval, the gate is single-line driven from the start amplifier, either by signals applied externally at input B in the case of periodic time or frequency ratio measurements, or by the time base output which then provides the standard gating times required for frequency measurement. As in the input amplifier, the start amplifier outputs are selected by the front panel controls.

Time interval measurement permits the start amplifier to open the gate only, subsequent reversal of the gate flip-flop resulting from the output of the stop amplifier unit. In all measurements the output from the stop amplifier is derived from a signal applied to input C.

Each amplifier is provided with adjustable pre-bias on the input circuit which gives a direct control of the input

Fig. 5
Schematic diagram of
time base selection gate



the input amplifier unit is switched by an additional transistor, this serving as the main counter gate which passes all pulses fed to the counting decades. These are, in general, internally generated for time and period measurement and externally applied via input A for the measurement of frequency.

The open/shut condition of the gate is governed either by a manual switch or, for automatic working, by the state of the high speed gate flip-flop located on the control unit. The function of this unit is to ensure that when the gate closes, no further operation of the gate can take place until a selected display period has elapsed. At the end of the display period, the control unit resets the counting decades to zero, and a few milliseconds later unlatches the gate flip-flop so that the counting cycle can repeat on the arrival of the next start pulse. This delay before final unlatching is derived from a recycle multivibrator, and ensures that all circuits have completely recovered from resetting before the gate can be reopened. If desired, the display can be held indefinitely until the manual reset switch is operated. The gate control flip-flop is driven via diode input gates, which are biased back to achieve latching during the display period. The input diodes can also be switched by the instrument function control to achieve single- or two-line drive working of the flip-flop.

voltage level at which the triggers will operate. Further switches associated with the B and C inputs give choice of input waveform slope direction which will give an effective output pulse to the gate flip-flop.

Standard gating times and timing units are derived from a 1 Mc/s crystal oscillator, the crystal being oven controlled. Also on the oscillator board is a $\times 10$ frequency multiplier, whose 10 Mc/s pulse output is made available as input drive to the main counter gate to serve as 0.1 μ sec timing units or as a counting source for self-checking the instrument. The 10 Mc/s pulses are also made available as an output from the rear panel.

A 1 Mc/s output from the oscillator unit serves to drive a cascaded chain of decade counting units, which in this application serve as highly reliable divider stages. The 1 Mc/s pulses are also available at a rear panel socket.

The 1 Mc/s pulses, together with all decade sub-multiples down to 0.1 c/s, are applied to the time base selection gate unit. The gate logic used in their selection has already been described, and the diagram shows the selected output made available for counting (input amplifier unit) or for gate operation (start amplifier unit). A further rear panel socket carries the time base gate output pulse selected.

The remaining section of the instrument comprises the seven cascaded decade counting units, each with its

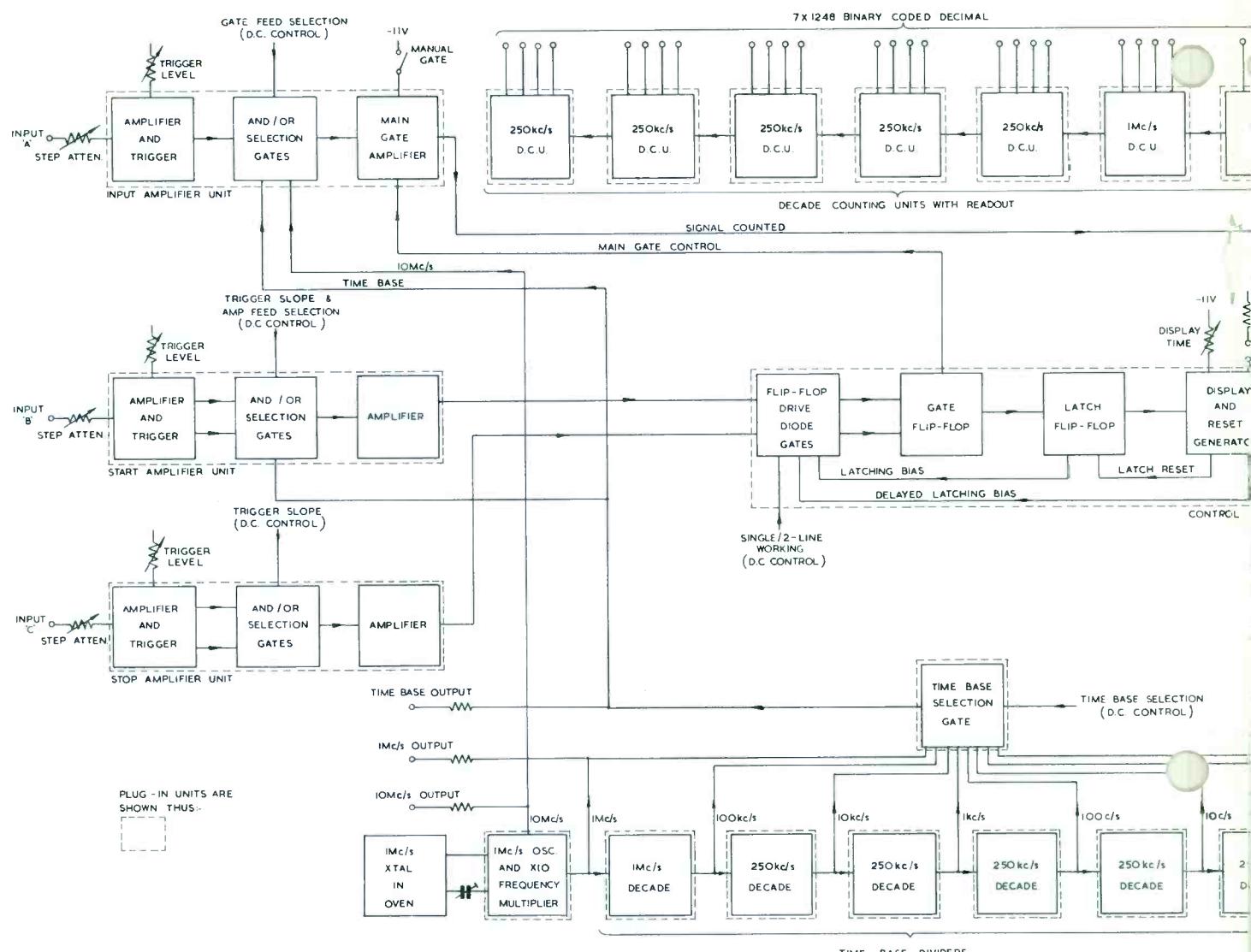


Fig. 6. Block diagram of Counter/Frequency Meter, Type TF 1417

associated readout tube. The high speed (10 Mc/s) unit is driven directly from the main gate output, and in turn this feeds the 1 Mc/s unit. The subsequent decades are identical units, and all seven make available a 1-2-4-8 weighted binary coded decimal output from the rear of the instrument. Associated with this output is a print command pulse derived from the control unit, and provision for external latching of the gate binary during the printing cycle.

CIRCUIT DETAILS

Decade Counting Units

The decade counting units are essentially identical circuit-wise, the switching sequence of the four flip-flops being such as to result in pure binary 1-2-4-8 weighted working. To achieve this, the first three flip-flops are cascaded as for normal binary division, while the fourth is two-line driven—one side from the output of the third flip-flop

and the other side directly from the output of the first flip-flop. This is shown diagrammatically in Fig. 7a. When the decade is reset to the 0 condition, the fourth flip-flop can only respond to the drive from the first after it has been reversed at the count of '8' by the output from the third flip-flop. In its reversed state, a d.c. coupling back to the input of the second flip-flop gates out its drive, which is restored only when the fourth flip-flop returns to its 0 state, leaving the decade unit ready to recycle.

The basic flip-flops employ transistors sufficiently fast to work under saturated switch-on conditions, even at the highest counting rates. This, together with input steering diodes as shown in Fig. 7b, makes for the highest reliability in operation. The flip-flop switches by a positive-going input turning off the 'on' transistor. By returning the back (-ve) end of the base drive diodes to the corresponding transistor collectors, the input pulse is directed only to the 'on' transistor base, the other drive diode being

biased off by a voltage near that of the -ve collector supply rail. Time constants R1-C1 and R2-C2 are not critical but must be sufficiently long to allow time for minority carrier clearance and short enough to differentiate any applied rectangular drive waveform.

Readout

The gas-filled numeral tube associated with each of the counting decades is driven by high voltage (75V) NPN transistors, one for each of the 10 tube digit cathodes. Fig. 8 shows the method of driving the tube; the resistors coupling the drive transistor base directly to the counting flip-flop collectors are arranged so that only one digit drive transistor is turned on at any time, this corresponding to the instantaneous count storage of the decade unit. R1, R2, R3 and R4 are the drive resistors shown for digit '1', the drive source swinging between some -11V and 0V. Only when all four collectors to which these resistors are connected are at 0V will VT2 turn on, causing VT2 collector to bottom and the digit '1' to strike. R5 ensures that when VT2 is turned off the digit cathode potential is that of VT2 breakdown voltage, which results in a sufficiently low voltage between cathode '1' and the common anode to ensure extinction of the digit.

Amplifiers

Input, start and stop amplifier units employ basically the same circuit arrangements, apart from the logic gating. A schematic diagram is shown of the input amplifier unit in Fig. 9.

Amplifier transistor VT1 is protected from overdrive by series resistor R1 (4.7 k Ω), which looks into the forward impedance of VT1 emitter/base diode for negative going inputs, and MRI for positive applied voltage. RV1, the trigger level control, feeds a bias current into one or other of the input diodes via R2. VT1 output drives Schmitt trigger VT2, VT3, which in turn switches amplifier VT4.

Output amplifier VT5 is fed either from VT4 output or from internally generated signals, depending on the measurement function of the instrument, logic switching with d.c. control being used as already described.

VT6 in the emitter circuit of VT5 serves to gate the amplifier output, VT6 being turned on and off by the gate flip-flop located in the control unit.

As with the decade counting circuitry, the input circuit triggers, gates, etc., work in saturating mode, and have maximum switching rates approaching twice that required by the instrument specification.

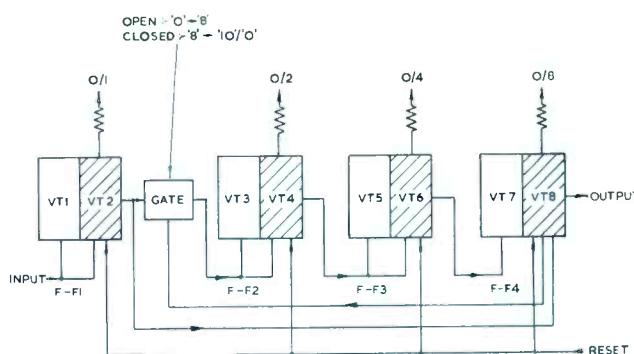
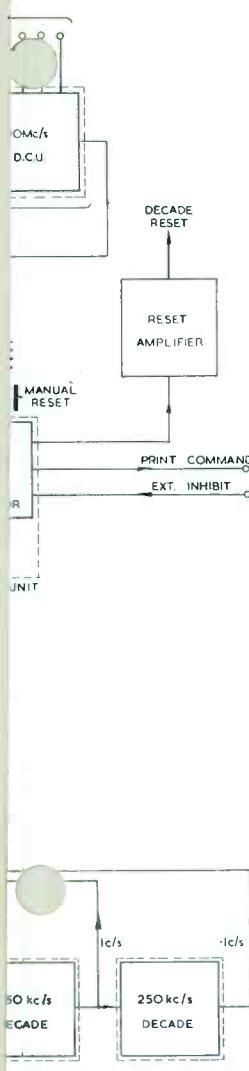


Fig. 7a. Schematic of decade counting unit operation

| COUNT | FLIP-FLOP STATE | | | |
|-------|-----------------|------|------|------|
| | F-F1 | F-F2 | F-F3 | F-F4 |
| '0' | 0 | 0 | 0 | 0 |
| '1' | 1 | 0 | 0 | 0 |
| '2' | 0 | 1 | 0 | 0 |
| '3' | 1 | 1 | 0 | 0 |
| '4' | 0 | 0 | 1 | 0 |
| '5' | 1 | 0 | 1 | 0 |
| '6' | 0 | 1 | 1 | 0 |
| '7' | 1 | 1 | 1 | 0 |
| '8' | 0 | 0 | 0 | 1 |
| '9' | 1 | 0 | 0 | 1 |

Fig. 7b. Basic flip-flop of decade counting units

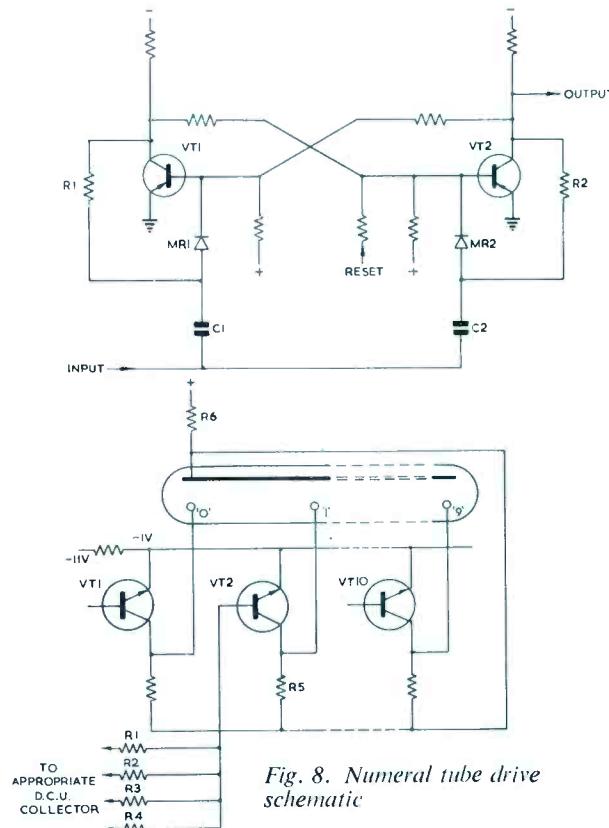


Fig. 8. Numeral tube drive schematic

1 Mc/s Oscillator and 10 Mc/s Multiplier Unit

The 1 Mc/s crystal is oven controlled and resonated in series mode in a circuit employing two transistors. The close temperature control of the oven unit together with stabilization of the oscillator circuit supply rail results in excellent frequency stability, typical performance being

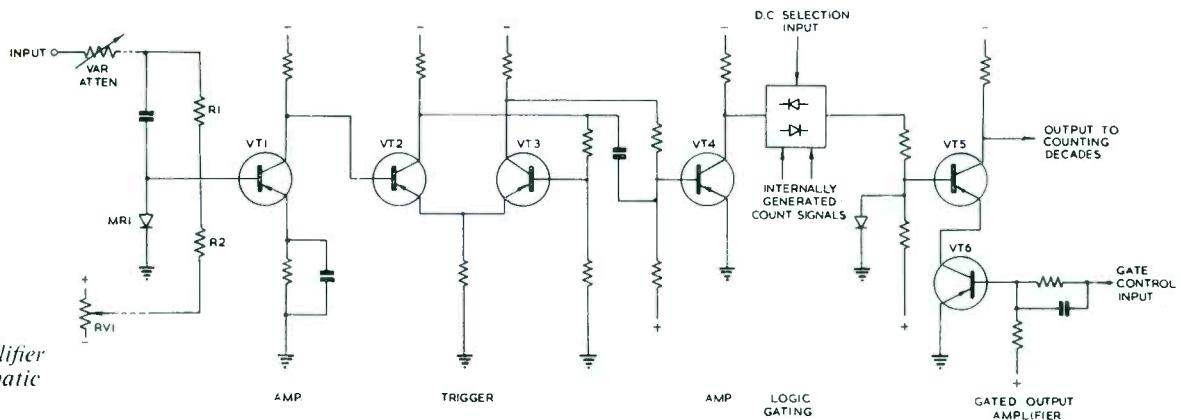


Fig. 9
Input amplifier
unit schematic

considerably better than 1 part in 10^7 total excursion over a 24 hour period.

The output from the oscillator is amplified and shaped to rectangular pulse form, giving an output at this frequency suitable for use as a drive to the time base divider chain, 1 μ sec timing units, and as an output from the instrument.

The 1 Mc/s signal is further shaped and applied to a tuned amplifier resonant at the 10th harmonic, the result-

ing 10 Mc/s signal being further amplified and shaped to pulse form, and subsequently used as 0.1 μ sec timing units.

Power Supply

The circuitry of this section is straightforward. A conventional series regulator provides the principle—11V supply, while the +5.6V and -5.6V rails are stabilized by shunt connected zener diodes. An unstabilized (+180V) supply rail is provided for operation of the digit tubes.

ABRIDGED SPECIFICATION

Range

FREQUENCY: 0 c/s to 10 Mc/s.
PERIOD: 0 c/s to 5 Mc/s.
TIME INTERVAL: 0.2 μ sec minimum.
FREQUENCY RATIO: Lower frequency, 0 c/s to 5 Mc/s; higher frequency, 0 c/s to 10 Mc/s.

Stability

SHORT TERM: 2 parts in 10^7 .
LONG TERM: 3 parts in 10^7 .

Input sensitivity

0.25 volt r.m.s.

Gate times (frequency measurement)
10 sec to 1 μ sec in decade steps; instru-

ment reads in c/s, kc/s, or Mc/s, with automatic decimal point indication.

Timing signals (period and time interval measurements)

1 c/s to 10 Mc/s in decade steps; instrument reads in sec, msec, and μ sec, with automatic decimal point indication.

COUNTER RANGE EXTENSION UNIT TYPE TF 1434

COUNTER RANGE EXTENSION UNIT TF 1434 is primarily intended as a means of extending the direct frequency measuring range of Counter/Frequency Meter TF 1417, described on the previous pages of this issue of *Instrumentation*. It may, however, be used without modification with any 10 Mc/s counter, provided the latter has adequate sensitivity, or if a suitable amplifier is included.

The instrument is essentially a receptacle for the plug-in converter units already used with Marconi Counters, Type TF 1345 series, and provides these units with the necessary power supplies and high level 10 Mc/s standard. Two plug-in converter units permit frequency measurement to 220 Mc/s; TM 5951 covering 10 Mc/s to 100 Mc/s, and TM 5952 covering 100 Mc/s to 220 Mc/s.

In operation, the instrument requires a standard 1 Mc/s signal applied to a socket on the rear panel, and can connect directly to the 1 Mc/s output from Counter TF 1417. The difference frequency output is available at a socket on the front panel.

Fig. 1 shows Range Extension Unit TF 1434 with TM 5952 in position, which can be mounted on top of

Counter/Frequency Meter TF 1417, the overall height of the two instruments together being some 15 inches. In rack mounting trim this would be reduced, since the height of each panel is only 7 inches.

PRINCIPLE OF OPERATION

The basic principle of operation is that any input signal having a frequency within the range of the particular converter unit in use can be mixed with an appropriate harmonic of 10 Mc/s, such that the difference frequency lies within the range of the associated counter. If the mixing harmonic used is the nearest below the input signal, the counter indicated frequency need only be added to the known harmonic frequency selected, to determine the input frequency to the accuracy of the reference standard used.

Fig. 2 shows a block diagram of the Range Extension Unit together with Plug-in Converter TM 5951. In addition to operating as a converter, the tuned input and mixer stages may be bypassed so that the unit serves as a straight amplifier for frequencies in the range 10



Fig. 1
Counter Range Extension Unit, Type TF 1434 with Converter Unit TM 5952. This instrument, using two plug-in converter units, extends the direct frequency measurement range of a 10 Mc/s counter to 220 Mc/s

kc/s to 10 Mc/s, increasing the associated counter sensitivity to better than 100 mV.

The magic eye indicator is included to provide a means of tuning the three-range input amplifier to the applied signal frequency, the calibrated dial giving a direct indication of the appropriate mixing harmonic. Switching to select this harmonic as mixer drive automatically couples the indicator to the video amplifier output, thus providing a measure of the drive level to the counter.

Operation with the higher frequency converter plug-in TF 5952 is similar in principle, differing only in that the input signal is untuned and applied directly to the mixer stage which is unbalanced. A wavemeter is included to determine the appropriate mixing harmonic.

The difference frequency output from the converter plug-in unit is routed via a cathode follower stage, and subsequently presented at a front panel socket, the effective source impedance being approximately 50Ω .

The output drive level available for counting is greater than 0.5V r.m.s. over a difference frequency range of 10 kc/s to 10 Mc/s.

The output drive level available for counting is greater than 0.5V r.m.s. over a difference frequency range of 10 kc/s to 10 Mc/s.

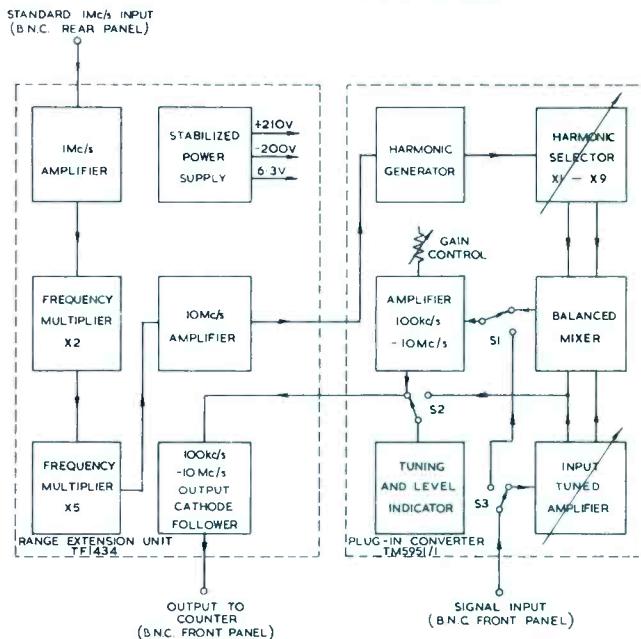


Fig. 2.
Block diagram of TF 1434 with TM 5951

ABRIDGED SPECIFICATION OF TF 1434

with TM 5951

Frequency range

10 kc/s to 100.1 Mc/s.

Minimum input (unknown signal)

100 mV r.m.s. from 10 kc/s to 10.01 Mc/s.

10 mV r.m.s. from 10.01 Mc/s to 100.1

Mc/s.

1-Mc/s standard input

200 mV r.m.s. minimum is required; high input impedance.

Output e.m.f.

Approximately 0.5 volt r.m.s. from 400 ohms source impedance.

with TM 5952

100.1 to 220.1 Mc/s.

100 mV r.m.s.



H.F. Spectrum Analyser

• • • TYPE OA 1094A

by J. H. DEICHEN,
A.M.I.E.E.

In s.s.b. transmission it is of particular importance to know the success of suppressing one sideband and the effects of intermodulation components; it is also beneficial to be able to see a display of all the signal components within the working band of the transmission. The H.F. Spectrum Analyser is an instrument which gives that facility over a frequency range from 3 to 30 Mc/s, or down to virtually d.c. with the aid of the L.F. Extension Unit, TM 6448. The total band of the signals that can be displayed simultaneously is up to 30 kc/s and relative amplitude measurements can be made over a range of 60 dB. This article describes the design features of the instrument and gives an outline of the path taken by a signal through the various circuits until the response is displayed on the c.r.t. face.

THE H.F. SPECTRUM ANALYSER, OA 1094, was originally designed by the General Post Office and marketed by Marconi Instruments Ltd. A description of that instrument appeared in the June, 1957, issue of this publication.¹ Since that time the instrument has been called upon for many more functions, some of which are performed under arduous conditions where the instrument is subjected to excessive vibration and high stresses. To meet these additional requirements a new model has been designed, known as the OA 1094A.

From the electrical point of view, the OA 1094A is basically not greatly changed from the OA 1094, although the opportunity has been taken to improve certain shortcomings of the original instrument. From a mechanical point of view, however, the similarity between the two instruments is very slight. Particular care has been taken in constructing the new instrument to obtain rigidity, reliability and ease of servicing.

The instrument is housed in a standard 19-inch steel cabinet which is mounted on a rigid steel trolley via six anti-vibration mounts and a flat steel plate (Fig. 1). The trolley is optional and if not required the instrument could be mounted on a suitable table via the anti-vibration mounts and the steel plate. It may be fixed to this table by four fixing bolts, using the four holes provided in the steel plate. The front panel is in two sections: one carries the controls for the main instrument and is attached to the main instrument frame; the second is the power supply. The main instrument and power supply are separated by a steel screening plate and are secured together by fixing screws. The whole is then mounted in the cabinet on runners which are secured to the power unit. Thus by removing the front panel securing screws the complete instrument can be pulled forward on its runners for servicing purposes (Fig. 2). The instrument is of unit construction and access to the components of a unit can be obtained after removing the unit screening covers (Figs. 5 and 7). It is not necessary to remove the instrument from the cabinet runners or to remove the units from the instrument frame to obtain access to the components for servicing.

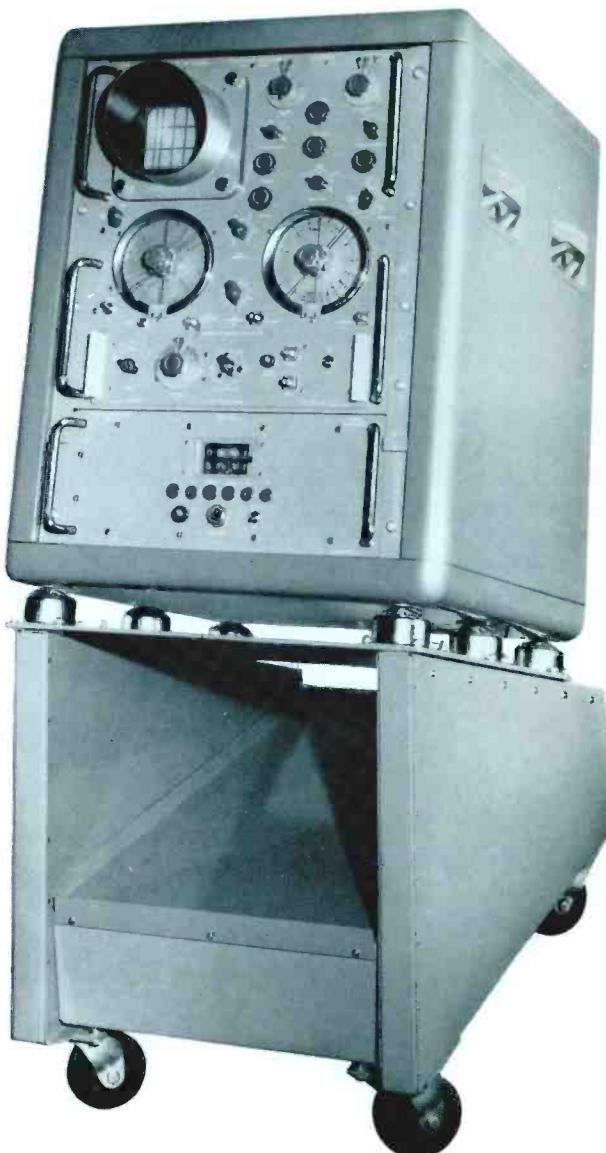


Fig. 1. H.F. Spectrum Analyser, Type OA 1094A

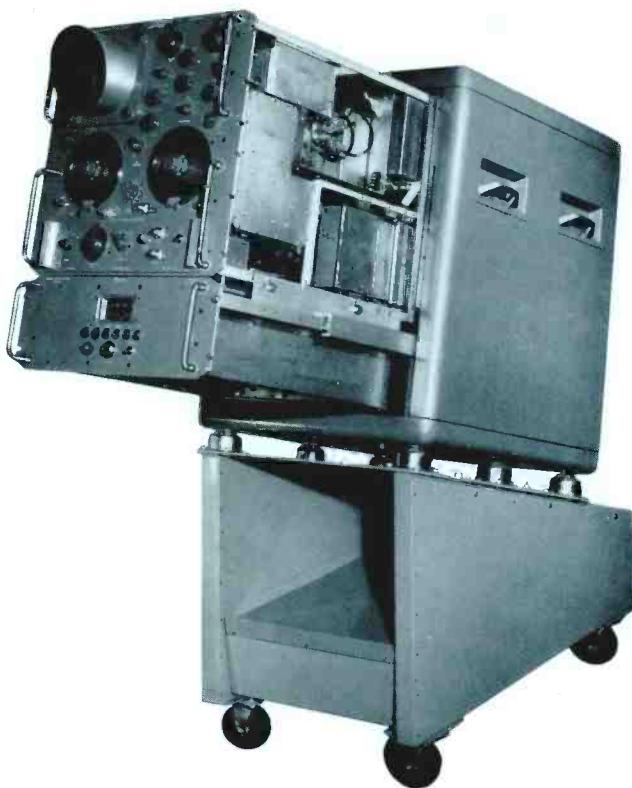


Fig. 2. The instrument ready for inspection

CIRCUIT FUNCTION

The instrument is a triple superheterodyne receiver which displays the rectified output from the last stage on a c.r.t. As the 'x' trace scans the tube face the 'y' deflection is proportional to the instantaneous amplitude of the signal which corresponds to the frequency at that instant. The instantaneous frequency is controlled by the sawtooth voltage derived from the time base oscillator which modulates the local oscillator of the third frequency changer.

To obtain the final picture, the path of the signal from the input to the final display can be followed on the block schematic diagram (Fig. 3). For frequencies up to 3 Mc/s the signal is fed into the input socket of the L.F. Extension Unit where it can be attenuated by up to 50 dB in 10 dB steps. It can then either be fed direct or pass through a filter stage to a frequency changer where the resultant frequency is between 3 and 6 Mc/s, the local oscillator frequency being 6 Mc/s. The output of this unit, or signals with frequencies between 3 and 30 Mc/s, are fed to the r.f. input socket of the main instrument. The signal is then amplitude controlled by a 50 dB step attenuator in 10 dB steps before passing into a tuned r.f. stage which prevents unwanted signals overloading the first frequency changer. In the first frequency changer the signal frequency is converted to a frequency between 3 and 6 Mc/s for all frequencies above 6 Mc/s or the stage acts as an amplifier to signal frequencies between 3 and 6 Mc/s. The 3 to 6 Mc/s signal passes through a tuned filter of two stages

before passing to the second frequency changer where it is converted to an i.f. of 700 kc/s. The local oscillator which operates between 2.3 and 5.3 Mc/s can be replaced by an external local oscillator if so desired.

In the anode of the second frequency changer the signal path joins that of the i.f. from the Fixed Frequency Changer. The i.f. from the Fixed Frequency Changer is obtained without any tuning or setting of controls except for the correct position of the range change control of the instrument. This unit is intended for analysing the signal from the drive unit for a transmitter and allows for a check to be made of the drive unit signal at any time during testing of the transmitter signal without requiring detuning of the instrument as set for the transmitter signal analysis.

The i.f. of 700 kc/s from either source passes through a continuously variable attenuator of up to approximately 20 dB before being fed through a bandpass filter. At this point the signal can divide into two paths. The secondary path feeds a Sound Channel which contains a mixer stage and a 700 kc/s local oscillator. Thus an aural null beat can be obtained indicating the i.f. is exactly 700 kc/s. The primary path feeds the third frequency changer via a step attenuator of 11 dB in 1 dB steps. The third local oscillator, centred on 760 kc/s, is frequency swept by the sawtooth voltage derived from the time base oscillator, using a valve reactance stage. The magnitude of the sweep is continuously variable in two ranges of 0 to 30 kc/s and 0 to 3 kc/s. Also the local oscillator can be frequency changed by a fine trim control by up to ± 10 kc/s. The i.f. from the third frequency changer is delivered at 60 kc/s, determined by the high selectivity bandpass filters and the high gain tuned 60 kc/s amplifiers. There are three bandpass filters to be selected by a switch control which gives bandwidths of 6 c/s, 30 c/s or 150 c/s. The switch control also switches an attenuator pad of 30 dB out of the circuit for either of the three filter switch positions, thus giving an extra 30 dB display on the c.r.t. face. Therefore, on the '0' position of the switch, for each of the filters the full display on the c.r.t. face is represented by 30 dB expanded approximately linearly on a dB scale and 30 dB cramped at the bottom of the tube face. On the +30 dB position of the switch for each filter the top 30 dB of the display is cut off by the limiting action of the 'y' deflection amplifiers and the second 30 dB is expanded over the tube face.

Following the filters and the amplifiers the signal is detected and amplified by a logarithmic amplifier, thus giving the linear dB scale for display. From this stage the signal is fed to the 'y' deflection amplifiers and hence the signal is displayed on the tube face. The 'y' deflection represents the amplitude of the signal and the 'x' deflection represents the frequency of the signal. The centre of the 'x' deflection corresponds to 700 kc/s or to the centre frequency of the input signal when the fine trim control is in the zero shift position. The outer vertical lines on the tube graticule along the 'x' axis represent the maximum frequency deviated from the centre frequency for a particular setting of the sweep width control; since the control is calibrated in the total width of the sweep, the

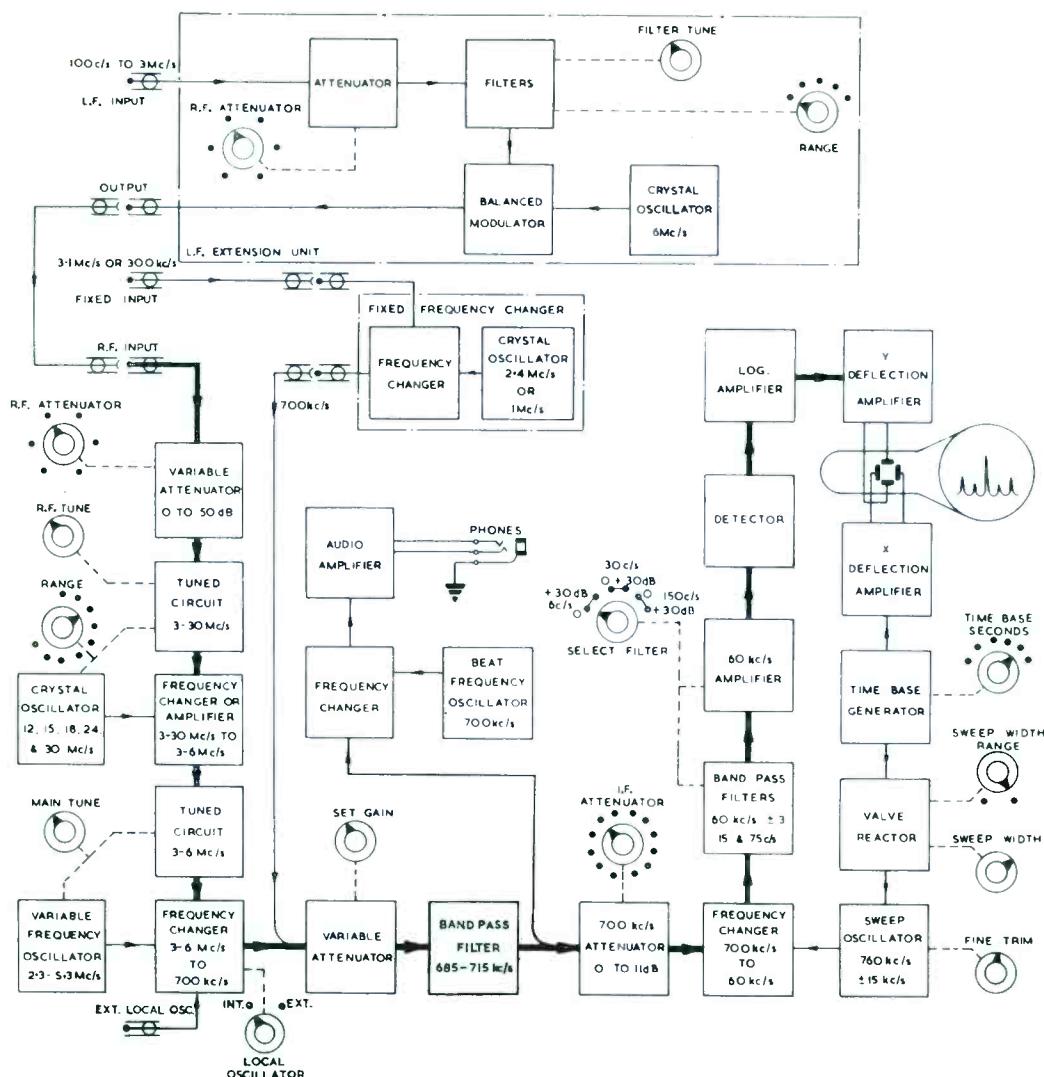


Fig. 3
Block diagram
of H.F.
Spectrum Analyser
Type OA 1094A

outer vertical lines represent half of this frequency. Thus for 30 kc/s sweep width the outer vertical lines represent 15 kc/s on each side of the centre frequency. Four intermediate vertical lines help to determine the frequency of the components within the frequency range displayed on the tube face. The graticule contains horizontal lines which represent 0, -10, -20, and -30 dB amplitudes relative to a full display which reaches the 0 line. Thus, with the added 30 dB sensitivity switched by the filter switch, these lines represent -30, -40, -50, and -60 dB respectively.

POWER SUPPLY

The power supply is entirely changed from its predecessor, both electrically and mechanically. It is electronically stabilized for h.t., e.h.t. and part of the l.t. The a.c. input is fed to two transformers where the primary windings are connected in parallel via a common mains tapping panel. The tapping panel is exposed for quick change of mains tap and voltage range by simple removal of a small window on the front panel of the unit. It caters for two voltage ranges of 100 to 150 and 200 to 250 volts. The

mains input lead is connected via a front panel plug and all fuses are available at the front panel.

Most of the h.t. supply is at 250 volts and the system uses a series regulator circuit. Two triodes are used in parallel for the series control elements. The feedback system uses two amplifier stages and two cathode followers and the reference voltage is taken from a neon tube. The a.c. input is rectified by silicon rectifiers used in a bridge circuit.

As well as the 250 volt h.t., a 400 volt h.t. supply is required for the 'x' and 'y' deflection amplifiers. This supply is obtained by a 150 volt supply added to the 250 volt supply. As the consumption is small, sufficient stability has been achieved by using a neon stabilizer. Rectification is obtained by silicon rectifiers in a bridge circuit.

To achieve the best stability with freedom from hum, essential valves are operated from a stabilized l.t. supply. About 1.3 amperes are used from a conventional transistorized series stabilizer. The stabilizer uses a series control transistor, a d.c. amplifier and an emitter follower stage. Rectification is obtained using two silicon rectifiers in a push-pull circuit.

Two e.h.t. supplies are used, one positive for the first anode of the c.r.t., the second negative for the cathode and the control electrodes. Both supplies are over 2 kV and this high voltage is derived from an oscillator operating at a frequency of about 100 kc/s. Stability in the presence of mains input changes is achieved by the fact the oscillator supply is taken from the regulated h.t. The output of the oscillator is rectified by valve rectifiers in a half wave rectification circuit for each supply. Smoothing is obtained by a resistive capacitive filter network. The positive supply is not required to be regulated for load changes, but the negative supply uses a corona stabilizer tube for this purpose. This corona tube is located in the main instrument on the e.h.t. distribution board as a convenience so as to be near to the c.r.t. control variable resistors. The nominal current through the stabilizer has been chosen so that when the brightness control is turned excessively to the bright position the current through the stabilizer reduces to zero and the stabilizer ceases to regulate. Thus the c.r.t. becomes defocused, preventing the concentration of electrons on the tube face and consequent damage.

The power supply is connected to the main instrument by two plug and socket connectors. To service the power unit it can be separated from the main instrument after removing both from the cabinet runners. The unit has been designed with all the heavy components near the front panel for greater support.

FREQUENCY CHANGER I

The instrument is of unit construction and the first to be considered is Frequency Changer I. This unit contains the tuned r.f. filters, the first frequency changer, the first local oscillator and an output stage. The total frequency of 3 to 30 Mc/s is covered in nine ranges of 3 Mc/s and is controlled by a range switch which has a tenth position for operation of the Fixed Frequency Changer. On this range the normal ranges are inoperative. The r.f. stage contains four transformers, one of which is switched into the circuit for the appropriate range. Tuning is obtained by a variable capacitor which is driven by a front panel control which also carries a hand calibrated dial.

The capacitor and dial drive has been specially designed for the instrument. It uses two concentric controls which are also concentric to the dial. One control gives a direct drive over an angle of 180° for quick tuning purposes. The second control has a 50 to 1 reduction, thus turning through 25 revolutions for the 180° travel of the capacitor and dial. The reduction is obtained by an anti-backlash gear train, but a clutch is incorporated which allows for the direct control operation to be performed without spinning of the reduction control.

The local oscillator is a tuned grid crystal oscillator using three crystals—12 Mc/s, 15 Mc/s, and 18 Mc/s—which are suitably switched for the nine ranges. The nine ranges are possible with only three crystals as on the first range the oscillator is not used and for the next six ranges the oscillator is used either above or below the input frequency and the second harmonic of the 12 Mc/s and the 15 Mc/s crystals is used for the two top ranges.

Thus on some ranges the i.f. goes from 3 to 6 Mc/s and on others 6 to 3 Mc/s as the input signal frequency increases. The table in Fig. 4 shows the range frequency and the corresponding local oscillator frequency; it can

| Range | Frequency (Mc/s) | Local Oscillator Frequency (Mc/s) |
|-------|---------------------|---|
| A | 3 to 6 | 0 |
| B | 6 to 9 | 12 |
| C | 9 to 12 | 15 |
| D | 12 to 15 | 18 |
| E | 15 to 18 | 12 |
| F | 18 to 21 | 15 |
| G | 21 to 24 | 18 |
| H | 24 to 27 | 2nd. H. of 15 |
| J | 27 to 30 | 2nd. H. of 12 |

Fig. 4. A table of the range input frequency and the corresponding local oscillator crystal frequency

be seen that at 8 Mc/s on range B the i.f. would be 4 Mc/s, but the second harmonic of 8 Mc/s would also give an i.f. of 4 Mc/s. A similar situation occurs at 10 Mc/s on range C and at 12 Mc/s on range D. This situation would, of course, give a double response and if the harmonic was very great it could not be tolerated. To overcome the difficulty there are three filters of a parallel tuned network configuration in the input circuit to eliminate or greatly attenuate the harmonics at these frequencies.

The output circuit consists of anode traps tuned to the frequency of the local oscillator to minimize the local oscillator breakthrough. This is followed by a cathode follower stage which matches the output to a 75 ohm cable which connects the unit to the next stage.

The unit is completely r.f. screened; this, coupled with the fact that the second unit containing the second local oscillator is also r.f. screened, completely eliminates spurious responses caused by intermodulation between the two local oscillators. The input transformers and other coils in the unit are also screened and being located inside the screened box are effectively double screened. The screening cans are of a biscuit tin construction with the can fixed and the coils secured to the lids. The lid is a push fit and for servicing the coil is readily available by simple removal of the lid. In some cases the attached connecting wires may require to be unsoldered. For retaining during operation of the instrument the unit cover plate contains plungers which bear lightly against the can lids. The cans can be seen *in situ* in the L-shaped unit in the picture of Fig. 5. A picture of one of the cans opened, showing the coil, is given in Fig. 6.

All the components except the valves, crystals and the variable capacitor are located in the screened box. Thus for servicing it is not necessary to remove the unit from the instrument frame. The valves and crystals are screened by the special screw-on cans now featured on many Marconi instruments.

FREQUENCY CHANGER II

The Frequency Changer II unit contains a variable band-pass filter, the second frequency changer, the second local oscillator and an output stage. The unit is located on the left-hand side of the instrument and can be seen in the picture of Fig. 7. The box is fully r.f. screened and all the components except the three-gang variable capacitor can be removed for servicing without removing the unit from the main frame. The coils and transformers are located in the small square boxes as seen in the picture.

A three-gang variable capacitor is used for the two stages of the bandpass filter and for the local oscillator. The capacitor drive is similar to that used for Frequency Changer I. The dial attached to the drive is hand calibrated and although calibrated in frequency for each range the principal marks are coincident for each range as the signal fed to the unit is always between 3 and 6 Mc/s.

The coils and transformer used for the filters and local oscillator are variable, using iron dust cores. Also the circuits use trimmers and padders so that it is possible to obtain three-point tracking between the three stages. The local oscillator operates at a frequency between 2.3 and

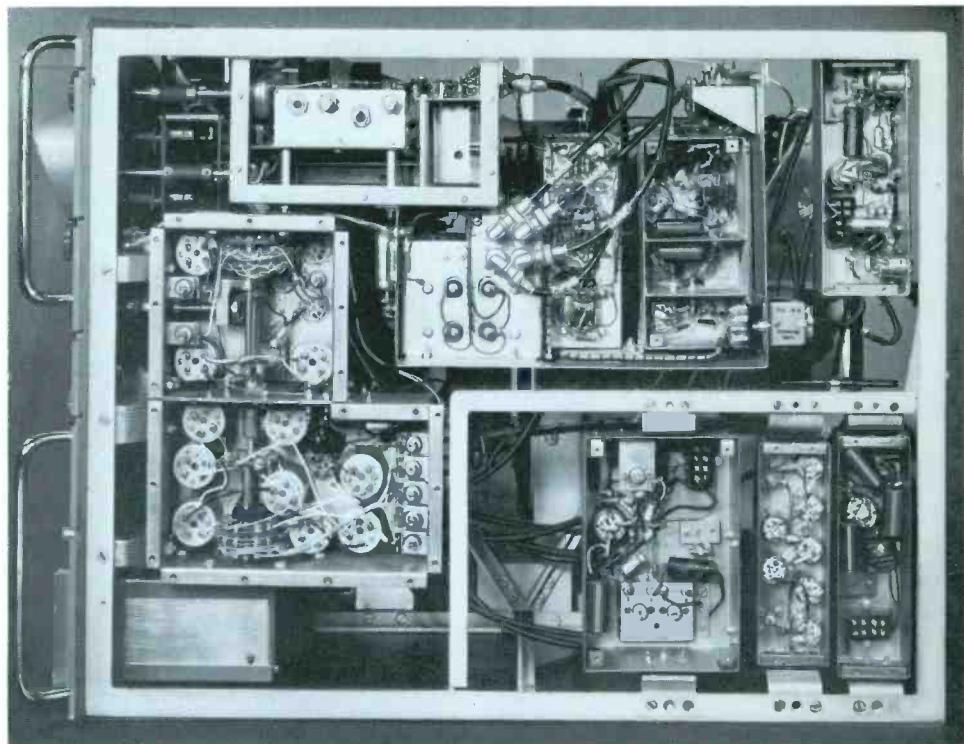


Fig. 5. The right side of the instrument with unit screening covers removed

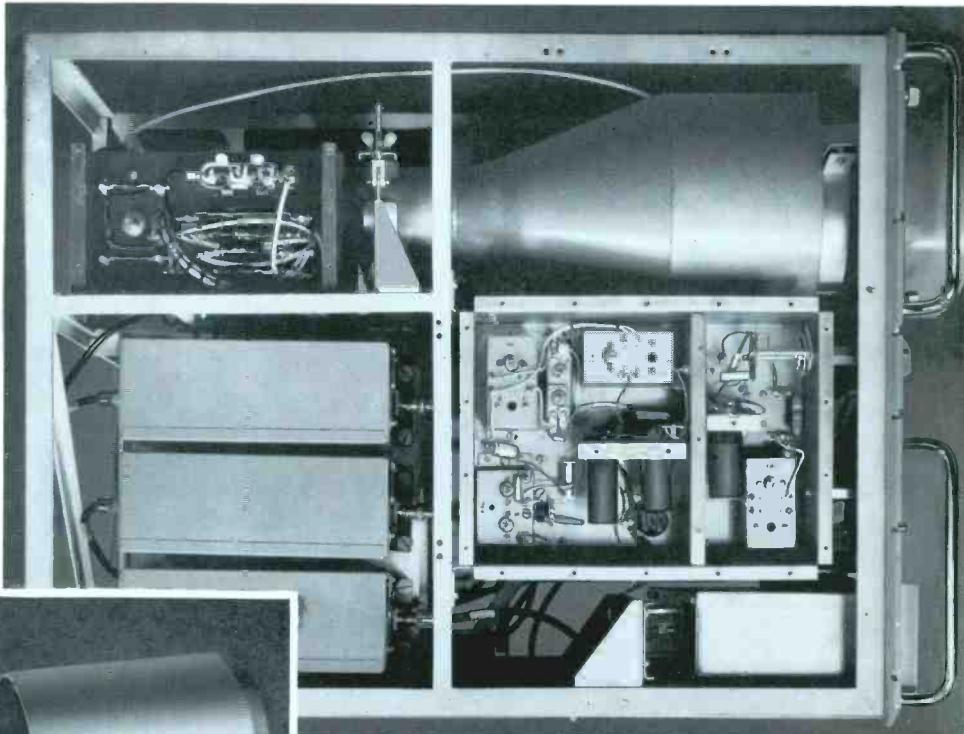


Fig. 7. The left side of the instrument with Frequency Changer II screening cover removed



Fig. 6. R.F. coil can with lid removed showing the coil fixed to the lid

5.3 Mc/s giving an i.f. from the frequency changer of 700 kc/s. Under adverse conditions of operation where the instrument may receive excessive vibration thus producing microphony in the local oscillator it is possible to substitute an external local oscillator which is crystal controlled, such as a synthesizer. A signal source of 1 volt e.m.f. is sufficient to drive the stage.

In the anode circuit of the frequency changer is a critical coupled i.f. transformer. The secondary winding of this transformer receives the 700 kc/s signal derived from the Fixed Frequency Changer via a fixed attenuator pad of 40 dB. As the adjustment of the transformer is dependent on the load impedance, the 40 dB pad is used to give a nearly constant impedance whether or not the Fixed Frequency Changer is connected. Thus the Fixed Frequency Changer can be an optional accessory.

The final stage of the unit is a cathode follower feeding a variable level control. The output has an impedance of 75 ohms and is connected via a 75 ohm cable to the input of the following unit.

700 kc/s FILTER UNIT

The Frequency Changer II unit is connected to the 700 kc/s filter via an i.f. step attenuator. The filter is used in the circuit to give a flat response of ± 15 kc/s but very steep attenuation at frequencies beyond the passband, being tuned for high attenuation at multiples of 60 kc/s off the centre frequency. Thus at 640 and 760 kc/s the attenuation is approximately 50 dB and at 820 kc/s it is over 60 dB. This is accomplished by parallel tuned circuits at these frequencies and series tuned circuits at the centre frequency.

The size of the unit is small, as a result of using ferroxcube pot core inductors and miniature fixed capacitors. Access to the components can be obtained by removing the unit cover, or the unit can be removed from the main instrument frame, if so desired, by undoing four screws.

SCANNING UNIT

The scanning unit, which is the irregular-shaped unit seen at the top in the picture of Fig. 5, consists of the final stages before displaying the signal on the face of the c.r.t. The input is a critical coupled transformer similar to that used in Frequency Changer II. The local oscillator is an L-C type centred on 760 kc/s and is frequency swept by the sawtooth voltage derived from the time base oscillator. A reactance valve is used and the sweep is continuously variable in two ranges from 0 to 30 kc/s or from 0 to 3 kc/s. This is accomplished by varying the drive from the time base oscillator using a variable resistor and switched capacitors. By correcting the bias to the reactance valve the display is constantly centred on the c.r.t. face regardless of the sweep width or sweep width range. The sweep speed is variable in six steps by switching the capacitance components in the time base oscillator. The six speeds are denoted in the time taken for a sweep and are 0.1, 0.3, 1, 3, 10 and 30 seconds.

To prevent a response curve being traced out on the c.r.t. face during the flyback period the input signal is

cut off by biasing back the frequency changer valve with a voltage derived from the time base oscillator via a silicon rectifier. Thus the trace is not blanked out and this gives a line across the bottom of the c.r.t. face during the flyback for reference purposes.

After the frequency changer the i.f. signal of 60 kc/s is routed from the Scanning Unit to the crystal filters and then back again to the 60 kc/s amplifier stages. This amplifier is in two stages using tuned circuits in both the grid and the anode. The inductors are variable using the Ferroxcube pot core type of inductor and the capacitors are fixed.

Following the amplifier the signal is rectified by a double diode valve. This is followed by the logarithmic amplifier using a variable-mu valve. To ensure maximum stability of the amplifier the screen grid voltage is controlled by a neon stabilizer. This stage feeds the push-pull 'y' deflection amplifier. To limit the response curve to the top of the viewing screen silicon diodes are used as clamps on the anodes of these amplifiers. Thus for the 'push' stage amplifier the anode voltage will not fall below a predetermined value and for the 'pull' stage the anode voltage will not rise above a predetermined value. This limiting action is nearly independent of the feed from the logarithmic amplifier or of the setting of the 'y' shift control.

The 'x' deflection amplifier is similar to the 'y' deflection amplifier except for the limiting. The gain of this amplifier is adjusted by a preset variable resistor.

CRYSTAL FILTERS

The crystal filters are switch controlled to give a choice of three selectivities of 6 c/s, 30 c/s or 150 c/s bandwidth. The circuits for the three are similar, using two sections with a close tolerance crystal in each section. Each section is a bridge network using each half of a centre-tapped transformer for two legs of the bridge, a capacitor for one leg and the crystal with associated capacitors for the fourth leg. The series capacitors of the crystal legs of the two bridge circuits are selected to give identical series resonant frequencies and the parallel capacitors are selected to give identical antiresonant frequencies. This fact plus the selection of capacitors in the capacitor legs and the careful adjustment of the two transformers for resonance and coupling makes it possible to obtain the required bandwidth with sharp attenuation outside the pass band. Finally, to ensure long life without deterioration in performance, the filter units are sealed and filled with carbon dioxide gas.

The three filters give at least 60 dB of attenuation at frequencies of ± 60 c/s, ± 300 c/s and $\pm 1,500$ c/s for the 6 c/s, 30 c/s and 150 c/s bandwidth filters respectively. To obtain even greater loss outside the pass band the 6 c/s filter is used in series with the 30 c/s filter when on the 6 c/s filter position of the switch. Likewise the 30 c/s filter is used in series with the 150 c/s filter. For convenience in operation the amplitude of the signal for the three filter positions is adjusted to be equal by the use of an amplifier and a selected attenuator pad.

L.F. EXTENSION UNIT (TM 6448)

The Low Frequency Extension Unit is a plug-in unit located near the bottom of the instrument and can be removed without removing the instrument from its cabinet. This unit is an optional accessory used to extend the frequency range down below 3 Mc/s. The practical lower frequency is about 100 c/s.

The local oscillator is a crystal oscillator operating at 6 Mc/s. Therefore, for input frequencies between 0 and 3 Mc/s, the i.f. is 3 to 6 Mc/s, which is suitable for the first range of the instrument proper.

The input signal can be attenuated in 10 dB steps up to 50 dB. There are five input ranges as follows: range 1 from 0.8 to 3.0 Mc/s, range 2 from 0.3 to 0.8 Mc/s, range 3 from 0.16 to 0.3 Mc/s, range 4 from 0 to 0.16 Mc/s and range 5 covering the entire range from 0 to 3 Mc/s. The first three ranges use a tuned filter stage, the fourth range uses a low pass filter and range 5 is a direct through connection.

Frequency changing is obtained by a balanced modulator using four pairs of germanium diodes in the legs of the bridge. The diodes are used in parallel to make it easier to select identical legs without undue rejection of components. The bridge is balanced by a front panel preset control which alters the bias current through the diodes.

FIXED FREQUENCY CHANGER (TM 6467 & /1)

The Fixed Frequency Changer is an optional accessory which is used in conjunction with drive units for a transmitter so that the signal of the drive unit can be investigated without upsetting the tuning for investigating the transmitting signal. There are two fixed frequencies currently catered for, namely 300 kc/s and 3.1 Mc/s, using TM 6467 & /1 respectively. Only one of the units can be used in the instrument at any one time.

The unit consists of a tuned input stage, a crystal derived local oscillator suitable for giving an i.f. output of 700 kc/s, the frequency changer and an output transformer. This output transformer is critically coupled and is similar to that described for Frequency Changer II. A fixed attenuator pad of 40 dB at the input allows for an input signal of +118 dB μ V to give a full display on the c.r.t. face.

SOUND CHANNEL

The Sound Channel is used to give an aural indication when the instrument main tuning control is correct to give a display on the c.r.t. face. This facilitates easy initial tuning of the instrument, especially when the frequency of the signal to be investigated is unknown. It is also useful for searching for remote spurious responses.

The unit consists of two stages of amplification at the input signal frequency of 700 kc/s. The local oscillator is tuned to exactly 700 kc/s so that a zero beat note is obtained when the instrument input tuning stages are tuned to give an exact 700 kc/s signal for the second i.f. The oscillator is anode tuned with low harmonic content and, used with the tuned input stages which reduces the

unwanted signal breakthrough, gives insignificant spurious responses. The first tuned amplifier stage contains a limiter in the form of a silicon diode across the tuned circuit in the anode so that a volume control is not required.

ACCESSORIES

Besides the two optional accessories already mentioned there are two other accessories available. One is the Camera Mounting Hood, TM 5604, which replaces the normal c.r.t. surround and is intended to accommodate a suitable recording camera. It contains a viewing aperture which allows the viewing of the signal at the time of photographing.

A second accessory is the R.F. Fuse Unit, TM 6723. This unit is a small box containing a special r.f. fuse of low impedance. The unit is terminated in a BNC plug and socket. The fuse is intended to protect the input attenuators and can be used on the input for either the instrument or the L.F. Extension Unit. The fusing current is 90 mA, *i.e.* an input of 6.75 volts. The rated current is 60 mA, *i.e.* 4.5 volts, which is a safe figure for the rated value of the resistors used in the input attenuators.

APPLICATIONS

The original H.F. Spectrum Analyser was designed specifically for analysing the spectrum of s.s.b. transmission. In this respect it gave a visual means of measuring the intermodulation distortion, crosstalk, carrier compression or suppression, noise levels and any spurious signals including 50 c/s hum. Measurements are easily and quickly determined by the relative amplitudes of the component signals. With the use of the variable sweep width the complete picture of all components on each side of the carrier can be seen at one time using the wide sweep, or any group of components in the spectrum can be investigated by narrowing the sweep, tuning as required and manipulating the plus 30 dB gain control switch. By using the slower sweep speeds, say 30 seconds, and the narrow selectivity filter, 6 c/s, it is possible to investigate components close to the carrier such as the 50 c/s hum. By using the fast sweep speeds, say 0.1 second, and the wide selectivity filter, 150 c/s, it is possible to quickly search the whole frequency range for spurious signals. In general, most measurements would be made using the medium selectivity filter, 30 c/s, and the 10 second sweep speed. Use of the instrument soon proves the proper sweep speed to use to give a clear picture free from ringing. Ringing is a form of spectrum distortion which is related to the sweep width, the sweep speed and the bandwidth.² The ringing is apparent by the damped oscillation occurring on the trailing edge of the response curve and causes a reduction in the amplitude of the response and thus gives false results for amplitude measurements. A test to prove ringing is not present is to increase the sweep width and if ringing is present the amplitude of the signal will increase. If ringing is present then the sweep width should either be increased or the speed decreased.

Another useful purpose of the Spectrum Analyser is in the determination of the frequency deviation of a frequency modulated signal by first principles. A direct measurement for frequencies up to 30 Mc/s can be made by viewing the carrier for carrier disappearance while a predetermined modulating signal is being applied. For frequencies above 30 Mc/s a second signal source can be used as a local oscillator and with a suitable mixer the resultant frequency can be fed to the Analyser for this purpose.

The harmonics of the modulation of an amplitude modulated signal can be quickly determined by measuring the relative amplitudes of the harmonics compared to the fundamental. This is easily determined using the dB calibrated scale of the tube graticule and the 1 dB steps of the i.f. attenuator.

It is possible to measure the harmonics of any modulating or carrier signal providing the harmonic is not

greater in frequency than 30 Mc/s. This is done by measuring the relative amplitudes of the fundamental and the harmonics.

The frequency of the components in the sidebands of a modulated signal can be determined by the use of the Spectrum Analyser. This is possible with the aid of the calibrated fine trim control and with the aid of the vertical lines of the tube graticule and the calibrated sweep width control.

Besides all the uses of the instrument at a transmitting station, similar tests can be taken at the remote end of a transmission by feeding the i.f. of a suitable receiver into the Spectrum Analyser and carrying out the tests in the usual fashion.

REFERENCES

1. Hayward, J. R.; H.F. Spectrum Analyser, Type OA 1094, *Marconi Instrumentation*, 6, 37 (June, 1957).
2. Slater, F.; 'Ringing' in Spectrum Analysers, *Marconi Instrumentation*, 6, 140 (March, 1958).

ABRIDGED SPECIFICATION

Main input frequency range

3 to 30 Mc/s in nine bands of 3 Mc/s each band.

Fixed frequency input

300 kc/s or 3.1 Mc/s.

L.F. Extension unit input

100 c/s to 3 Mc/s in five ranges.

Amplitude measurement ranges

0 to -30 dB, and -30 dB to -60 dB, where 0 dB represents level of reference signal.

Selectivity

Three values of 3-dB bandwidth can be selected, viz. 6, 30, and 150 c/s; frequencies outside bandwidths of 120, 600, and

3,000 c/s respectively are rejected by more than 60 dB.

Spectrum width

0 to 30 kc/s and 0 to 3 kc/s, continuously variable.

Sweep duration

0.1, 0.3, 1, 3, 10 and 30 seconds.

Summaries of Articles appearing in this issue

RESUME D'ARTICLES PUBLIES DANS LE PRESENT NUMERO

VOLTMETRE A TUBES TYPE TF 1041C

Cet exposé décrit un voltmètre électronique dont les sensibilités sur totalité de l'échelle varient de 300 mV c.a. et continu à 300 Volts c.a. et 1000 Volts c.c. L'alimentation des réchauffeurs de lampes et de la ligne haute tension est électroniquement stabilisée au moyen des techniques les plus récentes, réalisant ainsi une stabilité de lecture de premier ordre pour un instrument de ce genre.

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COMPTEUR/FREQUENCEMETRE TYPE TF 1417

Cet article décrit un compteur/fréquencemètre à lecture en ligne à sept décades, d'une conception entièrement nouvelle et d'une grande souplesse d'emploi. L'appareil est composé de diverses tiroirs et n'utilise que des transistors dans tous les circuits. Une de ses particularités est l'emploi de la logique de déclenchement 'Et' et 'ou' qui en fait un instrument aisément adaptable à la télécommande des fonctions principales. Le taux de comptage maximum est supérieur à 10 MHz et on peut effectuer une mesure de temps d'un minimum de 0.2 µsec. L'instrument est de construction robuste et ses dimensions réduites le rendent particulièrement approprié à l'usage général de laboratoire.

L'article décrit également un tiroir d'extension de la gamme du compteur qui étend la gamme de mesure de fréquence du compteur de 10 à 220 MHz.

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ANALYSEUR DE SPECTRE HF TYPE OA 1094A

Dans la transmission à bande latérale unique, il est particulièrement important de savoir si l'on a réussi à supprimer une bande latérale et de connaître les effets des composantes d'intermodulation. Il est également utile de pouvoir voir une image de toutes les composantes de signaux dans la bande de service. L'analyseur de spectre haute fréquence type OA 1094A est un instrument qui offre les susdites possibilités dans la gamme de fréquences de 3 à 30 MHz ou, virtuellement, jusqu'au courant continu, en utilisant le tiroir d'extension basse fréquence TM 6448. La bande totale de signaux que l'on peut montrer simultanément s'étend jusqu'à 30 KHz et la mesure d'amplitude relative peut être effectuée dans une gamme de 60 dB. Cet article décrit les caractéristiques de construction de l'appareil et donne un aperçu du parcours suivi par un signal à travers les différents circuits jusqu'à ce que la réponse soit montrée sur l'écran du tube cathodique.

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ZUSAMMENFASSUNG DER IN DIESER NUMMER ERSCHENENDEN BEITRÄGE

RÖHRENVOLTMETER TYP TF 1041C

Ein Röhrenvoltmeter mit einer Vollausschlag-Empfindlichkeit von 300 mV für Wechsel- und Gleichspannungen bis 300 V bei Wechselspannung und bis 1000 V bei Gleichspannung wird beschrieben. Die Versorgung mit Heizstrom und Anoden Spannung ist unter Anwendung der neuesten Technik elektronisch stabilisiert und ergibt somit eine erstklassige Anzeigestabilität bei einem Gerät dieser Art.

Seite 75

ELEKTRONISCHER FREQUENZ-ZÄHLER TYP TF 1417

Der Aufsatz beschreibt ein vollkommen neues und äußerst vielseitiges Frequenz/Zeitmessgerät mit einreihiger Ziffernanzeige in 7 Dekaden. Das Gerät wird unter Verwendung von Kleinbau-Einheiten gebaut und benutzt durchweg eine Festkörper-Schaltungstechnik. Eine Neuheit ist die Benutzung von logischen 'und' sowie 'oder' Torschaltungen, wodurch das Gerät sich leicht für eine Fernsteuerung der Hauptfunktionen einrichten lässt. Die grösste Zählgeschwindigkeit liegt über 10 MHz und Zeitmessungen bis herunter zu 0,2 μ sec können durchgeführt werden. Das Gerät ist robust gebaut und seine Kleinheit macht es für einen allgemeinen Laborgebrauch besonders geeignet.

Seite 75

Ein Gerät zur Erweiterung des Zählbereiches wird ebenfalls beschrieben. Dadurch kann der Frequenz-Messbereich des Zählgerätes von 10 auf 220 MHz erweitert werden.

Seite 80

KW-SPEKTRUMANALYSATOR TYP OA 1094A

Bei der Einseitenbandübertragung ist die Kenntnis über den Erfolg bei der Unterdrückung eines Seitenbandes und über das Auftreten von Intermodulationsprodukten von besonderer Wichtigkeit. Die Möglichkeit der Beobachtung aller Signalkomponenten innerhalb der Betriebsbandbreite des Übertragungskanals ist ebenfalls nützlich. Der KW-Spektrumanalysator liefert diese Möglichkeiten in einem Frequenzbereich von 3 bis 30 MHz und bei Benutzung einer Tieffrequenz-Zusatzeinrichtung TM 6448 bis praktisch herunter auf Gleichstrom. Das gleichzeitig anzeigbare Signalband geht bis zu 30 KHz. Relative Amplitudemessungen können über einen Bereich von 60 dB durchgeführt werden. Dieser Aufsatz beschreibt die Konstruktionsmerkmale des Gerätes und gibt einen Überblick über den Weg des Signals durch die verschiedenen Schaltungen bis zur Darstellung der Charakteristik auf dem Bildschirm.

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SOMMARIO DEGLI ARTICOLI PUBBLICATI IN QUESTO NUMERO

VOLTMETRO A VALVOLA TIPO TF 1041C

Si descrive un voltmetro a valvola la cui sensibilità assoluta varia da 300 mV corrente alternata e corrente continua a 300 volts corrente alternata e 1000 volts corrente continua. Le forniture di energia agli scaldaavalvole e alla linea ad alta tensione sono stabilizzate elettronicamente con i metodi più moderni; questo consente una stabilità di lettura di primissima classe per uno strumento di questo tipo.

Pagina 75

CONTATORE ELETTRONICO TIPO TF 1417

L'articolo descrive uno strumento assolutamente nuovo e versatile per la misurazione della frequenza e del tempo; in questo strumento i risultati appaiono su 7 cifre in linea. Lo strumento è di costruzione modulare, ed è completamente transistorizzato. Una nuova caratteristica è data dall'uso di circuiti logici condizionali 'and' e 'or', che fa sì che lo strumento possa facilmente adattarsi al telecomando delle funzioni di principio. La massima intensità di flusso supera i 10 Mc/s e si possono usare misurazioni di tempo brevissimo, di solo 0,2 μ sec. Lo strumento è costruito molto solidamente, ed essendo di piccole dimensioni, si adatta particolarmente all'uso generale di laboratorio.

L'articolo descrive anche un'unità addizionale che fa salire da 10 a 220 Mc/s la gamma di misurazioni di frequenza.

Pagina 80

ANALIZZATORE DI SPECTRO HF TIPO OA 1094A

Nella trasmissione a banda laterale singola è della massima importanza conoscere il grado di successo della soppressione di una banda laterale e dell'effetto delle componenti di intermodulazione. Di grande vantaggio è anche opportuno poter vedere una indicazione di tutte le componenti del segnale nell'ambito della banda di operazione della trasmissione.

L'analizzatore di spettro HF OA 1094A è uno strumento che dà questa possibilità su una gamma di frequenze da 3 a 30 MHz, cioè praticamente al livello della corrente continua, grazie anche al dispositivo addizionale per basse frequenze, TM 6448. La banda totale di segnali che possono venire indicati contemporaneamente va fino a 30 Kc/s e si possono effettuare misurazioni di ampiezza relativa su una gamma di 60 dB. Questo articolo descrive le caratteristiche di progettazione dello strumento, e delinea la traiettoria seguita dal segnale attraverso i vari circuiti, fino al momento in cui appare il risultato sul tubo a raggi catodici.

Pagina 88

RESUMENES DE ARTICULOS QUE APARECEN EN ESTE NUMERO

VOLTIMETRO DE VALVULAS TIPO TF 1041C

Se describe un voltímetro de válvulas con sensibilidades a plena escala que oscilan desde 300 mV en C.A. y C.C. hasta 300 voltios en C.A. y 1000 en C.C. La alimentación de energía a los calentadores de válvula y a la línea de A.T. son estabilizadas electrónicamente con el uso de las técnicas más modernas, consiguiéndose así una estabilidad de lectura de primer orden para un instrumento de esta clase.

Página 75

También se describe una Unidad de Extensión de Gama del Contador, el cual aumenta la gama de medición de frecuencias del Contador desde 10 hasta 220 Mc/s.

Página 80

ANALIZADOR DE ESPECTRO EN A.F. TIPO OA 1094A

En la transmisión de banda lateral única es de especial importancia conocer el éxito de la supresión de una banda lateral y los efectos de las componentes de intermodulación; es también conveniente que pueda observarse una presentación visual de todos los componentes de la señal dentro de la banda de trabajo de la transmisión. El Analizador de Espectro en A.F. es un instrumento que ofrece esta ventaja sobre una gama de frecuencias de 3 a 30 Mc/s, y prácticamente hasta c.c. con la ayuda de la Unidad de Extensión de B.F., TM 6448. La banda total de las señales que pueden presentarse simultáneamente alcanza 30 Kc/s y pueden hacerse mediciones de amplitud relativa sobre una gama de 60 dB. En este artículo se describen las características principales del instrumento y se da un esquema detallado del paso de la señal por los distintos circuitos hasta que la respuesta es presentada en la pantalla del t.r.c.

Página 88

MEDIDOR/CONTADOR DE FRECUENCIA TIPO 1417

En este artículo se describe un equipo de medición de frecuencia y tiempo completamente nuevo y altamente adoptable con lectura de 7 décadas en línea. Su excepcional adaptabilidad se consigue por medio de accesorios que están completamente transistorizados. Una nueva característica es el uso de la lógica de desbloqueo 'y' y 'o', lo que hace que el instrumento sea fácilmente adaptable al control a distancia de las funciones principales. El coeficiente máximo de recuento es mayor que 10 Mc/s y las mediciones de tiempo que pueden emplearse son hasta de 0,2 μ seg. El instrumento es de construcción robusta y su tamaño reducido hace que sea especialmente apropiado para uso general de laboratorio.

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