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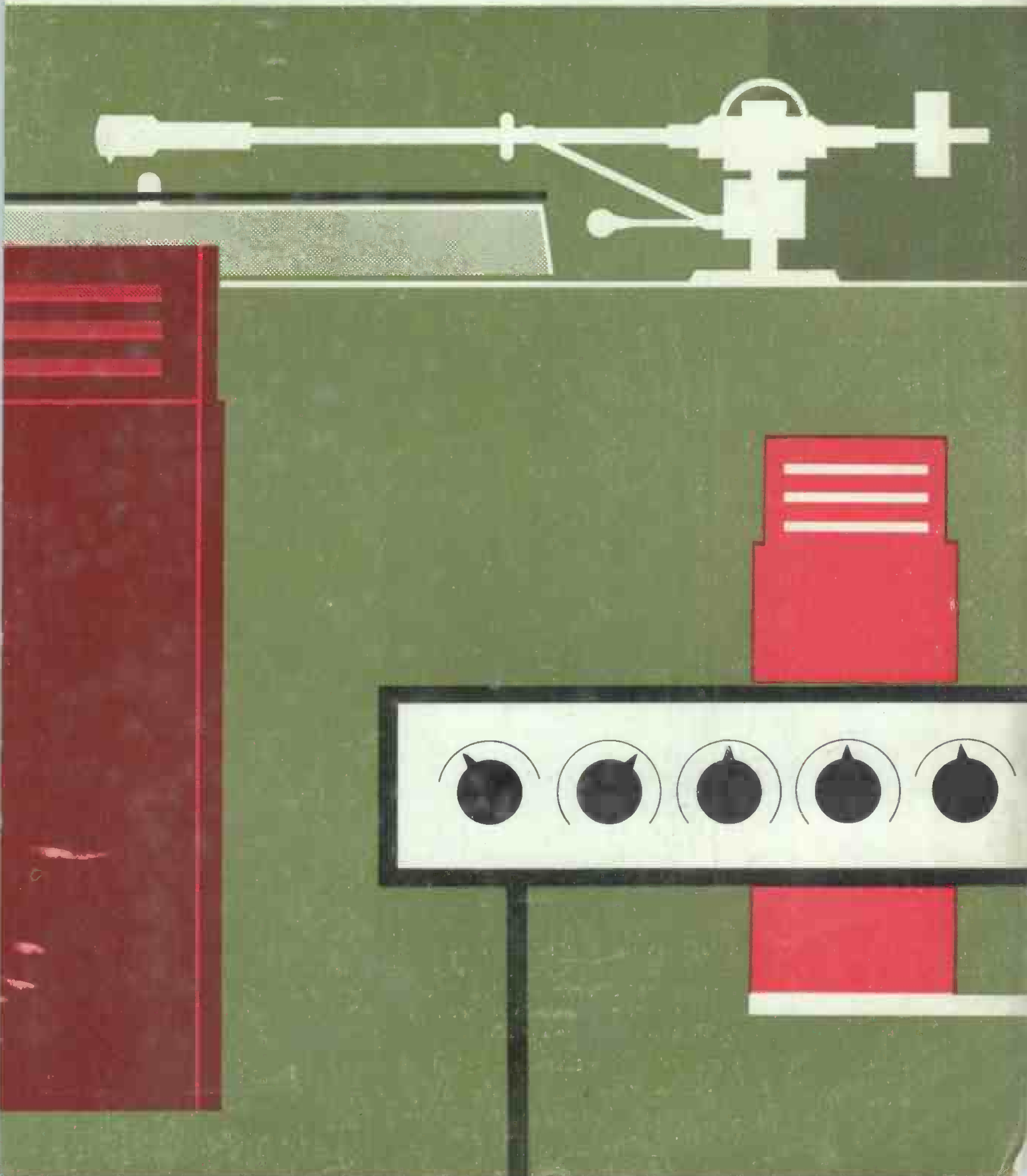

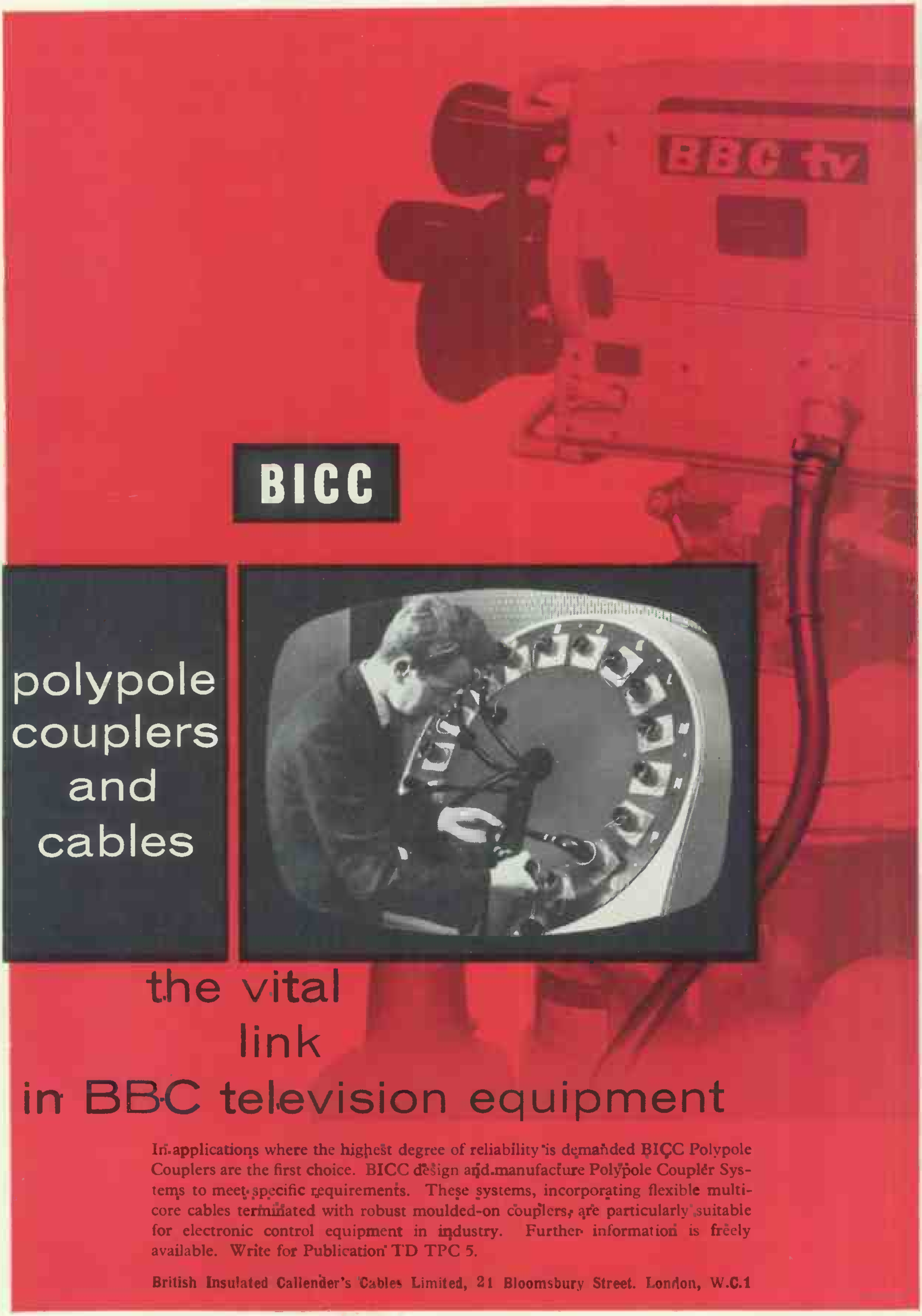
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Wireless World

ELECTRONICS, RADIO, TELEVISION

MAY 1961

Managing Editor:

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Editor:

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Assistant Editor:

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VOLUME 67 No 5.

PRICE: TWO SHILLINGS

FIFTY-FIRST YEAR OF PUBLICATION

Iliffe Electrical Publications Ltd. *Managing Director:* H. S. Pocock, M.I.E.E.

Dorset House, Stamford Street, London, S.E.1

Please address to Editor, Advertisement Manager, or Publisher as appropriate

PUBLISHED MONTHLY (4th Monday of preceding month). *Telephone:* Waterloo 3333 (65 lines). *Telegrams:* "Ethaworld, London-SE1." *Annual Subscriptions: Home and Overseas,* £1 15s. 0d. *Canada and U.S.A.,* $5.00. Second-class mail privileges authorized at New York, N.Y. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 25210. *GLASGOW:* 62, Buchanan Street, C.1. *Telephone:* Central 1265-6. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. NEW YORK OFFICE: *U.S.A.:* 111, Broadway, 6. *Telephone:* Digby 9-1197.

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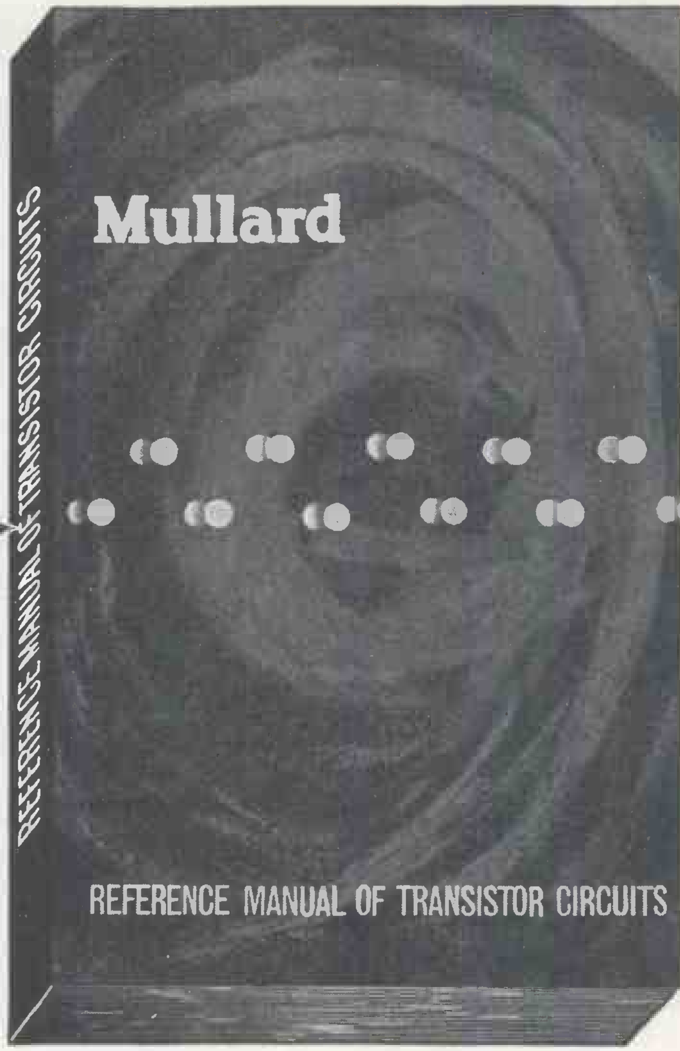

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Recreation in Sound

IN spite of sundry skirmishes behind the scenes between rival factions in the organization it is pleasant to be able to record that the Audio Fair—now renamed the International Audio Festival and Fair—has once again been held in London this Spring, and has drawn the crowds to the point almost of suffocation on four successive days.

Hotels in the off season are ready-made for multiple sound demonstrations, but one could wish that rooms and suites were larger, or that "walk through" arrangements similar to those organized by Leak, Lowther and a few other firms were more general. It is frustrating to have to queue outside a room for a quarter of an hour or more and then to be held captive for a similar period when five minutes would have been sufficient to form a reasonable judgment. Much better to be able to make a quick round of the possibles and still have plenty of time for a second or third visit as one's choice narrows.

It may be objected that the principle of the ever open door would lead to pandemonium and a babel of sound. Not if sound levels are kept to domestic volume and sound traps in the form of L-shaped screens are placed inside each door to act as two-way attenuators—after the fashion of the cowls sometimes fitted to telephone installations in public places. These could be quite simple temporary structures in sound-absorbing material, and need not be expensive. They could be stored flat between exhibitions.

What do people listen for when they go to a demonstration? There must be as many criteria as there are individuals, but broadly one might divide visitors into at least three categories.

First, if only because the noises produced for them are difficult to ignore, are the "hi-fi" enthusiasts. Their preoccupation is with sound for its own sake. The reproducing equipment must be extended to its limits, and if it wilts under the strain by as much as half a decibel or exhibits any signs of a hangover the weakness must be diagnosed and remedied at all costs. This is (one is tempted to say "should be") a solitary pursuit. No two "hi-fi" enthusiasts have ever been found to agree that the job has been properly done, though each may claim that his favourite method has been successful. With success comes satiety, and having exhausted the list of friends who can be enveigled into listening to snatches of larger than life test recordings the pastime begins to pall and the "hi-fi'" enthusiast moves on to tuning sports cars.

Next, one may observe a sprinkling of the intelligentsia, a reserved and contemplative group, more often than not professionally engaged in the recording or broadcasting of sound, competent to apply all known techniques in the design of equipment of the highest quality, but as yet unsure of the scientific criteria by which good sound may be distinguished. Their patient work, mathematical in its precision even when taking into account subjective factors in the listener,* is slowly improving the ratio of science to art in sound reproduction. Their penetrating questions do much to keep firm's technical representatives on their toes. (Is this why some take refuge behind closed doors in the demonstration rooms?)

Finally, the most important group of all, the reasonable layman who wants natural reproduction of music at the lowest possible cost and who is prepared to spend time and effort in coming to a decision as to whether (and if so whose) commercial equipment meets his sense of value, or whether he must take the plunge and find out enough about the technicalities of the subject to assemble an installation which will satisfy his needs.

As our reporter has recorded elsewhere in this issue, this year's Fair has produced no startling innovation; nothing to compare with say, the introduction of stereo records and all the national publicity in width and depth that went with it, and which attracted the public in its thousands to previous exhibitions. Yet attendances this year have been as high as ever; the interest in sound reproduction of a quality not normally purveyed by cheap domestic receivers (or expensive television sets) is now wide and sustained. It is no longer the exclusive cult of the *cognoscenti* but is sought by quite ordinary people, sometimes, one must admit, as a status symbol but more often for the genuine satisfaction which it gives them as a recreation. Like gardening it requires some technical knowledge and some skill and judgment founded on observation and experience; but these having been acquired the rewards are perennial.

* See for example "New Distortion Criteria" by E. R. Wigan, *Electronic Technology*, April and May, 1961.

FIELD EFFECT DEVICES

By DR. A. V. J. MARTIN, A.M.Brit.I.R.E.

PRINCIPLES UNDERLYING THE TECNETRON AND ALCATRON

THE familiar transistor relies on the transit effect of charge carriers, but this is not the only effect which can be used in semiconductors. It is sufficient to recall, for example, the Hall effect which creates a voltage between opposite faces of a semiconductor immersed in a magnetic field, or Peltier effect, used in purely electronic refrigeration systems. Another phenomenon is field effect, which appears when a semiconductor junction is reverse-biased.

Resistance Modulation.—Field effect can be put to work to control the resistance of a slab of semiconductor. For example (Fig. 1), a slab of n-type germanium is submitted longitudinally to a voltage V_1 and a current flows. This slab carries two indium junctions on opposite lateral sides. Now, if a reverse bias V_2 is applied to the junctions, a depletion layer appears as shown in the semiconductor underlying the junctions. The only conducting part of the germanium is the cross-hatched part, which is called the channel. The effect of the depletion layers is to reduce the cross-section of the conducting zone, hence to increase the resistance of the germanium slab, which in turn reduces the current due to V_1. This current can be controlled by modifying V_2. Since V_2 provides almost no current through

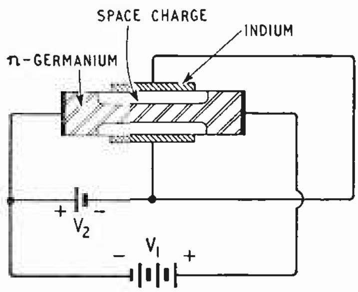


Fig. 1. Resistance modulation by field effect.

the reverse-biased junction, the device gives power gain and behaves as an amplifier. The negative connection to the germanium is the (electron) source electrode S (Fig. 2). The positive contact is the drain D. The control electrodes are the gate G.

Geometry.—The semiconductor slab can be plane and carry two gate electrodes on opposite faces, as has been described. It is in this form that the device was first proposed by W. Shockley, under the name of unipolar transistor[1]. This denomination is due to the fact that the device uses charge carriers of one polarity only, contrary to ordinary transistors which use both electrons and equivalent positive charges or "holes."

Some secondary considerations come into play when practical applications are envisaged [2,3,4]. First, the depletion layer thickness is never large. If efficient resistance modulation is to be obtained, the semiconductor must be very thin between the

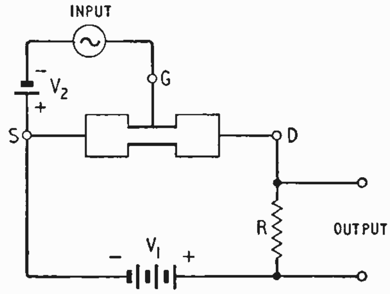


Fig. 2. Tecnetron in amplifying circuit.

gates. A few tens of microns is a common value. Second, the working frequency limit is determined by the time-constant associated with the space charge capacitance, that is, by the time it takes for this capacitance to charge up through the channel resistance. When frequency is too high, the capacitance charge cannot follow variations quickly enough and the device is useless. It can be seen that both considerations dictate small devices. Unfortunately, reducing the dimensions reduces the power-handling ability, since heat produced by the current flowing through the germanium has to be dissipated somehow. This becomes more difficult as the device becomes smaller.

A planar geometry is not the only one which can be utilized. The device can be designed with a symmetry of revolution. For example, rotating the device of Fig. 1 around its longitudinal axis to produce cylindrical symmetry yields the tecnetron. Rotating the same device about an axis passing through the drain yields the alcatron.

Tecnetron

The tecnetron was simultaneously studied by Teszner at the French CNET Laboratories and by the author at Carnegie Tech. in Pittsburgh (U.S.A.) (References 5 to 13). It is made (Fig. 2) of a cylindrical rod of n-type germanium carrying source and drain ohmic contacts on its ends. A groove has been cut in the germanium in which is deposited the indium collar constituting the gate electrode.

V_1 is the drain voltage and V_2 is the gate reverse bias.

The similarity with Fig. 1 is apparent. It can be added that the drain contact is an n+ electrode to avoid injection of unwanted minority carriers (holes). The germanium rod has a progressive, or gradient-type, n-doping.

Representative dimensions would be: length 1 mm, maximum diameter 0.5 mm, gate diameter 50 microns, gate length 100 microns. Average performances of a laboratory sample are summarized here:

Drain voltage	50 V
Drain current	1.5 mA
Gate voltage	−15 V
Transconductance ..	0.1 mA/V
Power rating	0.1 W
Input impedance ..	1 MΩ + 2 pF
Output impedance ..	1 MΩ + 2 pF

Advantages and Drawbacks.—What are the drawbacks? The most important is probably power limitation. When field effect pinches the channel, maximum striction occurs near the drain end. The greater part of the voltage drop occurs across this small length of the channel. The problem is then to remove the resulting heat from this small and inaccessible spot. Thermal qualities of germanium from this point of view are not too good.

There is also the problem of fragility. A germanium filament 100 microns long and 50 microns in diameter does not constitute an example of ruggedness!

Finally, transconductance is low. With unavoidable external parasitic capacitances, the merit coefficient is low and the stage gain is limited.

Advantages, on the other hand, are numerous: small dimensions, high input and output impedances, frequency limit reaching several hundred Mc/s, simple fabrication processes lending themselves easily to automatic production, etc.

Alcatron

The alcatron has been developed by C.S.F. Laboratories in collaboration with CNET (Post Office) laboratories. As has been said before, it is developed, starting with Fig. 1, by rotating the device about an axis passing through the drain.

Practically, an alcatron looks like Fig. 3. It is made essentially of an n-type germanium wafer carrying electrodes. The upper face carries a central anode, and around the periphery of the disc

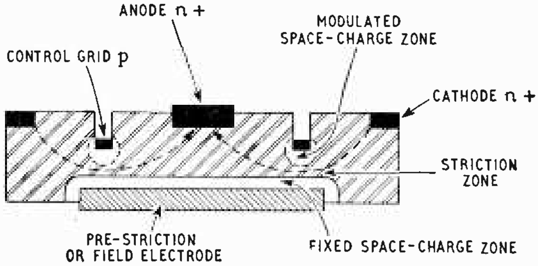


Fig. 3. Cross-section of the alcatron.

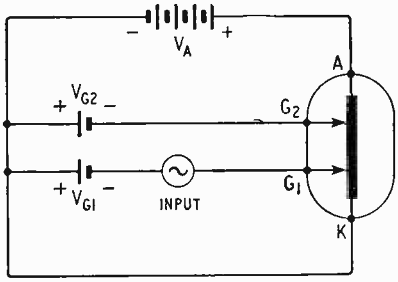


Fig. 4. Symbol and circuit for alcatron.

is a circular cathode. Both anode and cathode contacts are n+ to avoid minority carrier injection. Between cathode and anode, a deep, narrow circular groove has been cut in the wafer. Its bottom receives the indium electrode, producing a p-n junction and constituting the control grid.

Notice the use of the familiar terminology cathode, anode and grid, which is justified in this case.

The lower face carries an auxiliary electrode, made of a large indium p-n junction on the germanium. It is called the field or pre-striction electrode. Its rôle is to produce an initial striction of the channel. It receives a negative bias and creates a depletion layer inside the semiconductor.

The control grid on the upper face receives also a negative bias and produces a depletion layer. The conducting channel appears between the depletion layers due to the two grids. Its cross-section is controlled by varying the voltage of the control grid, thus modulating the flow of current and producing amplification by field effect. The frequency limit is again determined by the resistance and capacitance associated with the control grid. Since the groove is very thin, alcatrons reach 150 Mc/s or more in existing samples.

The power is evidently dependent on the device geometry, which is easily identified with that of a power transistor. The alcatron holds promises of high power at high frequencies, which is welcome news in the realm of semiconductors.

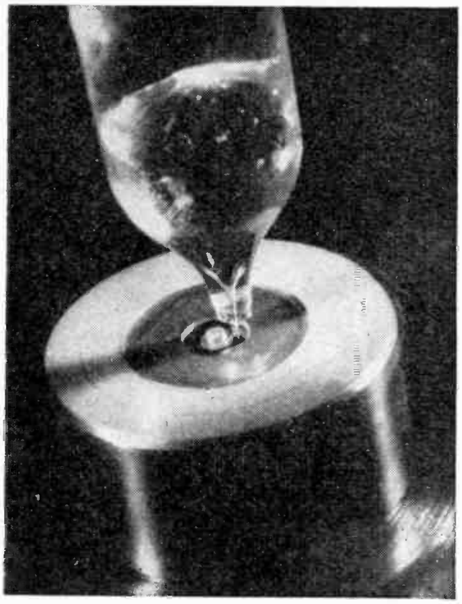
Up to now, development work has been performed on germanium, whose technology is well known. Other semiconductors, with more interesting characteristics, could be used with advantage. Higher charge-carrier mobility and lower resistivity would increase notably the frequency limit and the power rating. Powers of several watts at frequencies of several hundred Mc/s are immediate possibilities.

Characteristics.—Alcatrons are actually tetrode structures. The nearest equivalent in electron valves is probably the beam tetrode.

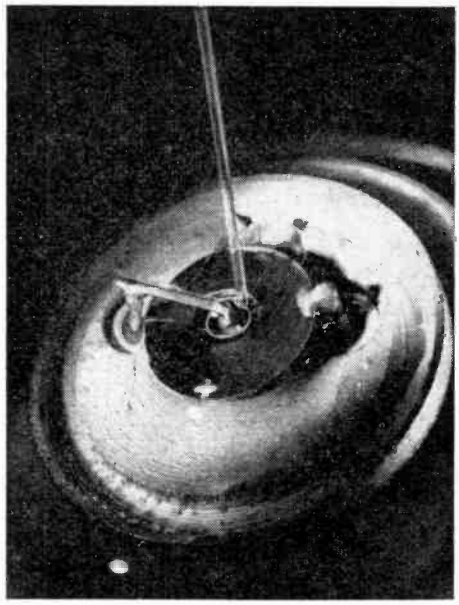
The proposed circuit symbol is given in Fig. 4. It corresponds to the physical device. V_A is the voltage between anode and cathode. V_{G2} is the bias voltage on grid 2, or field-grid. V_{G1} is the fixed bias for grid 1, or control grid, which receives also the input signal.

Anode characteristics resemble that of a pentode valve.

Typical alcatron dimensions would be: cathode diameter, 3 mm; control grid diameter, 2 mm; field grid diameter, 2.5 mm; groove width, 50 microns; groove depth, 50 microns; overall thickness, 200 microns; thickness between grids, 40 microns.



Electrolytic etching of grid groove of alcatron.



Cleaning the alcatron prior to grid connection.

Average performances of a laboratory sample are as follows:

Anode voltage	.. ..	50 V
Anode current	.. ..	100 mA
Field-grid bias	.. ..	−15 V
Control-grid bias	..	−6 V
Transconductance	..	6 mA/V
Power rating	.. ..	6 W (min.)

This sample worked satisfactorily on 120 Mc/s.

Advantages and Drawbacks

Let us first mention some of the more evident drawbacks. Although using well-tried power transistor technology, alcatrons are undoubtedly a complex device as far as production is concerned. Frequency performance, although good, is rather limited with the present state of the art. Also, the large exposed area sets some problems of surface states.

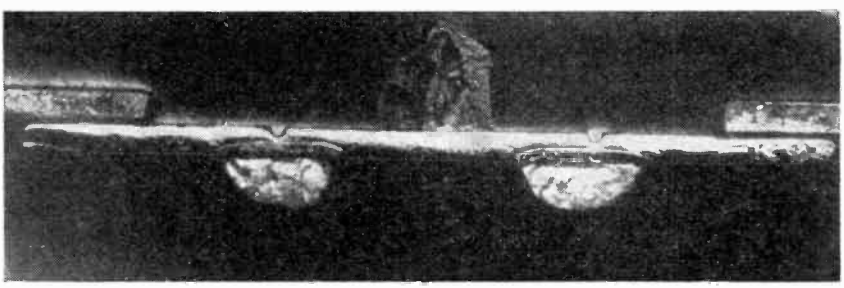
Advantages are no less evident: high power, high transconductance, high input and output impedances, ruggedness.

An auxiliary point is worth mentioning. If the dimensions of the device are increased to increase power handling ability, control grid capacitance evidently increases. However, total channel resistance decreases simultaneously. The paradoxical result is that the control grid time-constant does not change much, so that frequency performance is not much impaired. This is important as far as high powers at high frequencies are concerned.

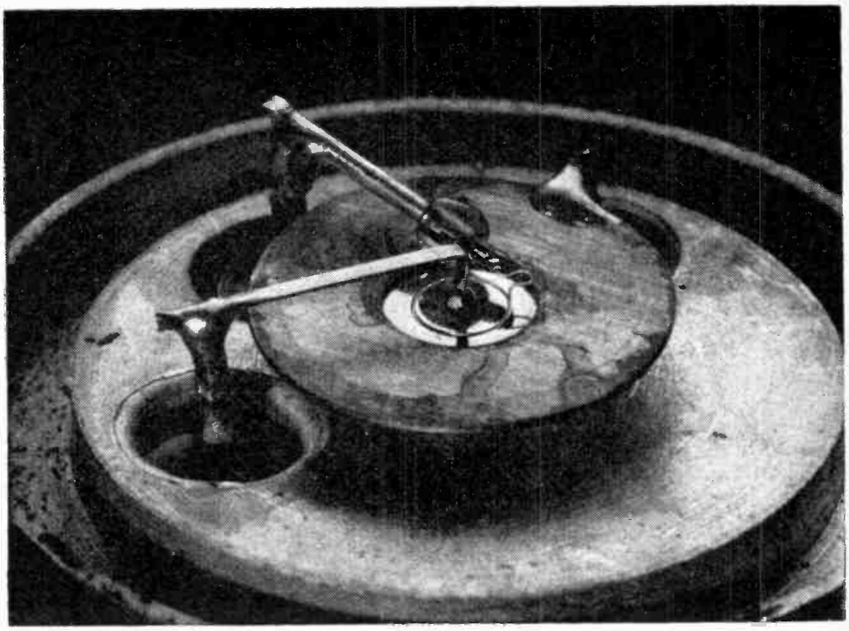
Possible Improvements

Upper frequency limits, it has already been said, can be improved by using a better semi-conductor. For example, using gallium arsenide would multiply by 4 the frequency limit, as a first approximation. (It may be mentioned that commercial production of germanium alcatrons is not planned). Another advantage accruing from the use of gallium arsenide would be a better temperature performance.

Superficial doping of the upper face with diffused arsenic, to a depth of 25 microns, significantly increases performance. This doping produces a superficial layer of n+ material, which reduces the cold resistance of the anode-to-cathode channel from 200 to 15 ohms. In fact, this n+ layer extends the anode and cathode ohmic contacts right to the sides of the grid groove. In so



Photomicrograph of a cut through alcatron. Notice this is an early model, which had an annular field grid instead of a circular field grid.



Completed alcatron. Notice grid connection by spring of gold wire, and large Kovar disc soldered to cathode.

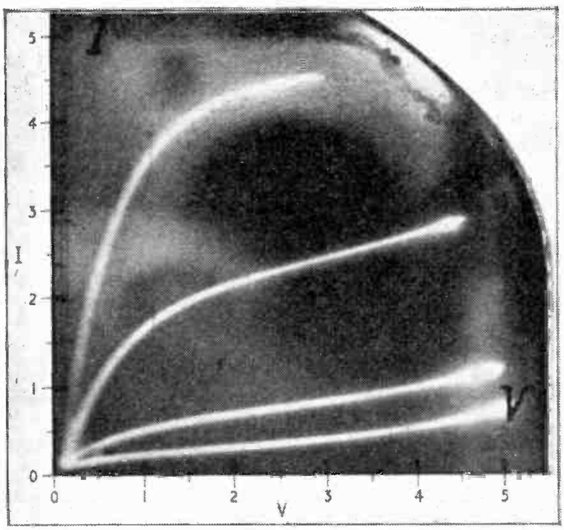
doing, it reduces the total channel resistance, reduces the grid time-constant, and increases the frequency limit. It can be noticed that, with this technology, separate ohmic contacts for anode and cathode are no longer necessary. Their elimination would, of course, simplify production.

Referring now to the photomicrograph showing a cut through the alcatron, it will be remarked that the field-grid is annular. This arrangement was used in development work and has been abandoned in favour of a circular field-grid as shown in Fig. 3.

Two birds are thus killed with one stone. On the one hand, the space charge capacitance charges up also through capacitance to the field grid. This reduces the effective time-constant and improves frequency performances. On the other hand, the field-grid electrode is made of indium, which is a good thermal conductor, and reaches the vicinity of the striction zone. This ensures good heat removal and consequent improvement in power rating, specially when the field-grid electrode is directly soldered to the metal case for heat sinking. This can be done since no r.f. signal is applied to the field electrode.

The device being apparently electrically symmetrical, it may be asked why the central electrode is the anode, and not the cathode. This arrangement has been adopted because experience has shown that it leads to best results. The reason for this is probably to be found in secondary effects, which modify somewhat the distribution of the internal field.

Finally, the circular symmetry makes the alcatron particularly well adaptable to coaxial circuits.



Family of anode characteristic curves for alcatron, displayed on oscilloscope.

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Suppressed-Carrier Double-Sideband

METHODS OF CONTROLLING PHASE OF REINSTATED CARRIERS

FROM time to time one sees references, in American technical literature, to a communications system which is known as d.s.b.s.c. (double-sideband, suppressed carrier). Although some details of this were published nearly four years ago, it appears to be almost unknown in Britain. This is a pity, since an essential part of the d.s.b.s.c. system is a new kind of radio receiver which can be regarded as a synchrodyne with its main limitation (the method of locking the oscillator) removed. As such, it should have applications to normal a.m. reception as well as to single-sideband reception.

In 1956 the American Institute of Radio Engineers held a symposium on single sideband communications systems. At that time s.s.b. was being tried for ground-to-air working and for military purposes. J. P. Costas pointed out that, as a matter of practical politics, the expected increase in usable channels due to the narrower bandwidth requirements of s.s.b. could not always be realized[1]. Serious interference by the nominally suppressed sideband can occur. Suppose, for instance, that an aircraft a few miles from an airfield is transmitting on the channel adjacent to that of a very distant aircraft, and that the distant transmission occupies the same band of frequencies as the *suppressed* sideband of the near transmission. The distant transmission may suffer an attenuation of, say, 60dB more than the near transmission. If the suppressed sideband of the near transmission is attenuated only 50dB (a typical figure in this kind of application) then it will arrive at the airfield at a level of 10dB greater than the distant signal, completely blotting out the latter.

Even if there is not much point in s.s.b. on a bandwidth-saving basis, however, there would seem to be a good case for it on the grounds of power economy. Why transmit all that useless carrier power? Why, indeed! At this point Mr. Costas comes up with an idea that has every appearance of being a winner. Why not transmit *both* sidebands, but no carrier? Each sideband contains useful information; so no power is wasted, and it is far easier to produce a double-sideband suppressed-carrier signal than a single-sideband signal.

Receiving Techniques

The snag—and in the past it has always seemed a very big snag—is in the requirements which have to be met at the receiver. Single-sideband reception is bad enough, since it requires the reinsertion into the signal of a carrier equal, or very nearly equal, in frequency to the original carrier*. To receive a double-sideband suppressed-carrier signal, the locally generated carrier frequency must be *exactly* equal to the original carrier frequency, and, in addition, it must be approximately in phase. Considering that the receiver has not got a sample of the original carrier to use as a yardstick, the position seems hopeless. However, the very exacting nature of these requirements contains the key to their solution. Suppose that by some feat of design and

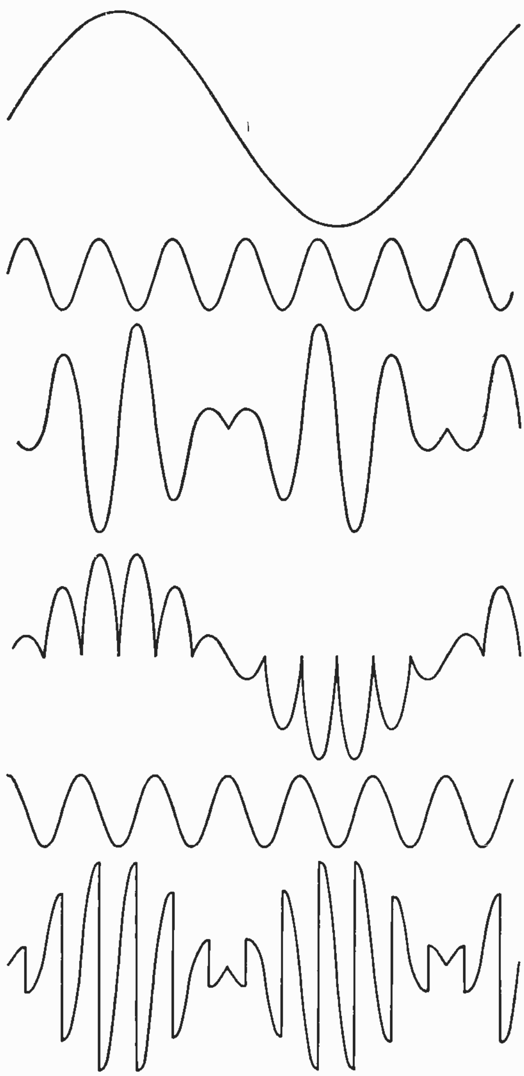


Fig. 1. (a) Audio waveform; (b) carrier; (c) double-sideband suppressed carrier [from (a) and (b)]; (d) output of full-wave phase-sensitive rectifier [from (b) and (c)]. This has an audio component; (e) carrier shifted 90°; (f) output of rectifier derived from (c) and (e). This has no audio component, since successive half-waves sum to zero

* In a superhet receiver the sum or difference of the local oscillator and intermediate frequencies must equal the required carrier frequency.

Systems

By G. W. SHORT

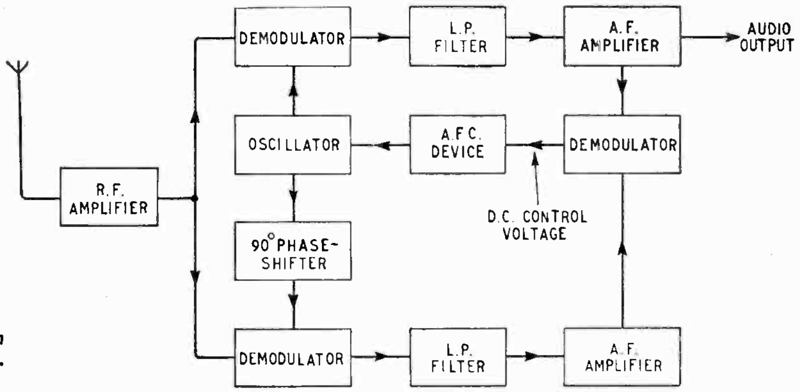


Fig. 2. Block diagram of d.s.b. receiver.

operating skill, the receiver can be made to provide the right carrier frequency and phase. What happens when the frequency starts to drift? The answer is that, as the phase angle between the required carrier and the actual oscillation increases, the audio output decreases, falling to zero at 90° phase difference and then rising to a maximum of 180°, and so on. This is illustrated by the waveforms of Fig. 1, which shows how there is no audio output for the quadrature condition. Now, the phase of the *audio* output reverses as the carrier phase passes through 90°. This provided Mr. Costas with the answer to the problem, for by incorporating an audio-frequency phase detector in the receiver a voltage suitable for automatic frequency control of the oscillator can be produced.

The receiver is shown in block diagram form in Fig. 2. There are two demodulators, supplied with locally generated carriers in phase quadrature. One of these (say the upper one) is in the main channel. If the phase angle between the original and the local carrier supplied to this demodulator is 0°, then the audio output is a maximum. The audio output from the lower demodulator is then zero. If the phase angle changes, owing to frequency drift, the audio output from the main channel is reduced, and an audio output appears in the second channel, its polarity (compared with that of the main channel) depending on whether the phase error is a lag or a lead. These two audio outputs are combined in a third demodulator, which, being "phase sensitive," yields an a.f.c. voltage of the required polarity with a magnitude depending on the phase error.

System Advantages

The beauty of the arrangement, which resembles the synchrodyne, is that the selectivity is independent of the r.f. bandwith. Only the wanted signal gives rise to an intelligible audio output. Other signals give rise to supersonic outputs, if they are remote in frequency, or "monkey chatter" if they are close. In the first case, they can be got rid of entirely by a low-pass filter, and in the second, a low-pass filter will usually reduce the annoyance. As a matter of fact, it is claimed that by combining the audio outputs of the two channels in particular ways with the aid of phasing networks certain types of interference can be reduced even if they yield audio-frequency outputs.

Although this system of reception has been developed, out of necessity, for double-sideband suppressed-carrier working it is not limited to this. Ordinary a.m. signals and s.s.b. signals can also be received.

The only obvious deficiency of the system is the absence of a.g.c. It is not possible to derive an a.g.c. voltage in terms of the carrier amplitude, since, even if the carrier is transmitted, the resulting d.c. output from the demodulator is not passed by the audio stages. It might be possible to obtain a.g.c. from a normal a.m. signal by interposing a modulator in the r.f. part of the receiver (Fig. 3). All signals would then be varied at the modulating frequency, but only the wanted signal would give rise to an audio output at this frequency. A filter could therefore be used to separate the a.g.c. frequency, the filter output signal being amplified and detected. (This scheme was originally suggested by D. G. Tucker[2] as a means of receiving c.w. signals with a synchrodyne.)

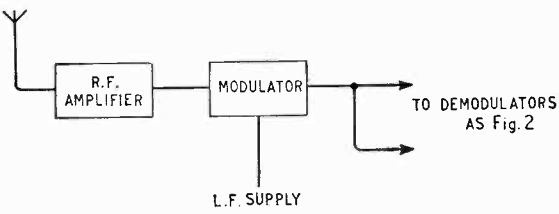


Fig. 3. Auxiliary modulator for a.g.c. system.

Alternatively, the audio output could be rectified and used as a.g.c. This is not ideal in that there is no output during silent intervals. On the other hand, the audio and carrier levels are related in that the maximum peak audio voltage is fixed by the maximum depth of modulation permitted at the transmitter. There seems to be no reason why this "peak possible" audio voltage should not be stored in a capacitor and employed to operate an a.g.c. device.

REFERENCES

[1] Costas, J. P., "Synchronous Communications," *Proc. I.R.E.* Vol 44 Part 2; December 1956, p. 1713.
[2] Tucker, D. G., "The Synchrodyne," *Electronic Engineering*. Vol. 19, November 1947, p. 366.

London Audio Festival

NEW LOUDSPEAKER DEVELOPMENTS

The period since the last audio exhibition held in London would seem to have been occupied by manufacturers in consolidation—we use this term in preference to the possibly derogatory one of marking time.

One new small departure we were glad to note was that two exhibitors—Pamphonic and Chitnis—were issuing questionnaires to find out customers' requirements and preferences.

Loudspeakers.—The main developments since last year were in loudspeakers, but we feel that this was just "how it turned out" and does not necessarily indicate any general trend.

The new Celestion Colaudio II incorporates a patented 12-in bass unit in which the diaphragm is made of "exploded" polystyrene so as to achieve a higher than usual stiffness-to-weight ratio. In this case this has resulted in the virtual elimination of cone breakup up in the useful frequency range. The diaphragm is actu-

Front view of "solid-cone" bass loudspeaker used in Celestion Colaudio II.

ally shaped roughly in the form of a solid rather than the usual hollow cone. However, because the polystyrene from which the cone is made has a low density, the total weight of the solid cone is in fact only about the same as that of an ordinary hollow-cone woofer. Besides the normal suspension at its apex near the voice coil and at its rim, this diaphragm is also suspended (on the outside) about half-way along it by means of a corrugated surround.

The fundamental resonance of this unit is as low as about 10c/s in free air: it can thus be mounted in a small cabinet without producing too high a combined cabinet volume and loudspeaker resonance. In fact, although the volume of the cabinet used is only about 1.8 cu ft, this resonance is raised to only about 40c/s. A 2¼-in pressure-driven tweeter crossing over at about 2kc/s is also incorporated.

A higher than usual stiffness-to-weight ratio can also be achieved by making the diaphragm in sandwich form with a light filler between denser skins, as described by D. A. Barlow in our December 1958 issue. In the production version of a Leak 13-in bass unit made according to this principle, the sandwich filler is ⅜-in thick expanded polystyrene, and this is backed on both sides by 0.001in thick aluminium. The whole unit is conventionally cone shaped, but here the sandwich construction has resulted in a stiffness-to-weight ratio at least 200 times that obtainable with conventional cones. This virtually eliminates cone breakup up in the useful frequency range. Cabinet resonances are damped from Q's of about 40 to 6 by gluing ½-in thick bituminous felt to the walls. A 3-in tweeter crossing over at 1kc/s is also incorporated.

One of the problems in the design of coaxial double-cone loudspeakers is the elimination of resonances of the free edge of the inner cone. In a new Wharfedale 12-in unit—the 12/RS/DD—these rim resonances are damped by attaching the inner cone rim to the main outer cone by a ⅜in wide band of polyether. This band also absorbs the sound produced from that part of the main cone which lies behind the inner cone: this sound can cause interference effects in the region of mechanical crossover between the two cones.

Circumferential ribs have long been used to strengthen loudspeaker cones. Lowther, however, have preferred to use irregularly-placed nearly radial ribs—which look somewhat like the spokes of a bicycle which has been in a collision!

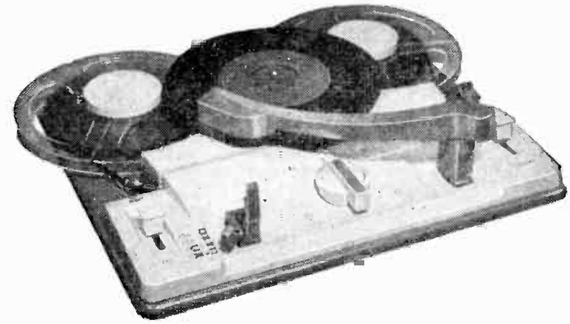
Amplifiers and Pre-amplifiers.—More transistorized units were seen this year. Pre-amplifiers included a Wellington Acoustic Laboratories unit compensated for use with tape heads but which could also be used with the compensation removed, as well as a Lowther uncompensated 8:1 step-up unit for low-level pickups. One the power amplifier side, completely transformerless units were introduced by Lowther and Pye.

Radford have recently introduced a range of valve power amplifiers which are characterized by being unconditionally stable under any load conditions and by having stability margins as high as 25dB with resistive loads. In the "ultra-linear" output transformer anti-resonant notches of rapid phase shift caused by cross coupling between the anode and screen windings are reduced by winding the sections with unequal sizes. An unusual feature of the associated pre-amplifiers is that the maximum filter slope is deliberately made only 12dB/octave because the designer considers that the "ringing" produced by higher slopes can introduce more noise than is removed.

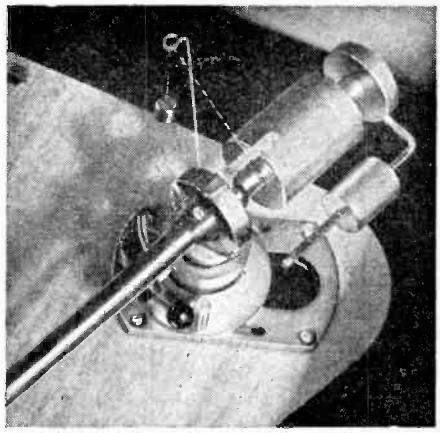
Aveley Electric were showing American Dynaco amplifiers and other circuits for use with their output and mains toroidal transformers. A toroidal construction offers a number of advantages: the stray fields are less, the single-piece core and better utilization of grain-oriented core material gives reduced distortion and increased power at low frequencies, and the increase in the fraction of the core length which can be covered with windings results in reduced leakage capacities and high-frequency coupling effects.

A new triode-pentode introduced by Mullard—the ECL86—by comparison with their well-known ECL82 offers an increase in overall sensitivity by a factor of 3 and an increase in output power from 3.4 to 4W.

Tape Recorders.—A new two-speed, three-headed, four-track deck developed by the Gramophone Co. and used by them as well as by Wyndsor in new recorders, is very unusual in that both tape and records can be played simultaneously by making use of an additional pickup kit. Basically this facility has been provided simply by extending the capstan motor spindle at both ends and driving the tape with one end and the record turntable with the other, using a conventional two-stepped pulley and rubber idler drive in both cases. The heavy record turntable is actually



Gramophone Company's "Voicemaster" tape deck shown with its additional pickup kit playing a record.



Pivot end of S.M.E. pickup arm showing offset counterweight for providing sideways balance for the head offset, as well as weight pulling device for counteracting side thrust.

under the deck, the record itself being carried on a three-pronged support.

A professional transistorized battery portable tape recorder was shown by Casian. At the single speed used ($7\frac{1}{2}$in/sec) the total wow and flutter is stated to be <0.2%, the signal to noise ratio >55dB and the frequency response within 1dB from 30c/s to 12kc/s.

Unusual models and features in the range of Japanese Sony tape recorders shown by Tellux include the incorporation of a three-transistor radio in their Model 362, partial transistorization of their Model 101 and a professional spring-driven model.

An unusual feature of the Veritone "Sixteen" two-track recorder is that one tract can be recorded from the other (in the same direction) with, if required, additional material. To do this one half of a stereo head is used to record the signal replayed from the other half. By using the two halves of a stereo head rather than spaced separate heads, exact synchronism is obtained between the two recordings.

A new type of single-transistor sine-wave oscillator suitable for use in erase circuits has been developed by M.S.S. This gives an efficiency >75% so that, for example, 1W output can be obtained from an OC72.

Tape Accessories.—Semi-automatic splicers which besides providing the diagonal cut also longitudinally trim the tape edges around the cut by means of two slightly-curved blades (producing a waisted effect) were shown by Wilmex and Cine Accessories.

A head demagnetizer (WAL D-Mag) which was originally developed for erasing short lengths of sound film was introduced by Wellington Acoustic Laboratories. Instead of a single probe two are used, connected to opposite ends of a cylindrical coil and core. The demagnetizing field is, of course, produced between the probes.

Microphones.—In the new S.T.C. Type 4108 condenser microphone a cardioid response is obtained by altering the phase of the sound impinging on one side of the diaphragm by passing it through a small block of compressed polystyrene granules. The valve head pre-amplifier is followed by a transistor impedance step down and buffer stage.

The new Lustraphone DRA66 incorporates an improved balanced-armature construction in which an extra "tail" attached to the armature vibrates in a very confined air space so as to damp the whole movement and reduce the distortion.

Grampian showed a 24-in diameter parabolic reflector for focusing distant sounds on to a microphone. This can provide an increase in microphone sensitivity of about 14dB and has a directivity of 10° for 5dB down.

Pickups and Arms.—In the S.M.E. arm lateral and vertical movements (about intersecting axes) are provided by pairs of precision ball races and knife edges respectively so as to keep the equivalent frictional forces produced at the stylus down to as low as about 0.02gm. The tubular arm is damped internally with a fibre-wood insert, and the counterweight elastically decoupled. Part of the counterweight can be moved longitudinally and also laterally to provide a sideways counterbalance for the head offset. A recently-introduced accessory for this arm is a weight which acts via a fine thread on a lever attached to the arm so as to counteract the side thrust produced by stylus friction and head offset. A somewhat similar device was described by H. J. F. Crabbe in our May 1960 issue.

In stereo pickups in which two flexible arms transmit (by pushing) the stylus movements to the transducers, it might be expected that minimum crosstalk would be obtained by making the angle between the flexible arms a right angle, to correspond to the angle between the two cutting directions. In practice, however, a somewhat smaller angle may be preferable, and in two high-compliance crystal pickups shown by Collel angles of about 65° were used.

A simple pressure gauge introduced by Cosmocord consisted of a long brass strip spring fixed at one end and with the other end free and carrying a stylus support. The deflection of the free end provides a measure of the stylus force in the range 0 to 15gm.

Records.—The new Philharmonic records are unusual in being pressed from vinyl in powder rather than the usual solid form. In this process lower pressures are used so that there is less risk of damaging the complex groove structure. Blue or red rather than the normal black colouring dye is added to the vinyl. This makes the records semi-transparent and thus allows flaws in them to be more easily detected. The coloured dyes are somewhat more soluble in the vinyl than the normal black dye and this more easily-obtained dispersion allows a low surface noise to be more readily achieved.

Receivers.—An unusual feature of the Armstrong Stereo 12 Mark 2 combined a.m./f.m. tuner and 2×8W push-pull amplifier is that the second a.m. i.f. amplifier uses a triode operated in Class A. This avoids the modulation rise and consequent distortion produced by the normally-used variable-μ valves.

Features of the new Quad a.m. tuner are the use of an r.f. stage and provision of a 9kc/s bridged-T whistle filter as well as of variable selectivity.

Transistor receivers shown by Denham and Morley included one covering the short waves down to 13 metres and also an a.m./f.m. set. The Japanese Sony 12-transistor a.m./f.m. portable was shown by Tellux.

Elements of Electronic Circuits

25.—Using Delay Lines

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M.Brit.I.R.E.

LAST month we dealt with the characteristics of delay lines and mentioned some of their applications, one of which was the production of rectangular pulses. As well as providing very precise pulses, delay lines can be built to handle great powers, so that they are frequently used for the production of the "h.t." for the transmitters of pulsed radar systems, where a peak of several megawatts may be needed for the production of the r.f. pulse.

Generation of Rectangular Pulses

An important application of the delay line is the production of rectangular pulses of voltage or current, by terminating the applied voltage or current after a fixed time interval.

First of all let us refer to Fig. 1. A constant-voltage generator having an e.m.f. v_o (this is the open-circuit voltage, not to be confused with potential

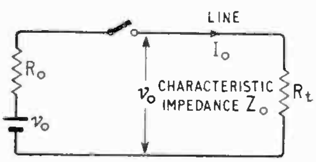


Fig. 1.

difference) is suddenly applied to the line when the switch is closed. A voltage "step" travels down the line, which draws a constant charging current from the supply. As the generator output impedance is made equal to the line impedance the voltage which is impressed on the line is $v_o/2$. The value of the constant charging current is therefore $v_o/2Z_o$. The voltage step eventually reaches the end of the line and sets up a potential difference across the terminating impedance R_t. Now if the terminating impedance is equal to the characteristic impedance of the line ($R_t = Z_o$) the energy in the wave is completely absorbed in the termination, the line behaves as if it

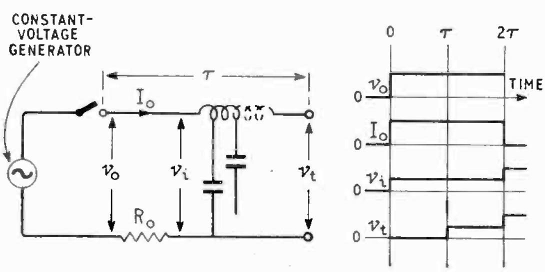


Fig. 2.

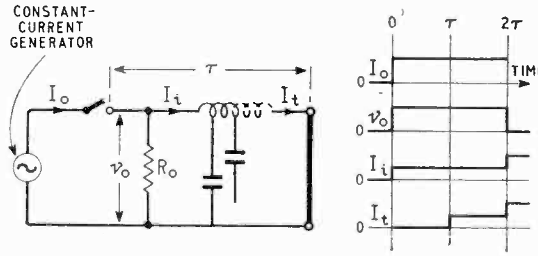


Fig. 3.

were infinitely long and there is no reflection from the end.

If the terminating resistor does not match the line impedance, then the travelling wave is not completely absorbed and dissipated in the resistor.

When R_t is greater than Z_o the voltage developed across the termination impedance is greater than the applied voltage; similarly if R_t is less than Z_o the current through the terminating impedance is greater than the current which flows in the travelling wave. In both cases a wave of either voltage or current is reflected back to the sending end taking twice the delay time τ of the line to re-appear. The limiting conditions occur when the remote end of the line is either, as in Fig. 2, open circuit ($R_t = \infty$), or as in Fig. 3, short circuit ($R_t = 0$).

Open-circuited Line.—With no terminating impedance ($R_t = \infty$) and nowhere for the energy to be dissipated, the voltage wave is reflected from the end of the line without any alteration in phase. The line continues to be charged at the same rate by the returning voltage step. When the step reaches the input (which is matched to the line) all the energy contained in the wave is absorbed in the input impedance so there is no longer a charging current and I_o falls to zero.

Short-circuited Line.—Here a constant-current source, represented by a high-impedance generator, is applied to a line which is short-circuited at its far end ($R_t = 0$). The current divides equally at the matched input to the line: a voltage v_o is developed across the input and a current represented by I_i proceeds to charge the line. When the current step reaches the short-circuited end, it is reflected in phase. On its return to the sending end it produces a voltage across the input impedance in opposition to v_o and equal to it; v_o therefore drops to zero.

Summarising, we have an open-circuited line with a constant-voltage source producing a current pulse equal in duration to twice the length of the delay line. Alternatively the line, short-circuited and fed from a constant-current source, can produce a voltage pulse of the same length. A suitable low-impedance voltage generator is the thyratron or some form of triggered spark-gap while a pentode can be used as the high-impedance current generator.

Repetition of Pulses

It is often necessary to generate pulses for use as time markers. These pulses may be required to have the same sign as the input or to be inverted in phase, and delay lines with appropriate terminating impedances are nearly always used for this purpose, for example:—

(a) To generate one pulse all we require to do is to terminate the line in its characteristic impedance Z_o.

(b) Equally spaced pulses may be obtained by terminating both ends of the line with high impedances. Due to the mismatch, the pulse will be reflected from both ends, suffering attenuation during each excursion.

(c) If we require our equally spaced pulses to be inverted on each excursion it is necessary to make one of the terminating impedances less than Z_o but greater than zero.

Attenuation during each excursion is often undesirable, especially when we require continuous trains of waves. "Topping-up" of energy can be effected by making the reflected pulse trigger a circuit such as a blocking oscillator.

Pulse-forming Networks for Modulators

Transmitting valves in pulse radar systems are caused to generate r.f. pulses lasting for a short time (usually between one tenth and ten microseconds). The unit which governs the pulsing of the oscillator is called the modulator and it also controls the duration of the output pulse. It is usual for the pulse-forming network in the modulator circuit to carry the whole of the pulse energy which is discharged into the oscillator in series with the modulator "switch," which may be a valve or spark-gap. The network is charged from an h.t. source in the intervals between pulses, we are therefore concerned with the main problem of charging

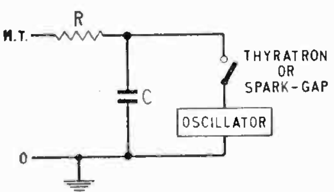


Fig. 4.

the network and causing it to discharge as and when required. First let us examine the simplest form of modulator circuit (Fig. 4). The switch is a gas-filled triode or thyratron which maintains conduction at a much lower voltage than its striking voltage.

Initially the triode is not conducting and C charges via a large resistor R. When the triode is caused to strike by application of a trigger waveform, C discharges through the oscillator until the potential is insufficient to maintain ionization in the valve: the cycle then recommences. It will be noted that in this simple form of circuit the discharge pulse across the oscillator is exponential. If however we now replace C by an open-ended delay line (Fig. 5) a rectangular pulse can be obtained.

The series inductors of the delay line (which has n sections) have little effect on the charging time constant (which is nCRsec.) because this period is usually very long compared with the transmitted pulse. When the gas triode conducts the line discharges through the oscillator. The more sections there are comprising the line, the more nearly

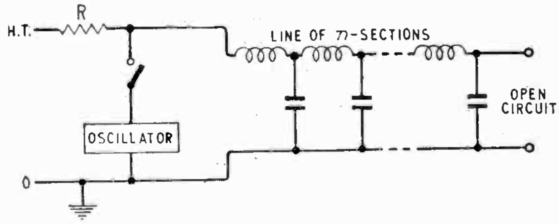


Fig. 5.

rectangular is the pulse which energizes the oscillator for $2n\sqrt{(LC)}$sec.

Various improvements of this circuit will be encountered, for example, the replacement of the resistor R by a charging choke. The effective charging circuit is now a series resonant L-C circuit which is shock-excited into oscillation by the application of the h.t. voltage. If the gas triode can be arranged to conduct after each half period of oscillation ($\pi\sqrt{(n\text{LC})}$ sec.) then the amplitude of the output pulse which energizes the oscillator will equal the supply voltage. A diode, known as a "hold-off" diode, is often inserted between the charging choke and line. This ensures that if the pulse recurrence period is greater than $\pi\sqrt{(n\text{LC})}$ the charging current cannot reverse, and the line voltage is maintained constant at its maximum value. It should be noted that the line must be capable of withstanding twice the supply voltage, as the voltage across both choke and capacitor of a series-resonant circuit is twice that of the supply. Not surprisingly, the charging of the delay line by this method is called "resonant charging."

An alternative method known as "symmetrical charging" is often preferred. In this case the line is not subjected to a charge of twice the supply voltage, as the excursion of this voltage across the line is arranged to swing equally above and below zero.

Finally it may be noted that although it is easier to understand the charging of the line from a d.c. source; a.c. can be used, provided that the supply frequency is kept constant within close limits. A.C. charging has many advantages, e.g., the absence of high voltage rectifier and smoothing circuits—consequently the modulator is much lighter in weight. The recurrence frequency (p.r.f.) is, however, tied to the supply. In many cases this is not a disadvantage because, as with the frame- or field-scan speed in television, locking to the supply-frequency allows less stringent specification to be adopted for smoothing throughout the system.

WORLD OF WIRELESS

Tape Recording Copyright

ONE of the consequences of a legal battle between GEMA (the German copyright society representing composers, authors and music publishers) and tape recorder manufacturers was that advertisements for tape recorders in West Germany must carry a note stating that the recording of copyright music is forbidden unless written permission has been granted by GEMA. As only a few owners of tape recorders have voluntarily paid fees to the society it has now demanded a flat payment of 5% of the list price of every tape recorder sold to cover copyright fees.

Manufacturers have, however, declined to pay the fees. GEMA claim that German gramophone record production has declined due to the fact that more and more broadcast receiver owners make their own tape records of broadcast popular music.

Technical Writing Awards

THE 1960 winners are announced by the Electronic Engineering Association and the Radio Industry Council of the six 25-guinea premiums awarded for technical articles "likely to enhance the reputation of the industry and focus attention . . . on Britain's leadership in radio, television and electronics." The panel of judges under the chairmanship of H. E. F. Taylor who succeeded the late Air Marshal Sir Raymund G. Hart, comprised Professor H. E. M. Barlow, B. C. Brookes, A. H. Cooper, F. Jeffrey, G. Reeves and Dr. R. C. G. Williams.

There is a growing interest in the scheme, introduced by the R.I.C. in 1952, and last year 93 articles were submitted compared with 63 the year before.

The 1960 prize-winners are:—

A. E. Crawford (Brush Crystal Co.), "Piezoelectric Voltage Transformers," *Wireless World.*

Dr. G. L. Grisdale and D. A. Paynter (Marconi's W/T), "A Tropospheric Scatter Link Over a 200-mile Path," *Point-to-Point Telecommunications.*

D. L. Swale (Decca Radar), "Integrated Electro-mechanical Design as Applied to Electronic Equipment," *British Communications and Electronics.*

C. M. Cade (Kelvin & Hughes), "Infra-red Radar Surveillance and Communications," *British Communications and Electronics.*

E. N. Rowlands (Central Middlesex Hospital) and H. S. Wolff (National Inst. of Medical Research), "The Radio Pill," *British Communications and Electronics.*

P. L. Owen, M. F. Partridge and T. R. H. Sizer (R.A.E.), "The Differential Analyser and its Realization in Digital Form," *Electronic Engineering.*

Commonwealth Technical Training

AT the suggestion of the Duke of Edinburgh a Commonwealth Technical Training Week is being held from May 29th. Its aim is, to quote H.R.H., "to draw attention to the very wide range of apprentice schemes and technical training programmes which are open to bright and ambitious young people." Most education authorities in the U.K. are participating. At the Royal Exchange, London, the City and Guilds of London Institute is staging an exhibition to illustrate the training and educational opportunities in industry, commerce and the professions. A special service is being held at St. Paul's Cathedral on June 1st.

Component Production

THE year's total of 2,650M components (approximately 10M each day of a five-day week) is recorded in the 28th annual report of the Radio and Electronic Component Manufacturers' Federation covering 1960. This output, an all-time record valued at £130M, is an increase of more than 10% on the previous year's figure despite the recession in the sale of domestic television equipment.

The total value of the 1960 exports of components and associated products (audio equipment and test instruments) was £26.4M which was an increase of approximately 17%. The U.S.A. again headed the list of buyer countries with purchases valued at £4.8M, with Australia next (£2.1M) followed by Canada (£1.8M) and India (£1.2M). China was the leading buyer of British test-gear in 1960 taking a total worth £186,000.

Multi-standard TV Gear

TO facilitate contributions to Eurovision and the making of video-tape recordings for use in other countries, without standards conversion, the five new mobile control units ordered from Pye by the B.B.C. are capable of operating on the 625- and 525-line standards as well as on 405 lines.

These mobile control units are each fitted with four Pye 4½in image-orthicon camera channels. Power consumption and heat dissipation from the equipment will be minimized by the use of transistors wherever possible. An innovation is that the vision mixer control panel will be detachable and can be operated when required up to 300 feet from the main equipment. Each camera will be capable of operation with up to 2,000 feet of cable. Production facilities will include electronic "wipe," permitting parts of two pictures to be transmitted simultaneously.

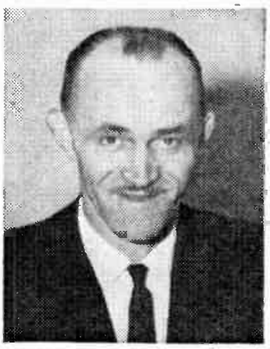
Communications Satellites

FRANCE, the U.K. and the U.S.A. are to co-operate in a programme of trans-Atlantic tests of communications satellites. Ground stations are to be built in England and France for the reception and transmission of telephone, telegraph and television signals across the Atlantic using satellites to be launched by the U.S. during 1962 and 1963.

The first project, Relay, will utilize a low-altitude active repeater satellite scheduled to be launched in 1962. The second, Rebound, will involve the placing of several inflated spheres in orbit. The first launch to orbit three spheres is scheduled for 1963.

Northern Nigeria—Heads of agreement to provide television and sound broadcasting in Northern Nigeria have been signed by the Northern Nigerian Radio Corporation, E.M.I. Electronics and the Granada Group. A new company is being formed, in which the Radio Corporation—a government body—will operate in partnership with E.M.I. and Granada. A television centre and studios will be built in Kaduna, the capital of the Northern Region, and there will be two linked transmitters—one to cover Kaduna and Zaria and the other in Kano. All transmitting and studio equipment for both television and sound broadcasting, is to be supplied and installed by E.M.I.

New A.T.V. Studios.—Opened on 7th April by Dr. Charles Hill, A.T.V.'s new Studio Centre at Elstree, Herts, covers some 340,000 sq ft and cost £4M. At present Studios C and D are in operation and, together with Studios A and B—to be completed shortly —the total studio floor area available will be 32,000 sq ft. Equipment includes five cameras (Pye) (using $4\frac{1}{2}$-in English Electric image-orthicon tubes) and "push-button" lighting control with automatic dimming and "memory" (Strand Electric) so that a given plot can be returned to. All the vision chain equipment can operate on 405-, 525- and 625-line standards: transistors and semiconductor diodes have been used widely in the mixing and distribution equipment which has been designed and made by A.T.V. staff.



P. A. Fleming

Closer liaison between U.S. and U.K. valve and tube makers may be expected from a conference recently held in Syracuse, New York, by the Joint Electron Device Engineering Council of the Electronic Industries Association of America. British manufacturers of valves, cathode-ray tubes and semiconductors were represented at the conference by P. A. Fleming, the technical secretary of B.V.A. and V.A.S.C.A.

V.A.S.C.A.—Following the retirement of G. A. Marriott, who was the first president and chairman of the Electronic Valve and Semi-Conductor Manufacturers' Association (V.A.S.C.A.), S. S. Eriks, O.B.E. (managing director of Mullard), has been elected president and chairman of the Council with C. A. W. Harmer, O.B.E. (a director of Pye), as chairman of the Association and also of the general management committee.

B.V.A.—The new vice-chairman of the British Radio Valve Manufacturers' Association in succession to G. A. Marriott is, J. Bell, managing director of the M.O. Valve Company.

Receiving Licences.—During February the number of combined television-sound licences throughout the U.K. increased by 38,023 bringing the total to 11,186,486. Sound-only licences totalled 3,940,859, including 468,806 for sets fitted in cars, giving an overall total of 15,127,327.

Technical Writing.—A course of six lectures on "Some Problems of Technical Writing" will be given at the Borough Polytechnic, Borough Road, London, S.E.1, at 7.0 on Wednesdays from April 26th. The fee is £1.

Dubilier.—It is regretted that some figures were dropped from Dubilier's advertisement, page 107, of the April issue. It was a **1961** capacitor that was compared with a 1930 condenser.

"Multivibrator Design"—a correction. On pages 221 and 222 of the April issue, Figs. 2 and 3 (but not their captions) should be interchanged.

R.E.C.M.F.—The new president of the Radio and Electronic Component Manufacturers' Federation, in succession to E. M. Lee, is Arthur Bulgin, and the vice-presidents, H. V. Slade (Garrard) and K. G. Smith (N.S.F.). The member firms and, in parentheses, their representatives elected to the council for 1961-62 are: Belling & Lee (N. Dundas Bryce), A. F. Bulgin & Co. (R. A. Bulgin), A. H. Hunt (S. H. Brewell), Multicore Solders (R. Arbib), Painton & Co. (C. M. Benham), Plessey Co. (J. A. Clark), Standard Telephones & Cables (L. T. Hinton), Telcon Metals (Dr. G. A. V. Sowter) and Bakelite (G. J. Taylor). The new chairman of the council is Dr. G. A. V. Sowter.

Radio Amateurs' Exam.—The City & Guilds report on the 1960 Radio Amateurs' Examination records a decline in the percentage of passes compared with the previous two years. Of the 1,274 candidates in 1960 only 55% passed compared with 60% of the 1,102 in 1959 and 72% of 716 in 1958. It is reported that the majority of failures were the result of a general inadequacy in all questions attempted.

Jack Binns, the first ship's wireless operator to demonstrate the value of radio in saving life at sea, who died in New York in December 1959, had requested that the citations and medals awarded to him commemorating the occasion in 1909 when he was instrumental in the saving of all the passengers on board the two vessels (*Republic* and *Florida*), should be presented to Peterborough, his home town. The presentation was made on April 11th on behalf of his widow by R. Ferguson, managing director of the Marconi International Marine Company, with whom Jack Binns was an operator from 1905 to 1912.

Back Numbers.—A reader has for disposal copies of *Wireless World* from April 1913 to November 1917. Anyone interested in acquiring these should write to L. Mawer c/o the Editor.

Secondary Radar.—The Ministry of Aviation has announced that secondary surveillance radar will be introduced shortly to serve the Southern Air Traffic Control Centre. It is intended that this service, experimental at first, should become part of the normal operational facilities in the United Kingdom, together with such other stations as are necessary to cover other U.K. air-space areas.

School TV.—The use of closed-circuit television to link two schools in an area to facilitate the teaching of special subjects was recently demonstrated by Pye in Hayes and Harlington, Middlesex. The schools are two miles apart and were linked by radio. An advantage voiced by some of the pupils in a science class was that experiments can be seen much more clearly on the 27-inch monitors than under normal class-room conditions.

OBITUARY

Since preparing the obituary notices on page 251, we regret to learn of the recent death, at the age of 70, of **Walter S. Barrell**, who had been associated with the recording industry for over 35 years. He retired at the age of 67, from the position of technical liaison officer of the E.M.I. group's recording activities. He was previously manager of E.M.I. Studios, for 10 years. Mr. Barrell joined the Columbia Graphophone Company in 1925 where he became chief engineer of the recording studios, a position he continued to hold after the merger in 1931 of Columbia and H.M.V. to form E.M.I. It was about this time that Blumlein developed a system of stereophony and Barrell co-operated with him in producing some of the earliest stereo records. He was elected president of the B.S.R.A. in 1948 and an honorary member of the Audio Engineering Society of America in 1956.

Personalities

Professor Harold E. M. Barlow, Ph.D., B.Sc.(Eng.), M.I.E.E., Dean of the Faculty of Engineering, and Pender Professor of Electrical Engineering and Director of Laboratories in the University of London, has been elected a Fellow of the Royal Society "for his work on engineering aspects of microwaves, particularly waveguides and semi-conductors." Professor Barlow, who has been a member of the Editorial Advisory Board of our sister journal *Electronic Technology* since 1956, is also on the panel of judges of the Technical Writing Scheme sponsored by the Radio Industry Council and the Electronic Engineering Association. He has also served on the Radio Research Board of the D.S.I.R. for some years.

E. Allard, B.Sc., A.M.I.E.E., has been appointed acting general manager of Associated Transistors, Ltd., following the resignation of **Dr. C. B. Mepham.** Mr. Allard is assistant to the general manager of the English Electric Valve Company. The English Electric Co. is one of the three which jointly own Associated Transistors; the others are A.T.E. and Ericsson Telephones.

H. B. Dent has retired from the editorial staff of *Wireless World* which he joined in 1927. His wide knowledge enabled him to contribute to all sides of editorial work but his particular interest was in short waves and he has been an active amateur transmitter (G2MC) for many years. Towards the end of the first World War he transferred from the Army to the Royal Flying Corps for special radio duties. After demobilization he spent a few years in Yugoslavia and then joined Igranic Electric from which he came to *Wireless World.* He was commissioned in the R.A.F.V.R. early in 1939 and was posted to Fighter Command HQ in August of that year and was closely associated with the operation of the radar chain and fighter control. In September 1941, he went to the Directorate of Communications Development in the Ministry of Aircraft Production. From August 1943 until he returned to *Wireless World* in 1945, Wing Commander Dent was in the Air Ministry Directorate of Signals.

H. B. Dent

Dr. A. C. Robb

A. C. Robb, M.Eng., Ph.D., A.M.I.E.E., has been appointed technical manager of Belling & Lee Ltd. Dr. Robb graduated at Liverpool University, and obtained a masters' degree for post-graduate work. Subsequently he was awarded a research fellowship at Glasgow University to work on the design of high-voltage particle accelerators, and gained his Ph.D. for related studies.

A. B. Howe, O.B.E., M.Sc., M.I.E.E., who retired some months ago from his position as assistant head of the B.B.C. Research Department, is now employed in a consultative capacity by the Independent Television Authority. He is a special assistant to the chief engineer and is concerned mainly with both the national and international aspects of the planning of a television service. He was a representative of the I.T.A. at the C.C.I.R. meeting of experts recently held in Cannes in preparation for the European Broadcasting Conference to be held in Stockholm from 26th May which he will also attend.

A. B. Howe

C. H. Colborn, B.Sc., M.I.E.E., has retired from the B.B.C. Engineering Division after 37 years' service. He is succeeded as head of the Television Studio Section of the Planning and Installation Department, by **D. R. Morse,** A.M.I.E.E. Mr. Colborn joined the B.B.C. as a maintenance engineer at Cardiff. In 1926 he transferred to London to do development work and after service with the Research and Equipment Departments he became head of the Low Frequency Section of the Station Design and Installation Department, as it then was, in 1941. He has been in charge of the Television Studio Section since 1949 and has been responsible for the technical installations at all B.B.C. television studios, including the new London Television Centre. Mr. Morse joined the B.B.C. in 1947 as an engineer in the London Control Room and transferred to the Designs Department in 1949. He has been head of the Film Unit of the Television Section of the Planning and Installation Department since 1956.

D. N. H. Lambert, B.Sc.(Eng.), A.M.I.E.E., has been appointed resident engineer of the B.B.C. Far Eastern Station, Singapore, in succession to **R. J. Keir,** O.B.E., B.Sc., A.M.I.E.E., who has completed his term of duty. Mr. Lambert joined the Operations and Maintenance Department of the B.B.C. in 1934 and transferred to the Research Department the following year. He returned to the Operations and Maintenance Department in 1946 and became assistant engineer-in-charge of the Burghead transmitting station in 1951. He was seconded as chief broadcasting engineer to Radio Belize, British Honduras, in 1955 and since his return to the United Kingdom in 1958 has been engineer-in-charge of the Clevedon transmitting station. The new engineer-in-charge at Clevedon is **V. A. E. Hember,** who joined the B.B.C. in 1940. He has been senior maintenance engineer at Brookmans Park since 1952.

Other B.B.C. appointments include: **K. G. Nicholas,** who becomes engineer-in-charge of the television studio at Southampton, and **E. S. Ahl,** A.M.Brit.I.R.E., who has been in charge of the Penmon and Llanddona sound transmitting stations since 1958 and now becomes engineer-in-charge also of the Bangor studios in succession to **S. Hett** who is retiring after 37 years' service with the Corporation.

Dr. A. V. J. Martin, A.M.Brit.I.R.E., editor of our Paris contemporary *Electronique et Automatisme,* writes in this issue on field effect and its applications. After 10 years in journalism first as editor-in-chief of the French journal *Television* and later of *La Radio Professionnelle,* Dr. Martin went to the United States in 1956 where he was for three years assistant professor of electronics at the Carnegie Institute of Technology, Pittsburgh. He returned to France in 1959. Dr. Martin, who received his doctorate (sciences) from the University of Paris in 1956, served in the R.A.F. during the last war and was for a year teaching at an R.A.F. radio school. He is 39.

W. A. C. Maskell, B.Sc.(Eng.), M.I.E.E., Sen.M.I.R.E., general manager of The General Electric Company's Telecommunications Group at Coventry since 1959, has been appointed managing director of the Group. Mr. Maskell, who is 55 and is a graduate of London University, joined the Coventry Telephone Works of G.E.C. as a post-graduate apprentice in 1925. Three years later he became an equipment designer in the Radio Development Laboratory. In 1942 he became chief engineer to the G.E.C. war-time factories at Bradford. He returned to London in 1946 to become deputy manager of the Radio Department at the company's headquarters and five years later went to Coventry as general manager of the Radio Works.

W. A. C. Maskell

OBITUARY

The Rt. Hon. **Sir Walter Womersley,** Bt., president of the Relay Services Association of Great Britain since 1948, died on March 15th at the age of 83. Sir Walter was from 1935 to 1939 Assistant Postmaster-General.

W. Witt Burnham, whose association with radio dates back to the days before broadcasting, died on April 3rd aged 80. He founded the firm of Burnham and Company, of Deptford, from which grew the original Burndept Company. As managing director of Burndept he was one of the original directors of the British Broadcasting Company. He later joined Edison Swan, where he was manager of the Radio Division when he retired 20 years ago. He was for many years chairman of the Radio Manufacturers' Association and also of the British Radio Valve Manufacturers' Association.

Gerald Marcuse, the internationally well-known radio amateur, died on April 6th. He was 73. Gerald Marcuse was an honorary member of the R.S.G.B. of which he was president in 1929-30 and was one of the founder vice-presidents of the International Amateur Radio Union. He will be remembered by "old-timers" as a pioneer in Empire broadcasting, for in 1928 he set up a studio at his home from which he regularly broadcast over G2NM programmes to overseas listeners.

F. W. Endicott, who as Scottish Engineer was responsible for the engineering services of the B.B.C.'s sound and television studios and outside broadcasting units in Scotland, died on March 21st aged 60. He joined the Corporation in 1929 as an assistant in the technical correspondence section at Broadcasting House.

E. A. Taylor, sales director of Belling and Lee, died on March 19th at the age of 53 after a long illness. He joined the company in 1932.

News from Industry

A.E.G.—The 1959/60 turnover of Allgemeine Elektricitäts Gesellschaft and its subsidiaries in which it has a majority holding was DM 2,497M. This was an increase of 16% over the previous year's figure. Exports accounted for 24% of the group's total turnover. The net profit for the year amounted to DM 43.5M. Telefunken, the capital of which was recently raised to DM 125M, and Ludw. Loewe & Co., are wholly owned subsidiaries of A.E.G.

Marconi's W/T Company and Wilcox Electric Company Inc., of Kansas City, Missouri, have signed an agreement for collaboration in the field of airborne radio and radar equipment. It covers the full interchange of design, engineering and production information and includes the manufacture and sale by either firm of equipment designed by the other. The Wilcox company is one of the two companies who have received development contracts for air traffic control transponders from the U.S. Federal Aviation Agency.

Ekco Electronics Ltd. has granted a 10-year contract to Wilcox Electric Company, Inc., of Kansas City, to produce airborne weather radar equipment under licence in the U.S.A.

Griffiths Electronic Guns Ltd. has been set up jointly by Griffiths Electronics Inc., of the U.S.A., and the Sam Carpenter Group of Companies in this country, to manufacture at Bray, County Wicklow, Eire, magnetic and electrostatic guns for cathode-ray tubes. The factory's initial production is at the rate of 10,000 guns per week, and these are mainly for Cathode Ray Tubes Ltd., another of the Carpenter companies. Production will later be increased to meet anticipated demands from the Continent and Commonwealth countries.

J. E. Dallas and Sons have been acquired from Keith Prowse by G. S. Lee, chairman and managing director of Lee Products. Keith Prowse acquired a 51% holding in Dallas about two years ago. Mr. Lee is now chairman of the company in succession to Mr. P. E. Cadbury who has resigned.

Multisignals Ltd., opened on March 28th its first wired television system in Wales—at Cwmbran New Town, Monmouthshire. The company was formed in 1959 with the backing of Thorn, Ekco, Ultra, Anglia TV and the Granada Group, to provide through the co-operation of local dealers a sound and TV distribution service. E.M.I. Electronics Ltd. supplied the equipment for the Welsh distribution system which provides three TV programmes (B.B.C., Television Wales & the West, and Westward TV), the three B.B.C. sound programmes on v.h.f., and Radio Luxembourg also distributed on v.h.f.

Closed-circuit television, both monochrome and colour, links the new *Daily Mirror* headquarters in Holborn, London, with one of its subsidiaries in Farringdon Street, a quarter of a mile away. The Marconi equipment has been installed to enable documents etc. to be seen by executives without wasting time travelling between offices. Similarly the recently opened branch of Coutt's Bank in Lombard Street, London, has been equipped by E.M.I. Electronics with closed-circuit television linking the ledger room with various administrative offices.

Racal have supplied two of their RA17 communications receivers with l.f. convertors and an s.s.b. adaptor to the R.A.F. Frequency Measuring and Monitoring Station at Stoke Hammond, Bucks, where all R.A.F. transmitters are constantly checked for frequency accuracy. A Racal SA21B digital frequency meter is used in conjunction with the radio equipment for direct reading of the measured frequencies.

Decca River Radar, Type 215, has been fitted in *Fireflair*, a 66-ft fire-float which is based near Gravesend for service in the lower reaches of the Thames and the Thames Estuary. It will enable the vessel to answer emergency calls more rapidly in all conditions of visibility. Decca also announce that they have received an order for harbour radar for the River Medway. The installation includes three 16-in radar displays and Pye v.h.f. communications equipment.

EXPORTS

Decca are to supply their Type 424 airfield control radar to the Portuguese Air Force. To meet mobility requirements the radar will be mounted on a trailer which will also incorporate Ekco C.R.D.F. and Pye v.h.f. equipment.

Surveillance Radar.—Marconi's are to supply a second S232/2 50cm radar to the Centre d'Essais en Vol, the French counterpart of our Royal Aircraft Establishment. It will be installed at Istres. This latest version of the S232 series can be used simultaneously for long-range surveillance and for close-control of aircraft.

E.M.I. recording equipment has recently been supplied to the Rumanian record industry. Each of the two recording suites supplied includes the new 10-way mono-stereo mixing control console. The consoles record stereo by the established spaced-microphone method or can be adapted to employ the E.M.I. "sum and difference" technique. Ten TR90 stereo tape-recording consoles, dubbing-mixing consoles, disc replay units, monitor speakers and other equipment are included in the order.

Marconi television equipment has been installed at Ottawa—the third Canadian commercial station to be supplied by Marconi's. The equipment includes a 4-kW Band III vision transmitter, an 18-kW vision amplifier, and a 9-kW sound transmitter. The aerial and ancillary equipment has also been supplied. The amplifier incorporates patented "anti-ghost" circuits to avoid the effects of snow and ice on the aerial. Marconi's are also supplying a further seventeen Mark IV television cameras to Radio Italiana Televisione. The new cameras will be installed in the Rome and Naples studios and will be used for the second television service scheduled to commence later this year.

Pye have been awarded a contract worth £40,000 for instrument landing and v.h.f. ground-to-air communication equipment to be used at the Schoenefeldt airfield in East Germany. The landing system employs a directional localizer and stabilized glide path.

Cossor packset, series CC.3, v.h.f. portable transmitter-receivers, have been ordered for the Rhodesian police. The instrument, which weighs only 5 lb, employs transistors and features a built-in speaker/microphone and power supply.

MAY MEETINGS

Tickets are required for some meetings; readers are advised, therefore, to communicate with the secretary of the society concerned.

LONDON

1st. I.E.E.—"Progress report on the development of a photo-electric beam index colour television tube and system" by R. Graham, J. W. H. Justice and J. K. Oxenham at 5.30 at Savoy Place, W.C.2.

3rd. Brit.I.R.E.—Symposium on "Computer control of air traffic" at 3.0 at the London School of Hygiene, Keppel Street, W.C.1.

5th. I.E.E.—Discussion on "Artificial muscles" opened by Dr. A. B. Kinnear Wilson at 6.0 at Savoy Place, W.C.2.

8th. I.E.E.—"The corona-discharge and its application to voltage stabilization" by E. Cohen and Dr. R. O. Jenkins; "Impedance frequency characteristics of glow-discharge reference tubes" by Dr. F. A. Benson and P. M. Chalmers; and "Comparison of argon, krypton and xenon as admixtures in neon glow-discharge reference tubes" by Dr. F. A. Benson and G. P. Burdett at 5.30 at Savoy Place, W.C.2.

12th. I.E.E.—Discussion on "The place of transistors in national certificate courses" opened by B. F. Gray and W. B. K. Ellis at 6.0 at Savoy Place, W.C.2.

12th. Institute of Navigation.—"Airborne weather radar" by Capt. R. C. Alabaster and P. L. Stride at 5.15 at the Royal Geographical Society, 1, Kensington Gore, S.W.7.

12th. British Interplanetary Society.—Symposium on "Communication satellites" from 10.0 to 5.0 at the Federation of British Industries, 21 Tothill Street, S.W.1.

15th. I.E.E.—Six papers on the banana tube colour television display system at 5.30 at Savoy Place, W.C.2.

15th. I.E.E. Graduate and Student Section.—Annual General Meeting followed by "The experimental investigation of space" by Dr. P. J. Bowen at 6.30 at Savoy Place, W.C.2.

17th. I.E.E.—"Air traffic control" by Dr. E. Eastwood and Dr. B. J. O'Kane at 5.30 at Savoy Place, W.C.2.

17th. Brit.I.R.E.—Discussion on "Television wireless distribution" at 6.0 at the London School of Hygiene, Keppel Street, W.C.1.

18th. I.E.E.—Annual General Meeting followed at 6.30 by "Experimental investigation of space" by J. A. Ratcliffe at Savoy Place, W.C.2.

19th. Institution of Electronics.—"Aerial techniques" by C. F. Whitbread at 7.0 at the London School of Hygiene, Keppel Street, W.C.1.

ARBORFIELD

1st. I.E.E. Graduate and Student Section.—"Aural properties of spaced loudspeaker systems" by J. B. Helder at 7.0 at the Unit Cinema, 3 (Tels.) Training Bn., R.E.M.E.

BIRMINGHAM

1st. I.E.E.—"Silicon power rectifiers" by A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams at 6.30 at the James Watt Memorial Institute.

17th. Television Society.—"Tomorrow's television" by D. C. Birkinshaw at 7.0 in the New Physics Lecture Theatre, University of Birmingham.

18th. Institution of Electronics.—"Tunnel diode circuit applications" by I. Aleksander at 7.0 in the Byng Kenrick Suite, New College of Technology, Gosta Green.

FARNBOROUGH

2nd. I.E.E.—"The potentialities of artificial earth satellites for radio communication" by W. J. Bray at 6.15 at Farnborough Technical College, Boundary Road.

16th. Brit.I.R.E.—Annual General Meeting of the Southern Section followed by "Electronic techniques in the measurement of acoustic noise" by K. R. McLachlan at 7.0 at Farnborough Technical College.

LEICESTER

15th. Television Society.—"The Neveye vidicon camera" by N. S. Rutherford at 7.30 at the College of Technology and Commerce.

MANCHESTER

18th. Society of Instrument Technology.—Annual general meeting of Manchester Section followed by "The thermocouple" by Dr. A. W. Foster at 6.45 at the Nags Head, Jacksons Row.

PRESTON

3rd. I.E.E.—Annual general meeting of the N. Lancashire Sub-Centre followed by "Electronic aids to banking and commerce" by Dr. R. Feinberg at 7.30 at the N.W.E.B. Demonstration Theatre, Friargate.

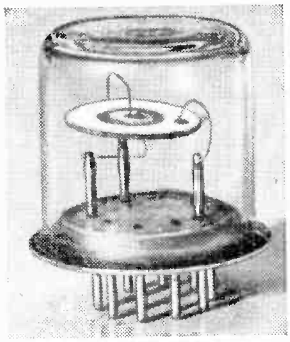
SHEFFIELD

17th. I.E.E.—Annual general meeting of Sheffield Sub-Centre followed by "Progress in permanent magnet material" by J. E. Gould at 6.30 at the Grand Hotel.

Ceramic I.F. Transformers

USE IN TRANSISTOR RADIO RECEIVERS

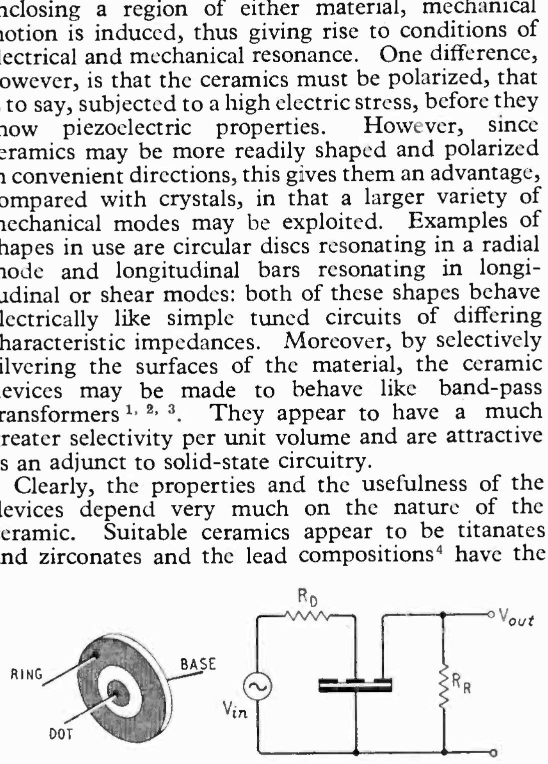
By R. C. V. MACARIO*, Ph.D.



Experimental radial-mode resonator made by Plessey.

THE behaviour of piezoelectric ceramics is similar in many respects to that of piezoelectric crystals. When a voltage is applied across electrodes enclosing a region of either material, mechanical motion is induced, thus giving rise to conditions of electrical and mechanical resonance. One difference, however, is that the ceramics must be polarized, that is to say, subjected to a high electric stress, before they show piezoelectric properties. However, since ceramics may be more readily shaped and polarized in convenient directions, this gives them an advantage, compared with crystals, in that a larger variety of mechanical modes may be exploited. Examples of shapes in use are circular discs resonating in a radial mode and longitudinal bars resonating in longitudinal or shear modes: both of these shapes behave electrically like simple tuned circuits of differing characteristic impedances. Moreover, by selectively silvering the surfaces of the material, the ceramic devices may be made to behave like band-pass transformers [1, 2, 3]. They appear to have a much greater selectivity per unit volume and are attractive as an adjunct to solid-state circuitry.

Clearly, the properties and the usefulness of the devices depend very much on the nature of the ceramic. Suitable ceramics appear to be titanates and zirconates and the lead compositions[4] have the desirable property of strong piezoelectric coefficients which are stable with time and temperature.



(a) (b)

Fig. 1 (a) Construction of a ceramic i.f. transformer. (b) Circuit for measuring the response of a ceramic i.f. transformer.

On the other hand, other properties of the devices are independent of the exact composition of the ceramic, but are pertinent to all types. The most important of these properties is that a given structure can resonate at several frequencies. The other frequencies correspond either to harmonics of a particular mode or to other modes. Frequencies higher than the fundamental response of a particular mode are referred to as overtones, or tones[5], and they can be very troublesome in band-pass amplifiers. Also, the amplifier circuit loads the resonators and thus the choice of ceramic and structure is not only a function of its piezoelectric properties but also of the amplifier arrangement.

This article discusses the principles underlying the use of the radial mode resonator[1, 2] as an interstage filter network and a replacement for i.f. transformers in broadcast radio receivers. A description of the resonator is given from the viewpoint of its circuit properties and the article is concluded with an illustration of a design for a standard receiver.

Description of the Radial-Mode Resonator.—The photograph shows an experimental radial-mode resonator displayed at the Physical Society's Exhibition, 1960. The component consists essentially of a thin disc of ceramic, polarized in the axial direction, and having a divided silvered surface on one side and a completely silvered surface on the other. The inner area of the divided surface forms the *dot* electrode, the outer the *ring* electrode, whilst the undivided surface is known as the *base* electrode. With an input signal applied between the dot and base, say, an output signal is observed between the ring and base electrodes. The signal is transferred from input to output by the mechanical coupling between the inner and outer regions of the disc and the electromechanical properties of the ceramic material. The response is a maximum when the dimensions of the disc are so that it is mechanically resonant at the frequency of the input signal. Because different electrode areas have different electromechanical coupling with the motion of the disc, an impedance transformation results and we arrive at the concept of a ceramic i.f. transformer. Fig. 1 illustrates the details of the device and the type of circuit by means of which the response may be investigated. For the connection shown the response is a series resonance, but the shape or selectivity of the response curve depends both on the ceramic itself and on the load across each pair of electrodes. The response, together with the transformer action, is very similar to that of a wound i.f. transformer, but clearly, if the ceramic device is to

* Now at IBM British Laboratories (formerly at The Plessey Co., Ltd.)

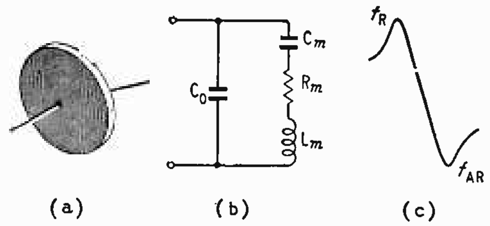


Fig. 2 (a) Uniformly silvered disc basic resonator. (b) Equivalent circuit of the basic resonator of Fig. 2 (a). (c) Voltage/frequency response of the basic resonator of Fig. 2(a).

compete with the wound component in all respects, it must respond to exact design.

Basic Resonator.—The approach used is to develop a design equation for the ceramic counterpart by extending the equivalent circuit of a uniformly silvered disc. We call this the basic resonator and the response about resonance of this two-terminal device is shown in Fig. 2 together with the equivalent circuit which very nearly describes the response. The characteristics are very similar to those of a quartz crystal, but resonance is less sharp, indicating a much lower mechanical Q-factor. The values of the components of the equivalent circuit can be readily measured, and use is made of these values in the design of the concentric-ring transformer.

The radial mode is used because of its relative freedom from spurious responses, and because the overtone frequencies are farthest apart[1]. To gain an idea of the dimensions and frequencies involved, Table I gives typical values for two sizes of disc[6],

TABLE I

Resonant Mode		f_R kc/s	Radius cm	C_0 pF	Δf kc/s	C_m pF	R_m Ω
Overtone Disc	Fundamental	180	0.611	1290	12.0	178	17
	1st overtone	465	0.611	1290	4.15	23	50
Fundamental disc	Fundamental	465	0.236	194	31.0	26	43

both 0.8mm thick, composed of a ceramic with the following properties:—

Electromagnetic coupling coefficient, k_R = 40%
Dielectric constant, ϵ = 1000
Mechanical Q-factor, Q_m = 300
Radial mode frequency factor (fundamental frequency × radius), f_R = 110 kc/s-mm

Here, $\Delta f = f_{AR} - f_R$, where f_R and f_{AR} are the resonant and anti-resonant frequencies respectively, indicated in Fig. 2. A more detailed description of the derivation of these values and their variation with ceramic composition is given elsewhere[3]. The important parameters of the ceramic are k_R, Q_m and ϵ; Table I shows typical values, but wide variations are possible[4].

From Table I it will be seen that the first overtone frequency is some 2.5 times higher than the fundamental. In practice, however, because of the small dimensions that are involved in the preparation of the electrodes of a fundamental 465 kc/s resonator, 465 kc/s overtone resonators are preferred. A second overtone then appears some 1.5 times above this frequency. However, this is in general a much weaker response[1] and the main problem is that of eliminating the fundamental resonance in the i.f. amplifier. This is considered below.

Before leaving the basic resonator, however, it is worthwhile noting that in certain instances it may be used to increase selectivity, but usually at the expense of a few decibels of gain.

Equivalent Circuit.— Fig. 3 shows an equivalent circuit that quite closely describes the behaviour of the three-terminal resonator of Fig. 1. The series-resonant components with the subscript 'm' are the equivalent mechanical components described in Fig. 2, whilst R_D, C_D and R_R, C_R refer to the dot and ring loads and electrode capacitances respectively. The two transformers of turns ratios n_1 and n_2 are introduced to take into account the partial coupling of the loads into the mechanical circuit. Both depend on the mode of resonance and the placement of the silvered electrodes.

It can be shown that the working Q of the device, called Q_W, at the centre frequency f_0 in a circuit such as Fig. 1 is given approximately by

$$Q_W = \frac{2\pi f_0 R_D C_0^2}{C_m F(N)} \quad .. \quad .. \quad (1)$$

In this equation $f_0 \approx f_R$ and R_D is the load across the dot electrode which is correctly matched to a load R_R across the ring electrode by a disc having electrode areas in the ratio 1 : N. Clearly $N = C_R/C_D$, whilst the matching ratio is given by

$$\frac{R_D}{R_R} = \frac{n_1^2}{n_2^2} N \quad .. \quad .. \quad (2)$$

The values of n_1 and n_2 can be measured and hence equation (2) solved. C_0 is the total electrode capacitance and

$$C_0 = C_D + C_R \quad .. \quad .. \quad (3)$$

F(N) is a function which depends on the position of the electrodes, the ratio of their areas, and the extent of the silvering. Even so for a typical overtone disc F(N) is very nearly equal to unity, which leads to a simple design equation. Thus Q_W depends merely on the working load and on the ratio of the inter-electrode capacitance to the equivalent mechanical capacitance. The latter ratio depends on the radial electromagnetic coupling coefficient k_R which increases as C_m/C_0 increases. Thus, summarizing conveniently,

$$\text{Working Bandwidth} \propto \frac{\text{Ceramic Coupling Coefficient}}{\text{Load} \times \text{Electrode Capacitance}}$$

The mechanical Q_m does not enter into the expression provided it is high. Moreover, for a given ceramic and resistive load, we are able to vary the working Q_W by adding external capacitances. Also we note

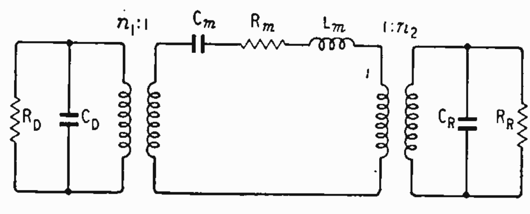


Fig. 3. Equivalent circuit of a ceramic i.f. transformer.

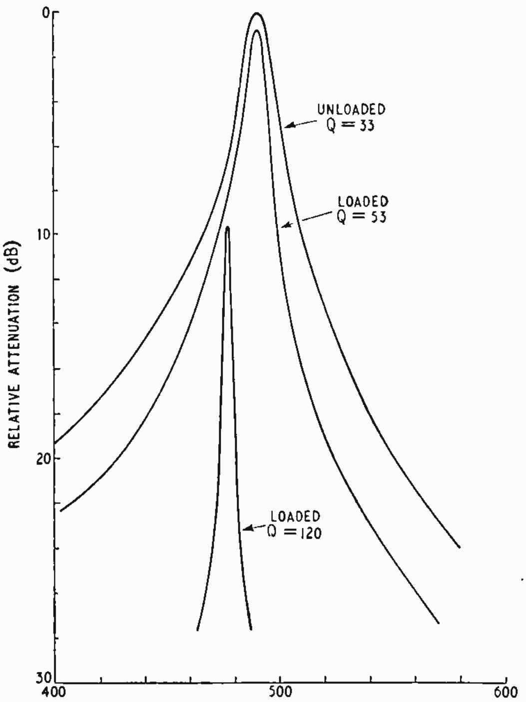


Fig. 4. Measured response curves for a single ceramic i.f. transformer with various external capacitive loads.

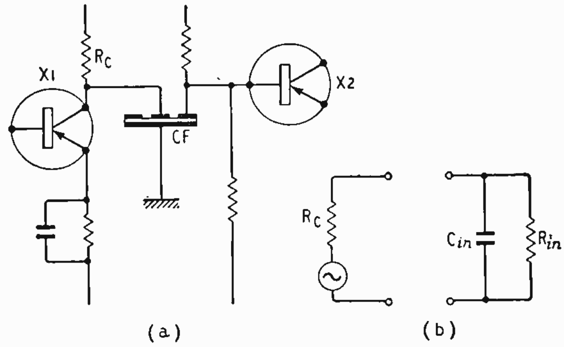


Fig. 5 (a). Connection of a ceramic i.f. transformer in a transistor amplifier. (b) Effective dot and ring loads in the circuit of Fig. 5 (a).

there is no limit on the value of R_D provided that $2\pi f_0 R_D C_D > 1$.

Fig. 4 shows some measured response curves for a single disc with various external capacitive loads. Q_W calculated from Equation (1) was 27, compared to the measured Q_W of 30 with the disc not loaded.

Practical I.F. Amplifier Design.—The ceramic i.f. transformer is utilized in a practical amplifier circuit in the manner shown in Fig. 5. As there is no d.c. path through the device it may be connected directly between the collector and base of successive transistors (or other components) but, in order to supply the current to the driving transistor without losing the signal, a resistive feed must be included in the collector circuit [1, 2]. This clearly has disadvantages as well as advantages. It is seen that the arrangement is identical with Fig. 1 but with the loads indicated in Fig. 5.

Practical values of the collector load R_C are limited by the transistor current to $< 10\text{k}\Omega$. This is usually less than the transistor output impedance and hence $R_D \approx R_C$. The load on the ring electrode is that of the base of the succeeding transistor, R_{in} and C_{in}; bias resistors can usually be ignored. It is then possible to calculate the power gain and the working bandwidth. The centre frequency f_0 is dictated by the diameter of the ceramic resonator; for a 470kc/s overtone disc this is about half an inch.

The power gain is given [7] by

$$\text{Stage gain} = \tfrac{1}{4} g_m^2 \, R_D \, R_R \quad \ldots \quad \ldots \quad (4)$$

when the loads are correctly matched. With practical values of the transistor mutual conductance g_m this works out to be about 30dB. Though this is somewhat lower than the maximum power gain frequently quoted, there is very little power insertion loss due to the disc. This loss depends on the ratio $Q_m : Q_W$, but is negligible when

$$Q_W \leqslant Q_m/4$$

Typically $Q_m = 300$, hence Equation (4) gives the working power gain.

Conventional i.f. transformers are often designed with an attendant power loss to overcome transistor amplifier instability. With ceramic i.f. transformers the resistive load R_C achieves the same effect, and it turns out that there is no real need to include neutralizing components in stages such as Fig. 5.

To achieve the desired working bandwidth for given loads, the disc must be designed to have the electrode capacitance dictated by Equation (1), or the correct padding capacitance must be added. The process is relatively straightforward and a wide range of interstage selectivities may be designed. This makes possible the design of synchronous or stagger-tuned amplifiers. The requirements on centre frequency and other parameters are not found to be serious.

Removing Unwanted Responses.—Since we have considered an overtone resonator, the chief problem is to eliminate the response at the lower fundamental frequency, usually 180kc/s. At the present time the method recommended is to retain one double-tuned i.f. transformer in the first stage of the amplifier. The advantages of this arrangement are

(i) Unwanted signal protection > 60dB.
(ii) The amplifier frequency response can be adjusted for balance.
(iii) Placing the transformer in the mixer stage ensures minimum breakthrough of the oscillator signal into the i.f. amplifier.
(iv) A diode may be placed across the coil to provide signal overload protection.

Receiver I.F. Stages.—Fig. 6 illustrates the pertinent section of a broadcast receiver utilizing ceramic i.f. transformers. Comparison with the well-known conventional i.f. arrangement shows how the ceramic device fits into the circuit. The detector stage is as described in a previous issue of *Wireless World*[8]. Component values have not been included in Fig. 6 as these may be varied to suit the requirement of battery supply voltage, $-V_B$, and the a.g.c. action. D_1 is a signal overload protection diode. C_1 and C_2 are capacitors which may

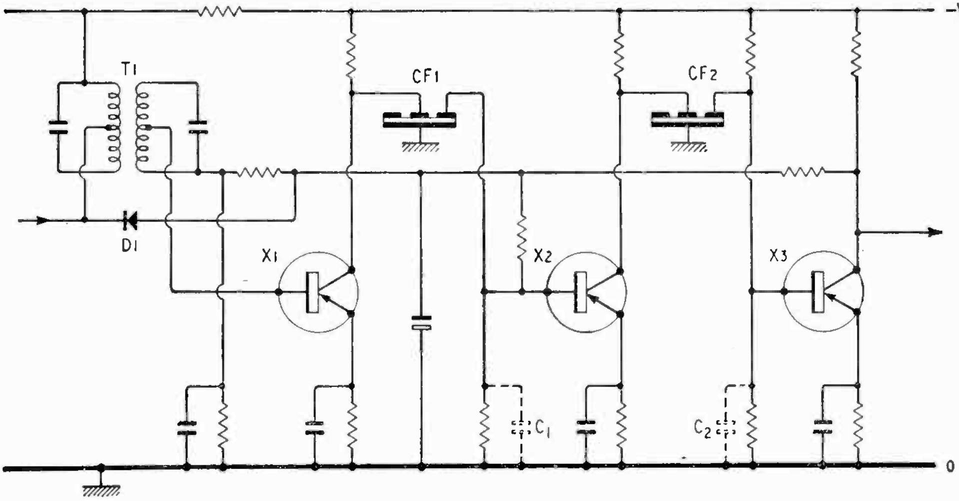


Fig. 6. Broadcast receiver i.f. stages using ceramic i.f. transformers.

be included if the ceramic discs are not in themselves correctly matched to the circuit.

Finally we quote a typical performance for this circuit:—

Centre frequency	480kc/s
6dB bandwidth	7kc/s
24dB bandwidth	18kc/s
Second channel	64dB down
Voltage gain per i.f. stage	28dB

In setting up the circuit two ceramic discs are selected having centre frequencies within 1-2 kc/s of each other, and the wound transformer is tuned for peak output.

Experience with this device in practical circuits of this kind suggests a wide field of application for filters of this type.

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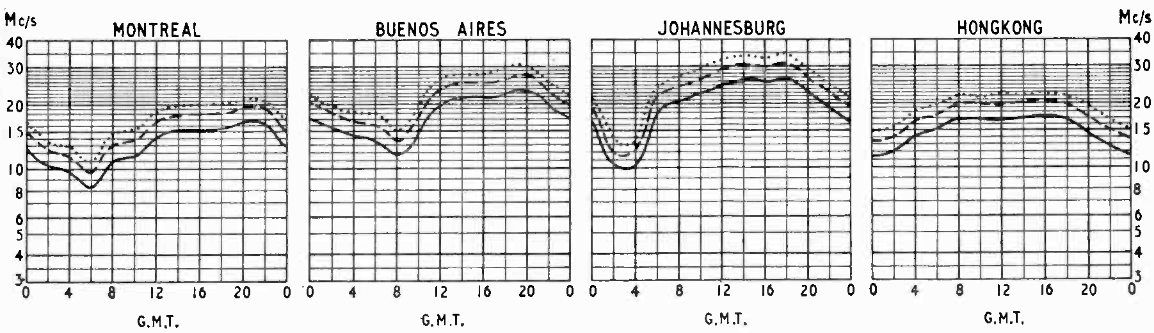
SHORT-WAVE CONDITIONS

Prediction for May



THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during May.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

•••••••••• FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY

——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

Multivibrator Design

2.—TRANSISTOR CIRCUIT WITH GOOD FREQUENCY STABILITY

By R. C. FOSS, B.Sc., Grad.I.E.E. and M. F. SIZMUR. B.Sc.

IN the previous article of this series, the authors discussed the principle of using a known constant current to improve the reliability and simplify the design of a simple multivibrator circuit. In this article, a multivibrator having excellent frequency stability is discussed and the principle is extended to include both valve and transistor circuits.

The usual type of transistor multivibrator is shown in Fig. 1. This uses "bottoming" to determine the voltage swings and is analogous to the pentode circuit previously mentioned. It has a further disadvantage, however, in that there is an additional delay in switching off the bottomed transistor due to hole-storage phenomena.

The circuit of the cathode-coupled multivibrator described previously does not willingly suffer "transistorization". The difference between base

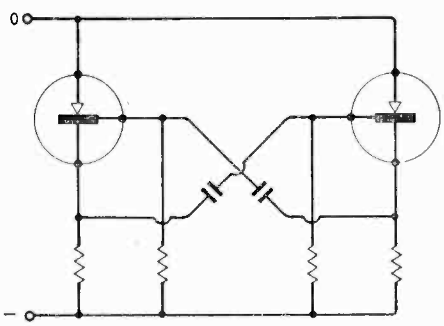


Fig. 1. Conventional transistor multivibrator.

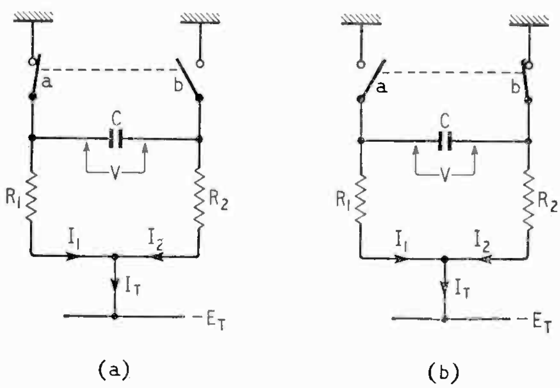


Fig. 2. Equivalent circuit of transistor version of White's multivibrator. In (a) $I_1 = E_T/R_1$, $I_2 = (E_T - V)/R_2 \approx E_T/R_2$ if $V \ll E_T$; $I_T = I_1 + I_2 \approx E_T(1/R_1 + 1/R_2)$. In (b) $I_1 = (E_T + V)/R_1 \approx E_T/R_1$ if $V \ll E_T$, $I_2 = E_T/R_2$; $I_T = I_1 + I_2 \approx E_T(1/R_1 + 1/R_2)$.

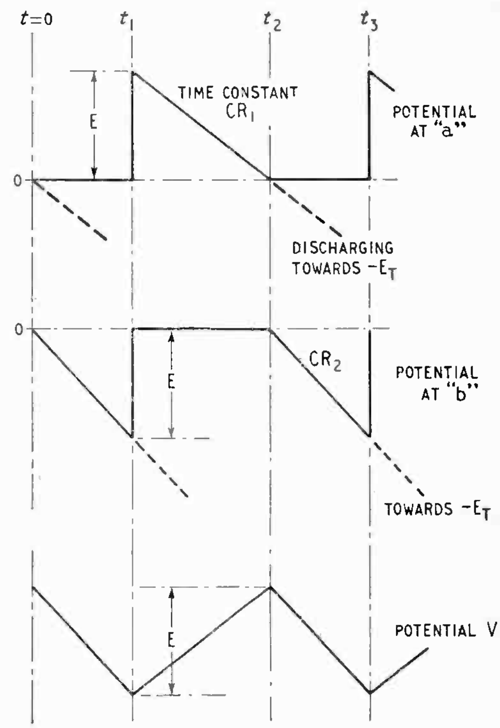


Fig. 3. Waveforms of Fig. 2.

currents in the on and off states gives rise to a large and unpredictable difference in mark and space times. (C.f. valve version, when V2 draws grid current.) To avoid this difficulty the timing components must be removed from the base circuit and placed in the emitter circuit.

A suitable arrangement was pointed out to the authors by E. L. C. White★ and is shown in Fig. 4. Although at first sight it may not be apparent how the constant-current principle may be applied, Fig. 2, in which the two transistors are replaced by equivalent switches, and the waveforms of Fig. 3 should help to make this clear.

Referring to Fig. 2(a), suppose both switches are initially closed. At time $t = 0$ the right-hand switch is opened. A constant current I_1 flows in R_1 while C charges towards $-E_T$ through R_2 on an exponential e^{-t/CR_2}. If V, the potential across C, is limited to a value $E \ll E_T$, the total current through the switch

★ In Ref. 4 of the previous article he describes the valve version of this arrangement as well as the circuit previously discussed.

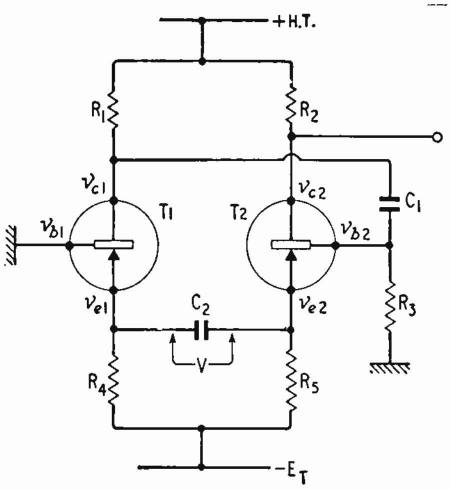


Fig. 4. Transistor version of White's multivibrator.

$,I_T$, is approximately $E_0\ (1/R_1+1/R_2)$. When this limit is reached at time t_1 the switches are changed over; see Fig. 2b. Point "b" is now earthed and as V cannot change instantaneously, point "a" rises to a potential E above earth. A constant current now flows in R_2 while C discharges towards $-E_T$ through R_1 on an exponential e^{-t/CR_1}. Again provided $E \ll E_T$, the current in the switch is approximately constant and of value $E_T(1/R_1+1/R_2)$. Hence if $E \ll E_T$ the assumption of constant current is justified and the "tail" current is $I_T \approx E_T(R_1+R_2)/R_1R_2$. In the circuit of Fig. 4 the transistors are used to provide the switching action and a positive feedback loop is provided to maintain the regeneration.

The operation of this practical circuit will now be discussed with transistors of n-p-n polarity. This is to clarify the analogy with the operation of a valve circuit: p-n-p transistors will perform equally well, with all polarities reversed. Fig. 5 gives the waveforms, and the assumptions made are listed below:—

(1) The change in emitter potentials is much less than E_T; i.e. the constant-current principle.

(2) The emitter-base voltage for emitter current cut-off is zero.

(3) The emitter-base voltage for emitter current I_T is $-e_b$ and independent of collector voltage.

(4) Both transistors have identical characteristics.

(5) C_1 is large, so that the change in its potential due to base current may be neglected during the period when T2 conducts.

(6) T2 base voltage swings between 0 and +E. The significance of this will be discussed later.

Suppose initially that T2 is conducting and T1 is cut off, and let T1 be switched on at time $t=0$. Then T1 collector potential falls, and the change is coupled to T2 base via C_1, cutting off T2. T2 base is now at earth, and the emitter of T1 is held at $-e_b$ by emitter-follower action. C_2 charges towards $-E_T$ through R_5, and when it has reached earth, T2 starts to conduct. Since the tail current is constant, less current flows through T1 and its collector potential rises. This rise is coupled to T2 base via C_1, and the emitter of T2 follows, lagging by e_b, completely cutting off T1. This is a cumulative action giving a rapid rate of rise of emitter voltage to $E-e_b$, and since the potential across C_2 cannot change instantaneously, T1 emitter rises by $E-e_b$. T2 emitter is held at $E-e_b$ by emitter-follower action and C_2 now discharges towards $-E_T$ through R_4. When it reaches earth, T1 starts to conduct and the cycle repeats. As T1 is cut on its emitter must fall from 0 to $-e_b$. This small drop is coupled by C_2 to the emitter circuit of T2 also.

The collector current of T1, when "on", will be less than the tail current by its base current. To calculate the swing at the collector of T1 accurately, this second-order effect must be allowed for. Less obvious, perhaps, is the need to allow for the base current of T2 when it conducts. Although T1 is then cut off, this base current flowing in R_1 and R_3 in parallel prevents the collector of T1 reaching the collector rail voltage. Thus the net change of current in R_1 and R_3 is the tail current less the sum of the two base currents, and the collector voltage swing is given by:—

$$E=(I_T-2i_b)R_1R_3/(R_1+R_3) \quad \ldots \quad \ldots \quad \text{(i)}$$

In a valve version of the circuit, R_3 could be made sufficiently large compared with R_1 to be neglected. Here, however, the mean base current flows through R_3. Thus if R_3 is made too large the mean base potential will not be accurately known and the circuit will be markedly temperature dependent.

Having chosen R_1 and R_3 to give a desired value of E, C_1 can then be chosen such that $C_1(R_1+R_3)$ is long compared with the period when T2 conducts and satisfies assumption 5 previously listed.

The collector of T2 is "free" in that it takes no part in the regenerative action and so the performance of the circuit is virtually independent of the collector load R_2, provided that T2 is not forced into bottoming. Thus R_2 is chosen to give the desired output swing, given approximately by:—

$$E_2 \approx I_T\ R_2$$

The other apparently "free" electrode in the circuit, the base of T1, can be used to synchronize the circuit to an external waveform. Care must be taken, however, to ensure that a low-resistance path from base to earth exists for the base current of T1, or the performance will be drastically affected. When free-running, the first part of the cycle has a duration controlled by the exponential decay of the voltage on C_2 through R_5 from an initial value of E_T+E-2e_b to E_T. i.e.,

$$E_T/(E_T+E-2e_b)=e^{-t_1/C_2R_5} \quad \ldots \quad \ldots \quad \text{(ii)}$$

Similarly the second part of the cycle is given by:—

$$E_T/(E_T+E-2e_b)=e^{-t_2/C_2R_4} \quad \ldots \quad \ldots \quad \text{(iii)}$$

and t_1 and t_2 may be calculated by taking logarithms or graphically by the method described in the previous article. The mark/space ratio is thus not necessarily unity but determined by the ratio:—

$$\frac{t_2}{t_1}=\frac{R_4}{R_5}$$

which can be large. The tail current I_T is determined by E_T and the resistance of R_4 and R_5 in parallel. These relationships are normally the starting point in a practical design.

Before considering an example, however, assumption 6 above will be discussed. If this assumption is satisfied then the starting points of each of the exponential decays is exactly the same, ensuring that the mark/space ratio is R_4/R_5. But with the swing E coupled to the base by C_1 and R_3 as shown, the mean base potential must be zero, neglecting the effect of base current. In practice this determines the actual limits of the base swing. For example, if the mark/space ratio is unity, the limits of base swing will be $\pm$ E/2 and the emitter potential of T2 will then decay from $(E_T+E/2-2e_b)$ to $(E_T-E/2)$, and the decay time will be given by:—

$$(E_T-E/2)/(E_T+E/2-2e_b)=e^{-t_1/C_2R_5} \quad .. \quad \text{(iv)}$$

This would make the mark/space ratio no longer equal to R_4/R_5 as t_2 would still be given by equation (iii). From the first assumption, which is usually easily satisfied in practice, $E \ll E_T$ and so the discrepancy in mark/space ratio is small. For precise results care can be taken to ensure that the base of T2 does swing between the assumed limits, either by clamping the base to earth with a junction diode or by returning the base resistor R_3 to a small positive bias E^{t_2/t_1}. If the mark/space ratio is such that t_2/t_1 is small, this bias is negligibly small and R_3 may be returned to earth as shown in the circuit of Fig. 4 and in the design example which follows.

This is for a multivibrator using OC71 p-n-p transistors. The repetition frequency is to be 50 c/s and the mark/space ratio 50 : 1 with T2 conducting for the short period. The supplies available are

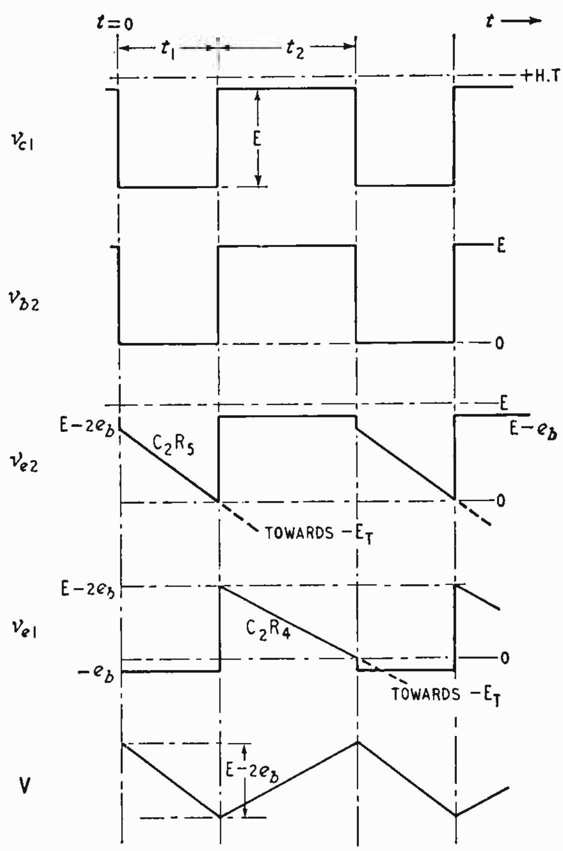


Fig. 5. Waveforms of Fig. 4.

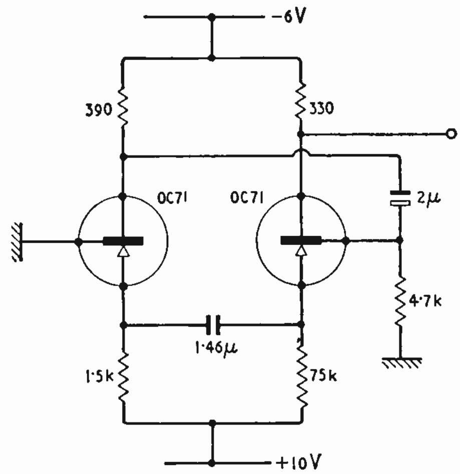


Fig. 6. Design example of a transistor multivibrator.

−6 and +10V and the tail current is to be about 6mA. As the ratio of R_5 to R_4 is 50 : 1, R_4 determines the total tail current to within 2%. Using permissible resistor values gives $R_5=75k\Omega$; $R_4=1.5k\Omega$ and a tail current of 6.8mA. From manufacturer's data for the OC71 the nominal base current for this emitter current is 120μA and the emitter-base voltage is 200mV. With a base resistor R_3 of 4.7kΩ and collector load resistor R_1 of 390Ω, the swing E is, from equation (i) given by

$$E=(6.8-0.24)\,\frac{0.39\times 4.7}{0.39+4.7}=2.36\text{V}$$

The resulting changes in emitter potentials are sufficiently small compared with the tail voltage (+10) to justify the assumption of constant tail current. Lastly, C_2 is calculated for t_1 equal to 19.6msec., using equation (ii)

$$\frac{10}{10+2.36-0.4}=\frac{10}{11.96}=e^{-t_1/C_2R_5}$$

Using the graphical method as before

$t_1=0.179\ C_2R_5$, whence $C_2=1.46\mu$F.

The measured periodic time of the circuit of Fig. 6 constructed to this design corresponded exactly to the design values within the limits of normal measuring techniques. Furthermore, these times are not critically dependent on precise transistor parameters which appear only as second order terms in the design equations. Because of this and because the timing circuit is in the emitter circuit where leakage currents are normally lowest, temperature stability is good. A change from 20°C to 50°C in transistor temperature was found to give about 4% decrease in periodic times. Changes in supply voltages also have remarkably little effect on the timing. Provided that the collector supply is sufficient to avoid bottoming and yet not so great as to exceed transistor ratings, it is apparent that variations in this supply will have very little effect on the circuit timing. At first sight the emitter supply appears much more critical because E_T appears in the timing equations (ii) and (iii). This is not so, however, because the tail current and therefore E are also proportional to E_T. Thus all the major terms on the left hand sides of equations (ii) and (iii) alter in proportion and so do not affect the ratio. Voltage changes of ±25% in the emitter supply alone or in the collector and emitter supplies together, were found to give a total variation in repetition frequency of only 6%.

Acknowledgements.—The authors wish to thank Professor Russell of the Department of Electrical Engineering, King's College, Durham University, for permission to publish this article and to Mr. F. J. U. Ritson for his help and encouragement. They also acknowledge their debt to Dr. E. L. C. White and Mr. R. T. Clayden of E.M.I. Electronics Ltd. and to their former colleagues in the computer division there.

When preparing this article the authors were unaware that a transistor circuit similar to that described had been developed by R. C. Bowes ("A New Linear Delay Circuit based on an Emitter-Coupled Multivibrator"—*Proc. I.E.E.*, 1959, Vol. 106, Part B, Supplement No. 16, p. 793).

Transmission-Line Attenuation Measurement

USE OF SHORT-CIRCUITED RESONANT LINES

By MICHAEL LORANT

A NEW method of measuring the attenuation of balanced, unshielded transmission lines, such as those used in television and f.m. receivers, has been developed by R. C. Powell at the U.S. National Bureau of Standards. The new procedure is simple and rapid and requires only easily-obtainable laboratory equipment. By using a grid-dip meter and a microammeter, for example, results reproducible to better than ten per cent can be obtained. With more elaborate apparatus, reproducibilities of better than one-tenth of one per cent and attenuation values to an estimated accuracy of one per cent are possible.

The apparent attenuation of unshielded, balanced, parallel-conductor transmission lines is sensitive to the amount of radiation that occurs along the line. In determinations of attenuation at frequencies between 30 and 300 Mc/s, external effects arising from the test apparatus, connectors, terminations, and bends often cause variations in the measured attenuation. A suitable measuring method must allow for these inconsistencies either by reducing the external effects, or by evaluating them.

The new method of measuring unshielded lines is based on the fact that if a section of line a number of half wavelengths long is resonated when both ends are shorted, then the standing wave ratio depends only on the attenuation in the line. The attenuation is, in fact, approximately equal to the arc hyperbolic cotangent of the standing wave ratio.

To avoid errors introduced by improper terminations, the test transmission line is rigidly fastened and held in tension by clamps made of low-resistance material. These clamps also act as good short circuits to the electric field. A coupling loop built into the input-end terminal loosely couples the output of a conventional power source to the line. A similar loop is part of the receiving-end termination, and its output is connected to a crystal rectifier. The standing waves are detected by a sliding probe made of polystyrene foam or a similar material. The probe is designed to hold a small pick-up loop at a constant distance from the line. In this way, irregularities in the line are compensated and, at the same time, the loop interferes as little as possible with the fields of the line. An additional rectifier is also built into the probe.

Although galvanometers and extensive generating equipment are used for these measurements by the U.S. National Bureau of Standards, very acceptable results can still be obtained by using a low-power generator, such as a grid-dip meter, as the signal source to be coupled into the line. Likewise, the standing waves along the line, detected by the probe, can be measured by a sensitive microammeter.

Other methods previously developed for this type of transmission-line attenuation measurement attack the problem from various directions. Some use substitution methods in which known attenuators are inserted in series with the line and the output power is adjusted to the same value for both conditions. Others depend upon the change in the resonant frequency of a system containing the line to be measured; such techniques require accurate measurement of the operating frequency in order to obtain accurate values of attenuation.

When the new method is used to measure the attenuation of the transmission line, matching of the line to the measuring circuit is unnecessary because the line is terminated in short circuits. The necessity of changing the lines during a measurement and using connectors of any kind is also eliminated. With the shorted input, balanced conditions are easily obtained. If the generator is capable of supplying sufficient power, the effect of the probe and coupling loops is negligible. The great advantages of this system, however, are its simplicity and speed, and the fact that only easily-obtainable apparatus is needed.

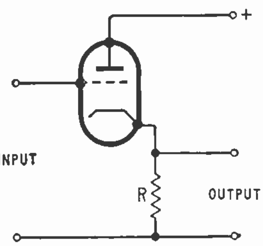
Post-graduate Course.—The University of Birmingham is running a one-year course in electrical machines for honours graduates in electrical engineering leading to the degree of M.Sc. It will deal primarily with the fundamentals of electro-mechanical energy conversion, mathematical analysis techniques (including the use of computers) and automatic control systems. The fee is £81. The University is also running for the fifth year a graduate course in information engineering leading to the M.Sc. degree. Both courses begin on October 1st.

Cathode-Follower Distortion

By "CATHODE RAY"

MY closing words last month were a half-promise to deal now with the distortion likely to be caused when a negative-feedback amplifier is handling steep pulses or high-frequency signals. This undertaking was rather rash, because the task of making it as simple as last month I was editorially said to be capable of doing has turned out to be even more formidable than I expected. In fact, it is highly unlikely that we shall get beyond that simplest of negative-feedback amplifiers—the cathode follower.

For the simplicity of the cathode follower is confined mainly to its basic circuit diagram, Fig. 1. Anybody who tends to judge the complexity of a circuit by the number of components in it will be gravely deceived by this one. For example, some time ago* I surprised myself as well as others with the complications that can arise in providing grid bias for cathode followers. As a supplement to last month's historical survey it might be mentioned that we have to go back farther still—March 1946—for the first warning in *Wireless World* of the phenomenon now lying on our plate for inspection. It was given by W. T. Cocking, and, as one would expect of such an authority on television circuit design, was concerned mainly with television pulse waveforms. True, a graph was given for sine-wave signals, but without any account of how it was derived. Having looked up the reference cited by Cocking† I appreciate his discretion. Though no doubt full of mathematical elegance, Goldberg's argument was such that I for one found it too subtle. On the assumption that a large proportion of *Wireless World* readers would share this view, I tackled it straightforwardly with school mathematics, with the result that follows.



Right: Fig. 1. *The simple(?) cathode follower.*

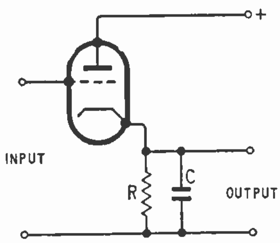


Fig. 2. *Whether visible in the circuit or circuit diagram or not, there is always some capacitance, marked here as C, which must not be ignored.*

Roughly the trouble is easy enough to understand. There is bound to be a certain amount of stray capacitance across R, shown as C in Fig. 2. In practice there may be quite a lot, because successive intakes of students have been informed that one of the main uses of a cathode follower is for feeding a high-capacitance circuit from one which would not stand direct connection to it. This, of course, is perfectly true, and is due to the very low output resistance of the cathode follower—$r_a/(\mu+1)$, which is commonly less than 200 Ω. It is effectively in parallel with R and enables C to charge and discharge rapidly. If however the input voltage drops suddenly from a positive peak, C may prevent the large positive cathode bias that has been built up during that peak from falling equally suddenly, with the result that the anode current is cut off. Once this happens, the valve ceases to exist so far as C is concerned, and its discharge, now through R alone, is considerably slower. In the meantime the input signal is completely disconnected and powerless to influence the course of events.

A large instantaneous rise of input voltage could, because of C, find itself in grid current (not very desirable in a device that is supposed to have a phenomenally high input impedance!) which would also cause distortion; but this state of affairs would very soon be over, because the resulting exceptionally large anode current would quickly charge C and allow the cathode potential to catch up.

A really steep input pulse, shown at Fig. 3(a), is therefore likely to be reproduced at the output with the distorted form shown at (b). Note that although this can only happen if the amplitude of the pulse is large, it doesn't have to be more than the cathode follower is quite capable of handling when the fall is less steep.

Those who like to think in time constants will

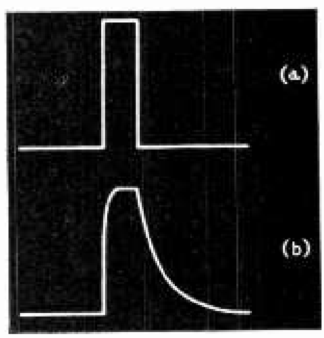


Fig. 3. *One effect of C in Fig. 2, when the input is a large-amplitude pulse with steep sides as at (a), is to distort it as at (b).*

*June 1955 issue.

†"Some Consideration Concerning the Internal Impedance of the Cathode Follower," by H. Goldberg. *Proc. I.R.E.*. Nov. 1945.

probably have realized that the rise in Fig. 3(b) is exponential with a time constant equal to C multiplied by R and $r_a/(\mu+1)$ in parallel:

$$\frac{CRr_a}{(\mu+1)\,R+r_a}$$

whereas the fall corresponds to the longer time constant, CR.

In practice, this phenomenon is obviously most troublesome with steep pulse waveforms. Television has been mentioned, and in radar the difficulty is perhaps even more acute. And anyone who supposes that the problem of measuring pulses by oscilloscope or valve voltmeter without distorting their waveforms can be solved merely by interposing a cathode follower clearly has to think again. So pulses have received most attention. But the effect does exist with sine waves if their frequency and amplitude are high enough for their down-swing to be more than critically steep. And, anyway, a pulse can be regarded as made up of a mixture of pure sine waves (Fourier's principle).

Fig. 4(a) shows a cathode follower, and (b) the corresponding vector diagram (" Cathode Ray " unambiguous pattern) for the condition in which the signal frequency is low enough for the effect of the capacitance C to be negligible. The important thing to remember in feedback systems is that the valve

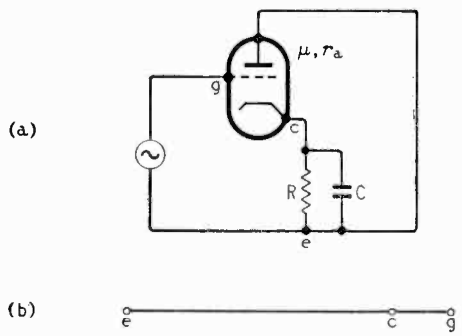


Fig. 4. *(a) The cathode-follower circuit diagram has here been marked so as to identify the voltage vectors in the vector diagram (b) which has been drawn for the condition that the effect of C is negligible.*

itself is unaffected thereby. So any signal voltage (and no other kind is considered in Fig. 4) existing between g and c is amplified in full just as if there were no feedback. The voltage developed across R is therefore (shall we say) A times greater, where as usual

$$A=\frac{\mu R}{R+r_a}$$

This is represented in the vector diagram by making ce A times longer than cg. And being, also as usual, in opposite polarity, their vectors are drawn on opposite sides of c. The gross input from the generator shown, applied between points e and g on the circuit diagram, is therefore represented by the vector eg. (Why doesn't everybody use this kind of vector diagram, without any confusing and unnecessary arrow heads and voltage labels?) We see at once that the output voltage is inevitably

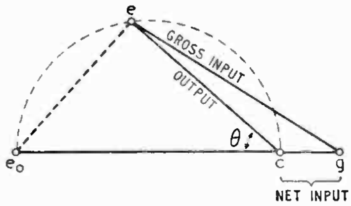


Fig. 5. *As the frequency of the generator in Fig 4(a) rises, and its voltage is adjusted to keep the net input constant, point e in the vector diagram moves around a semicircle.*

less than the input, and that reckoned from e they are in phase—familiar cathode-follower facts.

Next, Fig. 5 shows what happens to the vector diagram when the frequency is high enough to cause an appreciable phase shift, θ. (Note that the phase shift between *gross* input eg and output ec is considerably smaller; this is one of the benefits of negative feedback.) The original position of e is now marked e_o to distinguish it from the new position. The fact that the length cg is the same as before (implying that the net input is the same) is just for convenience in drawing; it could only be so in practice if the gross input eg happened to be less at the higher frequency, in the ratio eg/e_og. The right angle $e_o$ec corresponds to the 90° phase difference between the signal current through C and that through the resistance of R and the valve (r_a) in parallel. As it is always a right angle, Proposition-I-forget-which in geometry proves that, as the frequency varies, e must trace out a semicircle, shown dotted. The angle θ is calcuable from the fact that e_oe and ec must be in the ratio of the two signal currents just mentioned, which in turn are proportional to the susceptance of C (=1/reactance $=2\pi fC=\omega C$) and the combined conductance of R and the valve ($=1/R+1/r_a$).

$$\text{So:}\qquad \tan\theta=\frac{\omega C}{\frac{1}{R}+\frac{1}{r_a}}=\frac{\omega CRr_a}{R+r_a}\quad\ldots\quad\ldots\quad(1)$$

At this point someone will probably be wondering why we have here taken the valve's output resistance as r_a, whereas in connection with the rising slope in Fig. 3(b) we took it as the much lower $r_a/(\mu+1)$. The answer is that θ is the phase angle of the output with reference to the *net* input—directly between grid and cathode, so that feedback is outside the scope and the ordinary valve parameter r_a applies. C, however, sees the valve as modified by feedback, because any changes of voltage across it not only affect the anode current of the valve directly, in proportion to $1/r_a$, but much more through the grid connection, where they are multiplied by μ.§

The next problem is to define the condition that

§Anyone who is not quite sure about this should stop now to think it out. Imagine C to be disconnected and charged so that its upper terminal is positive with respect to the lower one. It is first connected to R alone, and by driving a current through it from c to e discharges at a rate depending on the value of R. Next, repeat the operation with the valve connected, but its grid joined to cathode to prevent it from affecting the anode current. Because the charge on C opposes the h.t. source (not shown) it reduces the total anode current. This can be regarded as being because it is driving a signal current through the valve from c to e. This current is therefore an additional discharge path, of resistance r_a, so C discharges quicker. Lastly, restore the connection between g and e. Applying the charged C now additionally makes g negative with respect to c and thereby causes a reverse signal current through the valve μ times as great as that due to the direct effect on the anode to cathode voltage. So C discharges much quicker, its discharge path being R, r_a and r_a/μ all in parallel.

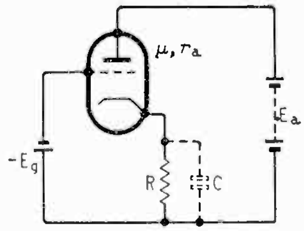


Fig. 6. *This shows the d.c. conditions of the cathode follower.*

just cuts the anode current off, because that is where distortion of the kind we are discussing begins. We can then calculate how much the gross input has to be reduced at high frequencies as compared with low, to meet this condition.

We may have become so used to thinking about valve equivalent circuits, which take account of signal currents only, that a problem involving the d.c. component stumps us for a moment. One might hastily suppose, for example, that the overloading point was reached with the same net input to the valve in each case. But in fact the net input required to cut the valve off depends on the impedance of the load formed by R and C.

Since even Mr. Goldberg had to keep the problem within reasonable bounds by assuming an ideal linear valve, we are not likely to disgrace ourselves if we fail to allow for the baffling curvature of real valve characteristics. The starting point, then, is the current/voltage equation of the ideal or linear triode:

$$I_a = \frac{V_a + \mu V_g}{r_a} \quad \ldots \quad \ldots \quad (2)$$

where I_a denotes the anode current and V_a and V_g the voltages applied to anode and grid respectively, with reference to cathode. It regards the valve, between anode and cathode, as being a resistor of r_a ohms, to which the effective voltage applied is the actual voltage, V_a, plus μ times the grid voltage. In practice V_g is usually negative. The equation can be used for d.c., or for signal current, or for both together, but it is invalid if $(V_a + \mu V_g)$ from all sources is negative. In our case we are interested in what makes it just zero.

Fig. 6 shows the d.c. situation. C is there, but being just an open-circuit to d.c. it takes no part and is drawn dotted. The h.t. and bias voltages are called E_a and E_g to distinguish them from V_a and V_g which are the voltages of anode and grid relative to the cathode. To get at $(V_a + \mu V_g)$, then, we have to allow for the drop across R:

$$I_a = \frac{E_a - I_a R + \mu(E_g - I_a R)}{r_a} = \frac{E}{r_a}$$

There is no need to pay much attention to this, because it is the cathode-follower designer's job to choose E_a, E_g and R so that E is positive and of such a value that I_a is a suitable standing current. The important thing for us is that when the signal current is superimposed its negative half-cycle will subtract from I_a and at a certain peak amplitude will momentarily bring the net current to zero. This condition obviously corresponds to an effective signal voltage exactly equal and opposite to E. Now E is the same regardless of the frequency of the signal; that is why the details of how it was made up were not worth memorizing. In making a comparison between two signal frequencies, all we need know about E is that it exists and that it is constant.

We have already noted that even in the simplest negative-feedback situations the way not to get stuck is to start with the *net* signal input voltage, which in conformity with Figs. 4 and 5 we shall call v_{cg}. This corresponds to V_g in equation (2). V_a is also affected, by the signal voltage drop across the load impedance, which we shall call Z. The effective signal voltage is therefore $\mu v_{cg} - i_a Z$ where i_a is of course the anode signal current, to be made equal and opposite to I_a at the negative peaks. And since this is done by making $-(\mu v_{cg} - i_a Z)$ equal to E, which is constant, it means that at the threshold of distortion $(\mu v_{cg} - i_a Z)$ must be the same at all frequencies.

So to compare the gross input v_{eg} allowable at some frequency f, at which C is significant, with v_{eog}, the gross input when f is low enough for C to have negligible effect (so that Z=R), all we have to do is equate $(\mu v_{cg} - i_a Z)$ in the two cases. In both, $i_a Z$ is of course the output voltage, represented in our two vector diagrams by ce.

For the first case, Fig. 7 repeats Fig. 4(b), with the addition of the vector cp, μ times the length of cg, and in the opposite direction, to represent $-\mu v_{cg}$. The length ep therefore represents the difference between $i_a R$ and μv_{cg}.

Fig. 8 is the corresponding elaboration of Fig. 5. Again, ep represents the difference between $i_a R$ and μv_{cg}, to be equated to the constant E. We could solve the problem graphically by redrawing Fig. 8 on a reduced scale so that its ep was the same length as Fig. 7's, and then noting how much shorter eg turned out to be there than in Fig. 7. That would be a measure of how much the maximum allowable signal input would have to be reduced because of C.

But no doubt we would like to have it as a ratio that we can compute, if only to check it against Goldberg's equations and Cocking's graph. Let us distinguish the quantities in Fig. 8 from those in Fig. 7 by a dash (or prime, as some call it). Then the ratio we want is v'_{eg}/v_{eg}, for the condition $v'_{ep} = v_{ep}$.

At first, lest we fail to see the sense for the symbols, let us use A as before to denote the amplification

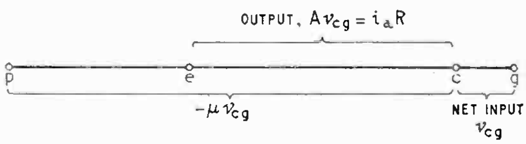


Fig. 7. *Vector diagram corresponding to Fig. 4(a), with the addition of a vector representing the voltage of the equivalent internal generator of the valve.*

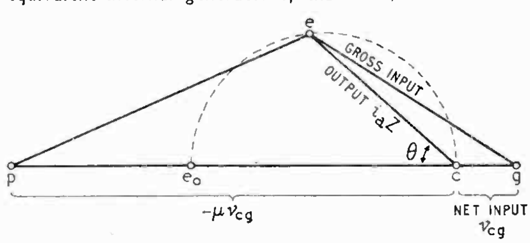


Fig. 8. *This diagram is related to Fig. 7 as Fig. 5 is to Fig. 4(b).*

of the valve itself with resistive load—$\mu R/(R+r_a)$. Then, as Fig. 7 shows,

$$-v_{ep}=\mu v_{cg}-Av_{cg}=(\mu-A)v_{cg}$$

To find v'_{ep} in Fig. 8 we make use of the well-known formula for solving triangles:

$$ep^2=cp^2+ce^2-2cp.\,ce\cos\theta$$

So: $-v'_{ep}=\sqrt{(\mu v'_{cg})^2+(Av'_{cg}\cos\theta)^2-2\mu A(v'_{cg}\cos\theta)^2}$

$$=v'_{cg}\sqrt{\mu^2+A(A-2\mu)\cos^2\theta}$$

So to fulfil the condition $v'_{ep}=v_{ep}$,

$$v'_{cg}=\frac{v_{cg}(\mu-A)}{\sqrt{\mu^2+A(A-2\mu)\cos^2\theta}} \quad .. \quad (3)$$

Now $v_{eg}=v_{cg}(A+1)$ .. .. .. (4)

and by applying the triangle formula again, this time to egc in Fig 8, in similar fashion we get

$$v'_{eg}=v'_{cg}\sqrt{1+A(A+2)\cos^2\theta} \quad .. \quad .. \quad (5)$$

Putting (4) and (5) together to form our wanted ratio, and substituting for v'_{eg} from (3) we get

$$\frac{v'_{eg}}{v_{eg}}=\frac{(\mu-A)\sqrt{1+A(A+2)\cos^2\theta}}{(A+1)\sqrt{\mu^2+A(A-2)\cos^2\theta}} \quad .. \quad (6)$$

We found tan θ a long time ago—eqn. (1), $\omega CRr_a/(R+r_a)$, and as $1/\cos^2\theta=(1+\tan^2\theta)$ we can substitute for $\cos^2\theta$ in (6). Before we do this, it will pay to divide by $\cos^2\theta$ under both square root signs in (6), because our formula is for $1/\cos^2\theta$. We must also fill in the full details of A, and after using the rules of algebra to tidy up the result I get (and I hope you do too)

$$\frac{v'_{eg}}{v_{eg}}=\text{(say) } D==\sqrt{\frac{a^2/b^2+1}{a^2/r_a^2+1}} \quad .. \quad .. \quad (7)$$

where for brevity

$a=\omega CRr_a$

$b=(\mu+1)R+r_a$

Goldberg didn't express his conclusion in quite the same terms, but that can very quickly be adjusted, with the satisfactory result that the two agree. To be quite sure (especially as we both assumed ideal linear valves) I did some measurements on an actual cathode follower, in which R was several times r_a, and two different large capacitances (0.5μF and 1μF) were connected across it in turn, so that their effect was considerable at the low test frequency of 50 c/s. The validity of the Goldberg-" C.R." formula was remarkably well confirmed. The onset of distortion was noted by looking at the waveform across R with an oscilloscope. Whereas it was very easily detected with the unshunted R by the negative peak being cut off, as in Fig. 9(a), the inequality of rising and falling slopes (b) caused by C had to be looked for more attentively.

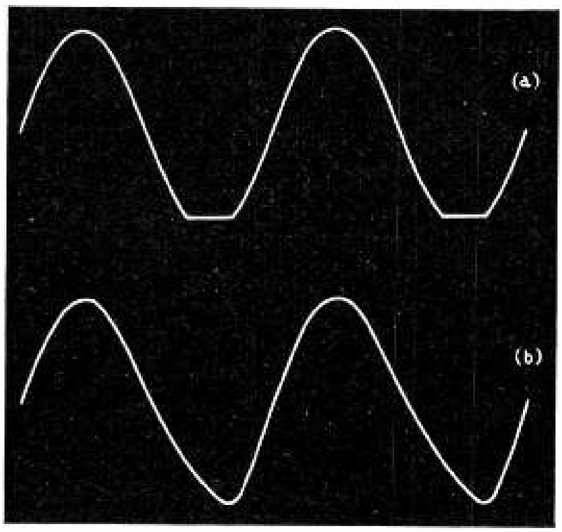


Fig. 9. With a purely resistive load, overloading of a cathode follower by cut-off shows up as at (a); with capacitance shunt, as at (b).

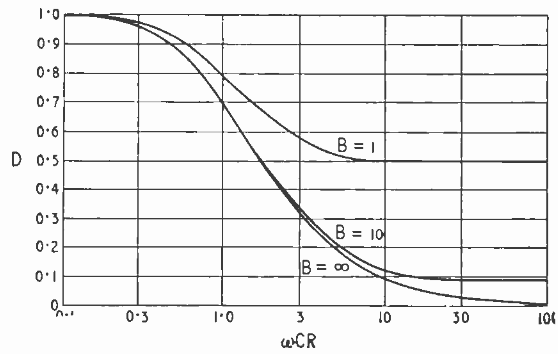


Fig. 10. The relation between the sine-wave distortion-threshold factor, D, and the load resistance/reactance ratio, ωCR, is shown here for several values of a parameter B, which is the ratio of (μ + 1) times the load resistance to the valve resistance.

What about Cocking? His graph was (in our symbols) D plotted against ωCR for various values of a parameter B, which is our $(\mu+1)R/r_a$. It appears here as Fig. 10. Dividing by r_a under the root sign in our formula (7) we get the alternative form

$$D=\sqrt{\frac{\left(\frac{\omega CR}{B+1}\right)^2+1}{(\omega CR)^2+1}}$$

from which it is easy to plot D against ωCR, and the result again is an encouraging agreement. Incidentally, B is usually at least 10, so except perhaps for the values of D that mean that C is too large for reasonable signal-handling ability, one curve gives the necessary information.

It is always a help to take a typical example. Suppose R is 3kΩ, C is 25 pF, μ is 20, r_a is 5kΩ, and one wants to find the frequency at which the maximum allowable signal input is 3 dB less (D=0.707) than at low frequencies. B works out at 12.6, so the 10 curve will do, and it shows ωCR to be 1. Dividing this by $2\pi CR$ to get f, we have 2.1 Mc/s.

That concerns maximum allowable *input*. The *output* for a given input—the cathode follower's voltage " amplification "—at that or lower signal levels falls off as the frequency rises, as can easily be seen by watching the output and gross input vectors in Fig. 8 as the point e moves round towards c. But the negative feedback in a cathode follower (100%, actually) considerably raises the frequency at which this effect begins to be noticeable. In our example, although θ is as much as 32°, the " amplification " is reduced only from 0.882 to 0.880—a negligible difference. We conclude that, as the

(*Continued on page 265*)

frequency is raised, signal-handling ability of a cathode follower deteriorates considerably before its performance for small signals is appreciably affected. As Fig. 10 shows, the frequency could be raised to 21 Mc/s, or the capacitance at 2.1 Mc/s to 250pF, so long as the signal amplitude was not much more than one-tenth of the low-frequency maximum.

Nor must it be supposed that the ordinary anode-loaded amplifier is free from the maximum input and output reduction effect at high frequencies. And of course its amplification falls off at a much lower frequency. But when using cathode followers it certainly is necessary to remember that they cannot work into a capacitive load without drastic reduction of signal amplitude at high frequencies. It may be necessary to use a simple low-pass CR circuit in front.

The same sort of effect occurs in negative-feedback amplifiers with more than one stage, but, as I predicted, we have no time left for that. I'm yet to be convinced that I'll ever have time for it, because there are so many variables that it is difficult to draw general conclusions. However, anyone who is sufficiently interested can find some in an article by J. E. Flood, *Wireless Engineer*, August 1952, p.203.

Data Logging and Alarm-Scanning Equipment

FULLY SOLID-STATE PROCESS-MONITORING

WHEN the number of measuring points in process-monitoring equipment reaches a certain point, it becomes possible to justify the cost of a comprehensive data-logging system. The separate channels are sampled by a central equipment, which then operates read-out devices, alarm-systems, etc., and which forms the control unit for the system.

A very flexible data-logger and alarm-scanner has been evolved by Microcell Electronics, which will handle up to a thousand information channels at the rate of 150 a second. The output of the system may take one of several forms—printed records, punched paper or cards, or magnetic tape. It will also give an alarm signal by flashing lights or Klaxons if selected channels exceed predetermined limits.

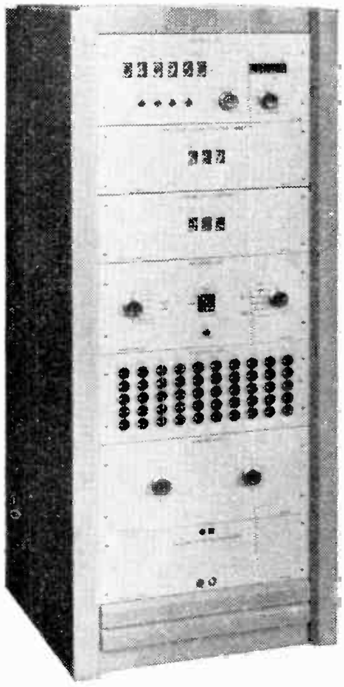
The equipment is made up of "building bricks" to fulfil any particular specification, a high degree of flexibility thereby being possible. Many of the units are selected from a range of high-quality American and British instruments; the remainder have been designed by Microcell. A systems-engineering service is provided by this method of design, each individual equipment being custom-built.

Applications of the data-handling equipment include wind-tunnel instrumentation, component-testing and process-monitoring, while a typical alarm-scanning requirement is in nuclear power-station burst fuel-can detection.

The master unit of the equipment is the Programme Unit, which controls the scanning rate and sequence. The scanning rate is controlled by dividing circuits which give outputs to the signal sampling units at selected sub-multiples of 50c/s.

The signal sampling unit is, in effect, a high-quality commutating switch consisting of banks of sealed dry-reed relays with gold-plated contacts. The relays are driven from ring counters which, in turn, are triggered by the pulses from the programme unit. At the onset of a pulse, the ring counters step on and operate the relays, so connecting the information channels to the input in turn. Any sequence of relay operation may be selected by a front-panel patch board.

Several different types of input amplifier are available, depending on the input conditions. Both differential- and single-ended-input amplifiers are used, the necessity for common-mode rejection being the deciding factor. With certain types of input transducer having a non-linear transfer characteristic, for instance, thermocouples, it is necessary to linearize the output of the amplifier by means of transistor function generators.



Microcell transistor data logger/alarm scanner (Type 300).

The "end-product" of the system, whether it is punched tape or printed paper, is driven from the analogue-to-digital converter. The instrument used is the Mullard L281, which is a high-speed device having an accuracy of 0.1%. For higher accuracies where the speed of encoding requirement is not stringent, one of the range offered by Non-linear Systems is employed.

The system described is applicable to measurements in many fields of industrial process control and has the advantages of being digital in form and completely automatic. The modular conception of the design makes it possible for the customer to be supplied with exactly the units he requires; no compromise between cost and performance is necessary.

LOW-COST STEREO AMPLIFIER

2.–CONSTRUCTIONAL DATA: ALTERNATIVE INPUT SYSTEMS

By E. JEFFERY, A.M.I.E.E.

(Concluded from page 190 of the April issue)

THE left-hand and right-hand channel amplifiers were constructed on a common chassis with a common power supply unit. The following notes relate to the left-hand channel and where there are differences in approach between the two channels attention is drawn to the point concerned.

The general layout of the chassis is given in plan view in Fig. 6, a view of the underside of the chassis is given in Fig. 7. Particular attention is drawn to the orientation of the cores of the output transformers in relation to each other and to the mains transformer, this is done in order to minimize inter-channel coupling and hum pick-up. Transformer dimensions are approximate and will depend on pattern chosen. Constructors who choose to use a larger chassis and are willing to experiment with orientations could possibly improve on the author's figures for crosstalk and hum.

The layout for the tag board which relates to the left-hand channel, is given in Fig. 8. An elementary point (but one not to be overlooked!) is that the sequence of the components on the right-hand channel tag board is the mirror image of this.

The output valve grid and screen stoppers are terminated on a 5-way tag strip mounted between V3 and V4, i.e., they are not mounted on the main tag board. This auxiliary tag strip could also serve to mount any anode/screen capacitors which might be required if a constructor wishes to use up an early pattern of "ultra-linear" output transformer (such transformers were sometimes prone to give rise to parasitic oscillations).

In the discussion of circuit principles it was noted that the effective load impedance on V1 (i.e., the effective grid-earth impedance of V2) is several megohms and the a.c. resistance of V1 is also of this order. It follows that the V1 anode to V2 grid connection is at a very high impedance level with respect to earth, it is therefore most vulnerable to the effects of stray capacitance and also to electrostatic pick-up of hum. Fortunately, the use of the 6BR8 enables these difficulties to be minimized; the critical electrodes concerned are, of course, on the same valveholder and the critical capacitor C_3 can therefore be connected directly on the holder between the electrodes concerned. The capacitor should also be as small as the voltage rating allows and no liberties should be taken with this part

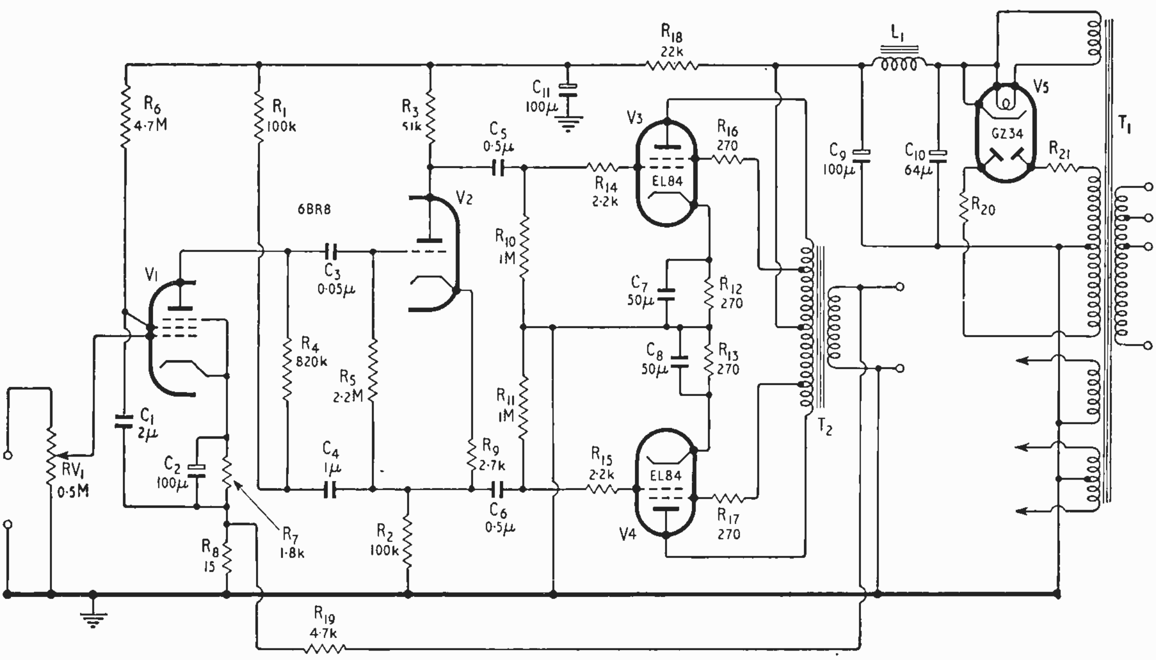


Fig. 3 (Repeated for convenience). Circuit of one channel of main amplifier and power supply for both channels.

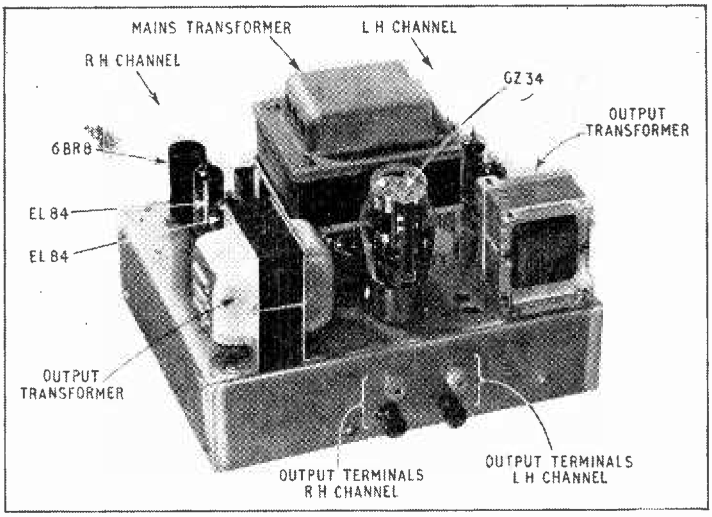
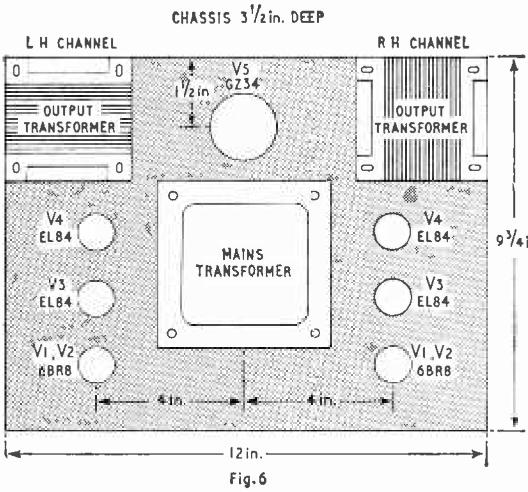
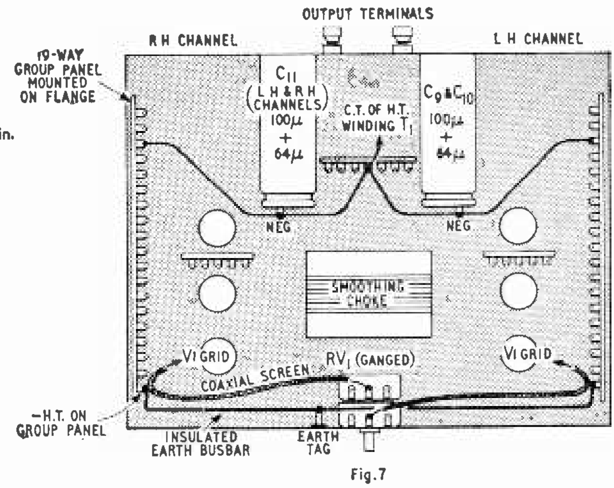


Fig. 6. Plan of chassis showing relative positions of transformer cores.





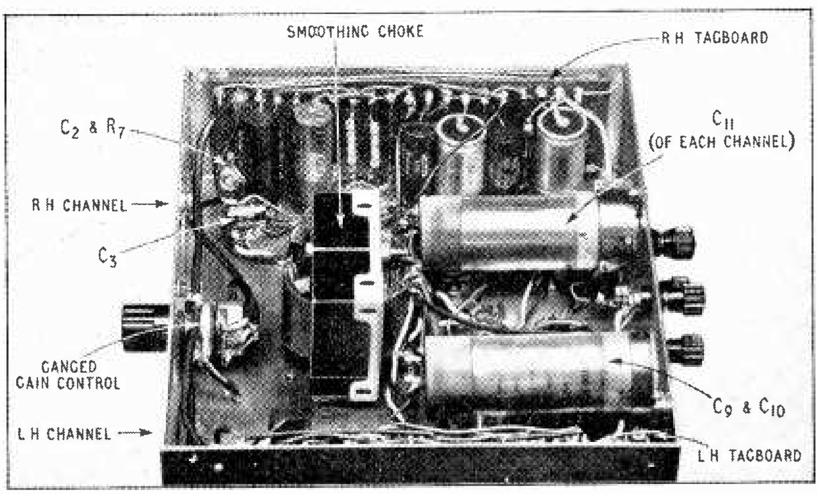


Fig. 7. Layout of principal components on underside of chassis.

of the circuit. Since a great deal of gain is packed into the curtilage of this valve base it should be of the highest quality, preferably nylon-loaded or of p.t.f.e., with a screening skirt.

One of the most important factors in achieving a good hum level in a combined stereo amplifier is earthing (or rather not earthing) and it is most important that fortuitous earths should not be created.

The problem is especially difficult in a stereo system because, by the nature of the beast, certain earth connections exist whether one likes it or not. Thus in the interests of economy a common power-supply is used and this means that the h.t. negative point is common to both amplifiers, on no account should this h.t. be connected to chassis at any additional point other than that recommended.

Small-diameter, p.v.c.-covered coaxial cables are used for connecting the input circuits to the gain controls and from the gain controls to the input grids of each amplifier. Again care must be taken to ensure that, if coaxial input sockets are used, these are isolated from chassis, otherwise one of the fortuitous earth connections referred to will occur.

As a further precaution against accidental earths the two smoothing electrolytic capacitor cans should be isolated from earth by inserting a polythene layer between each can and its mounting clip.

If gain control values higher than $\frac{1}{2}$MΩ are used (e.g., with certain crystal pickups) there is some advantage in providing a hum-balancing potential divider of 50Ω across the heater supply, in place of the direct connection to the side of the heater shown in Fig. 3 (repeated here for convenience).

The amplifier should first be tested without the negative feedback connected, i.e., the connection from the " live " side of the output transformer should not be soldered to R_{19}. The secondary of the transformer should be connected to a loudspeaker *via* a series 100-ohm resistor; this series resistor is intended to safeguard the loudspeaker against any errors which may have been made in wiring. The negative feedback connection may now be made; if the phasing of the connection is correct no change should be heared in the loudspeaker (except that any slight background noise heard initially should disappear). If the phase of the feedback connection is incorrect a loud continuous oscillation will be heard in the loudspeaker and the connections from the output transformer will have to be reversed.

If, for any reason, it is desired to use the amplifier without negative feedback, or to carry out measurements in this condition, attention is again drawn to the very high sensitivity of the basic system, i.e., full output is obtained for only 3mV input compared with, for example, the Williamson type of circuit which requires 190mV for full output.

The author has never experienced any instability with any version of the circuit as recommended although a number of different output transformers have been used. If an oscilloscope is not available it is, however, possible to make a few simple checks to ensure that neither low-frequency nor high-frequency instability is present. Any low-frequency instability is normally easily discernible visually as a movement of the loudspeaker cone. If the speaker is replaced by a 15-ohm $\frac{1}{4}$W resistor any continuous high-frequency oscillation present will cause the resistor rapidly to overheat. The gain control should be set at zero for these tests to ensure that any random pick-up of extraneous signals, which might mask internally-generated oscillations, does not occur.

It will be noted that a number of high-stability

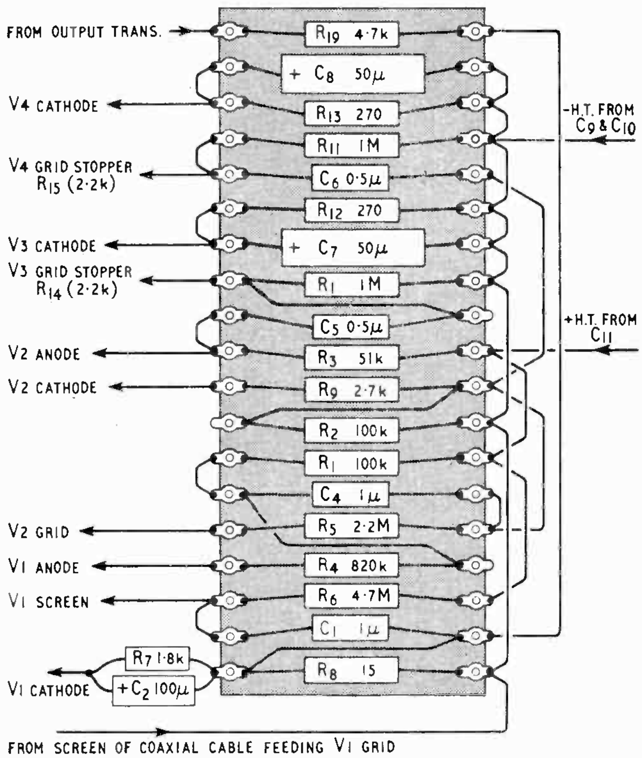


Fig. 8. Layout of LH tag board. In the RH channel which is the mirror image of the sketch, the h.t.-connection is taken to the negative tag of the 100+64μH capacitor in the RH channel side. The earthy side of the input of each channel is earthed only via the coaxial cable screens and the earth bus bar.

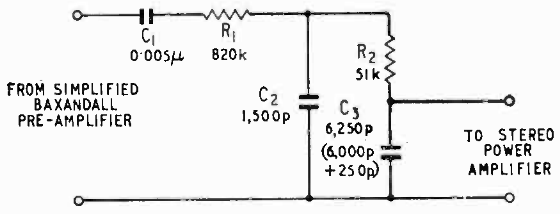


Fig. 9. Passive BS1928:1960 equalizer for use with Baxandall pre-amplifier.

resistors are recommended; these are necessary to prevent the generation of resistance noise in the high-gain part of the system. They are also used in the feedback circuit to ensure that the basic gains of the two channels are equal and remain equal.

A table of d.c. checks taken on a prototype is given in Appendix II; d.c. measurements should normally be within ±10% of the values given.

Stereo Systems and Pre-amplifiers

One of the difficulties in presenting any article on amplification systems for stereo, and to a lesser extent for monophonic gramophone reproduction, resides in the wide variety of sensitivities and characteristics which the pickup selected may offer to the system. If the designer tries to cater for every possible contingency then for a very great proportion of readers the system may be ludicrously complex and expensive. The present design has therefore concentrated on a basic power amplifier of high sensitivity and low cost.

A number of alternative systems are however now discussed, the majority of pickups available should fall into one of the following categories and although in an earlier section the author has inveighed against overelaborate tone control systems (which seem to be aimed at obtaining a fair performance of the records of Dame Clara Butt on a wide-range stereo system), the fact remains that some users do want some measure of tone control and are prepared to accept a little more elaboration and cost.

Low-sensitivity Magnetic Pickup Systems.—Pickups of this type are usually of a very high quality and tend to have an output in the order of 1mV/cm/sec. Since the record manufacturers admit to maximum velocities of about 30 cm/sec the maximum output from a pickup of this type should be about 30 mV. However, amplifier designers tend to play safe and make the basic sensitivity of the corresponding system of the order of 10-15 mV, i.e. a pre-amplifier with a minimum overall equalized gain of about 2½ at 1 kc/s is required.

Since a pickup of this type is a velocity-operated device the pre-amplifier must also provide equalization to the BS1928 : 1960 (R.I.A.A.) characteristic; this implies that the minimum basic gain of the pre-amplifier before equalization is applied must be of the order of 25. If tone controls are required then, of course, the pre-amplifier gain must be correspondingly more.

Valve Pre-amplifiers.—A number of very satisfactory pre-amplifier designs already exist, one of the most elegant and economical is the Baxandall which has been adopted, usually without acknowledgement, on a considerable scale in commercial equipment.

Two such pre-amplifiers (one for each channel) can be easily fed from the spare power supply capacity of the main amplifier unit. As published, the Baxandall simplified pre-amplifier circuit[8] gives adequate tone control but does not provide equalization for the BS1928 : 1960 recording characteristic. The sensitivity of the power amplifier now described is such, however, that a passive equalizer network can be interposed between the Baxandall pre-amplifier and the power amplifier; a suitable network to give the BS1928 characteristic is shown in Fig. 9. This circuit has a basic loss at mid frequencies of 1/12 or −24 dB, since the Baxandall pre-amplifier has a nominal gain of about 90 the combination requires only 7 or 8 mV input to load the power amplifier.

Of the alternative systems referred to, this combination (set out in block schematic form in Fig. 13(a)) is the best overall solution. Since the Baxandall circuit uses only one valve per channel and the stereo power amplifier uses three per channel a complete stereo system, sensitive enough for a low-output pickup, can be made using a total of only four valves per channel, plus the common rectifier, i.e. nine valves in all. This compares very favourably with the majority of systems of similar performance which frequently require six valves per channel or a total of 13 valves for the system.

The complete system will then have an overall equalized sensitivity 7.5mV and will of course have the tone control characteristics of the Baxandall circuit as well as equalization to the BS1928 specification.

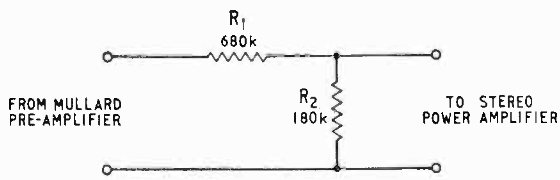


Fig. 10. Attenuator for use with Mullard Stereophonic Pre-amplifier.

The Mullard Stereophonic Pre-Amplifier[9] provides similar facilities; as published the sensitivity is some six times greater than that required for the power amplifier and it is necessary to attenuate the output of the Pre-amplifier as shown in Fig. 10.

Transistor Pre-amplifiers.—The use of transistors in pre-amplifiers is a very attractive proposition for the following reasons:

(i) The impedance level of the circuits minimizes the probability of hum pick-up.

(ii) The elimination of heater wiring reduces the probability of hum pick-up in all wiring associated with input and output circuits.

(iii) The low current consumption enables the units to be self contained with their own batteries, this together with their small size enables them to be mounted immediately adjacent to the motor plate.

The disadvantages of high cost have largely disappeared; the OC71, for example, is cheaper than a valve and needs fewer associated components; but transistors are still more liable to scatter of characteristics than valves and therefore it is correspondingly more difficult to design circuits which are reproducible without minor modification to obtain optimum results. Furthermore, some transistors are noisier than the best valves designed for low-signal audio use. Even so, many users would consider this a fair exchange for a negligible hum level. The principal disadvantage of the transistor for gramophone pickup pre-amplification is its low impedance. This can be raised by inserting series resistance or by applying feedback, but both methods result in a loss of gain which is directly related to the rise in input impedance required.

Transistor Pre-amplifier for Low Sensitivity Pickup.—The simple circuit of Fig. 11 provides amplification for the low-sensitivity type of pickup and at the same time gives equalization to within ± 2 db of the BS1928 characteristic from 30 c/s to 15,000 c/s.

The pre-amplifier consists of two basically similar stages each using an OC71 in the grounded-emitter configuration. Each stage has a measure of d.c. stabilization provided by the resistor R_1 (or R_5) connected from collector to base. This method does not give such good stabilization against very wide temperature variations as a potential divider chain but if the pre-amplifier is mounted in a location away from major heat sources (i.e. usually the main amplifier and power unit) no difficulty should be experienced. The author has been using a similar amplifier for monophonic reproduction for four years without trouble.

The majority of magnetic pickups of this category require a load impedance of the order 50kΩ; this is obtained by inserting the feedback resistor R_3 in the emitter circuit and raises the input impedance to a measured value of 65kΩ.

The h.f. roll-off above the nominal crossover frequency of 2130c/s is provided by shunting the collector load R_2 by the capacitor C_2. The low-frequency equalization, i.e. the rise in gain below the nominal corner frequency of 500c/s, is provided by shunting the feedback resistor R_5 (on Tr2) with the network R_7 C_4; the resistor R_4 is included to define, more precisely, the impedance level of the base-to-earth circuit.

The values of the network parameters may not appear to align strictly with those computed from

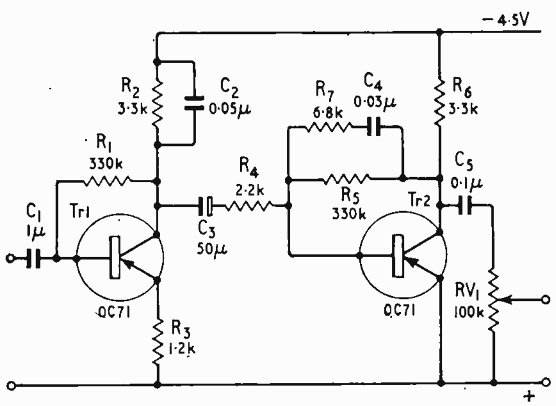


Fig. 11. Transistor amplifier-equalizer circuit.

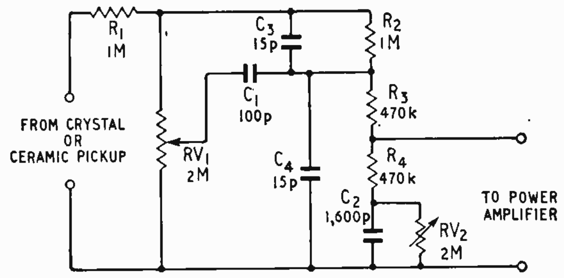


Fig. 12. Passive tone control network.

the nominal crossovers, this is because the values were finally determined experimentally.

The value of C_5 has been chosen in association with RV_1 to give significant attenuation below 20c/s in order to minimize the transmission of motor rumble.

The overall gain of the pre-amplifier equalizer at 1kc/s is such that 16mV in gives 40mV out, thus the sensitivity is more than adequate to load the main amplifier. The total distortion content is less than 1% at 50mV out, this distortion is almost entirely second harmonic in structure. As might be expected the hum contribution from the transistor pre-amplifier is negligible (i.e. too small to be measured). Even so, the usual sensible precautions should be taken: screened leads should be provided at the input and output. Fortunately the low-wattage components required permit a very compact layout which makes the reduction of hum loops comparatively easy. The author recommends that the two channel pre-amplifiers be mounted on opposite sides of an 18 s.w.g. aluminium sheet which should be made somewhat larger than the amplifier tag boards, this minimizes inter-channel cross-talk and if the aluminium screen is earthed the hum pick-up is reduced.

The pre-amplifiers should, of course, be mounted away from the motor and any a.c. wiring. The ease with which the pre-amplifiers can be located on or near the motor plate enables the volume adjustments to be made from the same point. RV_1 and the corresponding volume control on the right-hand channel should therefore be two sections of a ganged control, suitable matched volume controls are now offered for this special purpose.

Passive Tone Control Networks

It has been stated earlier that the sensitivity of the power amplifier is sufficient to allow the insertion of a tone control system consisting entirely of passive elements between the pickup and the amplifier.

A simple but quite effective system is shown in Fig. 12. The network has a basic attenuation at mid-frequencies of 8:1 (or 18dB) and provides:

(a) Bass-lift up to a maximum of 8dB at 50c/s.

(b) Treble-cut up to a maximum of 12dB at 10kc/s.

(c) Treble-lift up to a maximum of 4dB.

The range of control is somewhat less than that provided by many valve pre-amplifier units; this

(*Continued on page 271*)

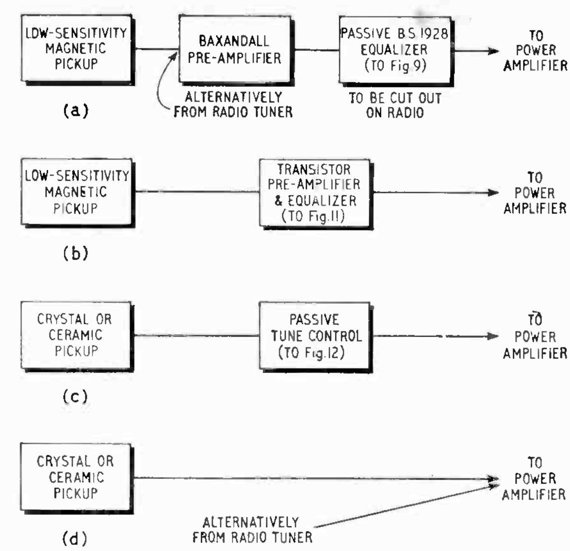


Fig. 13. A selection of typical input systems for coupling pickups to the main amplifier.

has been adopted because: (a) there is a practical limit to the amount of gain which can be thrown away for this purpose, and (b) modern recordings do not require drastic correction (they are scarcely worth listening to if they do!).

Bass cut has not been provided as this is rarely required in practice whilst the degree of treble lift amounts to little more than a " presence " control.

Ceramic and crystal cartridges normally require to be presented with a load impedance of about 2MΩ to give adequate low-frequency response. This is ensured by inserting the swamping resistance R_1 (= 1MΩ) although this does double the insertion loss of the network. If the pickup will tolerate a 1-megohm load, then R_1 can be omitted and the insertion loss of the network is halved.

The degree of bass lift is adjusted by RV_2 but the degree of lift is also restricted by the input resistance of the following circuit, i.e. the input impedance of the power amplifier. If the passive tone control is used the input volume controls (or replacement resistors) should be of 2 megohm value.

Typical Systems

As an illustration of the way in which different systems may be made up from the available "bricks" a number of typical arrangements is shown in Fig. 13. The author cannot claim to have tried each and every possible combination and his bitter experience suggests that the particular arrangement which suits the reader will be different anyway. If, however, a few simple commonsense rules are followed no undue difficulties should be met.

In general, tone controls and pre-amplifiers will be located in the vicinity of the pickup for operational convenience so that with reasonable care the pickup to pre-amplifier connection should not give rise to hum generation. If, however, in Fig. 13(a) the passive equalizer is located with the Baxandall pre-amplifier, then the pre-amplifier to power amplifier connection is at a high-impedance level and suitable shielding and earthing precautions should be taken. If this particular system is devoted entirely to gramophone reproduction then advantage should be taken of the fairly low output impedance of the Baxandall Pre-amplifier, and the passive equalizers should be located at the input to the power amplifier unit.

In the case of the transistor amplifier equalizer the output impedance cannot exceed the collector load on Tr2 which is only 3.3kΩ so that no trouble should be experienced with the interconnections.

In the arrangement of Fig. 13(c) the passive tone control will probably be mounted near the pickup and the network to power amplifier connection will therefore be at a high impedance level, the appropriate precautions should therefore be taken.

Conclusions

The object of the foregoing article has been to provide without any sacrifice of quality a stereo power amplifier design of high sensitivity which will enable an overall stereo system to be made with a minimum of elaboration and at a low total cost. The money saved can, if the reader wishes, be devoted to the transducers in which (begging their pardon) there are still sources of distortion which render academic arguments on the relative merits of amplifiers of 0.14% or 0.15% distortion. The author has had good results using a number of different pickups including the Cosmocord " HiLight " played directly into the stereo power amplifier; the loudspeakers used differed slightly, one being the Wharfedale W4 and the other a similar speaker combination in a McProud corner horn[10, 11].

REFERENCES

[8] " Inexpensive Pre-Amplifier," P. J. Baxandall, *Wireless World*, May 1957, pp. 209-12.

[9] Stereophonic Pre-amplifier in " Mullard Circuits for Audio Amplifiers."

[10] " A New Corner Speaker Design," C. G. McProud, *Audio Engineering*, Jan., Feb., 1949.

[11] " Corner Speaker for 12in Cones," C. G. McProud, *Audio Engineering*, May, 1949.

APPENDIX II

Voltage Checks on a Prototype

Taken at an a.c. supply voltage to primary of mains transformer of 230V.

Unsmooth h.t. voltage (across C_{10})	= 350V
Smoothed h.t. voltage (across C_9)	= 330V
Filtered h.t. voltage (across C_{11})	= 292 V
V1 measurement	
Cathode/earth (across R_7)	= 0.55V
V2 measurements	
Anode/earth	= 210V
Across bias resistor (R_9)	= 3.3V
Across cathode load (R_2)	= 115V
V3 measurements	
Anode/earth	= 312V
Screen/earth	= 319V
Cathode/earth	= 11V
V4 measurements	
Anode/earth	= 312V
Screen/earth	= 319V
Cathode/earth	= 11V

APPENDIX III

Schedule of Components

The schedule shows representative components; all possible manufacturers' versions cannot, of course, be included, but provided wattage tolerance and voltage ratings are satisfied any suitable alternative should be acceptable.

Stereo Power Amplifier and Power Supply Unit (Fig. 3)

The number of components shown cover *both* channels of the Stereo Amplifier.

Resistors	*Qty.*	*Value*	*Tolerance (%)*	*Wattage*
R_1	2	100kΩ	5	½
R_2	2	100kΩ	5	½
R_3	2	51kΩ	5	½
R_4*	2	820kΩ	5	½
R_5*	2	2.2MΩ	20	¼
R_6*	2	4.7MΩ	5	½
R_7*	2	1.8kΩ	10	¼
R_8*	2	15Ω	5	½
R_9	2	2.7kΩ	10	¼
R_{10}	2	1MΩ	20	¼
R_{11}	2	1MΩ	20	¼
R_{12}	2	270Ω	5	3
R_{13}	2	270Ω	5	3
R_{14}	2	2.2kΩ	20	¼
R_{15}	2	2.2kΩ	20	¼
R_{16}	2	270Ω	20	¼
R_{17}	2	270Ω	20	¼
R_{18}	2	22kΩ	10	1
R_{19}*	2	4.7kΩ	5	½
R_{20}	1	… Will depend on resistance of mains transformer. GZ34 requires a total effective resistance of 75 ohms per anode. In practice resistors will rarely be needed.		
R_{21}	1			
RV_1†	1			

Notes: *Indicates a high-stability resistor.

†Matched pair of ganged potentiometers, e.g. Reliance, for both channels.

Capacitors	*Qty.*	*Value (μF)*	*Voltage Rating*	*Remarks*
C_1	2	2	250	Hunts A.311
C_2	2	100	6	Electrolytic
C_3	2	0.05	350	Hunts A.311
C_4	2	1	350	Hunts A.315L
C_5	2	0.5	350	Hunts A.314
C_6	2	0.5	350	Hunts A.314
C_7	2	50	50	Electrolytic
C_8	2	50	50	Electrolytic
C_9 } C_{10} }	1	{100 {64	450 } 450 }	Electrolytic capacitors in single can
C_{11} } C_{12} }	1	{100 {64	450 } 450 }	Electrolytic capacitors in single can, for LH and RH channels.

Valves	*Qty.*	*Valve type*	
V1 and V2	2	6BR8	(Brimar)
V3 and V4	4	EL84	(Mullard)
V5	1	GZ34	(Mullard)

Transformers and choke

T_1 *mains transformer* (Drake Type WW.184. Gardner Type R178).
Primary 250V tapped at 220, 230, 240V.
H.T. secondary 300-0-300V at 250mA.
L.T. secondaries. 5V at 2A
6.3V at 4A
6.3V at 1A (centre-tapped)

Output Transformer T_2 (Drake Type WW.185. Aresco Type Mullard Ultra Linear. Partridge Type P.4131). To match 8000Ω to 15Ω with "ultra-linear" primary taps at 43% 12W power rating.

Smoothing Choke L_1 (Drake Type L/WW.186. Partridge Type C5/200). 4 (or 5) henries at 250mA, d.c. resistance approximately 100 ohms.

Chassis.

Recommended chassis size, using 18 s.w.g. aluminium, 12in × 9½in × 3½in.

Stereo Balance Circuit Modification (Fig. 4)

Resistors	*Qty.*	*Value*	*Tolerance (%)*	*Wattage*
R_8	(Exists in each amplifier (Fig. 3)).			
R_{22}	1	8.2kΩ	10	¼
R_{23}	1	6.8kΩ	10	¼
RV_2	1	20kΩ		

Alternative Stereo Balance Modification (Fig. 5)

Two sections of ganged logarithmic/antilogarithmic potentiometers following 10% law.

Passive BS1928: 1960 Equalizer (Fig. 9)

Resistors	*Qty.*	*Value*	*Tolerance (%)*	*Wattage*
R_1	2	820kΩ	10	¼
R_2	2	51kΩ	5	¼
Capacitors				*Voltage rating*
C_1	2	0.005Ω	—	350 wkg.
C_2	2	1500pF	5	
C_3	2	{6000pF +250pF}	5	

Attenuator for use with Mullard Pre-amplifier (Fig. 10)

Resistors	*Qty.*	*Value*	*Tolerance (%)*	*Wattage*
R_1	2	680kΩ	20	¼
R_2	2	220kΩ	20	¼

Transistor Amplifier Equalizer Circuit (Fig. 11)

Resistors	*Qty.*	*Value*	*Tolerance (%)*	*Wattage*
R_1	2	330kΩ	10	¼
R_2	2	3.3kΩ	5	¼
R_3	2	1.2kΩ	10	¼
R_4	2	2.2kΩ	10	¼
R_5	2	330kΩ	10	¼
R_6	2	3.3kΩ	10	¼
R_7	2	6.8kΩ	5	¼
Capacitors				*Voltage Rating*
C_1	2	1μF		150
C_2	2	0.05μF	5	150
C_3	2	50μF		6
C_4	2	0.03μF (consisting of 0.02 + 0.01 in parallel).	5	150
C_5	2	0.1μF	20	150

RV_1 and corresponding control in RH channel may be ganged potentiometers.
Transistors Tr1 and Tr2 are OC71s.
Supply battery 4.5V.

Passive Tone Control Networks (Fig. 12)

Resistors	*Qty.*	*Value*	*Tolerance (%)*	*Wattage*
R_1	2	1MΩ	20	¼
R_2	2	1MΩ	20	¼
R_3	2	470kΩ	20	¼
R_4	2	470kΩ	10	¼
RV_1	2	2MΩ		
RV_2	2	2MΩ		
Capacitors				
C_1	2	100pF	10	
C_2	2	1600pF	10	
C_3	2	15pF	10	
C_4	2	15pF	10	

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Response Curves and Tone Quality

MR. SCROGGIE'S review of the public reaction to tape recorder frequency response revives the old controversy over the advantages of a flat overall response.

Though the need for a flat overall response curve appears eminently reasonable, all attempts to confirm the point have only shown that an uneducated (in the "high-fi" sense) audience prefer a monophonic reproducer system to have a response that falls off at the high-frequency end of the spectrum. In the only well-founded experiment to produce a contrary result, Olson allowed the panel to listen binaurally. This is I think the significant difference between the technique used by Chinn and that used by Olson.

It is worth noting that Somerville and Brownlees (*B.B.C. Quarterly*, Jan. 1949) found that an untrained audience listening monophonically preferred loudness levels some 20dB below that of a typical concert hall performance. (Approximately one quarter as loud.) No well-grounded experimental evidence is available on the preference of an audience listening stereophonically; but supported by a short series of tests in one of Londons' leading cinemas I believe that preferred levels are some 10-15dB higher when a good stereophonic technique is employed.

A reproducer that provides an indication of the size of the original source always sounds softer and easier on the ear than a monophonic system having the same frequency and loudness ranges. Similarly a given amount of objectively assessed distortion is less distressing subjectively when a stereophonic reproducer is employed.

There is little doubt that an untutored audience unaware of any technical criteria will always choose the "most pleasing" rather than the "most accurate" reproduction. Deficiencies in the technical performance such as the presence of noise, non-linearity distortion, high-Q resonances, a polar diagram that changes rapidly with frequency, or a failure to produce a virtual source subtending the same angle as the original will all result in a preference for restricted frequency range. The importance of source size is only just being recognized, for until relatively recently the other distortions mentioned were subjectively more significant.

I would guess that in the tape recorder tests, all these distortions were more important than any restriction of frequency range and that in consequence the listening panel were making a choice based on other factors.

Chipperfield, Herts. JAMES MOIR.

Television Standards—NOT a World Problem

TELEVISION standards are not a world problem—as is suggested by the heading of your March editorial. The world at large knows where it is going—it is Great Britain (and to a lesser extent, France and Belgium!) that is muddled.

There has been international agreement on an 8-megacycle channel width for television. A 625-line system makes the best-known use of such a channel width, especially bearing in mind the inclusion of colour information. Therefore, Great Britain should make arrangements for a progressive change to such a system.

But what do we find? The B.B.C. and a number of people in authority—backed, for other reasons, by a well-known daily paper—wanting to start a new colour service on a system which is known to be outmoded. Additional programme channels are also under consideration; surely this is the stage at which new transmission equipment should be made to the 625 standard? Most modern studio equipment, already in use, is capable of switching to that standard. (Industrial television equipment also already uses 625 lines—another reason for standardizing this system.)

If 405-line colour broadcasts start and the public are inveigled into buying receivers at £250 a time, do you seriously consider that it will *ever* then be practical to change the standard? Not for 25 years or more. Naturally, the colour viewers would not want their expensive sets made obsolete by a change of standard.

Few people realize that *vertical* picture resolution is *not* equal to the number of picture lines. Merely elongating the spot or wobbling it to "fill the gaps" is not the answer. This fact would become apparent if the B.B.C. turned Test Card C through 90°. You would then have difficulty in resolving the 1½ megacycle bars! The actual vertical resolution is little more than *half* (Kell Factor) the number of scanning lines at best and it is, of course, in this respect and in interline flicker, that the 405 system is most deficient.

These facts account for the lack of popularity of the 21in/23in tubes in this country whereas in the rest of the world these tubes are standard. (You seem happy enough to stay with a smaller tube!)

By proper planning and looking a little beyond our noses, a 625 system could be brought in without disruption in service or to the industry.

Clacton-on-Sea. D. W. HEIGHTMAN.

Bootstrap-Follower Amplifier

I FEAR that I did J. R. Ogilvie an injustice in my comments on his letter in the March issue, by hinting that a gain of 2,500 is more than can be expected from a 6BR8 bootstrap-follower amplifier. In the same issue, E. Jeffery reports a gain of 3,500 from the same valve!

The reason why the gain obtained is greater than the amplification factor of the pentode part of the valve under the makers' typical operating conditions is, as Jeffery suggests, that μ is increased in the low-current circuits employed. The reason for the increase was explained by the late W. A. Ferguson (*Mullard Technical Communication* No. 6, Jan. 1954) as follows:—

"If a pentode is operated under constant bias and with constant anode voltage, and the screen voltage is reduced below the value normally adopted for a resistance-capacitance coupled amplifier, the mutual conductance is reduced, but initially this reduction is more than compensated by an increase in the internal resistance of the valve, so that the amplification factor ($\mu = g_m r_a$) increases."

In both Mr. Ogilvie's circuit and Mr. Jeffrey's, screen resistors of very high value are used (2.7MΩ and 4.7MΩ). The screen voltage in these circuits must be much lower than in the manufacturer's data.

Croydon. G. W. SHORT.

WHILST largely agreeing with all that Mr. Short states in his article in the January and February issues, I do feel that in some respects he is unduly blackening the bootstrap follower.

First, regarding the low-frequency response, there is no necessity for using such a low value of C_s as 0.1μF, as this capacitor is in the positive feedback to the anode of V1 (Fig. 9, p. 79, February, 1961). As he states in the text, this can be an electrolytic capacitor and a 4μF capacitor will give a frequency response very close to that of the cascade amplifier.

Regarding the use of a 5pF feedback capacitance between output and input, I feel that this is a rather artificial device and it would be interesting to know the effect of a 5pF capacitor fed back from output to input on the cascade amplifier. I may be wrong, but I suspect that it would go into self-oscillation.

This brings me to what is definitely an advantage of the bootstrap follower for constructional purposes, and this is that there is very little tendency for the circuit to go into self-oscillation. Anyone who has constructed high-gain amplifiers will have normally encountered this problem.

Finally, I would like to congratulate Mr. Short on producing a very interesting and accurate treatise on the performance of this rather unusual circuit.

Bradford, 7. A. R. BAILEY,
Senior Lecturer in Electrical Engineering,
Bradford Institute of Technology.

Nodal Analysis

MY applause goes to Mr. Jones for his excellent pair of articles on "Nodal Analysis" (Nov. and Dec. 1960 issues). There was one slight blemish in the first, however, and I wish to correct this. Mr. Jones used as an example the case of tuned coupled circuits and arrived at the result that the response has maxima at frequencies $1/2\pi[C(L \pm M)]^{\frac{1}{2}}$. This can be shown to be false by differentiating the expression for the secondary current. It can easily be seen to be wrong when we remember that if M is very small (undercoupling) there is only one peak.

Mr. Jones' answer does not behave in this manner and therefore cannot be correct. The real point is that Mr. Jones has implicitly assumed R is zero. If R is increased from zero the peaks in the response move inwards until they coalesce (critical coupling). Any further increase in R results in a single peak smaller than the above peaks. This is indicative of the fact that matching is no longer properly achieved.

Cambridge. B. J. AUSTIN

The author replies:

Mr. Austin's remarks are correct—in both the examples on tuned coupled circuits the effects of resistance were ignored. This is in part due to the fact that the treatment was intended to be indicative, not exhaustive, since a reasonably full treatment of tuned coupled-circuit theory in the space available would have been impossible, and indeed irrelevant.

Again the equation $\omega_1(L+M) = 1/\omega_1 C$, given in the first example, leads directly to $f_1 = f_o/\sqrt{1+k}$ which is so often quite good enough for radio work, where Q commonly lies between 50 and 100. (See *Solutions of Problems in Telecommunications*, by C. S. Henson. Pitman 1956, page 31.)

However, apart from this, I agree with Mr. Austin that it should have been explicitly stated in the first example—as was in fact done in the second—that, to a first approximation, the effects of resistance were ignored.

F. R. B. JONES

Why Xtal?

"FREE GRIDS" heart-rending cry "Why Xtal?" (page 154 of the March issue of *W.W.*) has affected me so deeply that I hasten to dry the undoubtedly accompanying tears of the interrogator.

I doubt whether the abbreviation "xmitter" might have any relation to St. Andrew's cross. As far as I know this word is derived from the Latin expression—alas, another "X"—"exmittere" that means: to send out, emit, radiate, and finds its manifestation, for instance, in the term "class-of-emission." The ancient Latins known not only for their exceptionally precise grammar, but also for their extraordinarily delicate feeling of euphony have, therefore, omitted the letter "x," and have abbreviated the word "exmittere" to "emittere." But, nevertheless, after some odd 2,500 years have passed the unabbreviated term "ex" is always present in our minds—and is still being found either in words like: express, expel, export where there is no danger to some kind of "hiatus" or, in commercial language, in expressions like ex ship, ex works or so. "Ex" means "out of." Why not simply substitute it by the single letter "x" which is pronounced exactly the same way. So far "xmitter."

The letter "X" in the word "Xtal" has a different origin. The Christians, in ancient times, used a combination of the capital letters chi and rho as a symbol for their fraternity. Try to pronounce the word "Christ" and add the letters "al," and please don't take any offence at the difference between an open syllable and a closed one. There you are, or are you?

There is indeed another not so far-fetched interpretation of the letter "X." The lazy American amateur-hams—or am I to say: they are always in a hurry?—used to abbreviate all they deemed possible or desirable in order to get their message through as quickly as possible, cf. shorthands like: tx for transmitter, rx for receiver, dx for great distance, xyl for a married woman (ex-young-lady), and—don't mind it—xtal for crystal.

Now, please, you may make a selection that suits you.

Berlin-Siemensstadt. PAUL HAMEYER

Fettered by Physics

"FREE GRID," in last month's issue slipped up a little in his paragraph "Fettered by Physics." Several writers have written "science fiction" stories in which the characters moved and had their being in sub-atomic or wave form. One American writer (I think in 1939) wrote a series concerning two characters who "lived" in some such states. So let us be fair to the science fiction writers who have not overlooked ψ waves as a means of expression.

Birmingham. A. S. WARBURTON.

Commercial Literature

Miniature Lever Keys, offered as an alternative to the full-size type often used for line-switching, are only $1\frac{3}{4} \times {}^{39}/_{64} \times 2{}^{3}/_{16}$in overall and are available mounted as single, double and triple units which can be "nested" to make up switch boards. Negligible wear or loss of contact pressure is claimed after one million operating cycles. Leaflet from Ericsson Telephones Ltd., 22, Lincoln's Inn Fields, London, W.C.2.

Vacuum Coating for optical, electric and decorative use is described together with illustrations of equipment in a book from Edwards High Vacuum Ltd., Manor Royal, Crawley, Sussex. Among the electrical uses covered are aluminizing of c.r.t.s., deposition of contacts and quartz crystals, manufacture of selenium rectifiers and roll-coating of paper for capacitors.

Gamma-radiation Detector, built up as a self-contained "prod" 33in long, weighing only $4\frac{1}{2}$lb, is one of the many items described in a catalogue of Ekco and Dynatron nucleonic equipment. Apply to Ekco Electronics Ltd., Southend-on-Sea, Essex.

Bimetals produced by Henry Wiggin and Co., Ltd., having a wide variety of characteristics and capable of withstanding immersion in water or steam, or use at high temperature, are described in a booklet entitled *Wilco-Wiggin Thermometals,* from the company's office at Thames House, Millbank, London, S.W.1.

R.f. Coaxial Cables using a helical spacer of polythene or p.t.f.e. on to which an aluminium sheath is drawn have attenuation as low as 2.2dB/100ft at 3Gc/s and can operate at peak r.f. voltages up to 12kV: in addition bending radii as small as 7in can be used. Booklet from Telegraph Construction and Maintenance Co., Ltd., Mercury House, Theobald's Road, London, W.C.1.

Applications of Frequency-Sweep Oscillators

3.—CABLES AND FILTERS

By R. BROWN

Concluded from page 133 of the March 1961 issue

SO far we have explored the use of the swept oscillator mainly for alignment of active pieces of equipment; that is, equipment which gives gain or employs deliberately non-linear elements such as demodulators. The frequency-sweep oscillator's utility is not, of course, confined to these items—it can be an immense time-saver in the setting-up of filters and the matching of cables. This latter, incidentally, makes use of one of the snags that can be encountered in its employment for amplitude/frequency and phase/frequency measurements.

Impedance Matching for Cables

The variations in output level that can be caused by mismatched cables can be put to good use when checking and adjusting cables which are terminated in resistive loads or radiating elements[6].

This can best be seen by looking into the principle

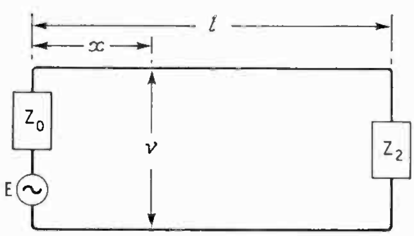


Fig. 16. Generator of e.m.f. E volts corrected via line of characteristic impedance Z_0 to load Z_2.

of operation a little more closely. Consider a generator of e.m.f. E volts and internal impedance Z_0. This is connected to a load Z_2 via a length (l) of lossless cable, which has a characteristic impedance of Z_0, (Fig. 16). If the load Z_2 is equal to the characteristic impedance Z_0 of the line, then the line will be matched and the energy in the wave travelling down the line from the generator will be absorbed in the load, and there will be no energy reflected. Should, however, Z_2 have a value different from the characteristic impedance of the cable, then some of the energy in the wave travelling down the line from the generator will be reflected at the load, and will travel back up the line to the generator.

Under these conditions the voltage v at any point, say x, along the line will be the vector sum of the outgoing wave from the generator, and the returning reflected wave. This voltage will have a maximum value when the two vectors are in phase and a minimum value when the two vectors are out of phase, and a standing wave pattern will be set up along the line (Fig. 17). The number of maxima and minima depends upon the electrical length of the line.

The degree of mismatch can be expressed in terms of a reflection coefficient P_2, which is the ratio of reflected voltage to forward voltage, and is given by

$$P_2=(Z_0-Z_2)/(Z_0+Z_2) \quad \ldots\ldots\ldots\ldots\ldots \quad (6)$$

This reflection coefficient can be deduced from the standing-wave ratio on the line, which is the ratio of the value of the voltage at a point on the line at which a maximum occurs to the value of the voltage at a point on the line at which a minimum occurs.

The conventional fixed-frequency method of checking the accuracy of matching, is to measure the standing-wave ratio on the line by moving some form of detector along the line.

Practical Sweep Technique.—If the fixed-frequency generator of Fig. 16 is now replaced with a swept-frequency generator, then the electrical length of the line will vary continuously as the frequency is swept. Thus the number of standing waves in the cable will vary, and the position of the various maxima and minima will move along the line. If a detector is connected across the line at some point and its output is displayed on an oscilloscope then it will be found that the standing-wave pattern on the line is, in effect, moving past this point.

For convenience the point chosen for the detector is the sending end of the cable, and the block diagram of a suitable set up is shown in Fig. 18. The output from the swept oscillator is connected to the input end of the cable; this cable is terminated in a load Z which should have an impedance equal to the characteristic impedance Z_0 of the cable over the

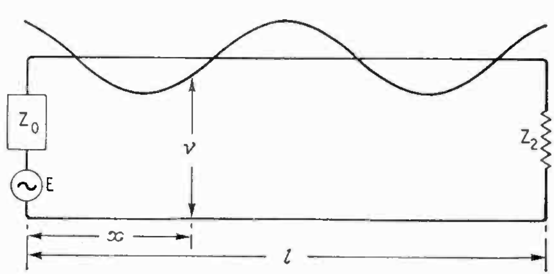


Fig. 17. Standing waves on a line terminated in load other than the line's characteristic impedance.

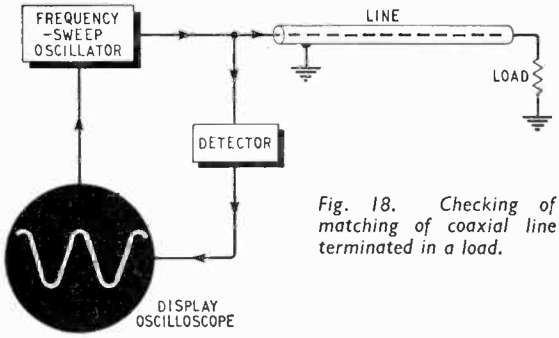


Fig. 18. Checking of matching of coaxial line terminated in a load.

frequency band of interest. A detector is connected across the input end of the cable, and its output is taken to the y amplifier of the display oscilloscope.

This arrangement will produce accurate results provided that the output impedance of the generator is equal to the characteristic impedance (Z_0) of the line over the frequency band of interest—so that the input reflection coefficient P_1 is zero. Also the output voltage of the generator must be constant over the same frequency band.

The actual value of the voltage at a frequency where a maximum occurs is:—

$$v_{max} = (E/2)(1+P_2) \qquad (7)$$

while the value of the voltage at a frequency where there is a voltage minimum is given by:—

$$v_{min} = (E/2)(1-P_2) \qquad (8)$$

and when the load is correctly matched to the cable, so that $Z_2 = Z_0$, and $P_2 = 0$ we have:—

$$v_{matched} = E/2 \qquad (9)$$

The s.w.r., which is v_{max}/v_{min}, is thus given by:—

$$\text{s.w.r.} = (1+P_2)/(1-P_2) \qquad (10)$$

The values of voltage which will be produced for any given swept oscillator and cable can be calculated from the above equation and marked up on the display oscilloscope as s.w.r. values (Fig. 19).

Sweep-width Required.—The width of the frequency band being swept must obviously be sufficient to allow at least one maximum and one minimum of the standing wave pattern to be displayed. This minimum frequency sweep depends entirely upon the electrical length of the cable, and if f_1 is the frequency at which a maximum (or minimum) occurs, and if f_2 is the frequency at which the next minimum (or maximum) occurs, then:—

$$f_1-f_2 = s\ [(1/\lambda_1) - (1/\lambda_2)] = s\ [(n/2l) - (2n-1)/4l] = s/4l \qquad (11)$$

where s is the velocity of electromagnetic waves in the cable, l is the length of the cable in metres and n is the number of half wavelengths in the length l at f_1.

Taking a typical cable, the Uni Radio No. 1, as an example, the value of s is 0.66 c, where c is the velocity of e.m. waves in free space. A length of 15m would thus call for a minimum sweep width of

$$0.66\times3\times10^8/60 = 3.3\ \text{Mc/s}.$$

These equations hold for conditions where P_2 is real and constant with frequency, its modulus is independent of frequency and its phase varies with frequency.

In the general case where P_2 varies in both modulus and phase with frequency, the conditions are very much the same, provided that the power is being delivered to the load over a very wide frequency range. The requirements for a minimum sweep width will, of course, normally ensure that this is so.

Equations (7) and (8) will, however, have to be modified to:—

$$v_{max} = (E/2)\ (1+|P_2|\lambda_1) \qquad (12)$$

$$v_{min} = (E/2)\ (1-|P_2|\lambda_2) \qquad (13)$$

where in Equation 12 the value of $|P_2|$ used is the value at a wavelength λ_1 at which a maximum occurs, while in Equation 13 the value of $|P_2|$ used is the value at a wavelength λ_2 at which a minimum occurs.

Equn. 10 for the s.w.r. now holds at λ_1 and at λ_2.

Equations (9) and (12) can now be used to calculate $|P_2|$ at λ_1 and the s.w.r. can then be evaluated from the expression

$$\text{s.w.r.}\lambda_1 = (1+|P_2|\lambda_1)/(1-|P_2|\lambda_2) \qquad (14)$$

The voltage standing wave ratio at λ_2 can be calculated in a similar manner. The minimum frequency sweep ($f_1-f_2 = s/4l$) is the same as before.

Effect of Cable Losses.—So far the cable connecting the swept-frequency oscillator to the load has been assumed to be lossless. This is, of course, impossible in practice and the cable will attenuate to some degree both the outgoing and reflected waves. For most applications however this effect is not important. For example consider a cable which introduces 1.9dB attenuation: this corresponds to a voltage ratio of 0.8, and it can be shown that a s.w.r. of 2 : 1 on a loss-free cable would show up as a s.w.r. of 1.8 : 1 on this cable.

The effect of the attenuation (α) on the display is greatest when $|P_2| = 1$. In this condition v_{min} should be zero: but it will in fact fail to reach zero by an amount depending upon the attenuation. The effect of the attenuation can be allowed for in calibrating the display. Equations 7 and 8 become

$$v_{max} = (E/2)\ (1+|P_2|\alpha) \qquad (15)$$

$$v_{min} = (E/2)\ (1-|P_2|\alpha) \qquad (16)$$

The y axis is calibrated by calculating the voltages which correspond to s.w.r.'s of 1, 2, 3 and 4, and marking these values on the face of the tube (Fig. 19).

For the x-axis markers can be introduced in the usual way. The display is to some extent self-calibrating because for any given length of cable the frequency difference between a maximum and a minimum is constant and can be determined from Equation 11, $f_1-f_2 = s/4l$.

Some typical matching displays are shown in Fig. 20. The x-axis represents frequency, and the y-axis represents the modulus of the vector sum of the outgoing and returning voltage waves at the generator end of the cable.

The first oscillogram (Fig. 20(a)) shows a line which is short circuited at its far end. $Z_2=0$, and the reflection coefficient $P_2=1$. With a lossless line this would give an infinite s.w.r. But, as has

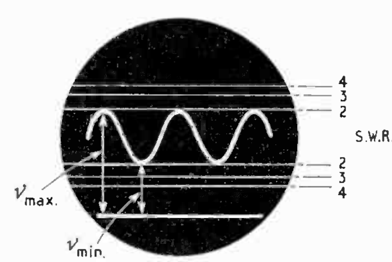


Fig. 19. Calibration of display for matching measurements. S.w.r. lines are drawn from calculated values.

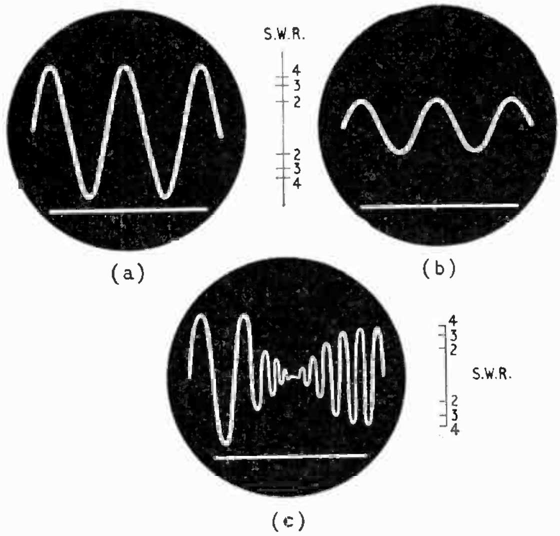


Fig. 20. Displays produced when a length of line is terminated in (a) short-circuit; (b) resistor equal to twice its characteristic impedance; (c) half-wave dipole.

already been mentioned, v_{min} fails to reach zero by an amount depending upon the line attenuation.

The second oscillogram (Fig. 20(b)) shows a s.w.r. of 2 : 1. This could be produced when using a cable of, say, 70Ω characteristic impedance terminated by a resistance of 140Ω, the termination being purely resistive and independent of frequency.

In the third oscillogram (Fig. 20(c)) the line is terminated in a half-wave dipole. This is a good example of a line which is terminated in a load which varies in both modulus and phase with frequency. Over a small frequency range in the centre of the oscillogram the aerial is resonant and has an input impedance about equal to the characteristic impedance of the cable. The s.w.r. is approximately one. Above and below this frequency band, however, the mismatch becomes progressively greater, and the s.w.r. rapidly increases.

Impedance Measurement

A common method of measuring impedance at the higher frequencies is by slotted line techniques[7]. The impedance to be measured is connected to the end of a standard line and the s.w.r. on the line is then measured by sliding a probe along a slot in part of the line. From a knowledge of the s.w.r., the characteristic impedance of the line and the frequency, the impedance can be determined. Fig. 21(a), shows a typical standing-wave pattern on a line (characteristic impedance Z_0) which is terminated in a load Z_2 which has an impedance different from Z_0. With a fixed frequency measurement the s.w.r. is first determined with the load Z_2 connected and the position on the line of a convenient voltage minimum is noted. Then the load is short circuited which will cause a shift in the standing-wave pattern (Fig. 21(b)). The length of this shift can be measured by measuring a distance (d_1) the voltage minimum previously noted has moved. Finally a measurement of the distance (d_2) between two voltage minima will give the length of one half wavelength of the signal in the line. From the two distances, d_1 and d_2, the electrical shift in the position of the minimum can be calculated (shift $= d_1/d_2 \times 180° = \phi°$). This is equal to the distance between the load and the nearest voltage minimum.

From these two quantities, the s.w.r., the distance between the load and nearest voltage minimum in degrees and the impedance can be evaluated with the aid of a transmission-line chart.

An arrangement similar to that used for cable-matching display will enable the impedance to be measured with a swept-frequency oscillator[6]. The swept-frequency method of impedance measurement will provide all the required information without slotting the line.

At frequencies where there is a maximum or a minimum at the sending end of the cable, the input impedance of the cable is resistive. The impedance at the receiving end can be found, as with fixed frequency measurements, by measuring the s.w.r. at one of these frequencies, the cable attenuation and the distance between the load and the nearest voltage minimum.

The s.w.r. can be measured as was done for impedance matching measurements, The attenuation can be calculated from the display.

Electrical Length of Line.—To find the distance between the load and the nearest voltage minimum, the electrical length of the line must be determined.

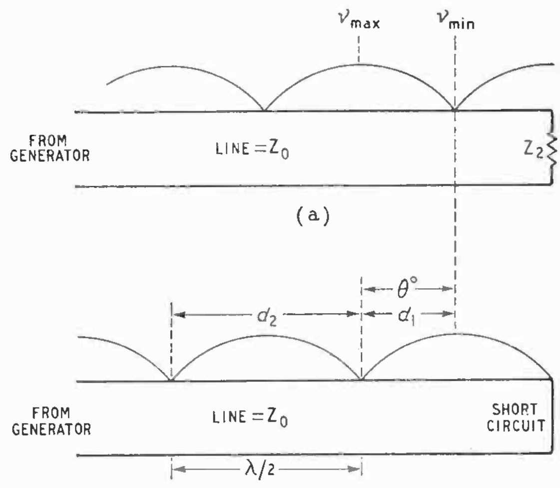


Fig. 21. Impedance measurements using slotted-line technique.

This can be done in the following manner. The cable is short-circuited at the receiving end and a frequency at which a voltage minimum occurs at the sending end is measured. At this frequency, call it f_1, there will thus be a voltage minimum at both the sending and receiving ends, there are consequently a whole number of half wavelengths in the line at this frequency. The actual number of half wavelengths in the line and therefore its electrical length can be determined from the length of the line and the phase velocity in the line. A typical co-axial cable has a phase velocity of $2c/3$. If the frequency (f_1) is 100Mc/s, and the cable is 10m long, then there are $(2c/3)/f_1 \times 10 = 10$ half wavelengths in the cable.

The phase velocity and the physical length of the line need not be known with any great accuracy, as they are only needed to identify the nearest integer.

The electrical length in degrees of this particular 10-m length of cable at 100Mc/s, is given by:—number of half wavelengths in line $\times$ 180°. That is, in this case $10 \times 180° = 1800°$.

The impedance to be measured is now re-connected to the receiving end of the cable, and the frequency, say f_2, at which a minimum occurs is accurately measured. The electrical length of the line at this frequency f_2, is found by multiplying f_2 by the electrical length of the line at f_1, and dividing the result by f_1. The number of half-wavelengths in the line at f_2 can then be determined, as was done at f_1. This will not be a whole number, normally, but will include a fraction of half a wavelength. This fraction is the distance between the load and the nearest voltage minimum.

Supposing the frequency f_2 was 111Mc/s. The electrical length at this frequency, of the cable in the previous example, would be:—

$$111 \times 10^6 \times 18 \times 10^2/10^8 = 1998°$$

The number of half wavelengths in the line is, therefore 11 : 1.

The electrical length from the load to the nearest voltage minimum is therefore 18°, (Fig. 22).

Thus, all the required information has been obtained from the display, and a transmission line chart can be used to determine the impedance.

Display of Filter Characteristics

Complex filters containing a large number of reactive components present a rather special problem. It is usually necessary to adjust the amplitude characteristic to be reasonably flat over the pass-band while ensuring that the input impedance is reasonably constant over the same frequency range. Any change made in a component with the object of improving the amplitude characteristic will, however, also alter the input impedance. Filter adjustment, then, usually means a tedious swapping backwards and forwards from an examination of the amplitude characteristic, to an examination of the input impedance/frequency characteristic.

A considerable amount of the work can be avoided by displaying, simultaneously, the amplitude/frequency characteristic, and, indirectly, the input impedance/frequency characteristic. A suitable set-up is shown in Fig. 23. A double-beam oscilloscope is used and the amplitude/frequency characteristic is displayed by one beam. The sweep generator is

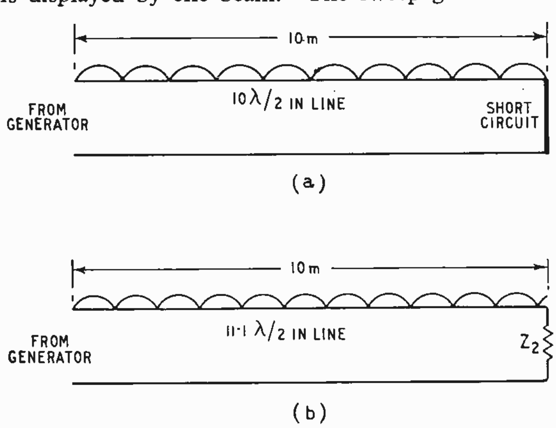


Fig. 22. (a) Line-length is 1800° at 100Mc/s and (b) 1998° at 111Mc/s.

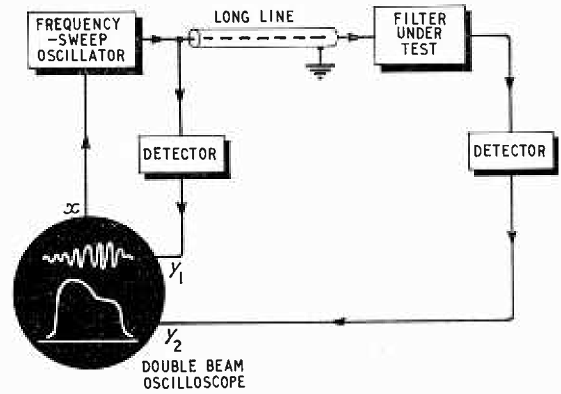


Fig. 23. Simultaneous sweep display of amplitude/frequency and input-impedance/frequency characteristics of a filter.

connected to the input of the filter via a long length of cable whose characteristic impedance is equal to the required input impedance of the filter. A detector is connected to the sweep generator end of the cable, and the output from the detector is displayed on the second channel of the oscilloscope.

When the input impedance of the filter is correct, the connecting cable will be correctly matched, there will be no standing waves on it, and the voltage across the sweep generator end will be independent of frequency. Under these conditions, therefore, the second trace of the oscilloscope will simply show a straight line. When, however, the input impedance of the filter differs from its correct value the cable will be mismatched; the voltage across the sending end will vary with frequency and this variation will be shown on the oscilloscope.

The best results will be achieved when the length of the connecting cable and the sweep width are such that the voltage at the sending end of the cable goes through a large number of maxima and minima. The sweep width will, of course, be fixed by the pass-band of the filter. The cable length required can then be determined using Equation 11.

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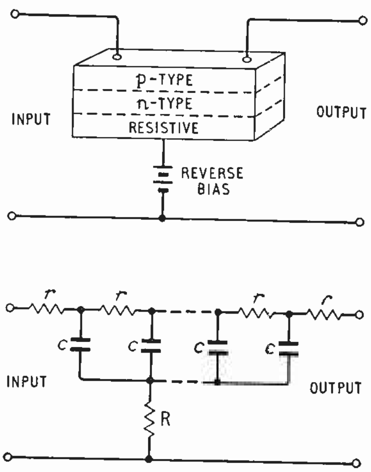
TECHNICAL NOTEBOOK

Solid-State Filter described by W. M. Kaufman in the September 1960 issue of *Proc.I.R.E.* is basically a distributed bridged-T device. Its lumped circuit analogue is shown in the lower part of the diagram and a schematic of the actual device in the upper part. In the device the p-type



layer provides the distributed series resistance *r*, the reverse-biased p-n junction the distributed shunt capacitance *c* (short circuited at one end by the low resistance n-region) and the resistive material the shunt resistance R. (Alternatively R may be provided by an actual resistor.) Such filters can be tuned by varying the reverse bias. (This alters the width of the p-n junction depletion layer and thus both the distributed resistance and capacitance.) In a practical case tuning from 1.5 to 6Mc/s was obtained by varying the bias from 0.3 to 6V. Such filters can be made very small, for example, only 0.09in by 0.04in by 0.003in for a 1Mc/s device.

Two New Piezoelectric Compounds—lithium-doped zinc oxide and cadmium sulphide—have been recently discovered by Dr. A. R. Hutson of the Bell Telephone Laboratories. These two substances are normally n-type semiconductors and so have resistivities which are so low that they short out any piezoelectric effect. However, by diffusing lithium into these substances so as to neutralize their excess conductivity electrons, their resistivities were increased sufficiently to allow their piezoelectric properties to be measured. After such neutralization zinc oxide and cadmium sulphide were found to be about four times and twice as piezoelectric as quartz respectively.

Portable Tape Recorders necessarily have to use a d.c. motor for driving the capstans, and a high degree of accuracy and constancy of speed is desirable. An article "Speed Control of D.C. Motors" in the February issue of *Electronic Technology* describes two methods of controlling small d.c. motors. A phonic wheel is mounted on the motor and used to generate a.c., the frequency of which depends on motor speed.

In one system, this frequency is locked in phase by means of a servo system and a phase comparator to a reference source derived from a stable local oscillator. Transistors are employed in the amplifier and a speed stability better than 0·1% can be achieved. A useful feature in some applications is the ability to control the motor speed by varying the frequency of the reference oscillator.

The second system is a simpler one but does not give such good control, the limit of stability being about 0.2%. No local oscillator is used, a frequency discriminator providing the reference for frequency. The system embodies a d.c. transistor amplifier and is basically a velocity-feedback control.

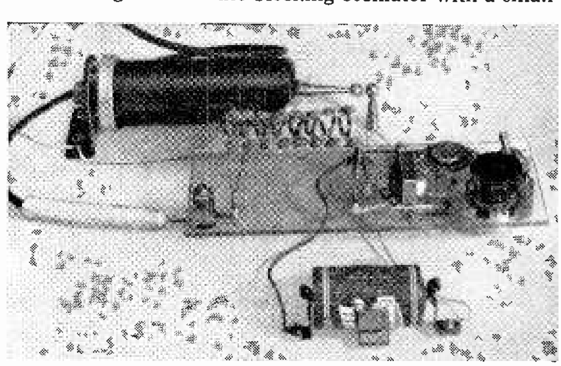
Generators of electricity from motion consist basically only of a magnetic field and a conductor which are in relative motion. Since the field and conductor must form part of two closed circuits, these circuits must be completed by extra magnetic and conducting material which does not generate any electricity. The problem is then to find a geometrical configuration for the conductor and field which minimizes the "cost" of completing the electrical and magnetic circuits, and different configurations may be preferable depending on whether this "cost" is measured in weight, volume or money. Usually generators use rotational motion with axial conductors and a radial magnetic field. In a generator developed by the Electrical Engineering Department of the University of Birmingham, however, radial conductors move in an axial magnetic field. The simpler magnetic circuit reduces the weight of magnetic material required, but unfortunately the proportion of end winding to total rotor conductor has to be considerably increased.

"Sandwich" Record Turntable is used in the new Garrard Laboratory Series Auto Turntable Type A. In this unit the turntable comprises, from the bottom upwards, an inner steel shell which magnetically screens the pickup head from the motor, a foam polyurethane disc (forming the sandwich filling), and a heavy non-magnetic outer turntable thick enough to separate magnetic pickups sufficiently from the magnetic inner shell.

Mossbauer Effect allows realization of the inherent extreme narrowness of certain γ-ray spectral lines (with widths less than 10^{-12} of their wavelengths). Unfortunately, normally atomic thermal movements produce random Doppler shifts in the γ-radiation which effectively greatly broaden these lines. For certain types of crystal binding, however, thermal movements are taken up by the crystal as a whole rather than each single radiating atom. This reduces the thermal velocities and thus the random Doppler shifts so much that the inherent narrowness of these γ-ray lines can be realized. This narrowness has already been made use of in measuring the very small red shift of lines in a gravitational field which is predicted by Einstein's general relativity theory.

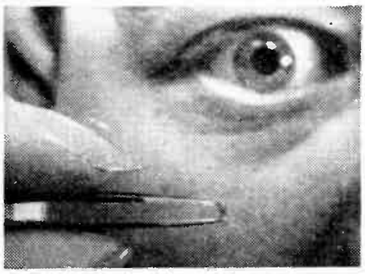
10kV E.h.t. Supply derived from a 1.5V Type U-2 cell by means of a transistor blocking oscillator and Cockroft-Walton multiplier has been developed by Plessey.

A medium-power transistor is used as the blocking oscillator with a small



transformer: the high-voltage peak appearing across the transformer is multiplied up by a chain of 32 silicon rectifiers (16 stages with two rectifiers in series in each leg) to charge a final capacitor.

Microminiature "Dot" Diode developed in the U.S.A. by Hughes is in the form of a cylinder only 0.03in long by 0.05in in diameter. It is a silicon unit and features a low leakage current (0.1μA at 50V) and high forward current (100mA at 1V).



For ease of handling, the cathode end of the cylinder is made of a magnetic material.

Automatic Weighing tends to conjure up visions of apparatus capable of handling tons of material rather than decimals of grams. However, Oertling have developed two precision chemical balances arranged for automatic weighing.

The Model FO5 beam-balance is fitted with a lamp and photocell unit to monitor the balance-beam position. If this deviates from the level state an electromagnet is energized to restore the level; the amount of current flowing is used to give a weight indication and the time for response to a change in weight is a few milliseconds.

The other balance gives a digital output suitable for operating a reversible counter which, of course, can be arranged to feed any convenient form of display or recording. Here a multiple photocell unit measures the beam position giving a pulse output.

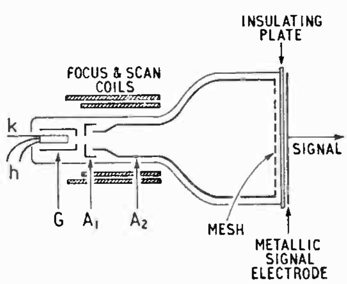
Magnetic Field Measurement from the Zeeman splitting of the spectral lines of rubidium 85 is being used at the Signals Research and Development Establishment. In a magnetic field each spectral line is split up into a number of components (called Zeeman components) whose separation is equal to the magnetic field strength multiplied by an accurately known constant. At S.R.D.E., instead of measuring the separation between the spectral line Zeeman components, transitions between two of these components are induced by applying an r.f. field of the correct frequency (from which the magnetic field strength was determined), and these transitions are detected by the increased light-scattering produced as such transitions take place.

To enable such transitions to be induced, changes must be made in the normal proportions of rubidium atoms in each Zeeman component level. In this new method such changes are produced by exciting the rubidium atoms by "pumping" them with rubidium light of a certain frequency such that, when the rubidium atoms return to their original levels, the quantum theory transition rules secure the required changes in the proportions of rubidium atoms in each Zeeman component level. Pumping with suitable radiation so as to produce changes in the proportions of atoms in their various energy levels and thus to allow transitions between these levels to be induced is also, of course, made use of in masers.

High-voltage Surges caused on switching off the ordinary mains transformer can cause breakdown of silicon rectifiers. For instance, a 350V secondary winding may produce a pulse greater than 1kV at switch off—this could exceed the peak-inverse voltage rating of a rectifier connected to the transformer. G.E.C. have developed a means of damping out this surge by the connection of a 33-V Zener diode clipper between two taps of the transformer's primary winding. This does not break down with the working potential induced between the mains voltage adjustment taps, but it conducts during the switch-off surge limiting the pulse to a few hundred volts.

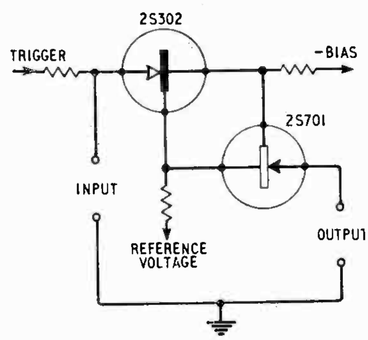
Storage Tube by Mullard, called the Tenicon, has a resolution of about 550 points along a line when scanned with a television raster. The Tenicon is very much like the Vidicon type of camera tube—in fact, it is designed so that it can be plugged in instead of a Vidicon—except that the photoconductive coating and "window" is replaced by a plate of insulating material backed, on the outside, by a metallic layer.

To write, the electron beam is just cut off and, starting with the insulated target stabilized at cathode potential, the incoming signal is allowed to cut on the electron beam, modulating its intensity. Secondary



emission causes the target to become positive by an amount determined by the instantaneous beam current (scanning speed, secondary-emission coefficient and target capacity also govern the amount of charge), so that after the writing scan an action identical with that of the camera tube can be employed for read out—an unmodulated beam scans the target, discharging it to zero. The discharge current from the capacitor formed by the charge on the target and the metallic coating produces an output signal across the target load. If the beam current is sufficiently large only a small part of the stored information remains and further writing-in can start immediately.

Switching Circuit developed by Texas Instruments uses two complementary (pnp and npn) silicon transistors and can be used for switching the speech path between two telephones. This is a particularly demanding task, as an extremely high "off" resistance is required—1,000MΩ is realized in the circuit shown. When a pulse greater than



the triggering level (about 25V) is applied to the trigger input the speech path between input and output is completed by only about 10-Ω resistance. Maximum current is about 100mA.

Airbrasive tool can make cuts as narrow as 0.008in wide by means of a gas-propelled stream of very fine particles. The cutting action is cool and shockless, permitting ready handling of very brittle materials such as germanium, silicon, ferrite, glass and tungsten, for example. This tool can also be used as an abrader for deburring and surface cleaning. Ten to fifty micron diameter particles are used, and these are ejected at a speed of about 1,100ft/sec by means of carbon dioxide or nitrogen gas at a pressure of 75lb/in^2. The cutting or abrasion speed can be varied by altering the tool nozzle tip distance or the rate of flow, particle size or material of the abrasive. This tool was developed in the U.S.A. by S. S. White Industrial Division and is distributed in this country by Elliott Brothers (London).

Sensitive Photoelectric Trigger

"PLANE OF LIGHT" TECHNIQUE FOR MEASUREMENT OF PROJECTILE SPEED

By D. E. O'N. WADDINGTON, Grad. Brit. I.R.E.

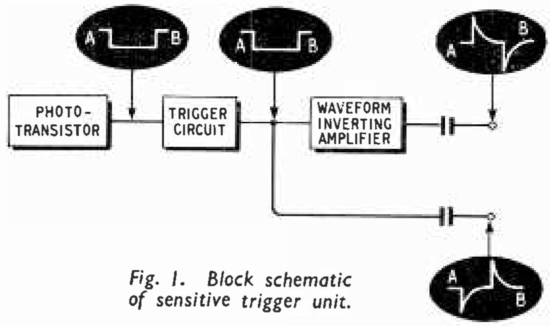


Fig. 1. Block schematic of sensitive trigger unit.

IN using the "Transistor Stopwatch,"* together with the photo-electric trigger circuit described in the same article, to measure the velocity of arrows shot from a bow, two main difficulties were experienced. Firstly, the sensitivity of the trigger circuit proved to be too low for this exacting task, and, secondly, it was found difficult to shoot an arrow accurately enough to break a beam of light. This latter difficulty is complicated by the fact that an arrow is oscillating violently as it leaves the bow. Obviously the answer to the first point was to design a more sensitive version of the photo-trigger circuit and, at the same time, the usefulness of this circuit was also enhanced by making it provide two outputs which could be used to start and stop the timer. The second difficulty was overcome by designing an optical system which produced a "plane" of light of sufficient size to make it comparatively easy to shoot through it.

Electronic Trigger System

To operate the timer it is necessary to produce positive-going "run" and "stop" pulses. In view of this, the logical approach was to make the photo-sensitive device operate some form of trigger circuit providing the right outputs. The block diagram (Fig. 1) and the circuit (Fig. 2) show how this is done.

To obtain maximum sensitivity from the photo-transistor it was operated in the earthed-emitter configuration and the output was fed direct to an emitter follower. This means that the load resistor is only shunted by the input resistance of V2, which is high. The variable resistor R_1 is used to adjust the bias on the base of V1 and thus sets the operating threshold. Normally the photo-transistor is illuminated and current flows through V1 driving its collector towards the positive line. R_1 is then adjusted so that V3 is cut off. V3 and V4 are connected so as to form a conventional Schmitt-trigger circuit. Reducing the illumination on V1 will reduce the current flowing through it, with the result that its collector becomes more negative. This switches V3 on and V4 off: the voltage at the collector of V4 is thus negative going. (Point "A" on the waveform). As has already been stated, a positive-going pulse is necessary to start the timer. This could possibly have been obtained from the collector of V3, but the voltage swing at this point is only of the order of 2.5, whereas the voltage swing at the collector of V4 is nearer 4. The voltage at the collector of V4 is thus fed, via an emitter

* *Wireless World* Vol. 65, p. 521 (Transistor timer measuring 0.5 m sec to 5 sec.)

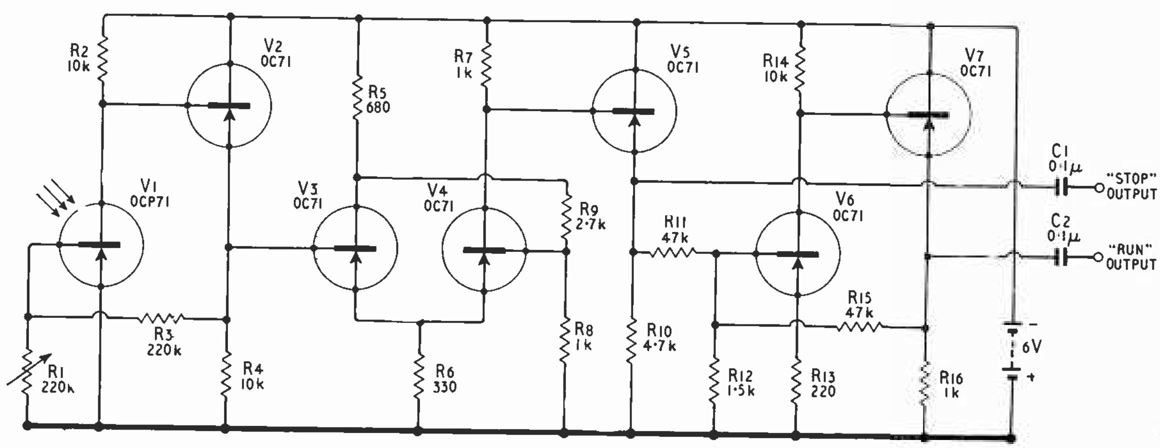


Fig. 2. Circuit diagram of sensitive trigger unit. V1 (OCP71) is phototransistor.

follower (V5) to a wave-form-inverting amplifier (V6 and V7). A two-stage amplifier is used here as it was desirable to have a low-impedance output. This output is coupled by means of the capacitor C_2 to the "run" input of the timer.

When the illumination on the photo-transistor is returned to normal the current through V1 increases, thus driving its collector positive. (Point "B" on the wave-form.) This switches V3 off and V4 on, so giving rise to a positive-going voltage at the collector of V4. This is fed via the emitter follower V5 and the capacitor C_1 to the "stop" input of the timer. Consequently reducing the illumination starts the timer and increasing it again stops it.

Optical System

The average diameter of an arrow is $\frac{5}{16}$in and it is easily seen that this will cause very little reduction in illumination when it passes through a simple plane of light. In order to increase the reduction of illumination, the author hit on the idea of folding a narrow beam of light so that it formed a plane. This was done by placing two strips of plane mirror parallel to each other and about four inches apart. (See Fig. 3(a).) If a light source producing a parallel-sided beam of light is placed at Point "C" and directed at the opposite mirror at a slight angle to the normal, the beam of light will be reflected back and forth between the two mirrors until it finally illuminates the photo-electric device placed at "D." Any opaque object placed between the mirrors, provided that it has a diameter equal to twice the width of the beam should, theoretically, prevent any light from reaching the photo-electric device. Due to dispersion of the light and imperfections in the mirrors, this state of affairs is not obtained in practice: however very satisfactory operation may be obtained. In order to prevent the ambient light upsetting the sensitivity of the device, suitable masking was fitted so that the ambient light could not produce any great illumination of the mirrors. (See Fig. 3(b).) This produced an effective "plane" of light.

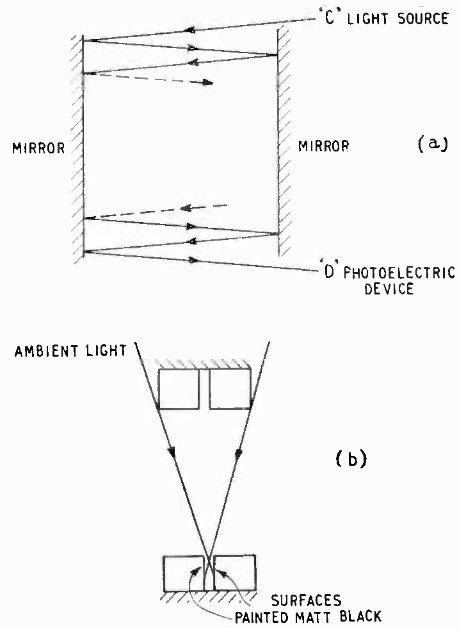


Fig. 3. (a) Method of production of "plane of light" through which projectile passes. (b) Shielding of mirror system from ambient light.

Using the new sensitive photo-electric trigger, the "plane" of light and the "Transistor Stop Watch" together it was a simple matter to carry out arrow speed measurements. The actual plane was made 3×4in, which is a relatively easy mark for an archer to shoot through. The errors due to the thickness of the light plane were reduced to a minimum by making it only $\frac{1}{16}$in thick. (The error due to this would be of the order of 0.3%, which was negligible with the speeds and arrow lengths encountered.)

The "plane of light" technique probably has many other possible applications, particularly in the realm of industrial control.

BOOKS RECEIVED

From Tinfoil to Stereo—Evolution of the Phonograph by Oliver Read and Walter L. Welsh. A history, in readable style, of the development of sound reproducing equipment. From a description of early attempts at "talking machines" the authors go on to describe the problems, both technical and legal, which beset the design of audio equipment and records, from the earliest tinfoil and celluloid cylinder records to modern, electrically-recorded, high-fidelity stereophonic discs and tape. Many previously unpublished photographs of early equipment are presented and the bibliography is extensive. Pp. 524; profusely illustrated. Howard W. Sams & Co. Inc. Price $9.95.

Numerical Methods for High-Speed Computers by G. N. Lance. An exposition of methods which have been specifically developed for use with automatic high-speed digital computers. In the introduction, the author explains the fundamental differences in methods required by hand and automatic machines. Three chapters are then devoted to the solution of problems using matrices or differential equations, while the last chapter deals with a variety of miscellaneous processes. A practical book for the programmer or engineer. Pp. 166. Published for "Data Processing" by Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 42s (42s 11d by post).

An Introduction to the Cathode-Ray Oscilloscope by Harley Carter. A simple explanation of the operation and application of the oscilloscope. Intended for the experimenter and student, the book is elementary in treatment and presupposes only a small knowledge of electronics. Descriptions are given of timebase circuits, vertical amplifiers and power supplies, with a chapter on some common cathode-ray tubes. The last chapter gives details of three complete oscilloscopes. Pp. 132; Figs. 99. Cleaver-Hume Press Ltd., 31 Wright's Lane, London, W.8. Price 15s.

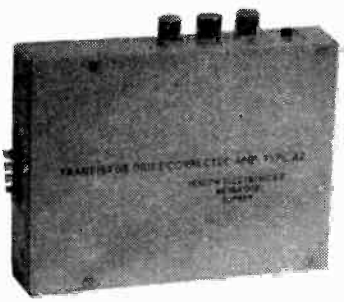
Applications of Electronics by Bernard Grob and Milton S. Kiner. A review, intended for the technician, of basic circuit principles and their application to modern electronic equipment. Industrial and military equipment is described. There is a chapter on test equipment and appendices give useful data such as frequency allocations, a time-constant graph and colour codes. Questions are set at each stage in the book. Pp. 628; Figs. 497. McGraw-Hill Publishing Co. Ltd., 95 Farringdon Street, London, E.C.4.

MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

D.C. Amplifier

THE type A.2 transistor d.c. amplifier made by Fenlow Electronics is intended for process control and computing applications. A zero-drift of less than 200μV is combined with an output of $\pm$9V at 50Ω impedance, the stability being achieved by means of a drift-correction feedback circuit employing a transistor chopper. The gain of the amplifier is 5000 and the bandwidth 1kc/s. Details are obtainable from Fenlow Electronics, Ltd., Springfield Lane, Weybridge, Surrey.



Left: Fenlow d.c. amplifier.

Right: Printed-coil, panel-mounting meter introduced by Painton.

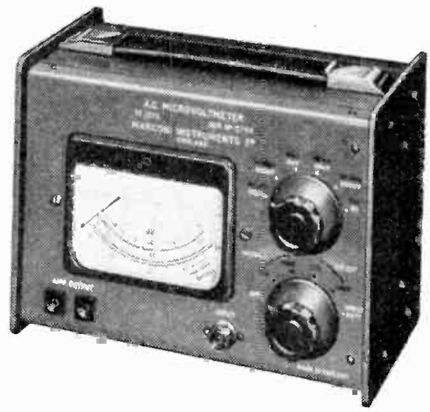
New Printed-circuit Meter

AN exceptionally robust and elegant panel-mounting meter has been introduced by the Parker Instrument Corporation of America, and is marketed in this country by Painton. Extremely light weight and slimness has been achieved by the use of a ceramic ring magnet and printed-circuit coil.

Overloads of 250 times and transients of 20,000 times the instrument rating produce no detrimental effects, except that the nylon pointer may be bent, in which case straightening is a simple matter. Operation in a magnetic field has no effect on performance. The instrument is manufactured in ranges of 1mA to 1A and 10V to 500V. Full information on the range of meters, which are obtainable in several colours, may be obtained from Painton and Co., Ltd., Bembridge Drive, Kingsthorpe, Northampton.

A.C. Microvoltmeter

MEASUREMENTS of the amplitudes of alternating currents down to 5μV may be made with the Marconi TF1375. Completely self-contained, the instrument employs semiconductors throughout, and the frequency

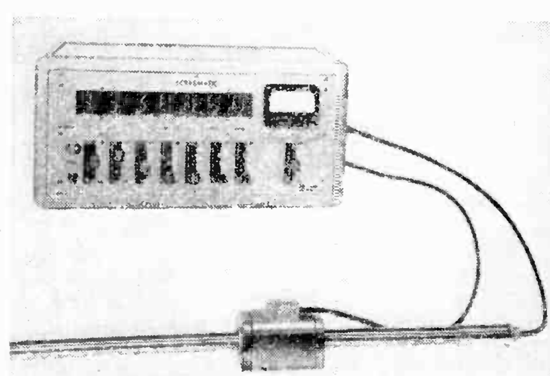


Marconi Instruments TF1375 Microvoltmeter.

response is $\pm$2dB from 50c/s to 1Mc/s. Alternatively, the lower end of the range may be curtailed when it is desired to reject external 50c/s signals, the attenuation then being —20dB at 50c/s. The amplifier output is taken to sockets on the front panel; the gain is X1000, and the output is 250mV r.m.s. maximum at 3kΩ impedance. The instrument is especially useful for measurements of field strength, or as an oscilloscope pre-amplifier. Obtainable from Marconi Instruments, Ltd., Longacres, St. Albans. Price £66.

Displacement Meter

AN accurate and stable length-measuring instrument has been developed by Reilly Engineering, Ltd. The equipment combines the accuracy of the slip-gauge method of measurement with an electronic bridge as the reading and indicating system. Numbers of slip-gauges in the form of cylinders are arranged end to end to form a round section rod. Each section is connected to a tap on a voltage-dividing transformer which is fed with an alternating voltage. A transducer head, also in the form of a cylinder, moves over the rod, and is capacitively



The Reilly Engineering Displacement Meter, showing the transducer and indicator unit.

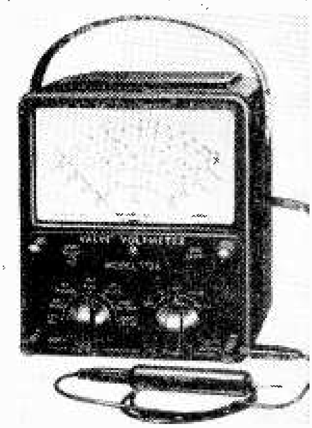
coupled to it over a length exactly equal to the length of one slip-gauge. The voltage induced on the head is thus a linear function of its position on the rod. The transducer head and transformer are connected in a bridge circuit with transformer ratio arms arranged in decades. The out of balance voltage is amplified and indicated on a centre-zero meter. A typical ten-inch rod has six decade transformers, the last decade indicating to within 10 micro-inches. The meter is calibrated, and small deviations of 1 micro-inch are discernible.

The equipment may be used to measure length directly, or it may be employed to control the position of the moving part of a machine tool. In this capacity, the rod is attached to the bed of the tool, and the head to the moving part. The switches are set to the desired reading and the head moved until the meter reads zero. Alternatively, the error signal may be amplified and used to drive a servo-motor. Normally, the switch positions are indicated by an in-line read-out display.

A range of transducers are available, measuring from 1 inch at an accuracy of ±0.00003″, to 100″ to within ±0.001″. The equipment is marketed by Reilly Engineering, Ltd., Forsyth Road, Sheerwater, Woking, Surrey.

Valve Voltmeter

THE Taylor Model 172A has an input impedance on its d.c. ranges of 11MΩ, and greater than 830k when measuring a.c. Full-scale readings on d.c. and a.c. volts are 1.5V to 1.5kV, or 30kV when an e.h.t. probe is employed (d.c. only); the scales are calibrated in both r.m.s. and peak-to-peak. The instrument will measure

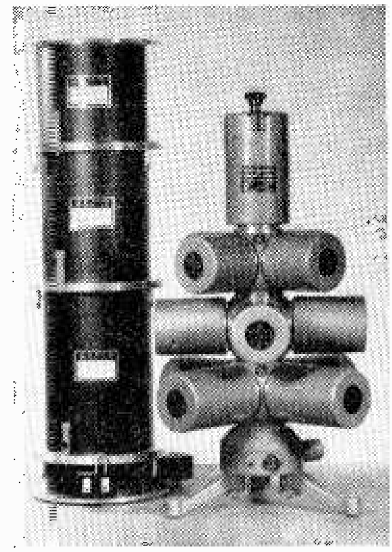


Taylor Model 172A Valve Voltmeter with d.c. probe in use.

resistance up to 1000MΩ and r.f. probe is available which extends the range to over 200Mc/s. Further information may be obtained from Taylor Electrical Instruments, Montrose Avenue, Slough.

Switchless Capacitance Standards

STANDARD capacitances in the range 10pf to 10μf may be assembled from units made by the German firm of Jahre introduced to the U.K. by Aveley Electric. Capacitance units adding up to the required value may be connected in parallel by means of five- and six-sided connector blocks, the whole forming a convenient and rigid assembly. Air dielectric is used in units up to 400pf, which affords a loss factor of less than 1 part in 10^5. Series inductance of the units is less than 0.06μH. Each capacitor is adjusted to within 0.1% ±0.1pF and calibration certificates are issued. Temperature coefficient of units up to 400pf is +20 parts per million per degree Centigrade and 30 p.p.m./°C for larger units. Variable capacitors provide continuous coverage of 16

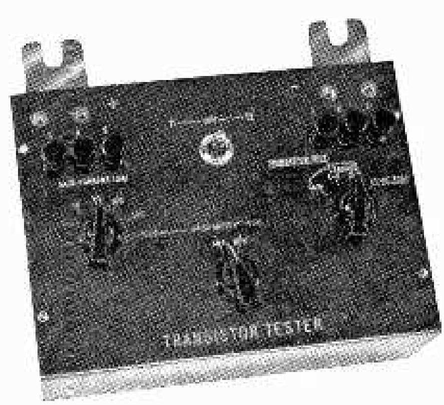


Jahre switchless standard capacitor assembly.

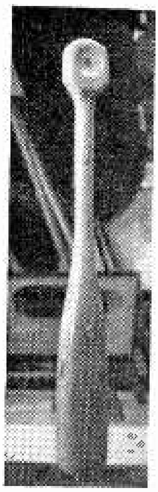
or 70pf. The units are obtainable from Aveley Electric Limited, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex.

Transistor Tester

AN n-p-n/p-n-p transistor tester recently introduced by Grundy is designed for use in conjunction with all multi-range meters of 1mA basic movement or better, preferably with inbuilt overload protection. The mounting terminals enable the unit to be mounted directly on to a Universal Model 8 Avometer. A useful measurement of current gain can be made up to 800mW dissipation and a reasonable indication is given for higher powers. Transistor measurements also include collector-emitter and collector-base leakage currents at a potential of 4.5V. Diodes are tested in the forward direction by passing through them a current of up to 10mA (depending on the forward resistance). The reverse current can be checked at a potential of 9V. Two similar transistors or diodes can be compared under the same conditions using the two sets of terminals provided. Provision is made for testing the internal battery under load. The size of this instrument is 7in by 6in by 2½in and its weight is 1¾ lb (including batteries). This instrument costs £4 19s 6d and is made by Grundy & Partners Ltd., of 3 The Causeway, Teddington, Middlesex.



Grundy Transistor Tester.



ELECTRONIC GUIDE

A DEVELOPMENT of the inductive-loop paging system has been adopted by the Ministry of Works to provide guided tours of the South Kensington Science Museum.

Tape-recordings lasting about twenty minutes are used to amplitude-modulate an oscillator working in the range 50 to 86kc/s. The signal is applied to a loop of wire encircling the area in use, and is received on small, hand-held sets shaped like truncheons. Four channels are available, selected by a switch on the receiver, which employs an automatic volume-control system. The input to the loop, when a large area is being covered, is obtained from a transistor power amplifier, and is 3 watts maximum per channel.

The transistor receiver is contained in the lower part of the handle, and the output fed to a $1\frac{1}{2}$ inch speaker in the earpiece, which is merely held close to the ear, and not inserted. There is, therefore, no problem of sterilizing. A volume-control is incorporated, and the receiver weighs only 7 ounces.

The equipment is a product of the Multitone Electric Company, Limited.

The accompanying photographs show a party of schoolchildren being conducted on a tour of the Sailing Ship Gallery at the Museum, and one of the receivers. The channel-selector switch is near the top of the handle, and the volume-control/on-off switch protrudes at the left.

HONG KONG TRANSISTOR SETS

ONE of the first nations fully to exploit the commercial opportunities offered by the invention of the transistor was Japan and the mass production of transistor radio receivers was very firmly established there by 1958.

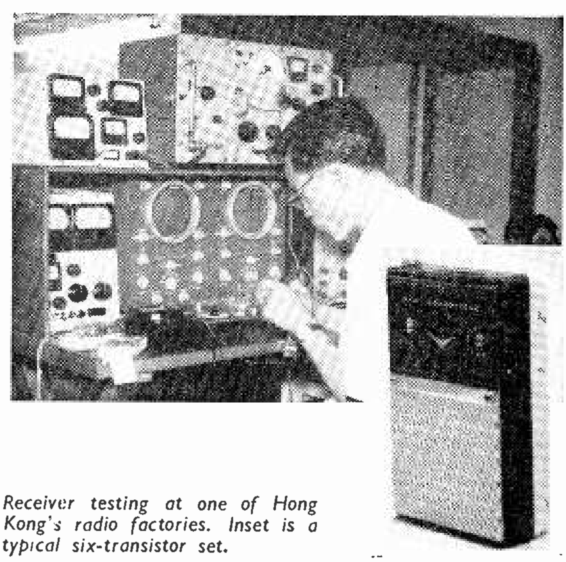
The manufacture of parts and the assembly of transistor sets did not, however, begin in Hong Kong until some 18 months later. Initial setbacks, due in some measure to the Hong Kong government's strict certification requirements, rendered early progress slow, but manufacturers are now producing sets which conform with the government's criteria for the issue of Certificates of Origin and Commonwealth Preference Certificates.

To qualify for the Colony's Certificate of Origin, manufacturers have to incorporate in each set a very large number of entirely locally made parts, ranging from the plastic cases, batteries and p.v.c. wiring to the transformers and tuning capacitors. Some also make the printed circuit boards, whilst others import these from the U.K. The currently manufactured Hong Kong receivers are exclusively small six-transistor models and the transistors themselves are imported from the U.K. They cover the medium-wave band with an i.f. of 455 kc/s. The sensitivity is given as 250 μV/m.

Transistor radio manufacture in Hong Kong has brought additional business to other sections of the Colony's industry, amongst which may be mentioned the leather workers who make attractive carrying cases for the radios (as well as for sets of European manufacture) and the plastics factories, which, besides producing the injection-moulded cases for the sets, also turn out the wafer-thin p.v.c. strips used in the variable capacitors.

All Hong Kong sets are built to allow use of earphones and the earphone plug automatically cuts off the loudspeaker. The earphones supplied with the set are of the magnetic type with a low impedance.

Transistor radios from Hong Kong are arriving in the U.K. at approximately £6 c.i.f.



Receiver testing at one of Hong Kong's radio factories. Inset is a typical six-transistor set.

RANDOM RADIATIONS

By "DIALLIST"

Interesting Radio Telescope

THE Australians have recently brought into service a high-resolution telescope, described as a crossed-grating interferometer. It is designed or use of decimetre wavelengths, and one of its most important purposes is the observation of radiation from the sun. Since this largely originates in the sun's outer atmosphere, observation by optical instruments is very difficult. Each arm of the aerial array consists of 32 paraboloids, 19ft in diameter and equally spaced along a 1,200ft base line. When the instrument is in use the paraboloids are steered so as to be always pointing at the sun. The narrow beam "scans" the surface of the sun much as the spot of a television set scans the screen. The earth's rotation moves the beam from west to east and when it has scanned one strip of the sun's surface it is moved about a beam width southwards. In this way a complete radio picture of the sun is built up.

Still Progressing Slowly

TO many it's extraordinary that television remains so slow in catching on in France. About 91% of French homes are within range of TV transmitters; yet not more than 12% of them have receiving sets, compared with over 80% in the U.S.A. and more than 60% in this country. Some people say that the programmes are to blame and that there will be a rapid increase when the second chain gets to work, as it is due to do in the not-far-distant future. I rather doubt whether that's the real reason. My own belief is that the small demand for TV sets is largely due to the comparatively small amount of time that the average Frenchman spends in his home. He prefers to go out when he can for eating, drinking and entertainment. It's a curious thing that there's no French word for home. The nearest equivalent is "foyer," which simply means hearth. But a Frenchman's foyer doesn't mean quite the same thing to him as home does to our countrymen.

Servicing Certificates

THE examinations for the sound radio and television servicing certificates conducted by the Radio Trades Examination Board and the City & Guilds of London Institute attract an increasing number of candidates every year. In sound radio there were 1,965 candidates in 1960 against 1,896 for 1959. Of these 911 passed, 471 have to retake the practical test, and 583 failed. There were 642 candidates for the television certificate in 1960 compared with 485 in 1959. Passes numbered 298, those referred 96 and failures 248. There are now 4,182 holders of the sound radio certificate and 1,074 of the TV certificate. Looking through the 1960 papers, one comes to the conclusion that the questions are well chosen and provide a fair and thorough test of the candidate's ability to do a good job as a serviceman. A typical composite question in the Radio exam. was: (a) Explain the differences between direct and alternating current; (b) Explain the terms (1) peak voltage, (2) r.m.s. or effective voltage; (c) A moving-coil meter movement with a metal rectifier unit may be used for measuring a.c. (i) What value of current does it measure? (ii) What value of current is indicated by the scale calibrations? The examiners report "Not many attempted this question, which is rather surprising." I agree. Still, the percentage of passes can't fail to be regarded as very satisfactory.

Remarkable Valves

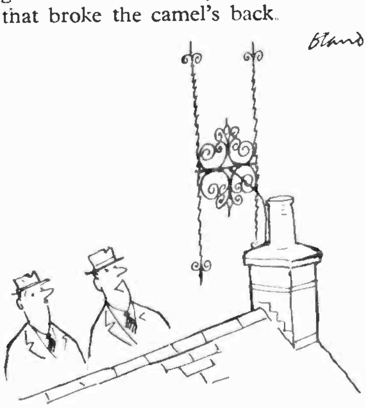
WONDERFUL things, some of the valves of to-day! Amongst the most remarkable of them are the frame-grid types such as PCC 89, PCF 86, EF 183 and EF 184. Their big advantage is that they enable a greater gain to be obtained without an increase in the noise factor. Their construction is quite remarkable, for the wire used for the grids is only 10 microns in diameter compared with about 75 microns for the average human hair. Further, the spacing between grid and cathode has been brought down to 50 microns, so that you could not pass a hair between the two. Frame-grid valves in themselves are no new departure, for special valves have been made in that way for some little time. What is new is their production in quantity for domestic TV sets.

Solar Batteries

THOUGH they have severe limitations, since they can work only on sunny days and must be idle at night, solar batteries seem to have considerable possibilities. One of them has recently been set up at Toulon—not an ideal position though it's in one of the sunniest corners of France. It works on the thermo-junction principle, the hot side of each junction being attached to a heat-collector plate 1 decimetre square, while the cold sides are connected to metal plates which conduct the heat to radiator fins placed on the side away from the sun. In this way, it has been found possible to maintain a temperature difference of about 120°C between the hot and cold parts of the junction. The output in full sunshine is some 6W per square metre. In tropical countries a considerably larger output is possible. The efficiency of the battery is low, since the input of solar power enormously exceeds the electrical output; but that doesn't matter much, for solar power costs nothing. It should be possible to build in equatorial regions huge batteries producing during the daytime vast amounts of electricity which could be stored and used as and when required.

Birds Like Them

IN East Anglia, where I now live, we use horizontal aerial arrays for both B.B.C. and I.T.A. television reception. These are regarded as heaven-sent perches by the birds. I can't look out of my sitting-room window in the daytime without seeing at least a score of them comfortably taking their ease and having a look round. And it isn't only small birds such as sparrows and starlings. Rooks, jackdaws and even seagulls find these horizontal arrays convenient seats. One mightn't have thought that a gull could curl its big webbed feet sufficiently to get a firm grip; but they can and do. One or two arrays near my place have been damaged by the weight of groups of large birds assembling on them. I expect that parts of these had previously been loosened by the winds, of which we certainly get our share, and that the feathered visitors just gave the final touch, like the straw that broke the camel's back.



"No, the picture's not so good, but it's a lot prettier."

UNBIASED

By "FREE GRID"

Wireless Museum

I HAVE often wondered why the Radio Industry does not establish a museum illustrating radio progress since the first wireless patent was taken out on June 2nd, 1896. But to establish and run a museum needs other things besides exhibits. It needs, for one thing, a building and quite a lot of money for its upkeep. I wonder, therefore, who would be likely to finance it? I suppose that firms belonging to the industry would have to put up the cash between them; in other words, the job of collecting the money would really devolve on an industrial organization such as the R.I.C. or the E.E.A.

However, radio firms are not in business just as a pastime. The bigger firms spend vast sums on research but the money so spent will, they hope, eventually return to them with interest. In the matter of a museum there is no hope of such a return for the money spent.

A very good museum of old motor cars is, of course, run by Lord Montagu at Beaulieu who regards it as his hobby. I wonder if there is a noble lord who is interested in old wireless receivers. I can't think of one, but then, I don't know many noblemen.

Of course, the Science Museum at South Kensington at once suggests itself as the ideal place. The authorities there certainly have got a good collection of pioneer wireless apparatus, and no doubt they have more in store for which they have no room in their display cabinets.

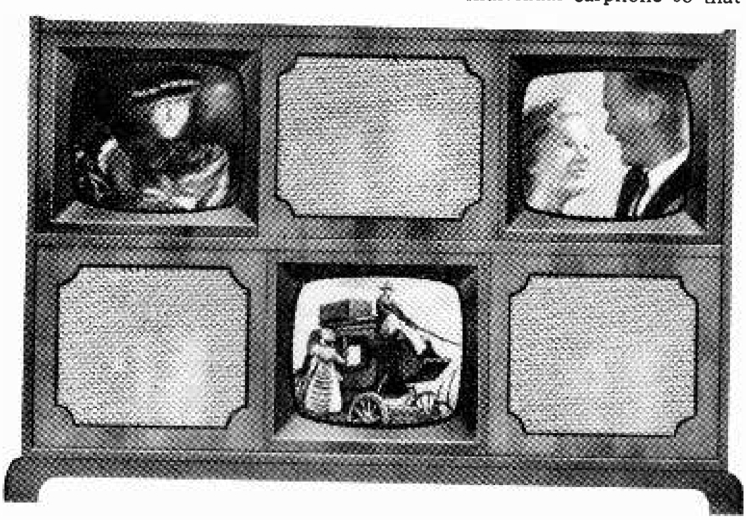
Maybe there is a radio museum overseas and if so I should be very glad to hear of it. Possibly there is one behind the iron curtain, and I have often thought I would like to pop off (surely *le mot juste*) to Moscow and see for myself.

Multi-screen TV

IT often happens that some members of the family wish to look at B.B.C. television while others prefer the I.T.A. offering with the result that the "peaceful hours I once enjoyed" have been shattered. This problem is much greater in the U.S.A. where they have several programmes to quarrel about. It is not surprising, therefore, that at least one American firm has produced a multi-screen television set for receiving several programmes simultaneously.

In essence it consists of three TV sets built into one cabinet as shown in my illustration. I wondered if some of the components, such as those of the power pack, would be common to all sets thus making for greater compactness; but no, "everything is completely independent so that you are never, never without TV."

In addition to the three TV sets it incorporates an f.m. receiver and a stereo record player which is revealed by sliding aside the top centre panel. The advertisement says "3-screen TV gives you all of the best all of the time. . . . You'll be surprised to find you can easily enjoy more than one channel at a time. . . ." You have your own control button with an individual earphone so that "when the show you are hearing drags you can switch to another and then back in time to hear the important part of the first."



Three-screen television being marketed by de Forest

I don't think headphones would be very popular in this country. I have, therefore, been trying to think of a way out of the difficulty; the only answer seems to be for people to learn lip reading.

As, however, lip reading couldn't deal with any sounds save speech I'm afraid my idea is ruled out which is a great pity as it would mean that multi-screen TV sets—or even ordinary ones—could be produced very cheaply as no apparatus for reproducing sound would be necessary. Quite frankly I don't think the American multi-screen set with its headphones would catch on here.

Photographic Panautomation

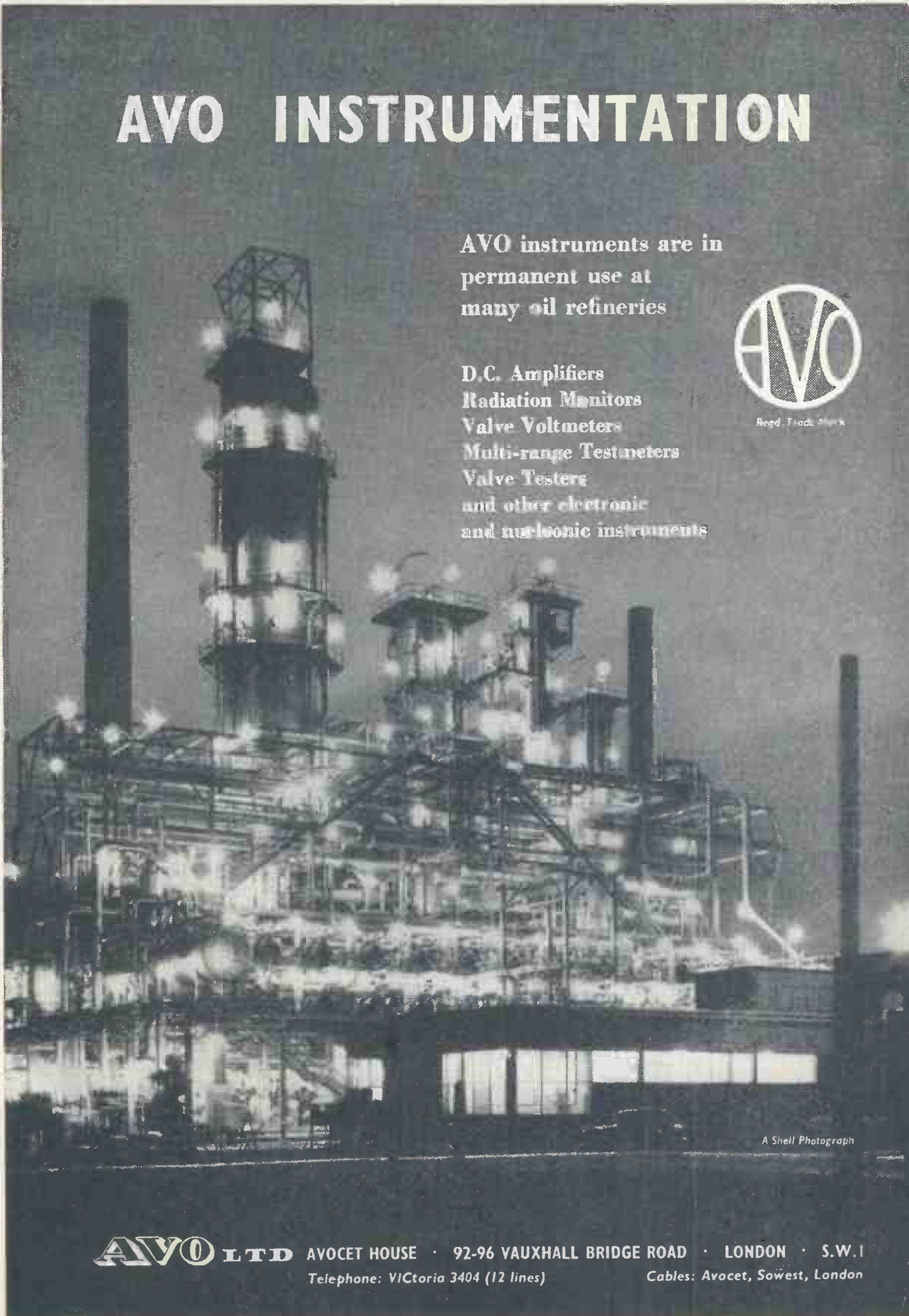
LAST October I chided the photographic industry for claiming that cameras, wherein stops and shutter speeds were self-adjusting, were panautomatic. Such a claim is, in my opinion, quite unjustified unless some automatic means be provided whereby the camera can focus itself.

As I pointed out last autumn, the camera experts have tried to get over the difficulty by using lenses of slightly subnormal focal length so that a minimum of manual focusing adjustment is called for. Maybe my complaint was read in the right quarters as at least one maker has now produced a camera, which, in effect, is claimed to be self-focusing.

The interesting point about it is that to achieve their end the makers have adapted a technique from the world of wireless which was popular in pre-war days. No doubt they thought that as the automatic stop and shutter adjustments employed an electronic technique, they could not do better than borrow yet another technique from us, albeit a completely non-electronic one.

You will probably remember that in pre-war days there were three main systems of push-button tuning. These were individual pre-set tuners for each station, motor-operated adjustment of one main tuner, and, finally, manually-operated adjustment of the main tuner by means of a number of cams or gears with stops, one to each push button.

It is this latter type which has been called out of obscurity by the photographic industry. Four buttons are provided, each labelled with a different zone of distance, the user presses whichever is the most appropriate for a given photograph. The first part of the button's travel adjusts the focusing, the shutter being fired at the end of its travel. I hope we shall be able to provide the photographic industry with further techniques as time goes on.



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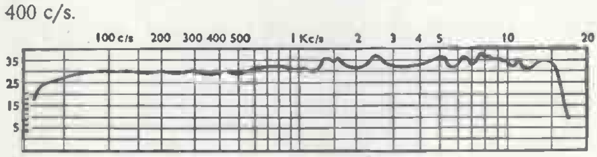
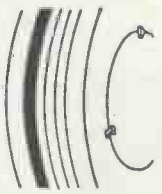
AXIOM 300 makes Sound Sense

The Axiom 300 is the latest model in a long line of famous and eminently successful 12" High Fidelity loudspeakers, and has achieved a record level of popularity all over the World entirely on its own merits. The complete absence of any compromises in design, and of any expensive but non-operative "features" give the Axiom 300 by far the best performance to cost ratio obtainable anywhere. It is an extremely versatile loudspeaker; in domestic use with monaural or stereophonic equipment it normally has a reserve of power handling capacity—important for low distortion reproduction. At the same time it is robust enough to be used for recitals, etc., to medium sized audiences.

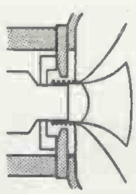
Axiom 300 *Specification*:

Frequency range: 30 c/s—16,000 c/s. *Power Handling Capacity:* 15 Watts. *Fundamental resonance:* 35 c/s. *Magnet System:* 14,000 gauss, 158,000 maxwells on $1\frac{3}{4}$" dia. pole. *Impedance:* 15 ohms at 400 c/s.

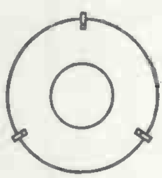




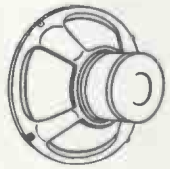
SMOOTH low frequency and mid-range output from vacuum formed controlled edge diaphragm with plastic termination.



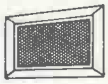
CLEAN bass and extended H.F. performance from long throw precision wound aluminium voice coil operating in high efficiency slug type closed field magnet system employing Alcomax III magnet.



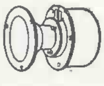
CONTROLLED low distortion output up to 16,000 c/s from specially terminated high frequency radiator, with automatic mechanical crossover.



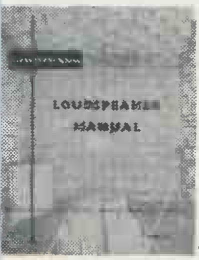
STRENGTH of construction is based on a robust cast chassis which ensures permanent alignment of the moving parts.



The Acoustic Resistance Unit type A.R.U. 172 provides ideal loading for the Axiom 300; an enclosure volume of 7,800 cubic inches is required.



The Axiom 300 is a complete full range High Fidelity loudspeaker in itself. However, it can be used as the basis of an advanced 3-way loudspeaker system.



GOODMANS INDUSTRIES LIMITED, Axiom Works, Wembley, Middx.

Tel: WEMbley 1200 (8 lines) Grams: Goodaxiom, Wembley, England.

Distributors in most countries including:— *South Africa:* Technical Ind. Services P.O. Box 2652, Cape Town.

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THE FERRANTI LABORATORIES, EDINBURGH

Standard Signal Generator TF 867 (at right) being used in conjunction with the F.M./A.M. Signal Generator TF 995A/5, and two Marconi voltmeters, to assess the performance of a C.W. Amplifier in the presence of an F.M. signal.

With a reputation to live up to, it pays to invest in the best. "There's safety in certainty" say Ferranti Ltd., and a look round their laboratories shows how much they rely on Marconi instruments. Very much in the picture is the Standard Signal Generator TF 867, a precision laboratory instrument covering the frequency range 15 kc/s to 30 Mc/s. Features include a high quality r.f. output, a built-in crystal calibrator, automatic level control, and sinewave a.m. monitored and variable to 100%. An alternative version, the TF 867/2, has special features of particular value when testing narrow-band communication receivers. For full details of these instruments write for Leaflet G183.

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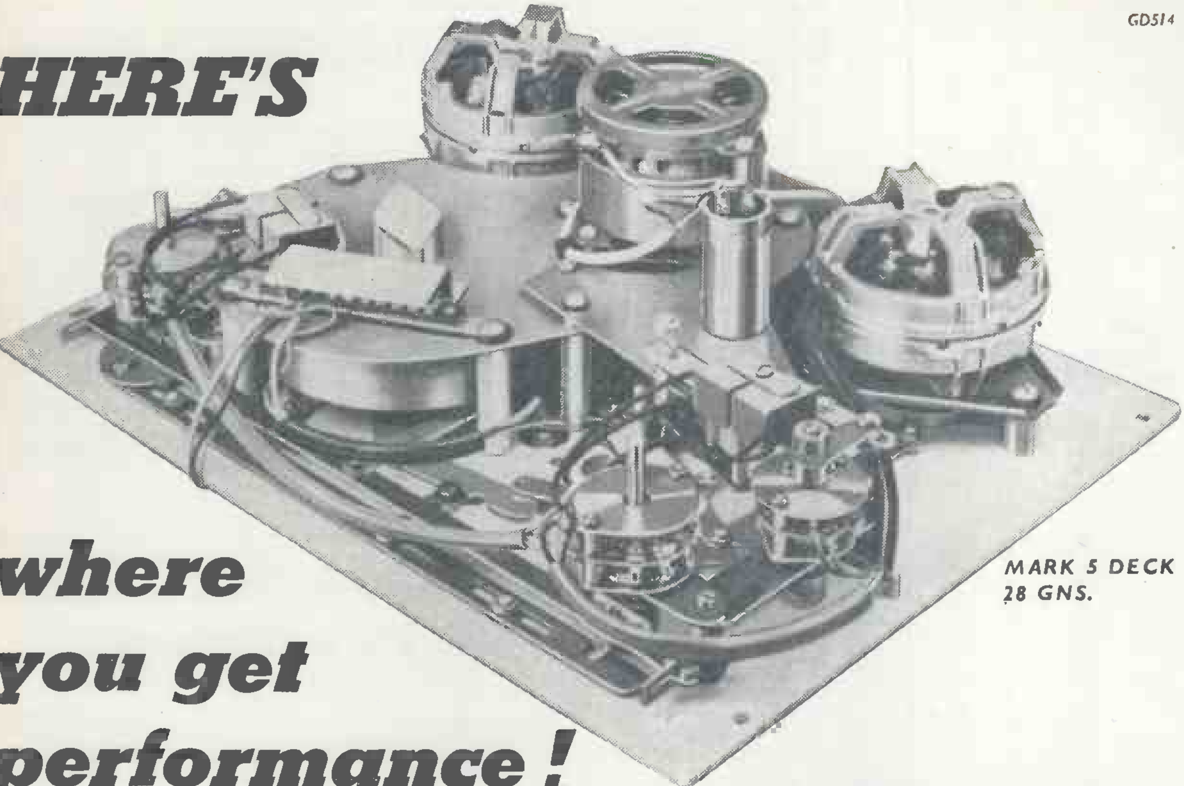

MARK 5 DECK
28 GNS.

3 STAR

MK. 5

A tape recorder is only as good as its deck. This is where precision in manufacture and assembly is vital for professional standards of recording and reproduction. In the Brenell Mark 5 deck there's a rare combination of advanced technology and an almost-forgotten kind of craftsmanship.

The Mark 5 deck has a remarkable, new main motor of a type widely regarded as the most efficient to be used in tape recording. The HYSTERESIS SYNCHRONOUS MOTOR, with a balanced outer rotor and a heavy, statically and dynamically balanced flywheel. It brings 'wow and flutter' down to below .1% at 7½ ips!

This and the other components providing the specification shown below are assembled with fanatical care. Brenell Mark 5 (and all other equipment) production is an individual task which is repeatedly checked and tested. Nothing less than mechanical and electrical perfection will do.

At 28 gns., you'd be missing a great deal to pay less and there's no need to pay more.

Abridged specification
3 INDEPENDENT MOTORS
4 RECORDING SPEEDS
FAST REWIND in either direction. 1,200ft. reel rewound in 45 seconds.

WOW AND FLUTTER	FREQUENCY RANGE:
Below .05% at 15 ips	15 ips: 50/16,000 c/s ± 3db
Below .1% at 7½ ips	7½ ips: 60/12,000 c/s ± 3db
Below .15% at 3¾ ips	3¾ ips: 60/7,000 c/s ± 3db
Below .25% at 1⅞ ips	1⅞ ips: 60/4,000 c/s ± 3db

SELECTIVE FREQUENCY CORRECTION at 15, 7½ and 3¾ ips.
ACCEPTS 8¼in. REELS, PAUSE CONTROL, DIGITAL REV. COUNTER, PROVISION FOR EXTRA HEADS.

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MK.5: 64 GNS.
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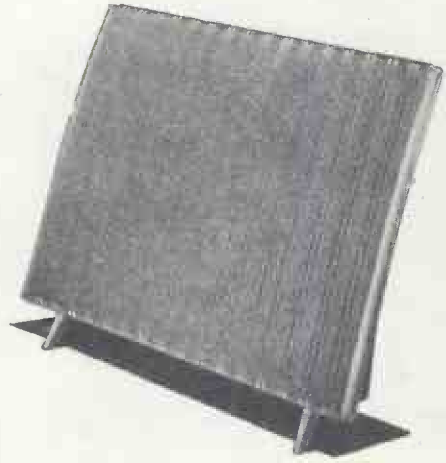

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QUAD 22 Control Unit
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QUAD Electrostatic Loudspeaker
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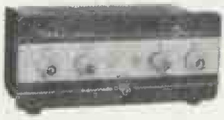
6 W STEREO AMPLIFIER KIT



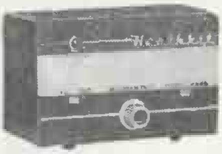
Model S-33

A versatile high-quality self-contained STEREO/MONAURAL Amplifier with adequate output for a living room. Can be used to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel; 0.3% distortion at 2.5 w/chnl.; 20 dB N.F.B., inputs for Radio (or Tape) and Gram., Stereo or Monaural; Ganged controls. Sensitivity 200 mV. **£11.8.0**

HI-FI SINGLE CHANNEL AMPLIFIER KIT Model MA-12

A compact high fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications include sound reinforcing systems, transmitter modulators, for use with tape recorders, also as a general purpose laboratory amplifier. **£9.19.6**

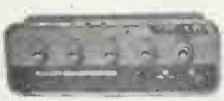
STEREO-HEAD BOOSTER KIT



Model USP-1

Hi-Fi Stereo Pre-Amplifier for low-output Hi-Fi P.U.s. Input 2 mV. to 20 mV. Output adjustable from 20 mV. to 2 V. 40–20,000 c/s. Also suitable as low-noise R.C.-Coupled high-gain monaural amplifier. **£5.19.6**

STEREO CONTROL UNIT KIT



Model USC-1

Incorporates all worthwhile features for high fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape heads and any stereo or mono-pick-up. **£17.19.6**

TAPE DECKS

Are available as "packaged deals" with other equipment. Customers purchasing much of their audio equipment at the same time will find our PACKAGED DEAL scheme more economical. Details on request.

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A NEW AND ATTRACTIVE CABINET in modern style designed to house all your Hi-Fi equipment (including tape deck and full-sized transcription record player). The cabinet parts are veneered and pre-drilled, with edging in Panaflex plastic strip, for ease of finishing. Complete with everything you need for assembly, including screws, hinges and even a padsaw! Left "in the white" for finishing to choice. Size 39⅛ x 32 x 21⅛in. **£16.15.0**

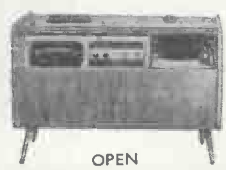
TAPE AMPLIFIER UNITS Models TA-1M and TA-1S

This Combined Tape-Record/Replay Amplifier is available in both monophonic and stereophonic models. Model TA-1M can be modified to the stereo version with modification kit TA-1C.

TA-1M, £16/14/-; TA-1S, £22/4/-; TA-1C, £6.

'GLOUCESTER'

STEREO CABINET KIT



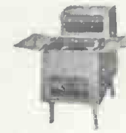
OPEN

Specially developed to meet the varying needs of different homes, it will house Tape Deck and/or Record Player, F.M. Tuner and Stereo Amplifier. In addition, for the convenience of those to whom space is an overriding consideration, it is possible to house speaker systems at each end. For this purpose a loudspeaker kit, comprising two 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padsaw and mounting details are also available. Neutral hardwoods have carefully been selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers. Dimensions: length 46½in., height 30in. depth 21in.

Mk. I for Tape Deck or Record Player £15 18 6

Mk. II for both T/D and R/P.............. £17 8 6

'CHEPSTOW' EQUIPMENT CABINET KIT



Specially designed for those whose floor space is at a premium. Will house Record Player, FM Tuner, Stereo Amplifier and additional power amplifiers where needed. An upper deck is available for the self-power stereo amplifiers to ensure maximum heat dissipation. Veneered and left in white for finishing to personal taste. Overall dimensions are 35in. x 18in. x 33in. high. **£10.10.0**

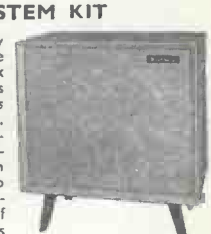
HI-FI STEREO AMPLIFIER KIT Model S-88

Gives 16 w. output (8 per channel with 0.1 per cent. distortion at 6 w. per channel). It has ganged controls, STEREO/MONAURAL gram, radio and tape recorder inputs and push-button selection as well as many other first-class features well above its price range. In two-tone grey metal cabinet with a golden surround and fittings. Also ultra-linear push-pull output. **£25.5.6**
Basic sensitivity 20 mV. (2 mV. available 20/- extra).

HI-FI SPEAKER SYSTEM KIT Model SSU-1

Ducted-port bass reflex cabinet, "in the white." Frequency response to 40–16,000-c/s. Power rating 25 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies.
With legs £11/12/6.............. **£10.5.6**

COTSWOLD SPEAKER SYSTEM KIT



This acoustically designed enclosure measures 26 x 23 x 15½in. and houses a special 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30–20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete, with speakers, cross-over unit, level control, Tygan grille cloth, etc. Left "in the white" for finish to personal taste, all parts are precut and drilled for ease of assembly. **£19.18.6**

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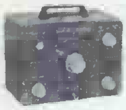
Laboratory quality at utility oscilloscope price and ease of assembly make this kit of outstanding value. Vertical frequency response 3 c/s to 5 Mc/s., + 1.5 dB. −5 dB., sensitivity 10 mV. per cm. at 1 kc. Horizontal frequency 1 c/s. to over 400 kc/s. (±1 dB. up to 200 kc/s.). The Heath patented sweep circuit functions from 10 c/s to 500 kc/s. in five ranges giving five times the usual sweep of other 'scopes. In addition it has exceedingly short re-trace and rise times and electronically stabilised power supply. Included is a 48-page instructional Manual. **£34.15.0**

ELECTRONIC SWITCH KIT Model S-3U (Oscilloscope Trace Doubler)

This extremely useful, low priced device will extend the use of your single-beam oscilloscope for duties otherwise only in the province of the double-beam tube. In short, at a nominal cost, the Heathkit model S-3U will give you the advantages of a double (or other multiple) beam 'scope, while retaining all the advantages of your present single-beam instrument.

Hitherto an electronic switch of this nature, permitting the simultaneous observation of two signals on the screen of a single-beam C.R.T. oscilloscope, has cost nearly as much as the 'scope itself. **£9.18.6**

RESISTANCE-CAPACITANCE BRIDGE KIT Model C-3U



Measures capacity 10pF to 1,000μF, resistance 100Ω to 5 megohms and power factor. 5-450 v. test voltages. Safety switch provided. **£7.19.6**

MULTIMETER KIT Model MM-1U

Provides wide voltage, current, resistance and dB ranges to cover hundreds of applications. Sensitivity 20,000 ohms/volt D.C. and 5,000 ohms/volt A.C. Ranges: 0-1.5 v. to 1,500 v. A.C. and D.C.; 150μA to 15A D.C.; 0.2Ω to 20MΩ. 4½in. 50 μA meter. **£11.8.6**

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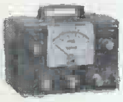

10 c/s. to 100 kc/s., switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and dB's. **£19.3.0**

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This popular meter is used in many recording studios and broadcasting stations as a monitor as well as for servicing purposes. Dissipation rating up to 25 w. continuous, 50 w. intermittent. **£13.18.6**

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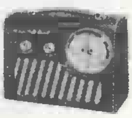

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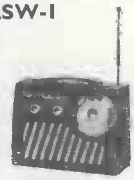

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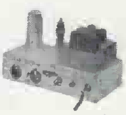

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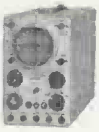

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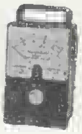

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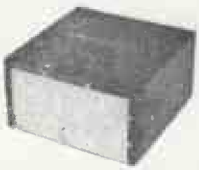

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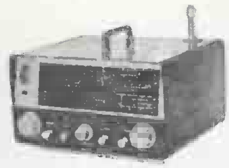

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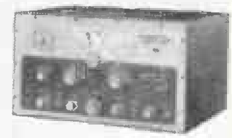

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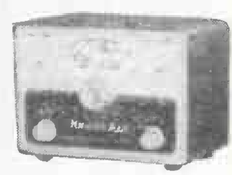

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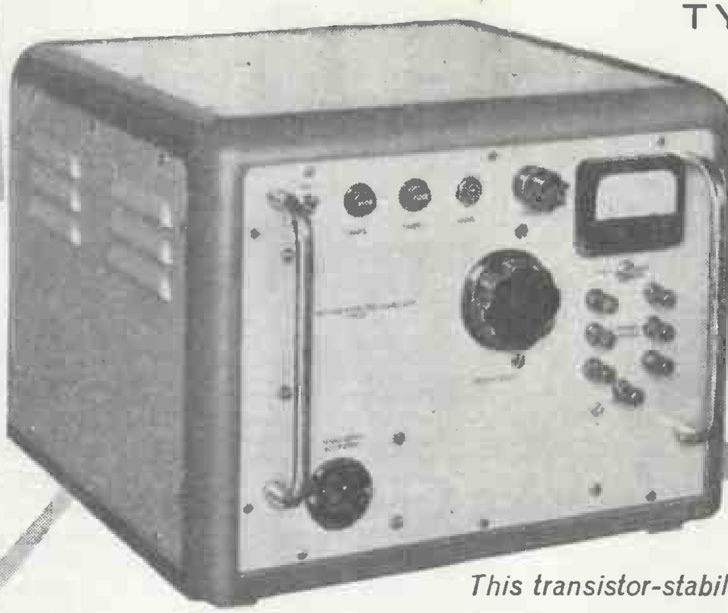

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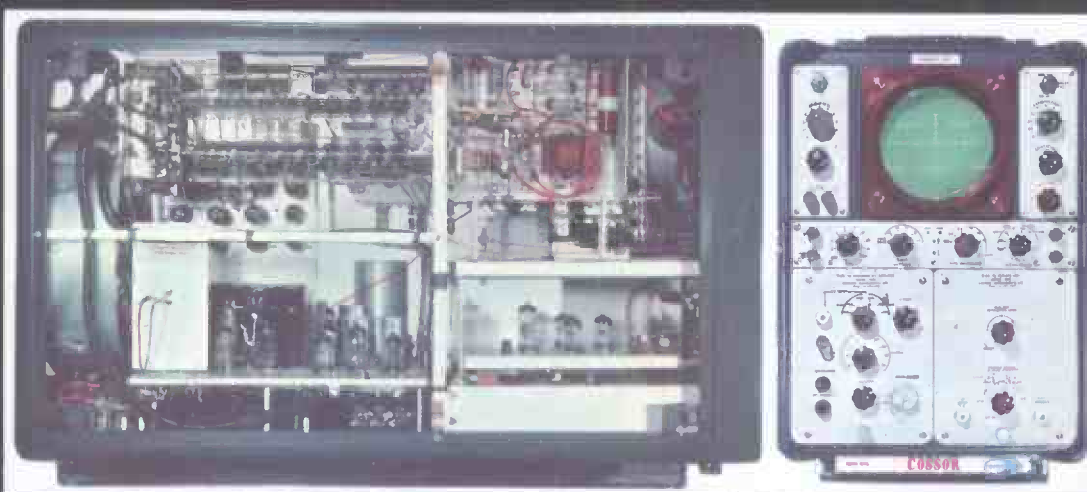

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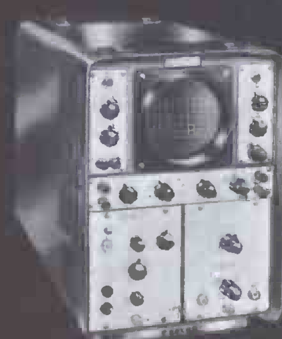

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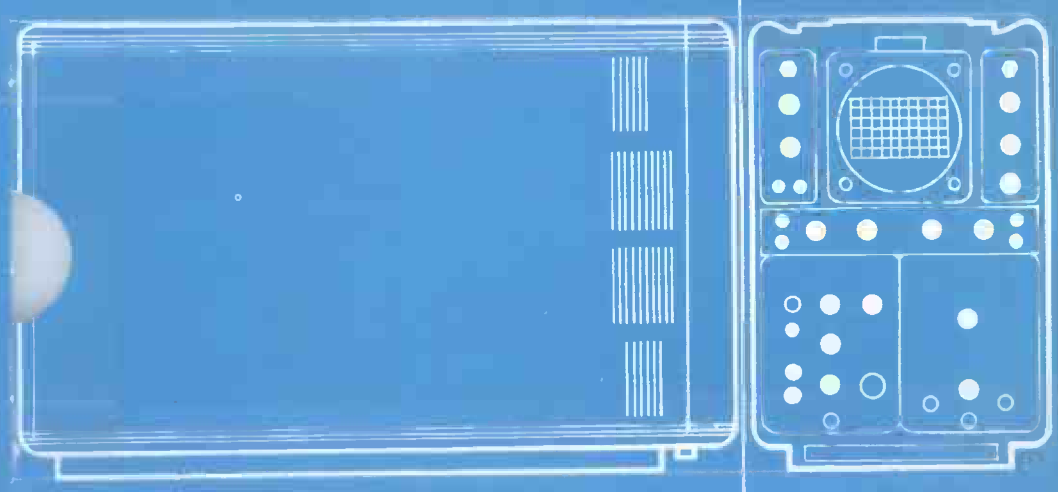

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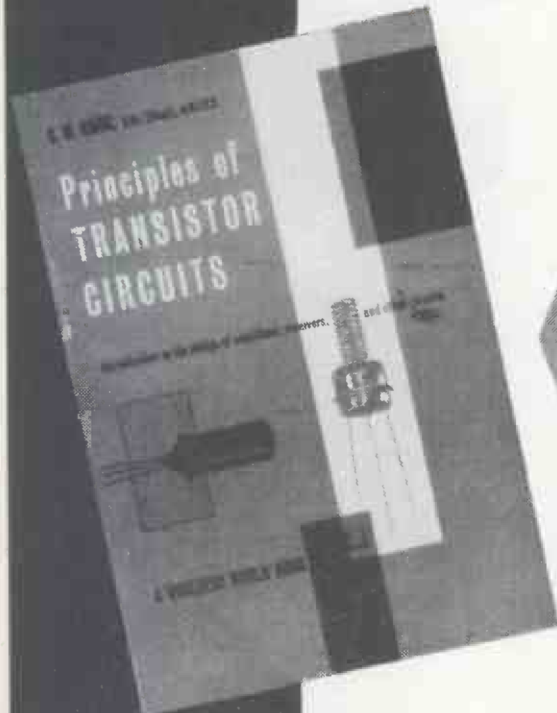

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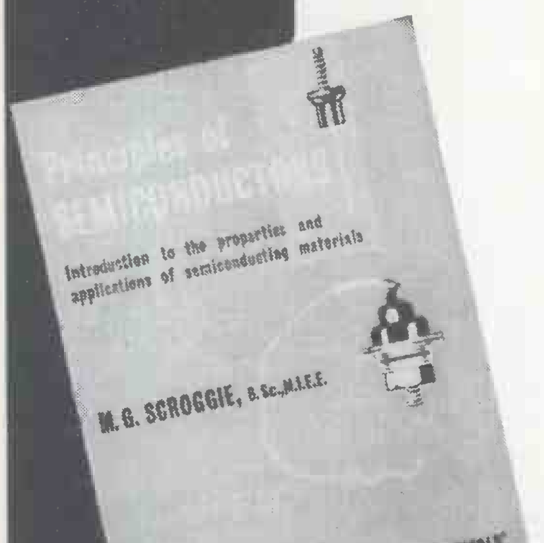

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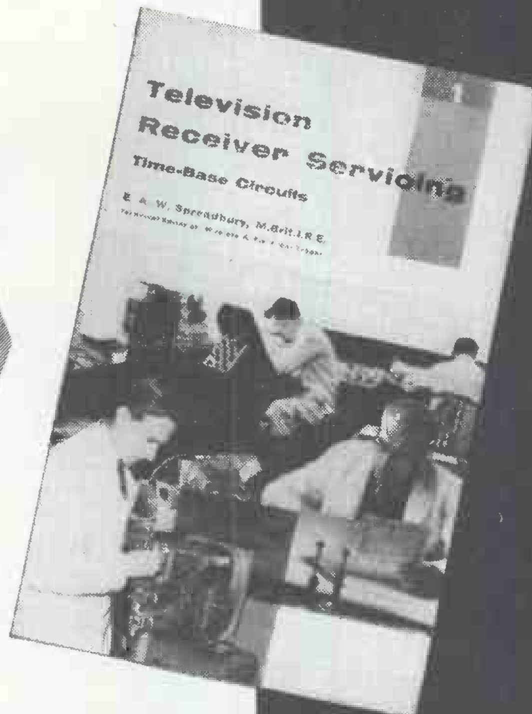

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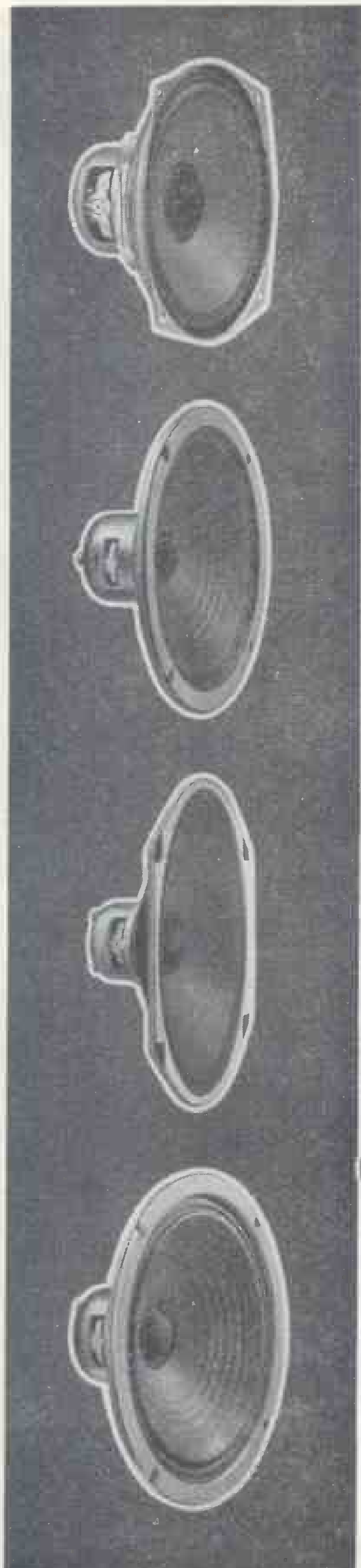

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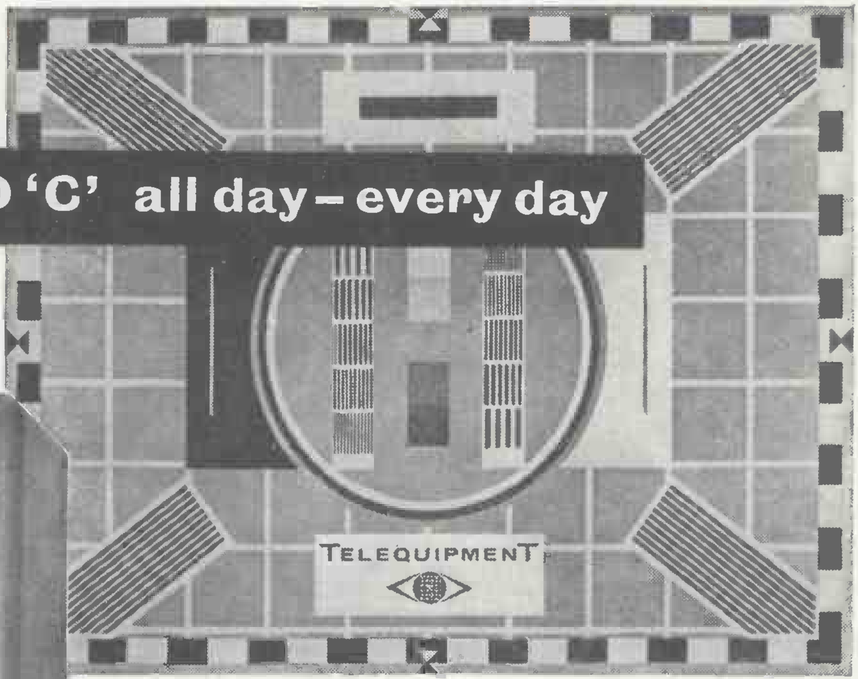


For efficient full scale servicing—the Telequipment Monoscope test card generator.

★ **C.C.I.R. standard.**
★ **Video response to 6 Mc/s.**
★ **Crystal controlled transmitters.**
★ **Rated for continuous operation.**
★ **Prices from £570.**

TELEQUIPMENT

For the smaller user—Telequipment WG44 portable waveform generator at **£62.**

R.E.C.M.F. Exhibition,
Olympia,
May 30th—June 2nd.
Stand No. 497, Grand Hall Gallery

Telequipment Limited, 313 Chase Road, Southgate, London, N.14. Telephone: Fox Lane 1166

DIGITAL VOLT-OHM DVOM METER

A fully transistorized instrument of exceptional versatility featuring in-line readout, with polarity, decimal point and quantity clearly displayed.

FEATURES...

Accurate measurement of resistance and A.C. and D.C. voltage. Can equally well be used as a counter. May be used as the basis of a data logging system. Outputs available for direct connexion to Venner printer.

BRIEF SPECIFICATION...

D.C. voltage 1mV to 1100 V.	Accuracy ± 0.1% of full scale.
A.C. voltage 1mV to 1100 V.	Accuracy ± 0.25% of full scale.
Resistance 1Ω to 1.1MΩ.	Accuracy ± 0.25% of full scale.

DVOM uses well-tried Venner packaged circuits, making for reliability in use and ease in servicing. Stepping switches, relays and need for frequent calibration have all been eliminated.

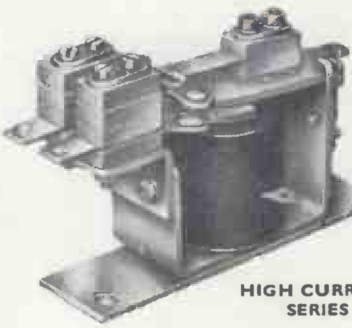
DVOM has been developed by Venner Electronics in collaboration with Epsco Incorporated of Boston U.S.A.

See it on Stand No. 496 at the RECMF Exhibition, Olympia, May 30—June 2

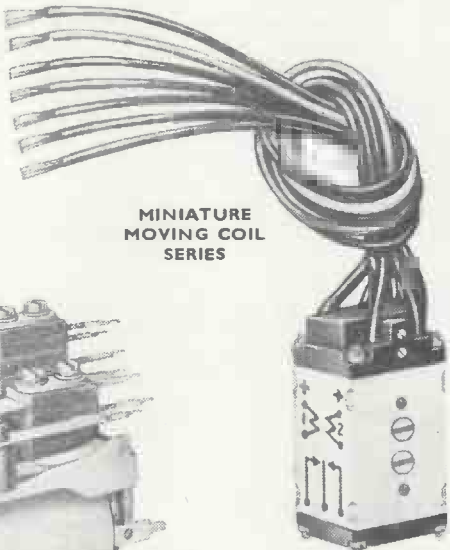
VENNER

VENNER ELECTRONICS LIMITED
Kingston By-Pass, New Malden, Surrey. MALden 2442

ELECTRO METHODS LTD



HIGH CURRENT SERIES



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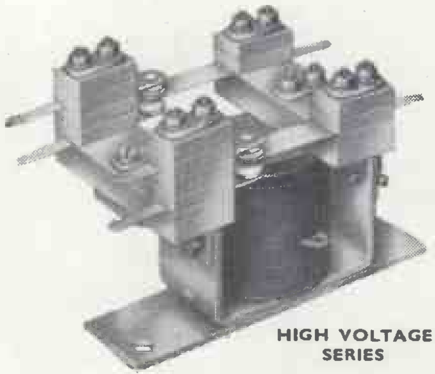

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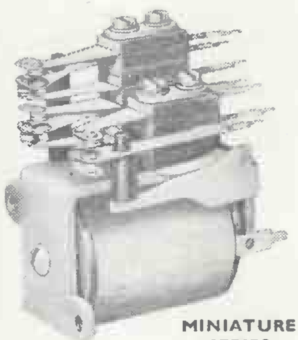
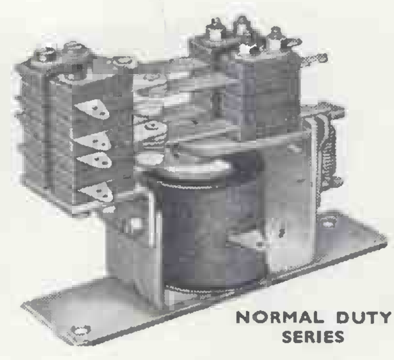
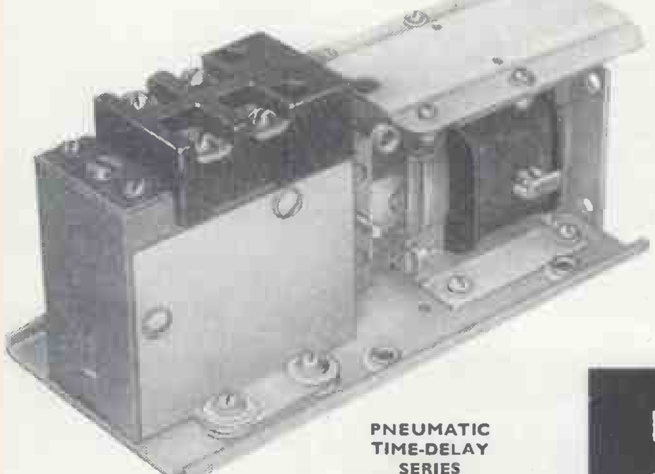


MINIATURE SERIES



NORMAL DUTY SERIES



PNEUMATIC TIME-DELAY SERIES

PRECISION RELAYS

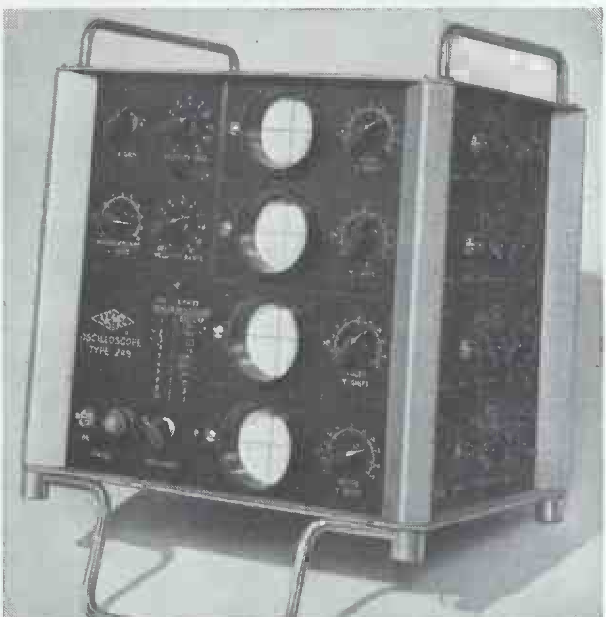
Illustrated technical data sent on request:

ELECTRO METHODS LTD., General Products Division, **CAXTON WAY, STEVENAGE, HERTS**

Telephone: Stevenage 2110-7

4 good reasons why you'll prefer to work with the Airmec

4 CHANNEL OSCILLOSCOPE



TYPE 249

This Airmec Oscilloscope can be applied to multiphase control systems, pulse generators, time base circuits, computers, etc.

Four separate cathode ray tubes mounted one above the other and operated from a common time base.

Four identical Y amplifiers with maximum frequency range of D.C. – 3 Mc/s (–3 dB).

- FOR VIEWING, COMPARISON AND MEASUREMENT OF FOUR SEVERAL RELATED WAVEFORMS SIMULTANEOUSLY
- TIME AND VOLTAGE CALIBRATION
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- RIGID SYNCHRONIZATION
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In instrumentation **Airmec** *makes most things.... better*

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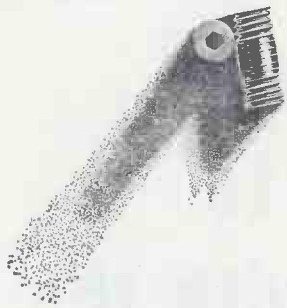
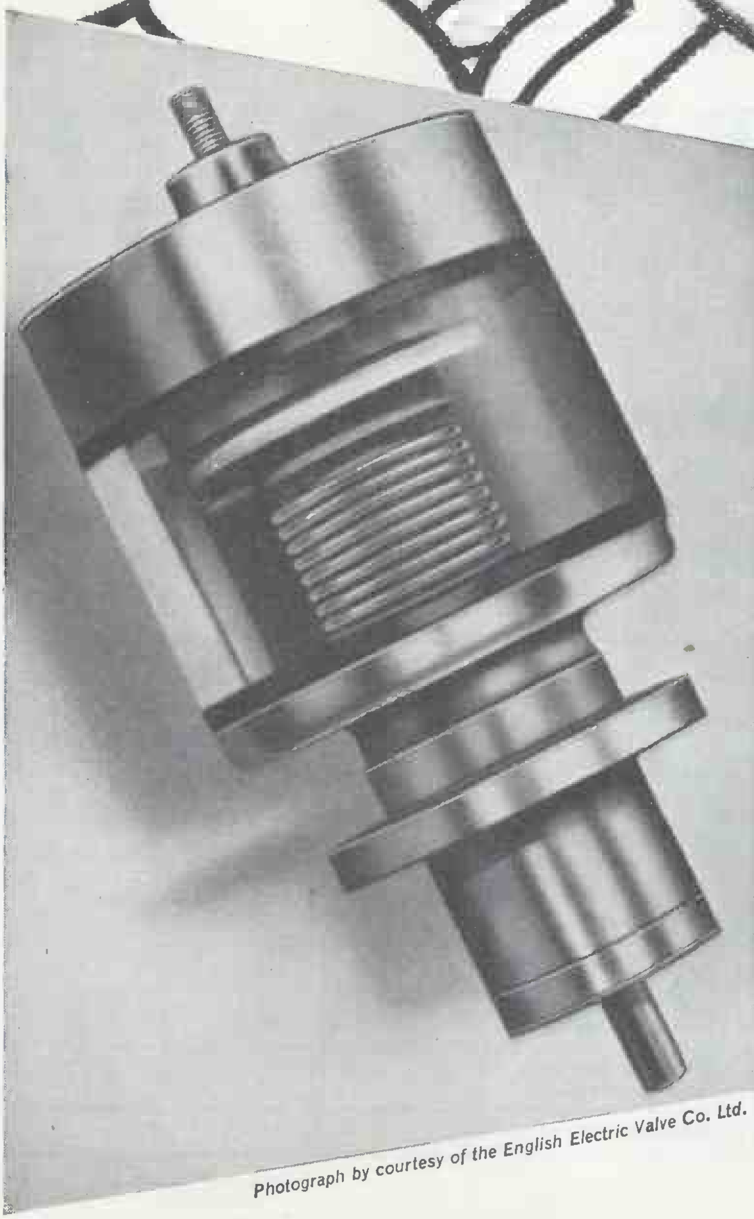


HYDROFLEXibility...



Photograph by courtesy of the English Electric Valve Co. Ltd.

In this 15 kV high vacuum variable capacitor—a typical example of the range developed by the English Electric Valve Company Limited and the first commercially available of British manufacture—a Hydroflex flexible metal bellows allows the capacitor plates to be moved to different setting without the vacuum seal being broken. Just one of the 1,001 exceptional jobs that can only be done with Hydroflex metal bellows.

Can we help or advise you?

Some other applications:

Temperature sensitive systems.
Pressure sensitive systems.
Flexible couplings.

HYDROFLEX

HYDROFLEX seamless metal bellows

B.30

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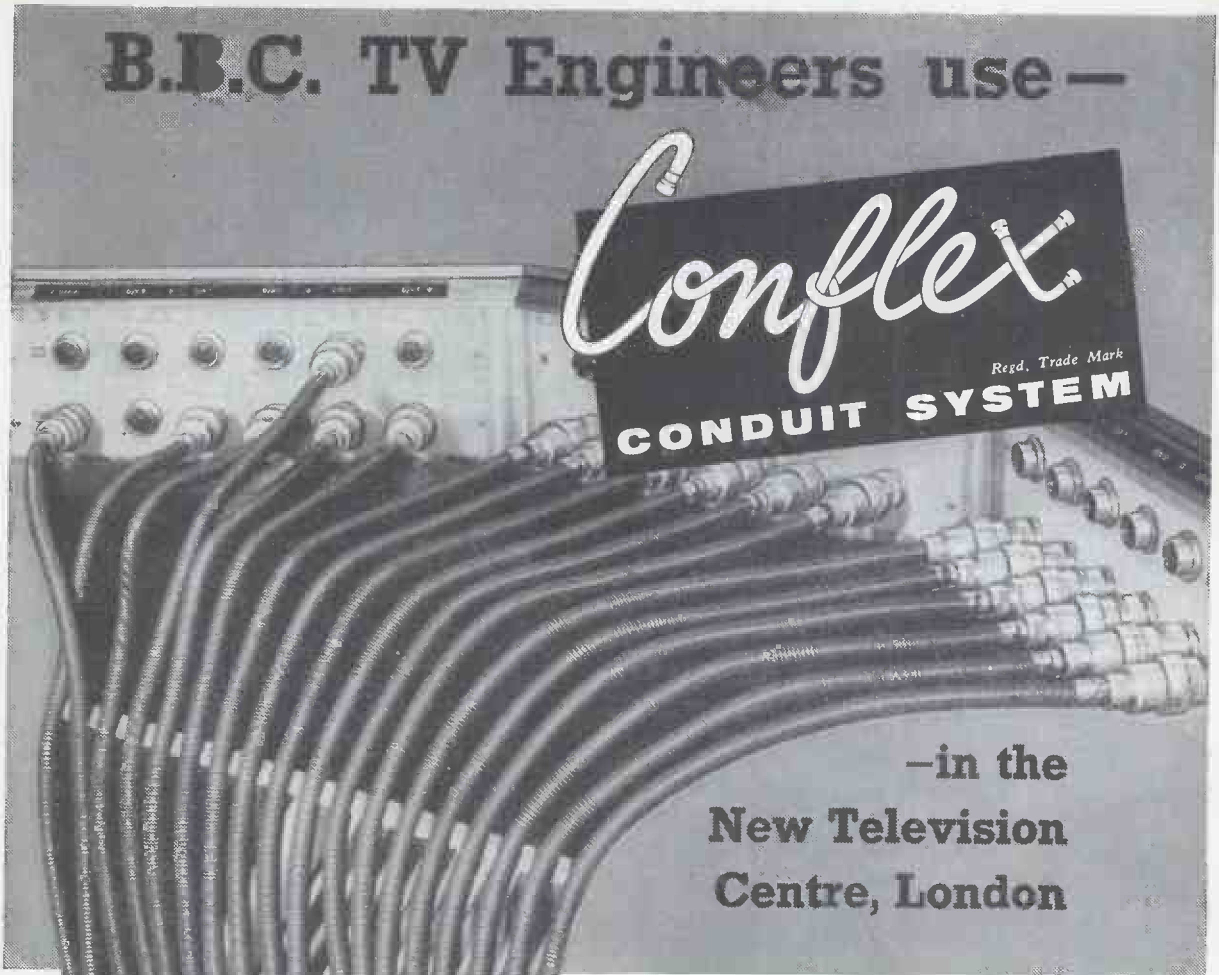


The Telecine Control Desk

The use of Conflex conduit system on the Telecine Routing Desk at the B.B.C.'s new Television Centre is a completely new approach to installations of this nature. Many troubles that are normally associated with circuit changing are completely eliminated.

Advantages of this system are many and include:—

- A high degree of flexibility—no metal fatigue.
- Terminations that fit British and American connecters, junction boxes, etc.
- Eliminations of special cable lays, moulded harnesses and problems involved in encapsulation.
- Simplification of connecter wiring and easier conductor changes.
- *In situ* assembly that requires no special tools.
- Provision for double-screening on R.F. circuits.

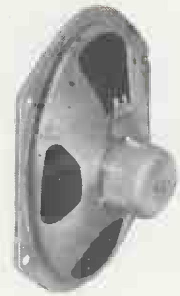
* *Write for technical details.*

SUPERFLEXIT LTD · BUCKINGHAM AVE · SLOUGH · BUCKS

theme and variations

The theme has always been top quality speakers, but the variations in size, shape and fitness-for-purpose have provided us with unrivalled experience in satisfying manufacturers' requirements, however unusual they may be.

It is the know-how, quality and service to manufacturers that have made the name Rola Celestion pre-eminent in this specialised field of sound reproduction at the point where the final product, be it radio, TV, record player or tape recorder, is judged by the listening public.



MODEL S58
8"×5" Elliptical

MODEL S8
8" Circular

MODEL F3
3" Inverted

MODEL M2
2" Circular

Manufactured in a wide range of sizes from 2in. to 12in. diameter, with a variety of "ellipticals" and "slots" in between, CELESTION set the standard by which all others are judged.

CELESTION

LOUDSPEAKERS FOR ALL PURPOSES

FULL DETAILS AVAILABLE FROM

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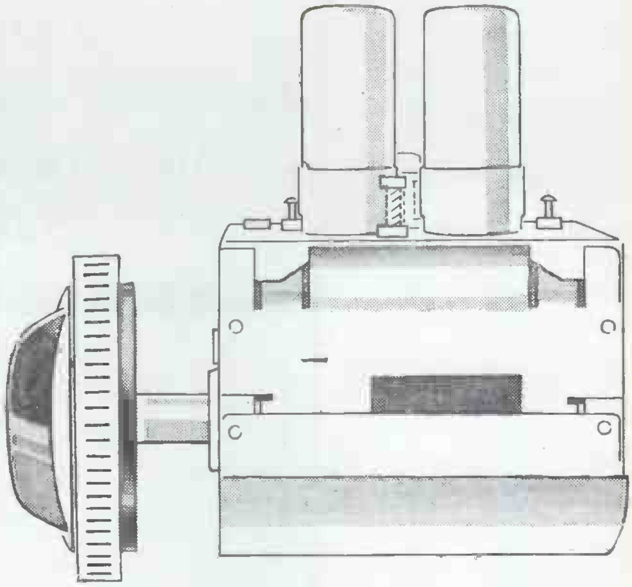

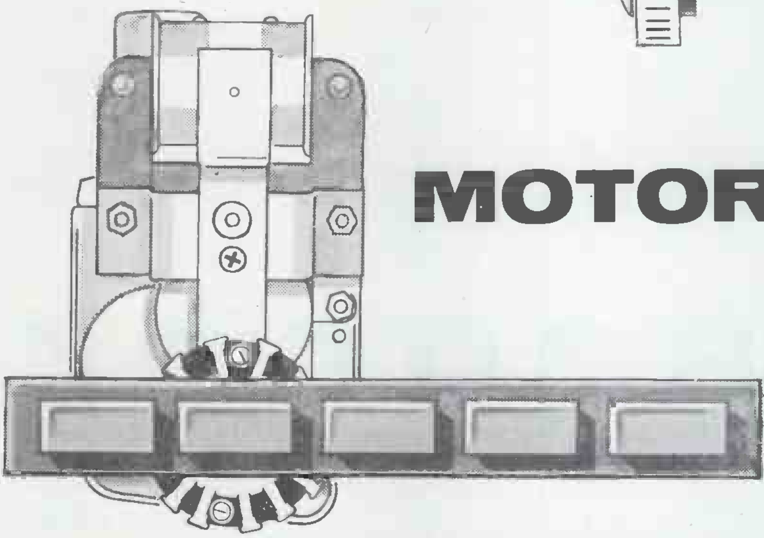

You must *try . . .*
Gevasonor Magnetic Recording Tape Now available in a full range of types and sizes

TYPE	SPOOL DIA.	TAPE LENGTH	PRICE PER SPOOL	STOCK NO.
TYPE M Standard Play	4″	300′	10/6	M/90
	5″	600′	18/-	M/183
	5¾″	820′	23/6	M/250
	7″	1200′	30/-	M/365
TYPE LR Long Play	3″	225′	7/6	LR/68
	4″	450′	13/6	LR/137
	5″	900′	24/-	LR/275
	5¾″	1150′	28/6	LR/350
	7″	1800′	42/-	LR/550
TYPE LRP Long Play Tensilized Polyester	3″	225′	9/-	LRP/68
	4″	450′	16/-	LRP/137
	5″	900′	28/-	LRP/275
	5¾″	1150′	35/-	LRP/350
	7″	1800′	50/-	LRP/550
TYPE DP Double Play Tensilized Polyester	3″	300′	14/-	DP/90
	4″	600′	25/-	DP/183
	5″	1200′	45/-	DP/365
	5¾″	1650′	55/-	DP/500
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gevasonor

GEVASONOR MAGNETIC TAPE

GEVASONOR MAGNETIC TAPE

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Obtainable from your radio or photographic dealer

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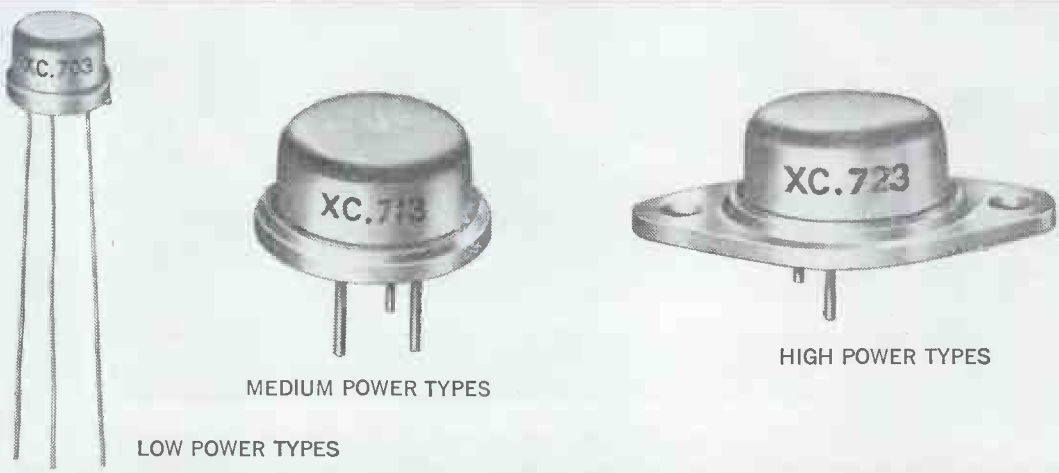
NPN DIFFUSED JUNCTION

SILICON POWER TRANSISTORS

2 TO 30 WATTS DISSIPATION AT 100°C

OUTSTANDING FEATURES

- ★ Extremely low saturation resistance
- ★ High current and power dissipation ratings
- ★ High beta at high current
- ★ High temperature performance (up to 175°C)



MEDIUM POWER TYPES

HIGH POWER TYPES

LOW POWER TYPES

		XC703	XC713	XC723
Maximum collector/base voltage (volts)		60	60	60
Maximum emitter/base voltage (volts)		12	12	10
Minimum h_{fe}	(V_{ce} = 4V, I_c = 200 mA)	15	—	—
	(V_{ce} = 4V, I_c = 750 mA)	—	15	—
	(V_{ce} = 4V, I_c = 1.5 A)	—	—	10
Average f_α	(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	1.5	—	—
	(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	—	1.25	—
	(V_{cb} = 12V, I_c = 100 mA) (Mc/s)	—	—	1

Have you our latest transistor data sheets? A request on your business notepaper will bring you a set made up to date.

EDISWAN SEMICONDUCTORS

MAZDA

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Semiconductor Department
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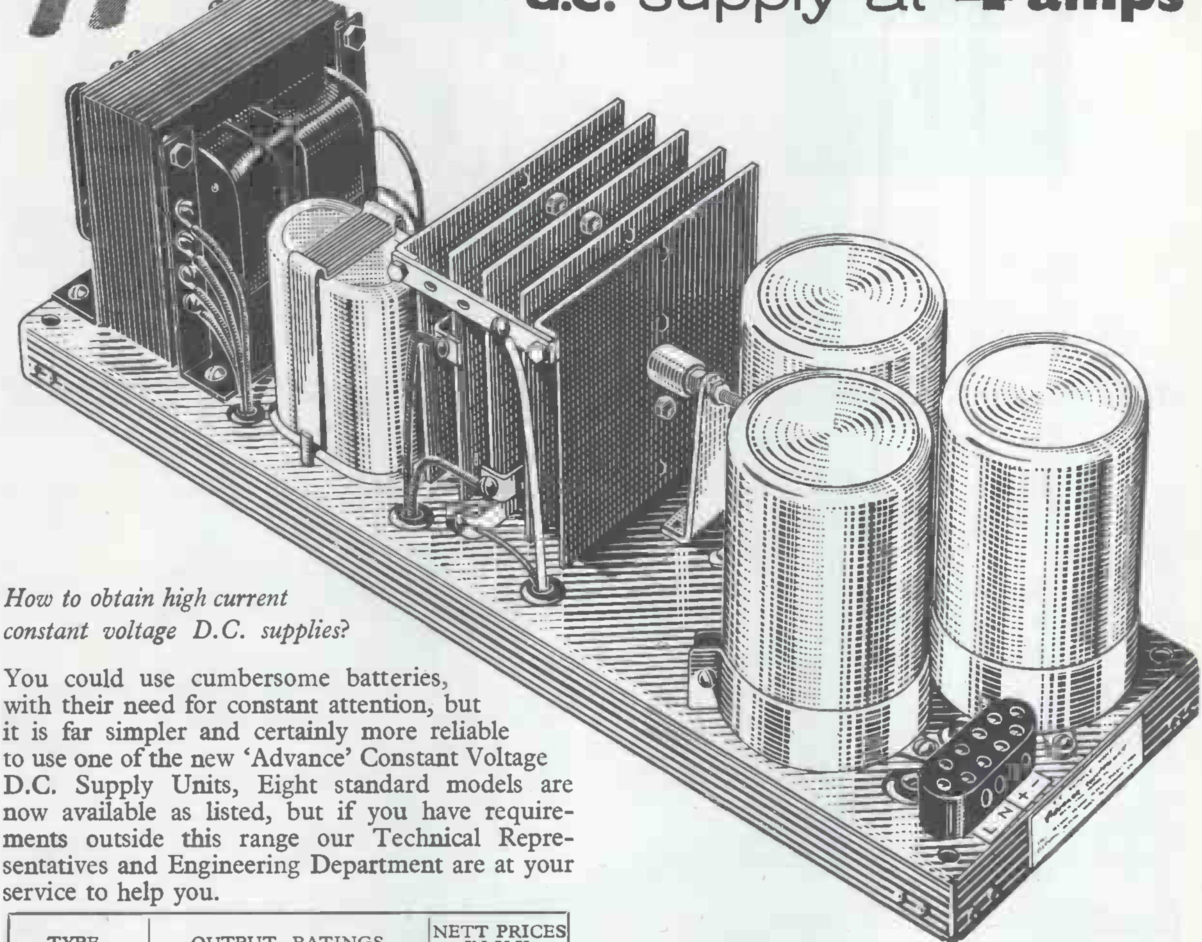
CRC 15/87

Here is a 12v. stabilized **d.c.** supply at **4 amps**



How to obtain high current constant voltage D.C. supplies?

You could use cumbersome batteries, with their need for constant attention, but it is far simpler and certainly more reliable to use one of the new 'Advance' Constant Voltage D.C. Supply Units, Eight standard models are now available as listed, but if you have requirements outside this range our Technical Representatives and Engineering Department are at your service to help you.

TYPE	OUTPUT RATINGS		NETT PRICES IN U.K.
DC.1	6 volts	1.25 amp	£20
DC.2	6 volts	4.00 amps	£25
DC.3	12 volts	1.25 amp	£20
DC.4	12 volts	4.00 amps	£27
DC.5	24 volts	1.00 amp	£20
DC.6	24 volts	5.00 amps	£30
DC.7	48 volts	1.00 amp	£20
DC.8	48 volts	4.00 amps	£35

These new D.C. Supply Units . . .

- Provide **HIGH CURRENT OUTPUT AT LOW COST**
- Are **SMALL IN SIZE AND WEIGHT FOR VA OUTPUT**
- Have **HIGH ENERGY RESERVOIR**, thus are suitable for pulse, intermittent or variable loads
- Operate with **HIGH EFFICIENCY**

Advance

CONSTANT VOLTAGE **D.C.** POWER SUPPLIES

Full technical details available in Leaflet D59

Advance COMPONENTS LIMITED
MAINS STABILIZATION DIVISION
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IT/GD77

EMT

MAGNETIC TAPE RECORDER FOR STUDIO PURPOSES

STUDER C37

These large push buttons, which are easy to survey, make its operation a pleasure. They are very easy to control. All functions can also be remote controlled. Transistor operated tape tension adjustment is effected by tape balance.
Convincing is its easy and amazing simple construction out of easy accessible and exchangeable building components.

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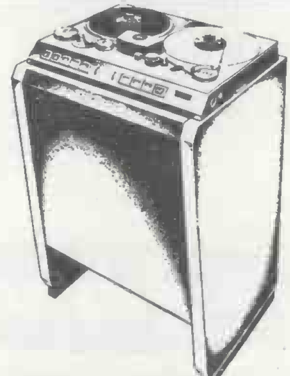
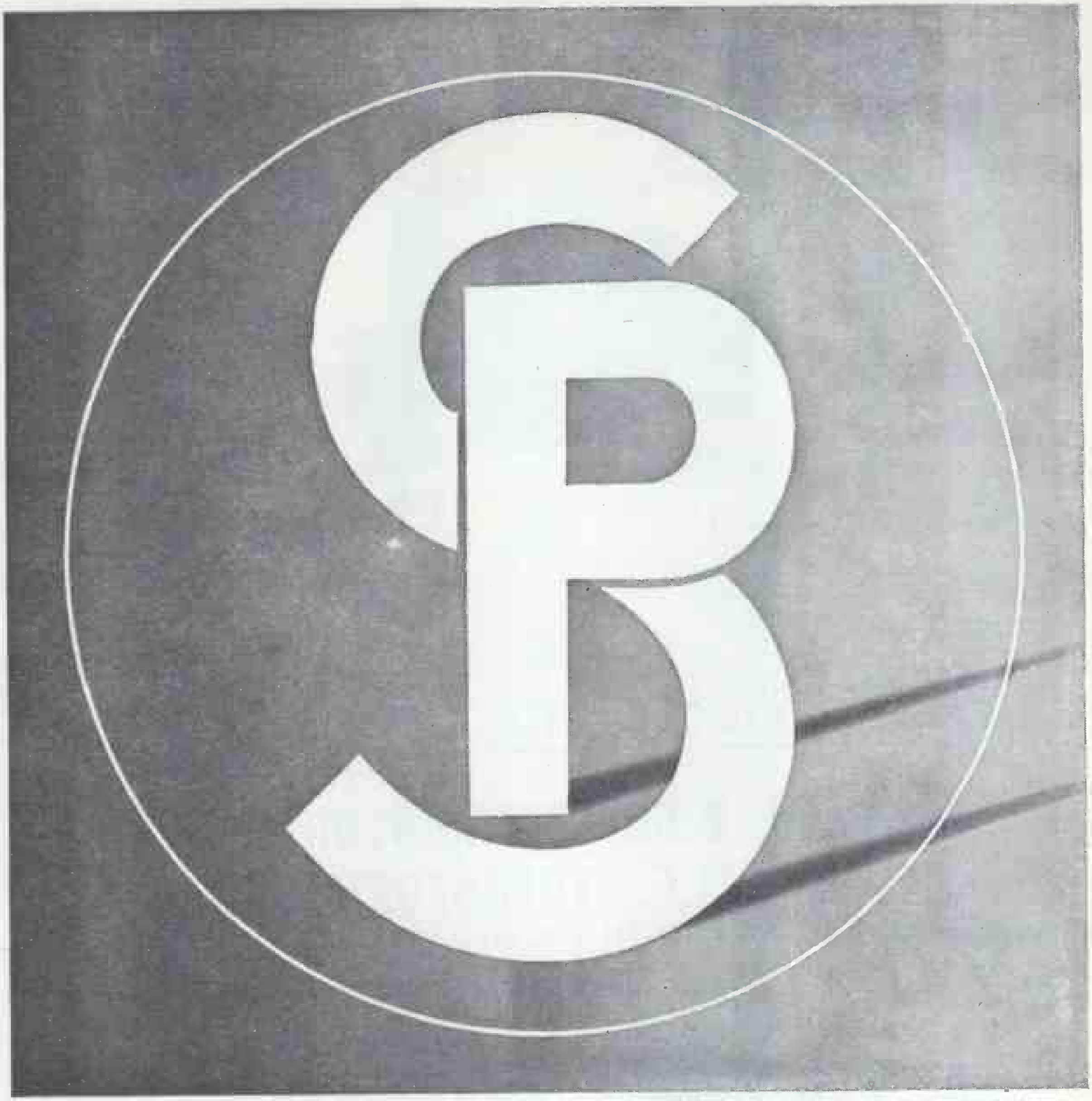


TECHNICAL DATA:

Tape Speed	15in. and 7½in./sec.
Frequency Response	30 cps to 12 kc/s +1 to −2 db
Signal to Noise Ratio	60 db minimum
Distortion Factor	2% maximum
Wow and Flutter, weighted	±0.075%

(All quoted values are for 15in/sec.)
The equipment being deliverable in full track or stereo construction.
Offer with detailed leaflet on request.

ELEKTROMESSTECHNIK WILHELM FRANZ KG
LAHR/SCHWARZWALD (WESTERN GERMANY), POSTBOX 327, TELEPHONE 2053, CABLES: MESSTECHNIK, TELEX: 752934



LINEAR

For HIGH SENSITIVITY!
HIGHEST FIDELITY!
MAXIMUM RELIABILITY!
REASONABLE COST!

MODEL L10 HIGH FIDELITY 10 WATT AMPLIFIER

WITH SEPARATE PRE-AMPLIFIER

Supplied complete only (i.e. Main Amplifier and Pre-amp.) **15** Retail Price GNS.

Size of main amplifier 9in. x 7in. x 5in., Pre-amp 11in x 4$\frac{3}{8}$in x 2$\frac{3}{4}$in Front Plate 12in x 3$\frac{1}{4}$in Stoved Gold hammered finished chassis Front Plate Polychromatic Gold. Weight of main amplifier 10lb Pre-amp. 3lb. For 50/60 c.p.s. A.C. mains 200-230-250 v. or to order for export.

The Following Outstanding Test Figures include Pre-amplifier.

Sensitivity (for 10 watts)
L.P. 25 m.v.
78 r.p.m. 20 m.v.
Radio, 35 m.v.
Microphone, 2.5 m.v.

Input Impedance
All inputs 500k. Plus 10pfd.

Frequency Response
±2 d.b. 30-25,000 c.p.s.

Power Consumption
90 watts.

Maximum Power Output
In excess of 12 watts.

Negative Feedback
Total 32 d.b.

HARMONIC DISTORTION
(Inc. Pre-amplifier)
0.09% measured at 10 watts.

Damping Factor 35

Bass Control
+9 d.b. to —9 d.b. at 50 c.p.s.

Treble Control
+9 d.b. to —9 d.b. at 12,000 c.p.s.

Hum Level
—70 d.b.

Filter
—7 d.b. at 9 Kc/s.
—10 d.b. at —5 Kc/s.

MULLARD VALVES:
EF86 (1); ECC83(2); EL84(2); EZ81 (1).

OUTPUT MATCHINGS
For 3 ohm and 15 ohm L/Speakers from high grade sectionally wound output transformer.

RESERVE POWER SUPPLY (for Radio Tuner) 300 v. 30 m.a. smoothed and 6.3 v. 1.5 a. at 4-pin socket.

Also Available

The L45. Compact High Quality 4-5 watt amplifier
Size approx. 7-5-5$\frac{3}{4}$in. high. Sensitivity is 28 millivolts so that the input socket can be used for either microphone or gram., tape, radio tuner, etc. B.V.A. valves used are: ECC83, EL84, EZ80. Controls are: Vol., Treble and Bass with mains switch. The Tone controls provide full compensation for long playing records. Output matching for 3 ohm loudspeaker. Retail price £5/19/6.

THE LT54 TAPE DECK AMPLIFIER. A complete unit (power pack and oscillator incorporated) ready for connection to A.C. mains. 3 ohm loudspeaker and practically any make of deck. Negative feedback equalization adjustment by multi-position switch for 1$\frac{7}{8}$, 3$\frac{3}{4}$ and 7$\frac{1}{2}$ per sec. Retail price 12 gns.

DIATONIC 10-14 WATT. High Fidelity amplifier with integal pre-amplifier. Retail **12** gns.

CONCORD 30 WATT. Hi-Fi amplifier with two separately controlled inputs. Retail **16** gns.

L50 50 WATT AMPLIFIER. Size approx. 14 x 10 x 8in. Sensitivity 25 m.v. Outputs for 3 and 15 ohm speakers. Retail price **22** gns.

L5/5 STEREOPHONIC AMPLIFIER. Sensitivity 10 m.v. Output 5 watts on each channel. Retail **12** gns.

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WEYRAD P.50 TRANSISTOR COILS AND I.F. TRANSFORMERS

FOR 2-WAVE PORTABLE WITH PRINTED CIRCUIT AND ROD AERIAL

P50/1AC M.W. OSCILLATOR COILS. For 176pF TUNING CONDENSER .... PRICE **5/4d.**

P50/2CC 1st and 2nd I.F. TRANSFORMER. 470 Kc/s. OPERATION. "Q" = 150 .... PRICE **5/7d.** (2 REQUIRED)

P50/3CC 3rd I.F. TRANSFORMER. 470 Kc/s OPERATION. "Q" = 170 .... PRICE **6/0d.**

RA2W L.W. and M.W. ROD AERIAL 6in. long, flying-lead connections. For 208pF TUNING CONDENSER.. PRICE **12/6d.**

LFTD2 DRIVER TRANSFORMER. Split Secondary Type, semi-shrouded. With 6 connecting tags.. PRICE **9/6d.**

PCA1 PRINTED CIRCUIT PANEL, 2$\frac{3}{4}$ x 8$\frac{1}{4}$in. ready drilled with component positions and references printed on rear.. PRICE **9/6d.**

BOOKLET OF DETAILED ASSEMBLY INSTRUCTIONS AND CIRCUIT DIAGRAMS FOR 6-TRANSISTOR LONG AND MEDIUM WAVE SUPERHET .... PRICE **2/0d.**

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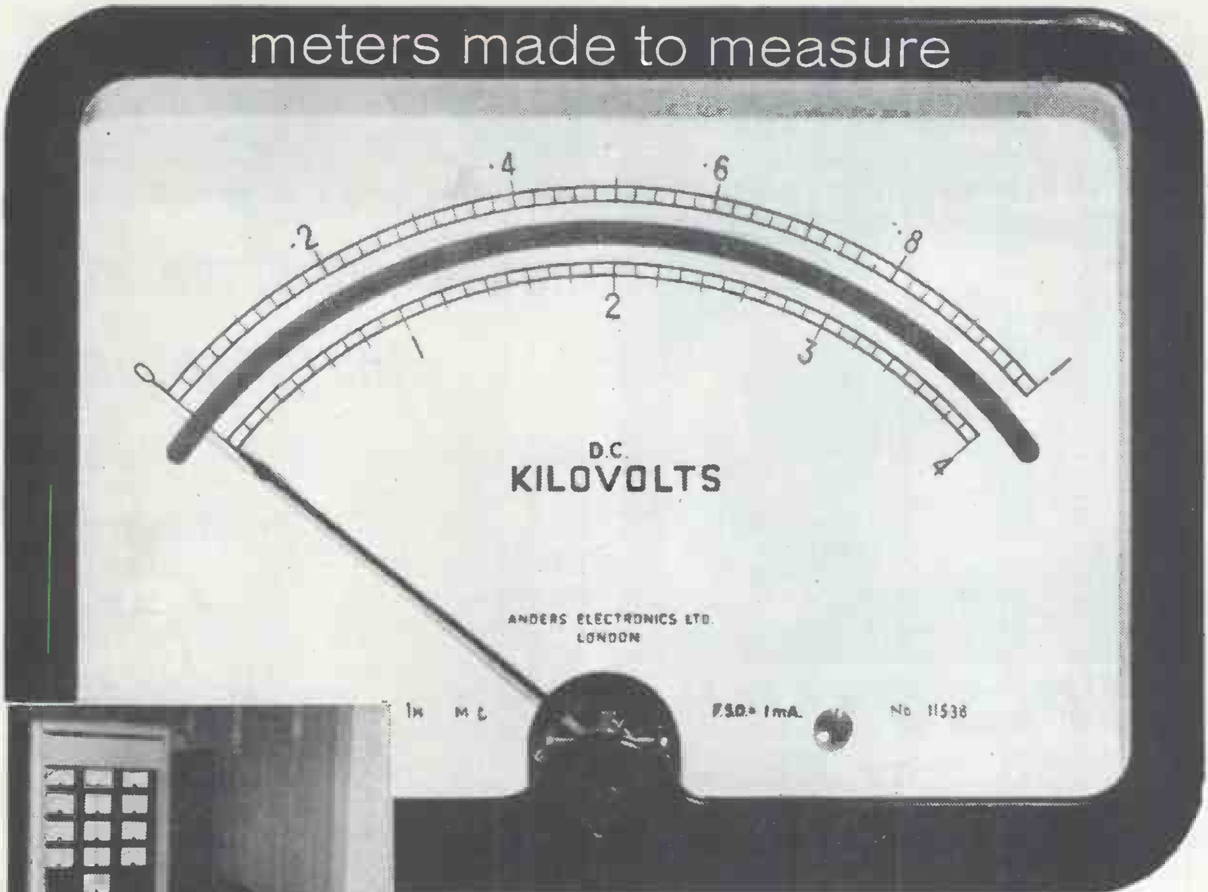
WEYMOUTH RADIO MFG. CO. LTD., CRESCENT STREET WEYMOUTH, DORSET



This Multi-range E.H.T. Series 705 meter is one of a number of instruments supplied to the M.O. Valve Company Ltd. by Anders Electronics at very short notice. These meters are used in the M.O. Valve Company Production Test Equipment for Travelling Wave Tubes shown here. Just the kind of work Anders excel in: special meters for very special equipment. Anders are indebted to the M.O. Valve Company for their kind permission to illustrate this test gear.

special EHT meter rushed through for MO Valve Company

The Anders Instrument Centre is in a unique position to meet the most urgent, and the most unusual, meter requirements from production, development and research. Many standard meter ranges are available immediately from stock. Non-standard meters are calibrated, tested and normally ready within 10-14 days. All shapes; sizes from $1\frac{1}{2}''$ to the largest switchboard meters. All well-known makes and all types including moving coil, moving iron, thermocouples, electrostatic, dynamometers and full range of meter accessories. Anders would like to demonstrate the kind of service they can give you and look forward to your enquiries, by letter or by telephone.

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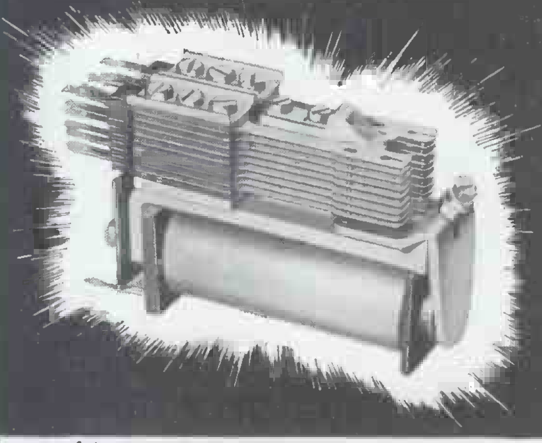
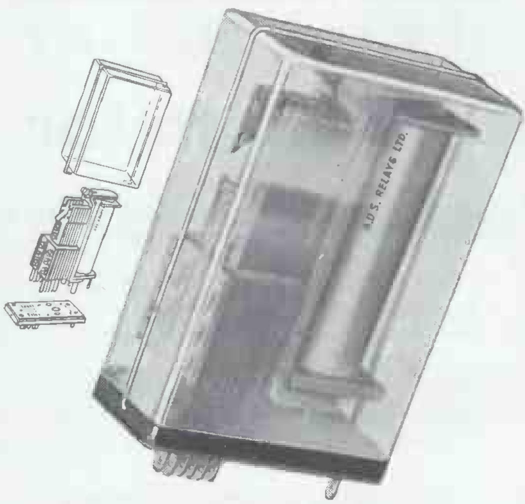
FULLY TYPE APPROVED
TO A.I.D., A.R.B., & ADMIRALTY

Still THE MOST RELIABLE K 3,000 type RELAY



"PLUG-IN"
3,000 type RELAY
with TRANSPARENT DUST COVER
and PLUG-IN BASE
as used exclusively in
BERKELEY POWER STATION



NOW SUPPLIED AS FOLLOWS :—
- 6 CHANGE-OVERS LIGHT DUTY
- 6 MAKES OR 6 BREAKS HEAVY DUTY
- 2 CHANGE-OVERS HEAVY DUTY AND 2 CHANGE-OVERS LIGHT DUTY
- TRANSISTORISED TO OPERATE AS LOW AS 3 MICRO-AMPS
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- OPERATE AND DELAY UP TO 5 SECONDS

A.D.S. RELAYS LTD
89-97, ST. JOHN STREET, CLERKENWELL, E.C.1
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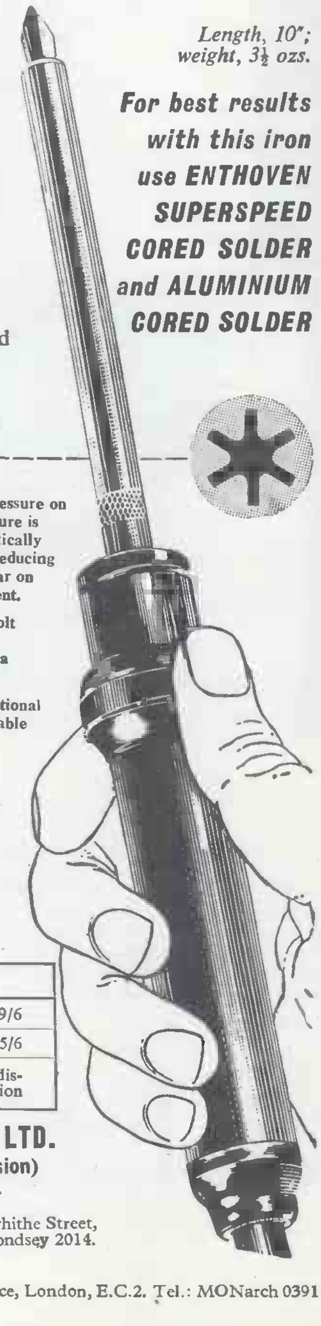
The Superspeed Soldering Iron
heats up from cold in 6 seconds

Designed on an entirely new principle, this lightweight, versatile iron is eminently suitable for soldering operations in the radio, television, electronic and telecommunication industries. For test bench and maintenance work it is by far the most efficient and economical soldering iron ever designed.

Length, 10"; weight, 3½ ozs.

For best results with this iron use ENTHOVEN SUPERSPEED CORED SOLDER and ALUMINIUM CORED SOLDER



- **Activated by light thumb pressure on the switch ring. When pressure is released, current is automatically switched off—thus greatly reducing electricity consumption, wear on copper bit and carbon element.**
- **Can be used on 2.5 to 6.3 volt supply (4 volt transformer normally supplied) or from a car battery.**
- **More powerful than conventional 150-watt irons; equally suitable for light wiring work or heavy soldering on chassis.**
- **Simple to operate; ideal for precision work.**
- **Requires minimum maintenance—at negligible cost; shows lowest operating costs over a period.**

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IRON	39/6
TRANSFORMER	35/6
All prices and trade discounts subject to revision	

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TRANSISTORS

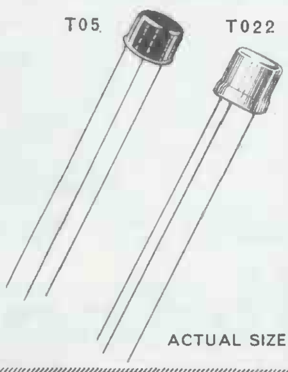
1955: 75mW 1957: 150mW 1959: 300mW

Our power ratings again increased—

1961: 500mW = 5 DECIWATTS

Now!

DECIWATT AUDIO TRANSISTORS



The pace of development at Newmarket Transistors has been so rapid that permissible dissipations in AF types are now reckoned in deciwatts (hundreds of milliwatts) rather than in milliwatts.

In addition to some units with ratings of five deciwatts, the 1961 NKT 200 range features higher voltages, higher currents, flatter betas and industry — standard T022 encapsulation. Where a T05 encapsulation is preferred an NKT 220 series is available with the same electrical specifications as the NKT 200 series.

NKT 201	High-current, high-voltage *output and switch.* 30V, 1A, beta at 500mA > 30.	**NKT 205**	Medium-gain, *mid-level amplifier.* 30V, beta at 1mA > 15.
NKT 202	General purpose *"donkey" switch.* 30V, beta at 25mA > 50.	**NKT 206**	Low-noise, *low-level amplifier.* 30V, beta at 1mA > 30, $N_f \leq$ 6dB.
NKT 203	Extra high-gain *mid-level amplifier.* 30V, beta at 1mA > 50.	**NKT 207**	High-voltage *switch.* 60V, beta at 25mA > 50.
NKT 204	High-gain *mid-level amplifier.* 30V, beta at 1mA > 30.	**NKT 208**	High-current, medium-voltage *output and switch.* 20V, 1A, beta at 500mA > 30.

Data sheets are available direct from Newmarket Transistors Ltd

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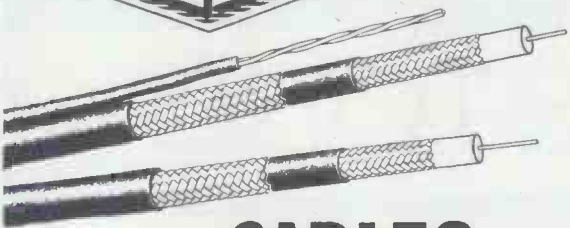

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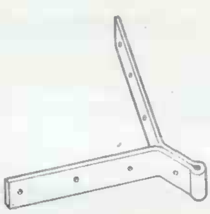
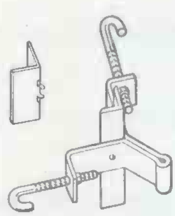


SINGLE TYPE CORNER BRACKET



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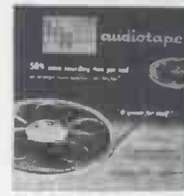

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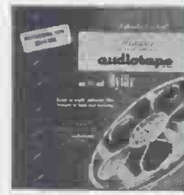

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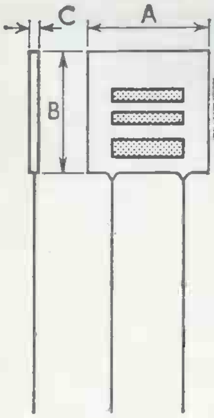

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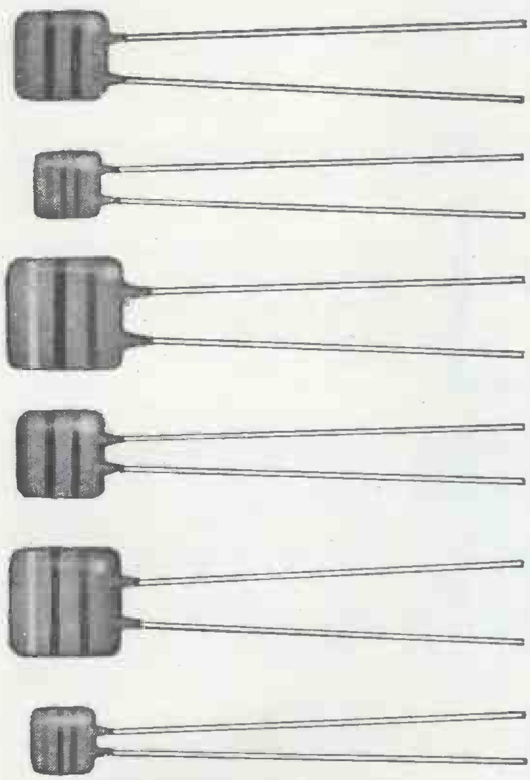

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POWER FACTOR (at 100kC/S at 25°C) $\leq 400.10^{-4}$
INSULATION RESISTANCE-------------- $\geq 5{,}000 M\Omega$
CAPACITANCE TOLERANCE at 25°C +80% -20%

CLASS Y Between -10°C and +70°C the capacitance remains at -85% and +20% with respect to the capacitance value at 25°C.
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TYPES AND SIZES

Capacitance in Picofarads	Dimensions in Millimetres A	B	C	Class	Type Numbers
4,700	6	6	3	X	GSX 706
10,000	10	10	3	X	GSX 710
25,000	10	10	3	Y	GSY 710
50,000	12	12	3	Y	GSY 712
100,000	15	15	3	Y	GSY 715

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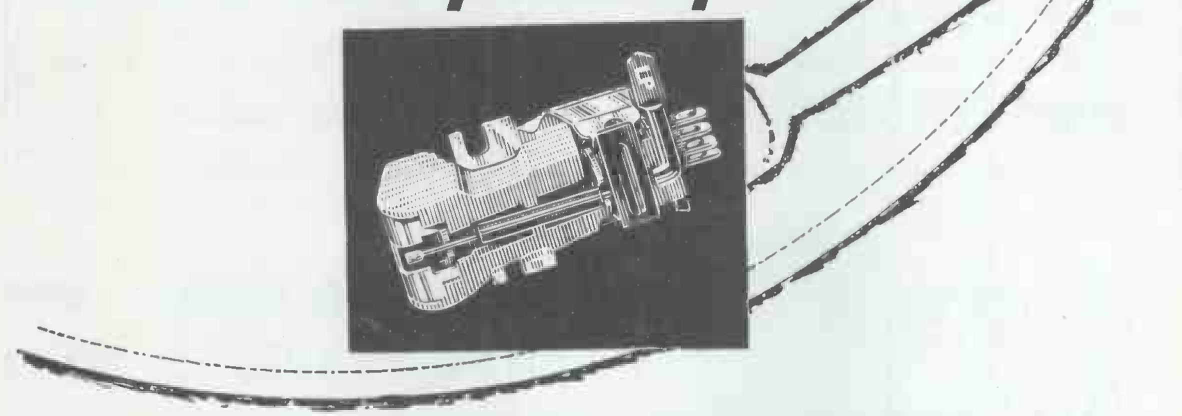

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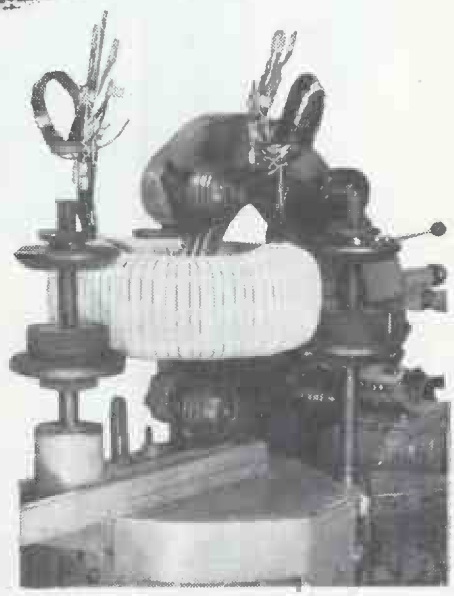

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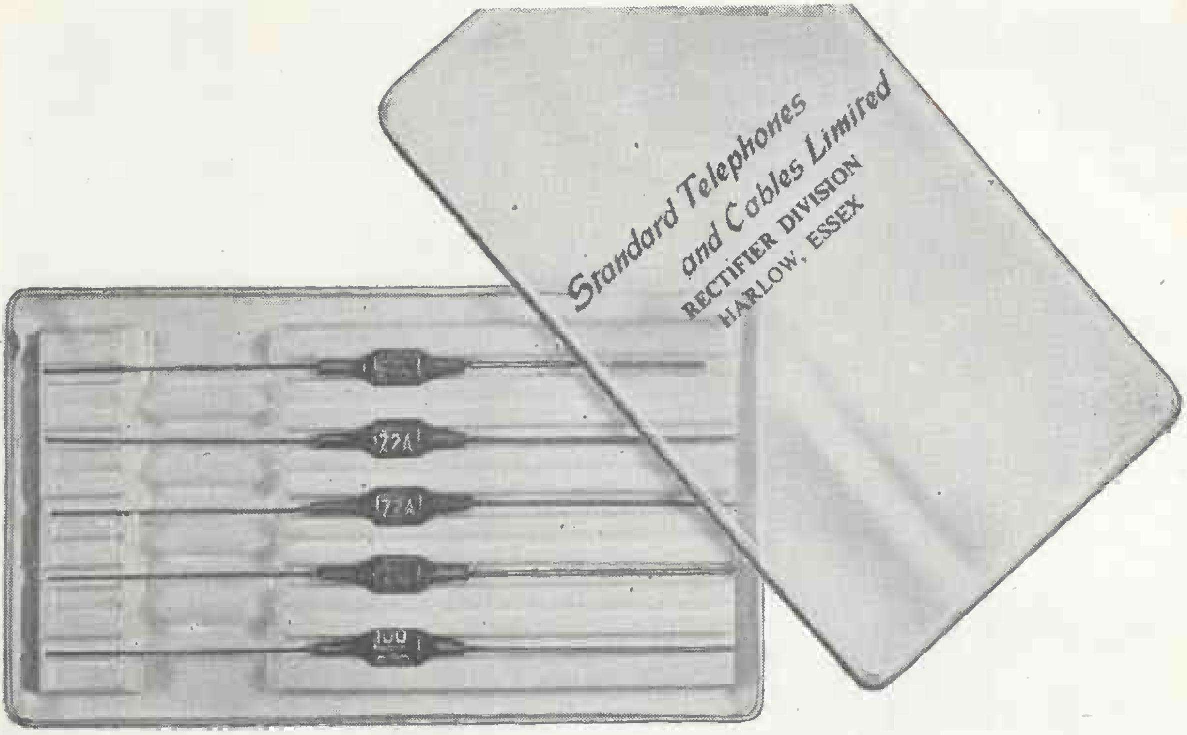

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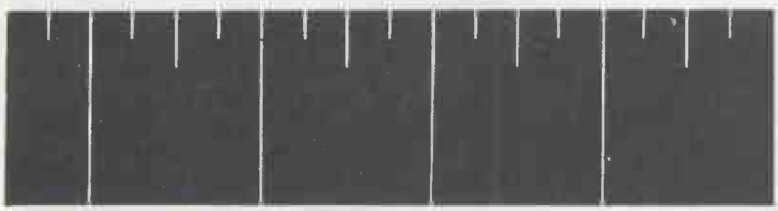

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	Z2A39F	3.9
	Z2A43F	4.3
	Z2A47F	4.7
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	Z2A56F	5.6
	Z2A62F	6.2
	Z2A68F	6.8
	Z2A75F	7.5
	Z2A82F	8.2
±20% Voltage Tolerance (Red and Blue Sleeves)	Z2A91F	9.1
	Z2A100F	10
	Z2A110F	11
	Z2A120F	12
	Z2A130F	13
	Z2A150F	15

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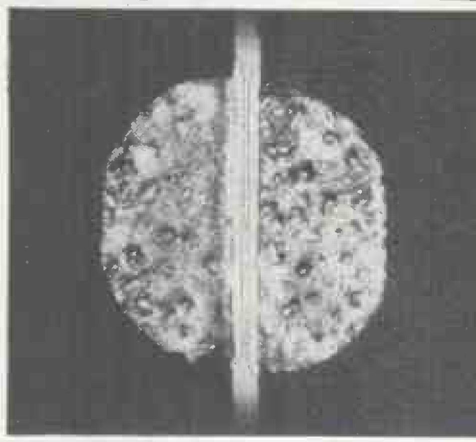
No. 2 IN THE SERIES

Technical Information for the Transistor Circuit Designer



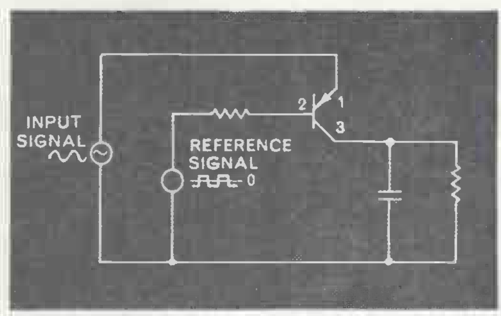
Micro photograph of a symmetrical alloy p n p transistor junction, (indium emitter and collector on germanium wafer base).

Bidirectional Switching Transistors

A bidirectional transistor has equal collector and emitter areas so that in a p n p structure it is immaterial which of the two p regions is used as the emitter and which as the collector. The transistor will give an appreciable, but not identical, gain in both directions and for most circuits it is sufficient that the gain shall be above a certain minimum in either direction. For convenience, one terminal of the transistor is assigned to the collector and the gain is termed "normal gain" when this terminal is connected into the collector circuit. With this terminal connected into the emitter circuit, the gain of the transistor is then termed "inverse gain".

Bidirectional transistors behave as efficient electronic switches capable of switching signals having a polarity which is either positive or negative with respect to the base or reference terminal. A typical example is the phase sensitive demodulator shown here. The reference phase signal is applied to the base of the transistor and terminal 1 acts as an emitter or collector according to whether the polarity of the input signal is positive or negative when the reference signal is negative.

Other examples of the use of bidirectional transistors are to be found in modulators, computer read and write circuits, analogue computer switching circuits, time division multiplex, voltage comparator circuits for analogue to digital conversion and various types of sequential switching circuits.



(T_{amb} = 25°C unless otherwise stated)

Type	Description and Applications	h_{FE} Min.	h_{FE} Typ.	h_{FE} Max.	measured at V_C (V)	measured at I_C (mA)	f_{hb} Typ. Mc/s	V_{CB} Max. (V)	V_{CE} Max. (V)	T_{junc} Max. (°C)	P_{cmax} at 25°C (mW)
	Germanium Alloy Junction Transistors										
TK20C	Bidirectional p n p. Excellent switching performance at relatively high collector currents. Very low saturation resistance.	15 †15	35 35	*95 *95	−0·15 −0·15	−100 −100	6·0	−30	−12	75	200
TK25C	Similar to the TK20C, but with a cut-off frequency greater than 8 Mc/s.	*30 †*30	50 50	*125 *125	−0·15 −0·15	−100 −100	11	−20	−6	75	200

†Inverse characteristics *Indicates 95% limit.

STC Application Report, "Bidirectional Transistors" will be gladly sent on request; ask for MK/139

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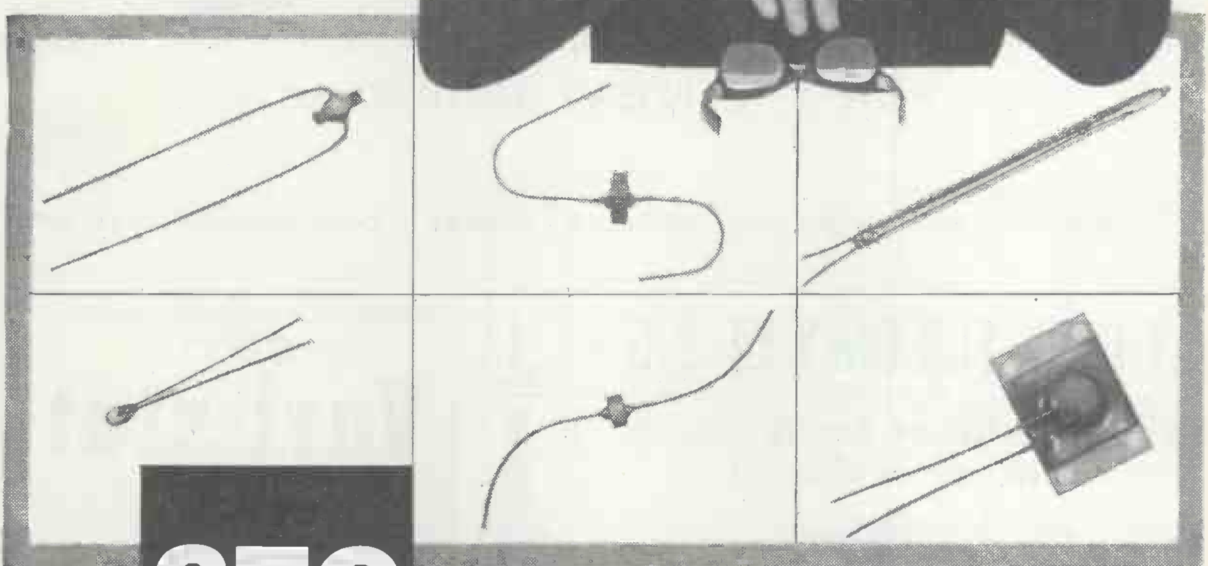

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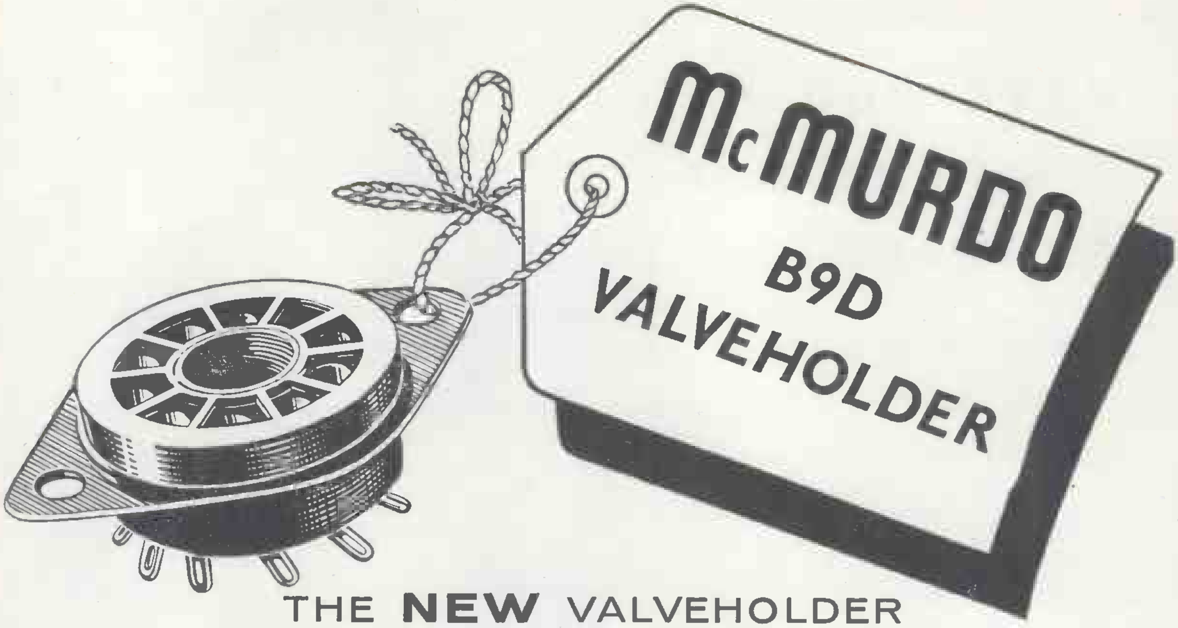

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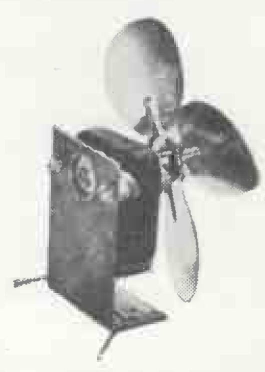

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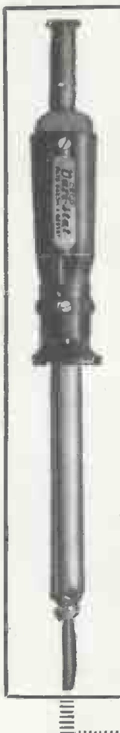

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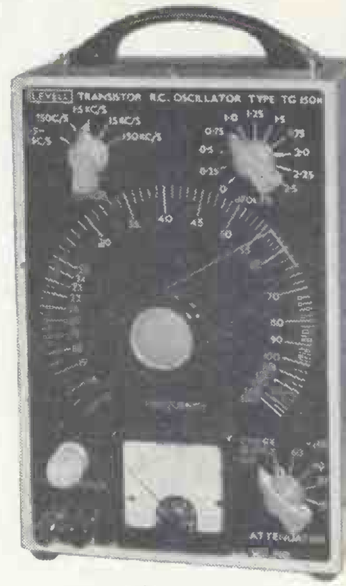

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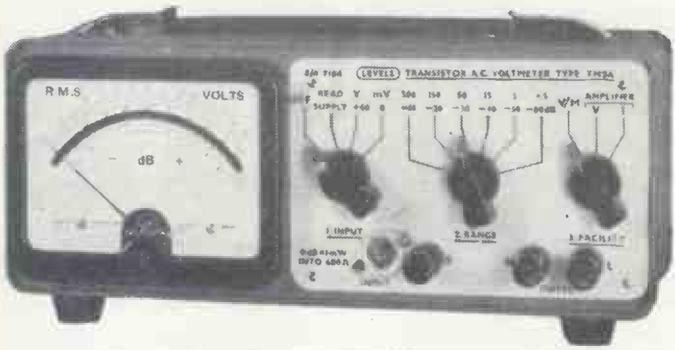

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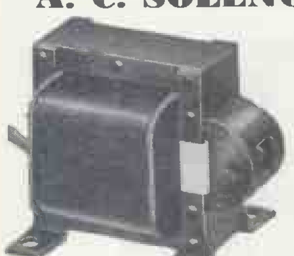

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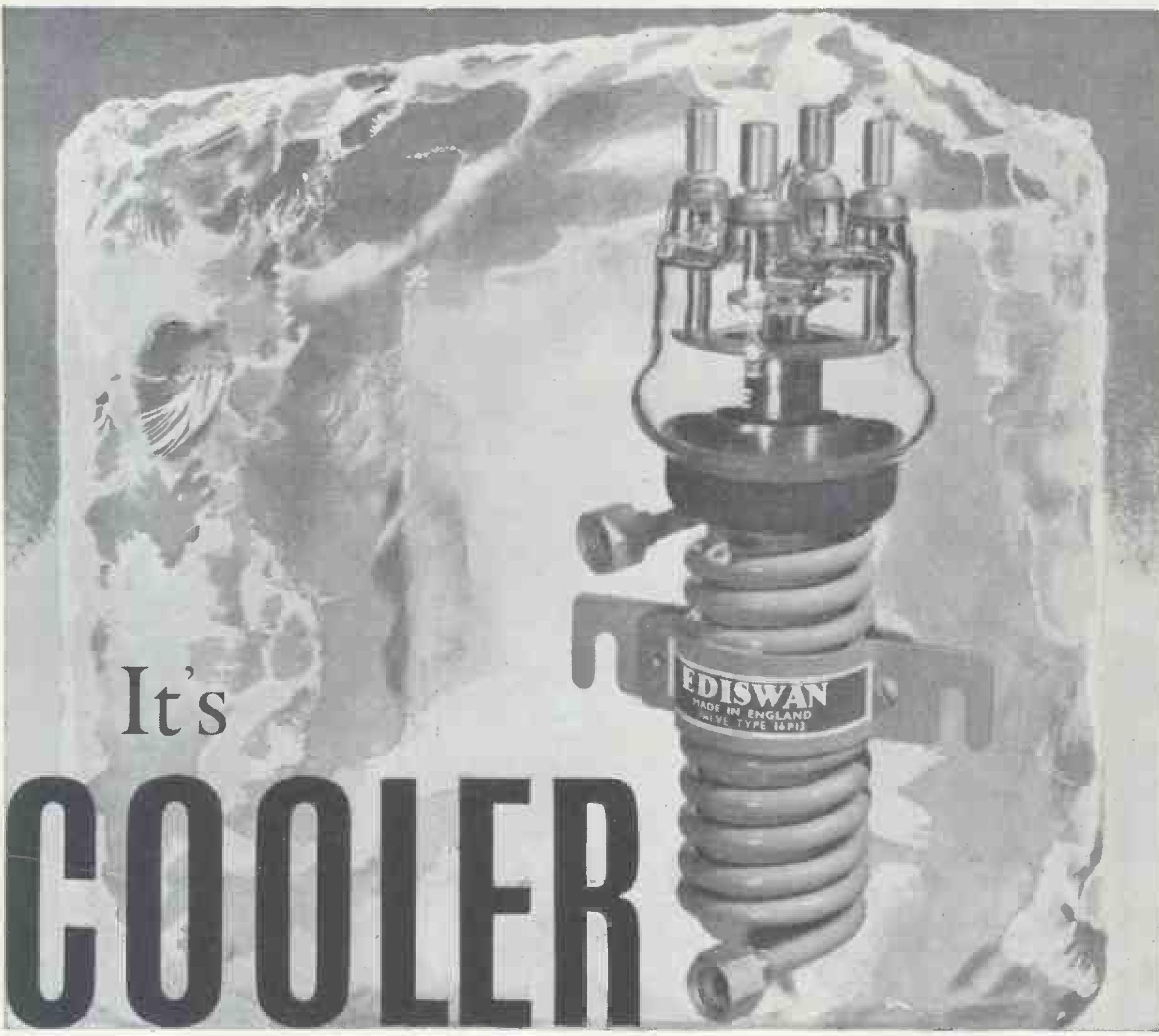

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It's COOLER without a jacket!

The latest Ediswan water cooled valve has no jacket. Instead there is a spiral copper water tube attached directly to the anode. This method is much more efficient, keeps the valve cooler, and makes it cheaper to install and easier to maintain.

Tot up the extra advantages and then switch to these new valves for any application where you are at present using water jacketted valves.

1. No water jacket—simplifies installation.
2. Seals eliminated reducing leakage risk.
3. Low water requirements—1 litre/3 kW anode dissipation.
4. More compact than conventional water cooled valves of similar rating.
5. Includes the Ediswan patented over-dissipation protection device.

RATINGS:		15P12	16P13
Filament voltage (volts)	Vf	5·0	8·0
Filament current (amps)	If	32·5	26·0
Maximum anode voltage (kV)	Va(max)	6·0	8·0
Maximum anode dissipation (kW)*	Pa(max)	0·6	3·0
Maximum operating frequency (full rating) (Mc/s)	f(max)	1·5	1·5
Maximum RF power output (kW)	Pout	2·5	7·5

** Other valves with anode dissipations up to 6 kW will be available shortly.*

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EDISWAN INDUSTRIAL VALVES AND CATHODE RAY TUBES.

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Radio & Electronic Components Division,
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CRC 16/22

DON'T FLUFF THE NOTES

Don't let gravel choke your Ravel. Don't let fluff fur up your Faith. Keep Britten tidy! Your records are valuable. Dust and grit are attracted to them by 'static'. If you allow impurities to settle, the stylus must grind them into the groove, damaging the sensitive sound track (and the stylus, too). This greatly reduces the life of your records (and of the stylus, too). By the time you can hear loss of quality, irreparable harm has been done. Prevent damage *before* it happens. Slip on an Acos Changer Dust Bug—and let it sweep away dirt *before* the stylus gets there.

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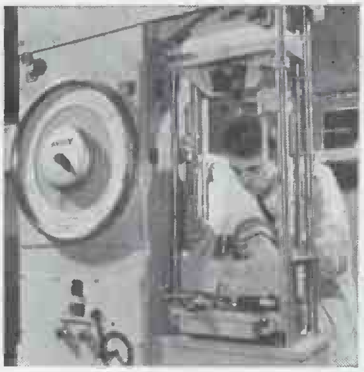
"BELLING-LEE" NOTES

No. 28 of Series.

Some Mechanical Aspects of Design: Part I.

In the selection of materials for electrical and electronic components, their mechanical properties are just as important as the electrical characteristics. One needs to know, for example, whether the tensile strength of a metal is adequate to withstand the loads to which it will be subjected in use, or whether it is suitable for tempering; in the case of an insulator, the crushing and cross-breaking strengths are important in determining whether it is adequate for the task envisaged, and so on. Facts like these are determined in the Research Laboratory by means of the equipment illustrated, which imposes and measures loads from 1 to 12,000 lb, and can detect increments of extension as small as .000002 inch.



The equipment also lends itself readily to the measurement of insertion and withdrawal forces of electrical connectors. In a conventional connector there must always be some resilience in the individual pins or sockets in order to achieve the correct amount of contact pressure to ensure a satisfactory value of contact resistance, and the force required to mate and unmate the connector is governed mainly by the contact pressures and the nature of the contact surfaces. The contact pressure between each pin and its socket need only be a few ounces for satisfactory performance, but in a multi-pole connector positional tolerances have to be reckoned with in addition to the dimensional tolerances of the individual poles, with the result that the mating force may rise to a pound or more per pole. Apart from the fact that this might necessitate the addition of a mechanical device to assist engagement or disengagement, it would indicate the existence of unnecessarily high contact pressures somewhere and, of course, every effort must be made to keep these as low as is compatible with consistent performance in order to minimise wear of the contact surfaces.

Advertisement of

BELLING & LEE LTD., Great Cambridge Road, Enfield, Middx.

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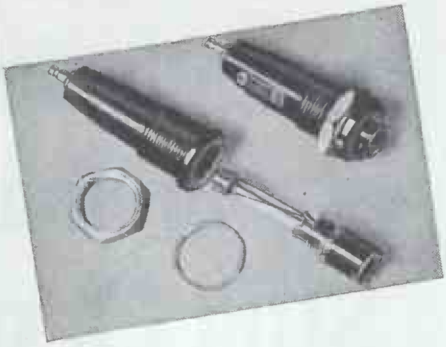
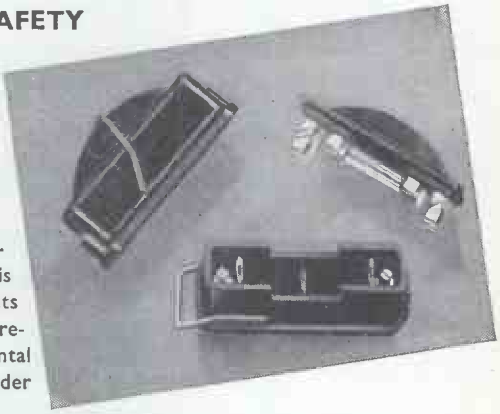


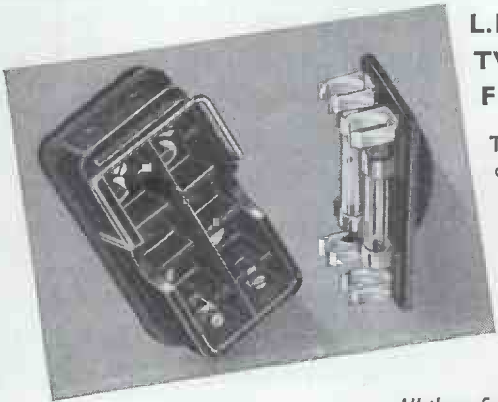
L.1348. STANDARD PANEL FUSEHOLDER, SIZE O TYPE APPROVED

This compact fuseholder has become virtually one of the standards of industry since it was first introduced nearly 23 years ago. Certain detailed improvements have been made over the years, chief of which is the change to a higher grade of moulding powder which has enabled it to retain Services' Type Approval in the face of the more stringent requirements of the present day specification, R.C.S. 262. Max. working volts, 250 V. a.c.; current rating, 5 amp.

L.1045/C3. SINGLE SAFETY FUSEBOX, SIZE O



A single pole fusebox for chassis or panel mounting, with facilities for end or rear wiring. The fuselink is carried in the lid, and is therefore exposed and automatically withdrawn from circuit as the lid is raised, permitting replacements in complete safety. A spring retaining clip prevents accidental disengagement of the lid under vibration.



L.1033/C4. TWIN SAFETY FUSEBOX, SIZE O

This is the double pole version of the above fusebox, and incorporates identical design features. The maximum recommended working voltage for both types is 250 V. a.c., and the current rating is 10 amp. per pole.

All these fuseholders accommodate $1\frac{1}{4}'' \times \frac{1}{4}''$ cartridge fuse links, such as types L338, L693, L762, L1055, L1358.

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Aspects of design

34

GAIN CONTROL FOR THE FREQUENCY CHANGER

This is No. 34 in the series of articles dealing with advanced problems in circuit design published by The Ediswan Mazda Applications Laboratory. No. 35 will appear next month. We shall be pleased to answer queries arising from this or other articles.
Reprints of the first twenty-four articles, in booklet form, are available on request.

INTRODUCTION

The application of gain control to the frequency changer stage of a television tuner enables improvements to be made in the AGC and cross-modulation performance of the whole receiver. When AGC is applied to the frequency changer, as well as the RF stage and common variable-mu IF stages, the utmost control is obtained. The cross-modulation requirements of the IF valves are greatly eased since the output from the tuner can be kept lower when two tuner stages are controlled.

Alternatively, it is possible to control the two tuner valves only and use a straight first-IF amplifier with the attendant advantage of extra IF gain resulting from the higher-slope valve (non vari-mu), and absence of a cathode degeneration resistor.

OSCILLATOR FREQUENCY SHIFT WITH AGC

In the past, attempts to use gain control on the frequency changer stage have resulted in pulling of the oscillator frequency, due to the coupling between the pentode grid circuit and oscillator circuit. Thus, the oscillator frequency will be dependent, to some extent, upon the pentode input capacitance, so that when this falls with the application of AGC bias the oscillator frequency rises and mistuning would, in the ordinary way, become excessive.

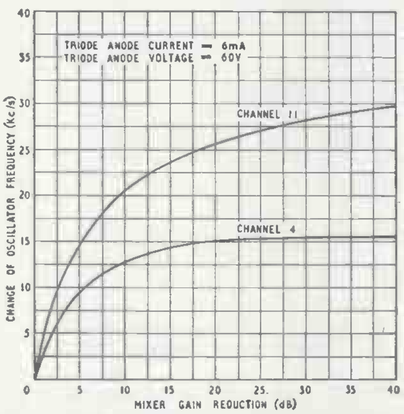

Fig. 1. Change of Oscillator Frequency with AGC applied to Pentode Section of Ediswan Mazda Valve 30C17

The solution is to reduce appreciably the coupling between the oscillator and the pentode sections, both in the valve and the external circuit, so that changes of pentode input capacitance have very little effect on the oscillator frequency. Because of the reduced coupling a more efficient oscillator valve is required to inject the correct heterodyne voltage into the pentode grid.

In the 30C17 a more efficient oscillator is provided by employing frame grid techniques, resulting in a triode having a higher slope than the 30C15 triode. Thus, with proper coupling, the oscillator frequency-shift with maximum AGC voltage can be kept below 35 kc/s on channel 11 as shown in Fig. 1.

In tuners employing capacitive coupling from the oscillator into the pentode grid it is often found that, with the more efficient triode of the 30C17, the capacitive coupling between adjacent spring-contacts is such that sufficient heterodyne injection takes place without the need for an additional coupling capacitor. The removal of this capacitor usually reduces the frequency-shift to an acceptable level but this does vary with individual layouts.

CROSS-MODULATION

The application of AGC to the frequency changer implies that it will be required to handle larger input signals than normal, but the pentode section of the usual frequency changer will not do this without serious cross-modulation. Therefore it is necessary, in the 30C17, to provide variable-mu characteristics to the pentode section to ensure that it will handle all likely requirements of input signal without cross-modulation.

EFFECT OF GRID CURRENT

Another requirement, when applying AGC to the frequency changer stage, is to reduce, as much as possible, the pentode grid current. This is normally about 25μA with a 100,000 ohm grid resistor and it is not practicable to allow a grid current of this order to flow into the common AGC line as it will apply unwanted bias to other controlled stages, and may upset the operation of the sync-separator in mean-level AGC systems. The reduction of grid current may be obtained, partly by the use of cathode self-bias, and partly by a high value grid resistor. A typical value of grid current with the 30C17 is 0.6 μA.

CHANGE OF TUNER RESPONSE WITH AGC

The effect of AGC bias on the oscillator frequency has already been mentioned. The change of input capacitance will also cause some mistuning of the RF transformer secondary, resulting in a change of the tuner response curve. For example, on Band III in a tuner using the 30F27 as the RF amplifier the response at the vision carrier will be set down 1.5 dB at a gain reduction of 40 dB, assuming equal response at the two carrier frequencies at maximum gain. On Band I, particularly on Channels 1, 2 and 3, it has been found that the mistuning of the secondary causes a rise in the primary impedance since, in effect, some of the primary damping is removed, resulting in a peak at or near the sound carrier frequency. To restrict this lift in response it is necessary to use a damping resistor across the primary coil contacts. The value of the resistor is such that its effect on Band III is negligible, but it does result in some loss of Band I gain if the tilt is not to exceed 2.0 dB over the frequency range, vision carrier to vision carrier minus 2.75 Mc/s. It should be noted that the direction of the tilt is opposite to that occurring in the RF stage; therefore, when both stages are controlled the overall tilt is generally less than that stated.

In order to maintain a sufficiently high input resistance on Band III, and to ensure high gain and a good response curve, the 30C17 has been designed to have a low internal cathode lead inductance in addition to the feature of using two pins (1 and 8) for the cathode connection as in the 30C15. For the same reason the internal lead inductance of the g_2 connection has been increased purposely to afford some g_2 regeneration.

GAIN INCREASE WITH THE 30C17

Owing to the higher conversion conductance of the 30C17 an increase of tuner gain can be obtained, and in a typical AGC circuit the gain increase over the 30C15, used without AGC, is about 1.5 to 2.0 dB on Band I and 3.0 dB on Band III.

The smaller gain increase on Band I arises from the need to restrict the rise of RF transformer primary impedance when the secondary is mistuned by the AGC voltage. The damping resistors required for Band I have little effect on Band III.

It should also be noted that the $g_1 - a_p$ capacitance (0.008 pF) of the 30C17 is much lower than is usually found in this class of valve resulting in improved stability on Channel 1. A further advantage of a low value of $g_1 - a_p$ capacitance will become evident if, for future UHF requirements, the tuner is switched to operate as an IF amplifier following a UHF mixer. The 30C17 will then serve as a stable, high-gain IF amplifier with AGC, and the cathode resistor will prevent the valve being over-run when the heterodyne voltage is removed for IF operation.

REPLACING 30C15 IN EXISTING TUNERS

As the basing of the 30C17 is identical with the 30C15 it can be used in its place in existing tuners without AGC, in which case the gain increase on Bands I and III will be 3.5—4.0 dB, including an 0.8 dB gain increase due to the higher IF transfer impedance obtainable with the 30C17. No alteration should be needed to the tuning or oscillator coils, and the only tuning re-adjustments required may be carried out on the trimmers. The IF transformer primary inductance will require to be increased to an extent which may lie outside the range of its present adjustment, since the output capacitance of the 30C17 is nearly 2.0 pF lower than the 30C15. Some modification to the value of the screen resistor and heterodyne voltage level will also be necessary.

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NEW VHF FRAME GRID FREQUENCY CHANGER

EDISWAN MAZDA 30C17
DESIGNED FOR AGC OPERATION

The 30C17 is a new VHF high gain triode pentode frequency changer for television tuners. The pentode section has variable mu characteristics enabling its gain to be controlled from the AGC line.

The application of gain control to the frequency changer stage of a television tuner will greatly ease the cross-modulation requirements of the IF valve since the output from the tuner can be kept lower when two stages are controlled. This leads to improvements in the AGC and cross-modulation performance of the whole receiver. To give the utmost control AGC can be applied to three stages, RF, Frequency Changer and Common Variable-mu IF. Alternatively it offers the possibility of controlling the two tuner valves only and using a straight IF amplifier with its attendant advantage of extra IF gain.

Heater Current (amps)	I_h	0·3
Heater Voltage (volts)	V_h	7·4

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

		Triode	Pentode
Anode Dissipation (watts) ..	$p_{a(max)}$	2	1·7
Screen Dissipation (watts) ..	$p_{g2(max)}$	–	0·5
Anode Voltage (volts)	$V_{a(max)}$	250	250
Screen voltage (volts)	$V_{g2(max)}$	–	230
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)rms}$	200	200
Cathode Current (mA)	$I_{k(max)}$	18	18

Inter-Electrode Capacitances* (pF)

		Triode	Pentode
Input	c_{in}	3·5	6·6
Output	c_{out}	2·1	3·1
Control Grid to Anode	c_{g-a}	1·8	0·008
Grid Triode to Grid 1 Pentode	c_{gt-g1}	0·01	
Anode Triode to Anode Pentode	c_{at-ap}	0·01	
Grid Triode to Anode Pentode	c_{gt-ap}	0·002	
Anode Triode to Grid 1 Pentode	c_{at-g1}	0·005	

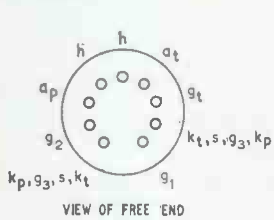
*Measured in fully shielded socket with can.

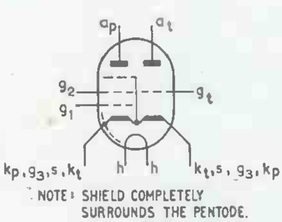
Triode Characteristics

Anode Voltage (volts)	V_a	100
Anode Current (mA)	I_a	15
Mutual Conductance (mA/V)	g_m	8·5
Amplification Factor	μ	20

Base: B9A (Noval) **Mounting Position:** Unrestricted

Connections





Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22·2

TYPICAL OPERATION AT 200 Mc/s WITH CATHODE BIAS

For operation with cathode bias where it is intended to apply AGC to the frequency changer. The oscillator voltage is applied to the pentode control grid.

Pentode

Supply Voltage (volts)	V_b	200
Anode Voltage (approx.) (Decoupling Resistance, R_a=4·7 kΩ) (volts).........	V_a	170
Screen Voltage (approx.) (R_{g2}=22 kΩ) (volts)	V_{g2}	155
Cathode Bias Resistance (Ω)..............	R_k	100
g_1 Resistance (MΩ)....................	R_{g1}	4·7
g_1 Current (µA).........................	I_{g1}	0·6
Anode Current (approx.) (mA)............	I_a	6·4
Screen Current (approx.) (mA)............	I_{g2}	2·0
Conversion Conductance at 1 Mc/s (mA/V)	g_c	4·9
Grid Voltage for Conversion Conductance reduction 10 : 1 (volts)...............		—6·7

Triode

Anode Voltage (volts)..................	V_a	100
Anode Current (mA)....................	I_a	5

TYPICAL OPERATION AT 200 Mc/s WITH GRID CURRENT BIAS

Operation with grid current bias is suitable for the 30C17 in existing tuners not provided with AGC on the frequency changer. The oscillator voltage is applied to the pentode control grid.

Pentode

Supply Voltage (volts)..................	V_b	200
Anode Voltage (approx.) (Decoupling Resistance, R_a=5·6 kΩ) (volts)........	V_a	148
Screen Voltage (approx.) (R_{g2}=33 kΩ) (volts)	V_{g2}	108
g_1 Resistance (MΩ)......................	R_{g1}	0·1
g_1 Current (µA).........................	I_{g1}	24
Anode Current (approx.) (mA)............	I_a	9·2
Screen Current (approx.) (mA)............	I_{g2}	2·8
Conversion Conductance at 1 Mc/s ($V_{het(pk)}$=2·6 V) (mA/V)............	g_c	5·2

Triode

Anode Voltage (volts)..................	V_a	100
Anode Current (mA)....................	I_a	5

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The W.V.B. recorder has an additional amplifier and head with provision for "before" and "after" record monitoring while the recording is in progress, and this also has echo facilities.

The W.V.A. recorder has provision for a plug in stereo head and can be supplied with this and stereo playback pre-amplifiers with equalisation each having an output of 1 volt from a cathode follower. This is type W.V.A/S.

A heavy mumetal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended to 440 yds. without appreciable loss.

The 0.5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.'s, microphone or radio inputs.

The playback amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

The power output is 4 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

THE VORTEXION W.V.B. or W.V.A/S

are eminently suitable for making a high quality recording almost indistinguishable from the original since these models have facilities for monitoring the recording actually put on the tape with only a fraction of a second delay.

By this means, when for any reason the signal is distorted or not as required, the result of the recording on the tape can be heard almost instantly, and adjustments can be made until the results are as required.

Many types of music today have the treble boosted considerably, and may result in greater power being recorded at high frequencies than at middle frequencies, an overload of the tape at high frequencies gives a mushy quality with lots of hiss and background noise.

Adjustment to the bias level while listening to the result is useful in this connection especially where the brand of tape and the bias setting for it are not exactly known.

Again if clean treble recordings at $3\frac{3}{4}$in. are of prime importance it is now recognised that no other method is quite so effective in achieving this as reducing the bias slightly while listening to the results. The meter reading of the new bias setting for the particular tape used may be noted for future use.

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

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A telephone interview with the winning driver was recorded over land lines from Monte Carlo to the A.B.C. Studios, while photographs were wired to Fleet Street and rushed by motor-cycle to Teddington.

For permission to reproduce this picture of the editing of the interview we are indebted to The Dunlop Rubber Company Limited and Charles F Higham Limited, their Advertising Agents and to A.B.C. Television Limited, in whose Teddington Studios the photograph was taken.

Evidence in Camera

Of interest not only for its story, this picture has provided (quite unintentionally) striking evidence of the reputation enjoyed by LEAK. It is a typical incident of the use of LEAK equipment by professional audio engineers in broadcasting and recording studios throughout the world, who choose LEAK for quality of performance and reliability. Does *your* installation measure up to these standards? If it does not, your LEAK Dealer can help you. The prices of LEAK studio quality equipment are made possible only by world-wide sales.

The new LEAK Varislope Stereo pre-amplifier (illustrated above) incorporates facilities which make it the most comprehensive pre-amplifier presently available.

PRICE £25

We shall be pleased to send you a copy of Thomas Heinitz' review of this "Remarkable new control unit for stereo" reprinted from "Records and Recording."

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Monaural	Stereo
Varislope III Pre-Amplifier	Point One Stereo Pre-Amplifier
TL/12 Plus Power Amplifier	Stereo 20 Power Amplifier
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.55 inductance at 1 Kc.
7.5 Mv. output at 1 Kc.
Fully modulated Tape.

ERASE
Dual gap.
20/25 v. at 55 Kc.
Inductance 6 Mh. at 60 Kc.
—70 db at 1 Kc. with 1 Va.

STANDARD ¼ TRACK FOUR TRACK
Stereo or Monaural operation

R/P
Gap .000125.
.55 impedance at 1 Kc.
3 M/v. output at 1 Kc.
0 to + 6 db at 10 Kc.
Fully modulated tape.

ERASE
Dual gap.
Impedance 350 ohms at 50 Kc.
—70 db with .6/1.0 Va.

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Monaural Erase Heads designed for dry battery operated equipment—economical in power required. Requires: .2 VA. at 50 Kc. with 90 v. bias supply winding incorporated.

Full specification, technical data and samples to the trade on request.

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10^{-12} Watts — 25 kVA

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Mains Transformers
Chokes
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Saturated Reactors
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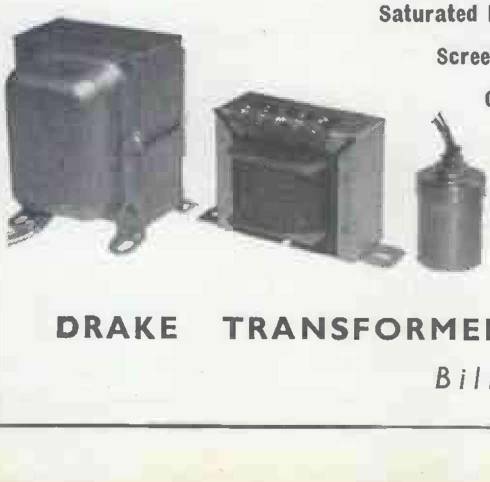

DRAKE TRANSFORMERS LTD., BILLERICAY, ESSEX

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POCKET LOUDSPEAKERS TRANSISTOR RADIOS

Read these Testimonials

D.A. Hilton, Leigh, Lancs.
"I received 'Pocket 4' on Christmas Day. I made it up on Boxing Day and I am very pleased with the results. It brings in local stations and many foreign stations including Luxembourg at good strength. I am 13 years old."

Mr. J. Bell, Wolverhampton.
"I am writing to express my satisfaction at the standard of your kit for your Pocket 4 Transistor set and also to state that it has come up to my expectations in regard to performance."

Mr. R. Balt, Newcastle-on-Tyne.
"I have built your Pocket 5 Transistor set, I am very pleased with it."

Mr. F. Jackson, Ickenham, Middx.
"I have built the Pocket 4 and am more than pleased with the results."

Mr. G. Bamford, Ramsgate.
"I find this set even better than you claim it to be and most certainly up to your usual standard of quality. I feel that nobody could fail to build it and get results. Even the first-time-ever novice, as your circuit diagrams and instructions are so clear and precise."

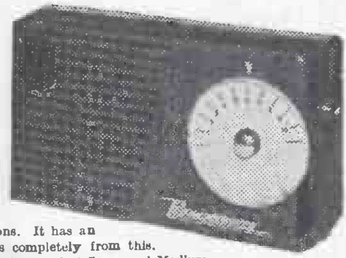
Mr. A. J. Simmonds, Welling, Kent.
"I purchased from you a week ago the Pocket 4 Transistor Kit. I put it together last night in 1½ hours, on switching on the set I was right on Radio Luxemburg. I must say thank you because not only has the set a very attractive appearance, it also behaves fantastically."

Over 1,000 letters received.

Pocket 5 Q.P.P.

This pocket receiver is just right for taking on holiday. It has a remarkable performance comparable in fact with portables being sold at £10 and over. It uses a three inch moving coil speaker to give high quality tone and the output circuit push-pull. It completely tunes over the medium and long wave-bands. The price is £4/15/0 complete, postage and insurance 2/6 extra.

AVAILABLE AGAIN FROM 32/6



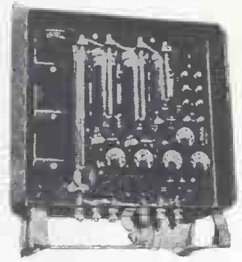
All circuits are reflex type and have been carefully tested and none need aerial or earth, also all are contained in proper radio cases (not adapted sandwich boxes) and use proper tuning condensers and scales.

POCKET 4 (3 Transistors, 1 Diode).
This set gives good performance in all areas and has real entertainment value, and can be heard all over the room in reasonably quiet conditions. It has an internal aerial and works completely from this. Basically it covers Medium Waves, but Long and Medium Waves are available as an optional extra. Also, details are given of additional stages than can be added to bring the volume up to car radio level. Price for all parts and case (size 5½in. × 3in. × 2in.) as illustrated but less motifs is £2/2/6, plus 2/6 postage and insurance. Batteries are 10d. extra.

POCKET 3 (2 Transistors, 1 Diode)
This is the Pocket 4 less the audio stage. In Eastbourne, recognized as a poor reception area, the Home Service comes in at a comfortable level, and the Light Programme comes in well with the Long Wave addition. Some Continental stations are also receivable. The Pocket 3 is essentially a "close to the ear" receiver, and although it is fitted with a miniature loud-speaker the volume is not enough to be heard more than a yard or so away from the loudspeaker except in areas of high signal strength. A point worth noting, however, is that a conversion is available which enables the Pocket 3 to be made into a Pocket 4 with very little re-building. Price for all parts and case as illustrated, but less handle and motif is 32/6, plus 2/6 postage and insurance.

POCKET 5 (4 Transistors, 1 Diode and DLR 5 Speaker)
This is the Pocket 4 with the necessary additional parts to add on an audio stage to bring up the volume two or three times, also components are supplied for tone correction, and feed back, features which all go to improve quality of output. Constructors are recommended to build the Pocket 4 first, get this operating properly then add the additional Pocket 5 stage. The price of the additional stage is 12/6 making a total cost of £2/15/6, plus 2/6 postage and insurance. Long and Medium Wave parts for any of the above 6/6 extra. Batteries 10d. extra.

Charging Switchboards



Type A. 550 w. 18 v.—contains three reverse current relays, one voltmeter rated 25 v. f.s.d., one main ammeter rated 40 amps. f.s.d., one secondary ammeter rated 15 amps. f.s.d. and two secondary meters rated 20 amps f.s.d., one 2 ohm variable resistor, one 11 ohm variable resistor and two 1.2 ohm variable resistors. Complete in metal case 2ft. 6in. × 2ft. 8in. approx. Price £2/15/-, carriage and ins. 15/-.

Type B. 1260 w. 50 v., .12 amps.—contains one 14 ohm variable resistor and four 1 ohm variable resistors, one main ammeter rated at 40 amps. f.s.d., four secondary meters rated at 20 amps f.s.d. and one voltmeter rated at 50 volts, and two reverse current relays. Complete in metal case—size approximately 2ft. 6in. × 2ft. 8in. Price £4/15/-, carriage 15/-.

Connecting Leads for these switchboards with Nifam plugs 30/- each.

"Dim and Full" Switch

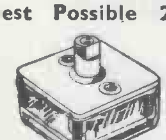
Particularly useful for controlling photo-flood lamps which have only a short life at full brilliance. This switch has three positions; first position puts two lamps in series at half brilliance for setting up, the second position is off and the third position full brilliance for the operation shots. Also useful for controlling night lights, heaters, etc., etc. Price 3/9 each, post 1/-. Circuit diagram included.
Ditto but without the off position i.e. d.p.d.t., 10 amp. 2/9.

Solderless Transistor 3

Any boy from eight years onwards will easily make this pocket size transistor set. No soldering is involved and in fact the set can be made up virtually without tools. It is nevertheless a workmanlike job which, when completed, will receive Luxemburg and local stations entirely without aerial or earth. Uses two transistors and diode in reflex circuit. Other features include optional medium and long waves and loud speaker.

The parcel contains everything necessary to complete as follows:—
Packet of Solderless terminals.
Packet of Condensers.
Packet of Resistors.
Packet of Transistors.
Connecting wire.
Proper plastic transistor set case with printed scale and tuner.
Hearing aid type headphone.
Plug and socket with on/off switch, and full comprehensive easy to follow instructions. Price 37/6 plus 2/6 post and insurance.

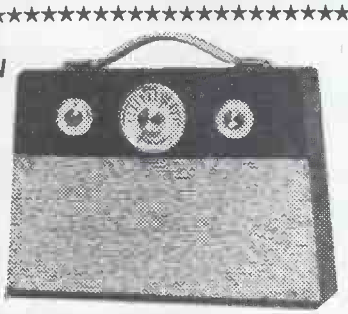
Smallest Possible 2-gang



With built-in trimmers, polystyrene cased, size only 1×1×7/16in., price 17/6. Smallest IF and oscillator to match, 21/-. P.P. input and P.P. output transformers, 12/6. Circuit diagram free with any of above.

THE REAL COMPANION

CAR RADIO PORTABLE



There's nothing to compare with this so don't buy your portable until you have heard this one—call at any branch for demonstration — you will be well satisfied — why not earn spare time cash making them up or your friends?

NOTE THESE FEATURES

- 400/500 mw. Output Push-Pull.
- 6 First Grade Transistors.
- Latest Type Superhet Circuit.
- Medium and Long Waves.
- Internal Ferrite serial litz wound.
- High "Q" coils.
- Latest type printed circuit with components plan.
- Slow motion tuning.
- Car aerial attachment.
- Two-tone cabinet.
- High flux elliptical speaker.
- Size 11 × 8 × 3in. aproximately.
- Easy to follow instructions.
- 12 months' guarantee all components.
- No technical knowledge required.
- Service available at moderate charges.

ORDER IN CONFIDENCE

Money returned in full if parcel not up to expectation and returned unassembled. Price complete, less battery £9/19/6. Battery 3/6 plus carr. and insurance 7/6

AGENTS WANTED

Agents wanted to make up these sets, send S.A.E. for details of special terms

THE ROADFARER

An AM/FM Transportable mains and battery transistor Radio. Total cost of parts £18.

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For Transistor Circuits or Deaf Aid. Very light weight and easy to wear, cord almost invisible, good quality production of music and voice, complete with miniature plug and socket, ready to use. Crystal and Magnetic, 9/-. Post and Insurance 1/-.

Transistors for R.F., F.M., T.V. and U.H.F.

Frequencies quoted are approx. cut-off

SB 078 15-20 Mc/s.	8/6
SB 305, 20-30 Mc/s.	9/-
SB231R 40-50 Mc/s.	15/-
AMERICAN 2N1727 100-150 Mc/s	15/-
AMERICAN 2N1728 100-150 Mc/s.	12/6
AMERICAN T1832 1000-1300 Mc/s	25/-
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Building A Scope?

3in. oscilloscope tube. American made type No. 3FP7, octal base 6.3 v. .6 amp, heater, electrostatic deflection, brand new and guaranteed, with circuit diagram of scope, 15/- each, plus 1/6 post and insurance.

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post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2. Callers may use any one of the Companies below.

226 London Road, Croydon.	29 Stroud Green Road, Finsbury Park, N.4.	520 High Street North, Manor Park, E.12.	42-46 Windmill Hill, Ruislip, Middx.	246 High St., Harlesden, N.W.10.
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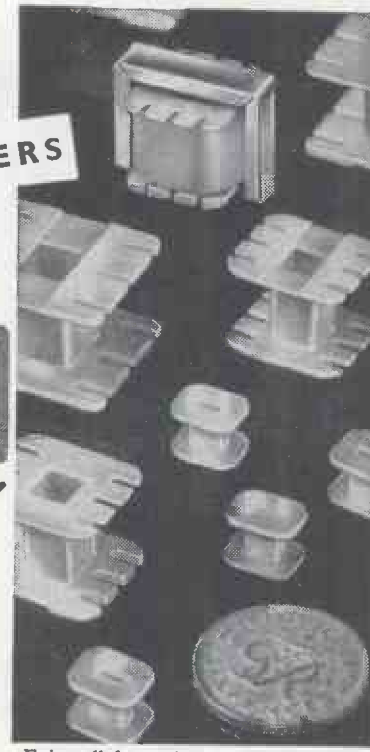
Nylon COIL BOBBINS

FOR MINIATURE TRANSFORMERS

GG MINIMOULDINGS IN NYLON



Ever thought about GG MINICASTS in Zinc Alloy? There's nothing to touch GG MiniCasts for tiny metal parts—cost less because all machining, assembly, welding, scrap and tool costs are either reduced or eliminated. Send for free details today!

SAVE UP TO HALF YOUR COSTS!

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PRECISION ACCURACY · UNIFORM QUALITY
GREATER DIELECTRIC STRENGTH
ONE-PIECE CONSTRUCTION (cannot come apart)
GREATER RIGIDITY

Bobbins to suit square stacks of standard laminations available from stock. Initial range sizes MEA 21 (RCL 421), 187 (RCL 450), 262 (RCL 531), 39 (RCL 439), 158 (RCL 458), 218 and L & H 552. Others subject to general demand.

Enjoy all these advantages by using GG MiniMouldings for Bearings, Washers, Connectors, Gears, Insulators, Rivets, Screws, Rollers, Valve Seats, etc., etc.

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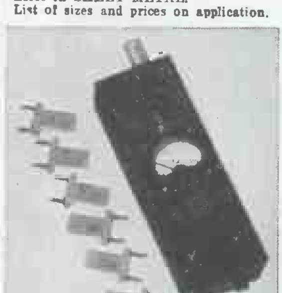
"Q-MAX" SHEET METAL PUNCHES
Patent No. 619178 and Patents pending. Round, Square and Rectangular. The easiest and quickest way of punching holes in SHEET METAL.
List of sizes and prices on application.



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An ideal instrument for the determination of tuned circuit resonant frequency, tuning transmitters without application of power, for the determination of coil mutual and stray inductances and both fixed and stray capacitances. Built-in mains pack. Covers 1.5 to 300 Mc/s. in eight ranges. PRICE 15 Gns. Complete.

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This small Grinder weighing approximately 3lbs. is an excellent tool for finishing metal patterns, scroll work, removal of burrs, lapping holes, polishing, filing and similar jobs. It is invaluable in every die shop.

Running at a speed of 15,000 r.p.m. it is a highly efficient, reliable tool.

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YOUR BEST INVESTMENT

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INCLUDING NEW EQUIPMENT AVAILABLE FROM 1961 AUDIO FESTIVAL

NOW AT LARGER PREMISES

PLEASE NOTE—Prices quoted subject to alteration in accordance to those advertised by manufacturers at time of receipt of order.

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Simon Minstrelle	39 gns.	$117
Ferrograph 4AN	81 gns.	$243
Ferrograph 4AH	86 gns.	$258
Ferrograph 808 Stereo	105 gns.	$315
Grundig TK55 Stereo	92 gns.	$276
Grundig TK20 with Mic.	42 gns.	$126
Grundig TK24	55 gns.	$165
Grundig TK30	65 gns.	$195
Philips 4 Track EL 3542	59 gns.	$117
Philips 4 Track Stereo EL 3536	92 gns.	$276
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Reflectograph "A" ½ Tr.	105 gns.	$315
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Wearite 4A mono	£36 10 0	$105
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Brenell Mk. V	28 gns.	$84
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Microphones by Lustraphone, Reslo, Acos, Simon, etc.

● TAPES BY ALL LEADING MAKERS

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Wharfedale Coaxial 12	£25 0 0	$72
Wharfedale Golden 10	£8 14 11	$20
Tannoy 12in. Monitor	£30 15 0	
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WB. 1016	£7 12 3	$16
Goodmans AL.120	£29 10 0	$84
Goodmans AL.100	£23 10 0	$67
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Goodmans 300	£11 5 9	$32
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Decca Stereo P.U. complete	£21 0 0	$45
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BINSON "ECHOREC" UNITS

BINSON STANDARD ECHOREC pre-amplifier unit enables echoes to be imposed on signals between microphone (or other source) and amplifier or recorder. 3 channels available, and timing of echoes is controllable. Details on request. 140 gns. $420

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- ★ PRINTED CIRCUIT, READY DRILLED
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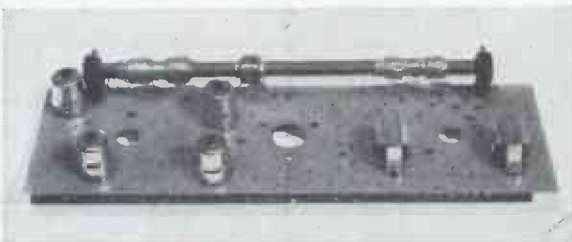
BASIC COMPONENTS & PRINTED CIRCUIT, AS SHOWN BELOW 55/- Post 2/-.

WITH FULL PARTS LIST OF COMPLETE RECEIVER AND DETAILED ASSEMBLY INSTRUCTIONS.



ALL COMPONENTS MAY BE BOUGHT SEPARATELY.
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TRANSISTOR COMPONENTS

LIST		
35	Oscillator Transformer. MW/LW 9/16in dia.	5/9
36	1st/2nd I.F. Transformer (pair) 9/16in. dia.	11/6
37	3rd I.F. Transformer 9/16in. dia.	5/9
38	Driver Transformer (C.T. Sec.) 3/4 × 5/8in.	7/–
39	Driver Transformer (Split Sec.). 3/4 × 5/8in.	7/–
40	Output Transformer 500 mW/3 ohm. 3/4 × 5/8in.	6/9
41	Output Transformer 150mW/3 ohm. 3/4 × 5/8in.	6/9
42	Output Transformer Class A 50mW/3 ohm. 3/4 × 5/8in.	6/9
30	Ferrite Aerial MW/LW. 7 × 1/4in.	9/3
31	Ferrite Aerial MW/LW. 4½ × 1/4in.	8/–
45	Printed Circuit, Drilled. 8 × 2½in.	9/–
43	Audio Oscillator Transformer, 1,000 C/S. 3/4 × 5/8in.	7/–
29	R.F. Choke, Screened. 250μH. 9/16in. dia.	4/6

½in. Square Transistor Transformers

20	Oscillator Transformer. MW/LW	Set of 4	22/–
21	I.F. Transformer. (2 required)		
22	I.F. Transformer.		

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NOMBREX LTD. SALES DEPT. W5 **DUNSTAN ROAD ESTATE, BURNHAM-ON-SEA, SOMERSET**

Grampian *DP4*

brings out the best in any recorder

Even the most expensive recorder will only give its best performance if a good quality, reliable microphone is used.
In the DP4, with a uniform wide frequency response from 50 c/s to 15,000 c/s, Grampian have developed an outstanding, moderately priced instrument which will please the most exacting recordist.
The DP4 is equally suitable for Public Address, Broadcasting, Call Systems, etc.

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DP4/L, low impedance 25 ohms 86 dB below 1 volt/dyne/Cm².
DP4/M, medium impedance 600 ohms 70 dB below 1 volt/dyne/Cm².
DP4/H, high impedance 50,000 ohms 52 dB below 1 volt/dyne/Cm².

Retail Price: **DP4/L** complete with connector and 18ft. screened lead, **£7/11.** (Medium or High Impedance models, **£1** extra).

A complete range of stands, swivel holders, etc., is available also.

A matching Unit (Type G7) can be supplied for adapting the microphone for a Recorder having a different input impedance, or when a long lead is required. **Retail Price £3/5/-.**

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Small in size . . .

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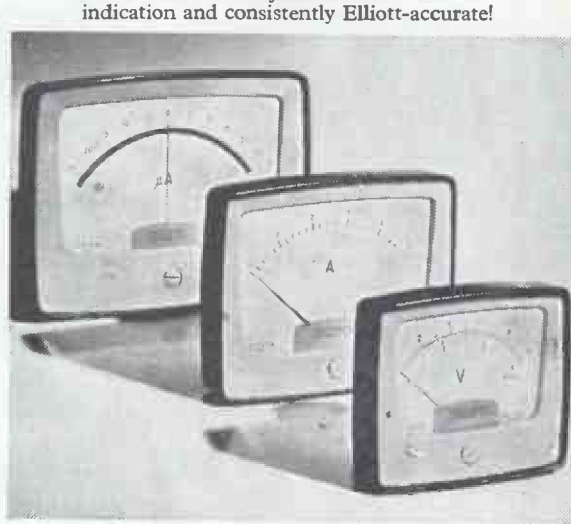
The introduction of these three new models completes the famous Elliott range of miniature instruments Small in size . . . crystal clear in indication and consistently Elliott-accurate!



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FOR BERYLLIUM COPPER PRESSINGS TO THE CLOSEST TOLERANCES

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By pioneering the use of beryllium copper and precious metals Brandauer have achieved many manufacturing successes which can be of great value to you.

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This is also helpful. So are our large stocks of material. They enable us to quote early deliveries for most pressings and competitive prices for all. Therefore—for time and tolerance, quality and price, choose Brandauer. Further information and samples gladly sent on request.

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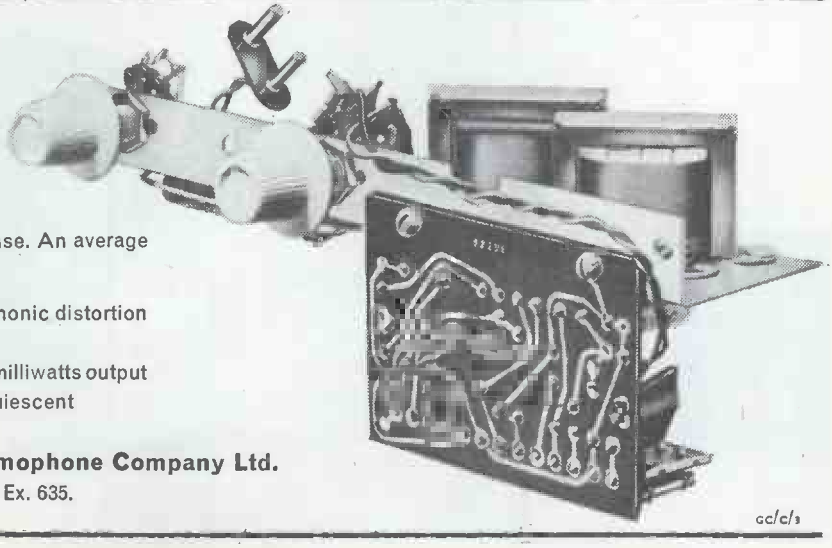
1 WATT TRANSISTOR AMPLIFIER

A dependable 4 transistor, 1 watt amplifier complete with volume and tone controls and simple facilities for mounting in almost any type of cabinet.

Main features are high thermal stability and smooth frequency response. An average of 6db negative feedback is used.



Power Output–1 watt for 10% total harmonic distortion
Frequency Response–50c/s to 10Kc/s
Sensitivity–120 millivolts +–3 db for 50 milliwatts output
Current Consumption–14 milliamps quiescent

Components Division, The Gramophone Company Ltd.
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GC/C/3

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Long and Medium wave bands, 5in. speaker, built-in frame aerial using Ever Ready B126 GOVHT and AD35 1½ VLT batteries. Attractive 2-tone finish, dimensions 9 × 8¼ × 4¼in. Original price 15 gns. OUR PRICE £8/19/6. P. & Pkg. 3/-. batts. 10/- extra. Suitable mains unit to fit in place of batteries. Original Price 63/-. OUR PRICE 45/-. P. & Pkg. 2/-.

A GIFT FOR THE SERVICE MAN

The Weston Model 772 Type 6 super sensitive analyser. This precision designed multi range test instrument has a large visible finely divided scale giving some of the range shown. Range: D.C. volts 20,000 ohms per volt or 1,000 per volt. 2.5 volt range 50,000 ohms. 10 volt range 200,000

IN WOODEN CASE

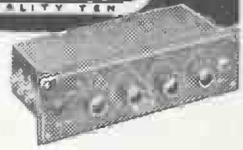
ohms. 50 volt range 1 megohm. 250 volt range 5 megohms. 1,000 volt range 20 megohms. Ohms: 0-3,000 ohms. 0-30,000 ohms. 0-3 meg. 0-30 meg. D.C. milliamps: 10, 50, 250 IM/A or 50 microamps. A.C. volts: 1,000 ohms per volt. ONLY £12/10/- plus post and pkg. 7/6.

THE NEW JASON RANGE FOR CONSTRUCTORS

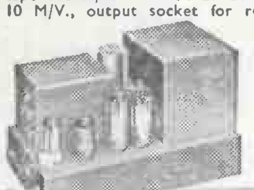
JTV2 Tuner completely assembled ready for use £25/7/-.
FMT2. In kit form with free standing case with power pack. Including valves £8/19/6.
FMT3. Variable tuner 88-108 mc/s.. Variable AFC control dual limiters, approx. 80 mile range, including valves £10/19/6.
JTV2 Tuner self powered switched tuner for FM and TV sound. Both BBC and ITA as required. including valves £13/19/6.
MERCURY II switched FM/TV sound tuner in kit form for building into cabinet, including valves, £10/10/-. Power pack kit, £2/14/9.
2/6 post and pkg. on all the above, S.A.E. for details.
Stockists of all other Jason Kits.

The VERDIK QUALITY TEN

THE POPULAR "VERDIK QUALITY TEN"



10 watt push-pull ultra linear Hi-Fi amplifier with pre-amp. control unit. **Amplifier** Valves EF86, ECC83, 2-EL84, EZ81. Sensitivity 40 M/V for 10 watts, output impedance, 4, 8 and 16 ohms, spare supply for tuner, 200/250 V., A.C. **Pre-Amp.** valve EF86. **INPUTS Radio** 100M/V., tape 100 M/V. **GRAM** LP 50 M/V., 78 60 M/V. **MIC** 10 M/V., output socket for recording direct to tape recorder. **Treble** between —10DB and +12 DB at 10 KC/S. **BASS** between —10DB and +12 DB at 20 C/S. Finished in grey, green, stone enamel, control panel in gold lettering, fully guaranteed. Original price 20 gns.



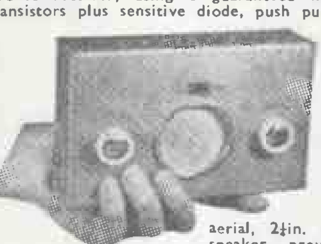
AMPLIFIER AND PRE-AMPLIFIER

OUR PRICE £14/19/6 P. & P. 7/6.

SPECIAL OFFER!

THE "FLEET SIX" TRANSISTOR

The "Fleet 6," a wow of a transistor set that really gets the stations. New design 6 transistor superhet pocket receiver, using 6 guaranteed first grade transistors plus sensitive diode, push pull output, medium and long wave bands, new type printed circuit, high Q internal ferrite rod aerial, 2½in. high flux speaker, provision for car aerial, overall size 6½ × 4½ × 1¾. Simple to follow instructions. All components guaranteed, service after sales. This is equal to many manufactured sets at double the price. All components including cabinet, transistors, speaker, circuit, etc., **only £8/19/6,** complete. Post and pkg. 3/6. PP4 Battery 2/- extra. Due to overwhelming demand from last month's advert., we have been able to reduce this receiver from £9/19/6. All components sold separately. Send S.A.E. for details. Circuit and Instructions 2/6 post free.

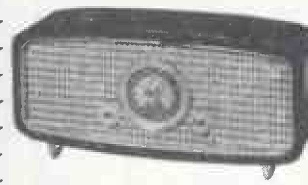


HI-FIDELITY TAPE HEADS

Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7½ I.P.S. Output 5 m/volts at 1 KC. at 7½ I.P.S. Erase heads low impedance.
Only 29/6 per pair. Post 1/-. State upper or lower track.

"SUPER SIX" TABLE MODEL

The "Super 6" Table Model Transistor Receiver using six Mullard latest top grade transistors, printed circuit, medium and long wave bands, 500 M/W push pull output, 7 × 4 High Flux Speaker, high Q ferrite rod aerial, calibrated direct drive,



beautifully polished cabinet, gilt trimmed, size 18 × 7¾ × 5¾in. Using Long-life power pack battery. All necessary components including easy to follow instructions and theoretical circuit, **£9/15/-** complete, post and pkg. 4/6. Battery extra. All components sold separately. Send S.A.E. for details. Circuit and instructions 2/6.

BUY NOW!

Definitely the last of the remaining stocks of the

AVANTIC BEAM-ECHO HI-FI EQUIPMENT

SP21 STEREO PRE-AMP CONTROL UNIT

A twin channel pre-amp. control unit, has 6 inputs for each channel. **INPUT SENSITIVITY** for 250 M/V or 1.5 V output **TUNER** 100 and 250 M/V. Tape 100 M/V flats 250 M/V. **PICK-UP** 5 and 50 M/V. Frequency response: 40 c/s. to 15 Kc/s. **TAPE OUTPUT** 50 M/V., continuously variable bass and treble controls, loudness control and stereo balance control. Power required 6.3 V. at 1.3 amp. A.C. 350 v. at 5 M/A. D.C. Will match any hi-fi amplifier. Manufacturer's price £28/10/-. **OUR PRICE** now **£16/19/6.** Carr. and packing 10/-.

AVANTIC FL6-21

High quality monaural power amplifier and pre-amp. compactly housed and suitable for shelf mounting or cabinet. Two EL84, three EF86, one ECC83, one EZ81. 00 watts peak; speaker impedance, 4, 8 or 16 ohms. Sensitivity: 4 M/V. on pick-up, 3 M/V. on tape. 100 M/V. on tuner, intermod. distortion 1% at 10 W equivalent. Sinewave output. Maker's price £28/10/-. **OUR PRICE 19** gns. Post and Packing 10/-.

AVANTIC SPA11 Stereo Amplifier

A twin channel amplifier and pre-amp., push-pull output. 10 W. peak each channel, rumble filter speaker, impedance 4, 8 and 16 ohms. Tape output: 100 M/V. Continuously variable treble and bass, stereo balance control. Input sensitivity: for 7W, 100 M/V radio; 100 M/V tape; 650 M/V pickup. Manufacturer's price 28 gns. **OUR PRICE 19** gns Post and packing 10/-.
STEP 11 Stereo pick up pre-amp. unit. 84/-. P. & P. 2/6.
STEP 21 tape pre-amp. unit, also 84/-. P. & P. 2/6.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

BC. 221 HETERODYNE FREQUENCY METERS

125 kc/s to 20Mc/s As new condition. Supplied complete with valves, crystal and calibration charts.

Only **£16** each P/P 7/6.

Also available less calibration charts only £9/10/- each.

7·5 K.V.A. AUTO TRANSFORMERS. 115/230 volts. Brand new boxed, ex-U.S.A. £15 each. Carriage 10/-.

POWER UNIT TYPE 234A

Input 200/250 volts A.C. Output 250 volts 150 mA., fully smoothed, double choke and paper condenser, and 6·3 volts 5 amps. Std. 19in. rack mounting chassis, 59/6 each. Carriage 7/6. Ditto but fitted with meter, 69/6.

15 PIN AMPHENAL CHASSIS UNITERS

3/6 pair. P.P. 6d.

FIELD TELEPHONES TYPE L.

Generator bell ringing, 2 line connection. Supplied fully tested complete with batteries, 59/6 each. P/P 3/6.

1,000 WATT MAINS ISOLATION TRANSFORMERS

230 volt primary, 230 volt secondary. Ex-Admiralty heavy duty type. New, boxed, £5 each. Carriage 10/-.

24 AMP VARIAC TRANSFORMERS

Primary 230 volts. Secondary adjustable from 185 to 250 volts at 24 amps. Can also be used in reverse. £12/10/- each. Carriage 10/-.

1 MEGOHM 1% WIREWOUND RESISTORS

10/- doz. P/P 1/-.

PHOTO VOLTAGE AMPLIFIERS

These special units contain a 1 microamp Tinsley mirror galvanometer, twin selenium photo cell. 12 v. lamp, lamp housing and focusing unit. Brand new boxed, £9/19/6 each. Carriage 7/6.

MUIRHEAD CELL TESTERS

Housed in teak case containing a 6in. scale 3 amp D.C. meter and large variable rheostat for controlling current. Brand new, 32/6 each. P/P 3/6.

SOUND POWERED TELEPHONE HANDSETS

Make simple intercom system. No batteries required. Just connect with twin flex. Brand new 15/- per handset. P/P 1/6.

FIELD TELEPHONES TYPE F.

Ideal for all intercom. systems, house, office, building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested, £4/19/6 pair. P/P 5/-.

R.C.A. AR88D RECEIVERS

This world famous 14 valve receiver offered reconditioned, perfect working order and in superlative condition throughout. Frequency coverage on 6 bands 500 kc/s to 32 mc/s. Circuit incorporates variable selectivity with crystal filter, tone control, aerial trimmer, b.f.o., a.v.c., R.F. and A.F. gain controls, mechanical bandspread, etc. Output is for phones or speaker. Operation 115 or 230 volts A.C. £35 each. Carriage 30/-.

BRAND NEW MEDRESCO HEARING AIDS

Supplied complete with earpiece, leads, battery pouch. Brand new boxed, only 32/6 each. P/P 1/-. Batteries 5/- extra.

COLLARO STUDIO TAPE TRANSCRIPTORS

Latest 1961 model. 3 speeds, $1\frac{7}{8}$, $3\frac{3}{4}$ and $7\frac{1}{2}$in./sec. Fitted with 3 separate motors, digital counter, press button switching, provision for fitting extra stereo head. Fitted with new Bradmatic heads. Supplied brand new with instructions, complete with spare 7in. spool. £12 each. P/P 3/6.

AVO SIGNAL GENERATORS

Frequency coverage 95 kc/s to 40 mc/s. Ideal for all general radio work. Variable attenuator, 400 cycle int. mod. or provision for ext. mod. Supplied fully tested and checked £7/19/6 each. P/P 3/6. Operation is from 2 v. and 60 v. batteries, but original Avo mains units can be supplied at 19/6 extra.

MINE DETECTOR NO .4A

Will detect ferrous and non-ferrous metals. Complete and as new in transit cases. Supplied fully tested with instructions. 39/6 each. Carriage 10/-. Batteries 8/- extra.

MARCONI TF-373 UNIVERSAL IMPEDANCE BRIDGES.

Reconditioned to maker's specification. 0-100 H., 0-100 mfd., 0-1 megohm, 0-100 Q. each on 5 ranges at 1,000 c/s. £35 each.

VALVE VOLTMETERS No. 2

Laboratory instruments. Five ranges A.C. and D.C. 1.5 v., 5 v. 15 v., 50 v. and 150 v. Operation 200/250 volts A.C. Supplied as new, fully tested and complete with internally mounted H.F. probe. £17/10/- each. Carriage 10/-.

R1155 RECEIVERS MODEL L/N

This model incorporates the 100-200 metre top band. Full coverage on 5 bands is 200 kc/s to 18 mc/s. Supplied fully tested and in perfect condition £12/19/6 each. Carriage 7/6. A combined 200/250 volt A.C. power unit and audio output stage to match 3 ohms supplied extra at 85/-.

AMERICAN ARB RECEIVERS

Frequency coverage on 4 bands 195 kc/s to 9.05 mc/s. Precision vernier drive. Valve line-up: 12SA7, 4-12SF7, 12A6 and 991. Operation 24 volts D.C. Supplied fully tested and checked, £6/19/6 each. Carriage 7/6.

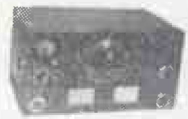
MULTI-RANGE TESTMETERS MODEL U1

1,000 ohms per volt A.C./D.C. Ranges: Volts A.C. 10, 50, 250, 500, 1,000 v. Volts D.C. 10, 50, 250, 500, 1,000 v. Current D.C. 1 mA. 100mA. 500mA. Resistance, 2,000 ohms, 200,000 ohms. Supplied brand new and guaranteed complete with instructions and leads 59/6 each. P/P 2/6.

SPARES KITS FOR CR.100 RECEIVERS.

Contains 15 valves. 2-DH63, 2-KT63, 2-X66, 2-U50, 7-KTW61. Condenser and resistor packs, pots, toggle switch, output transformer, etc. All brand new, 59/6 each. P/P 3/6.

NATIONAL H.R.O. RECEIVERS



Senior model, table mounting. Supplied with complete set of 9 coils covering 50 kc/s to 30 mc/s. Circuit incorporates a meter, variable selectivity, crystal filter, 2 R.F. and 2 I.F. stages, B.F.O. A.V.C., R.F. and A.F. gain controls, etc. Output is for phone or speaker. Power requirements 250 v. 80 mA. and 6.3 v. 3 amps. Supplied fully tested and aligned and in superb condition throughout. Price 21 gns. Carriage 10/-. Power units are available 59/6 extra.

AR88D SPARES

Complete wavechange switch assembly with screens. New boxed, 17/6 ea. P/P 2/6. 1st I.F. transformers. New, boxed, 3/6 each. P/P 9d.

PAINTON MINIATURE JONES PLUGS AND SOCKETS.

All new and unused.

2 pin	2/6 pr.	12 pin	5/6 pr.
4 pin	3/6 pr.	18 pin	7/6 pr.
6 pin	4/- pr.	24 pin	8/6 pr.
8 pin	4/6 pr.	33 pin	10/6 pr.

PARMEKO TABLE TOP TRANSFORMERS

Input 230 volts 50 cycles. Output 620/550/375/0/375/550/620 volts 250 mA. 5 volt 3 amp., 5 volt 3 amp. Size $6\frac{3}{4}$ x $6\frac{1}{4}$ x $5\frac{1}{2}$in. Brand new boxed. 45/- each. Carriage 3/6.

ROTARY CONVERTORS

24 volt D.C. input. Output 230 volts 50 cycles 100 watts, 72/6 each. Carriage 5/-.

R.C.A. PLATE TRANSFORMERS

Primary 200/250 volt 50 cycles. Secondary 2,000/1,500/1,500/2,000 volts 500 mA. Supplied brand new boxed, £6/10/- each. Carriage 10/-.

POST OFFICE 8 BANK UNISELECTORS

Std. type, 25 position. Ex-brand new equipment, 62/6 each. P/P 2/-.

AN/APR4 SEARCH RECEIVERS

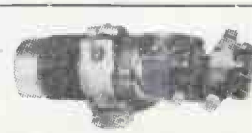
Covers 38 to 1,000 mc/s with 3 plug in R.F. units. TN16 38-95 mc/s. TN 17 74-320 mc/s. TN18 300-1,000 mc/s. Operation 115 v. 50-2,600 cps. Reconditioned to maker's spec. Superb order throughout, £75 each.

SANGAMO WESTON STANDARD VOLTMETERS

Range 0-30 volts D.C. 1,000 ohms per volt. Correct to B.S. 89 pr. limits. 6in. mirror scale, £25 each.

SUB-STANDARD I.F. ALIGNMENT OSCILLATORS. 3 ranges covering 445 to 485 kc/s. Crystal controlled and fitted with precision variable attenuator. Operation 200/250 volts A.C. Brand new, £15 each. Carriage 10/-.

PLESSEY 24-VOLT D.C. PUMPS



Self lubricating, capacity 60 g.p.h. at 30 lb./sq. in. Will operate O.K. on 12 v. $\frac{1}{4}$ BSP inlet/outlet union. Only 15/6 each. P/P 2/6.

HOURS OF BUSINESS: 9 a.m.-6 p.m. Thursday 1 p.m. Open all day Saturday. Please print name and address clearly.

VALVES

ALL NEW AND GUARANTEED

AZ31	9/6	EF42	10/6	R3	8/6	5V4	9/6	6U4	10/-
AZ41	7/6	EF50	3/6	R10	5/6	5Y3	7/6	6V6G	6/-
CL33	9/6	EF55	7/6	R12	9/-	5Z4	7/6	6V6GT	6/6
D77	6/-	EF80	7/-	S130	4/6	6A7	9/-	6X4	5/6
DAF91	6/-	EF85	8/-	U25	11/6	6A8	9/-	6X5	6/-
DAF96	8/6	EF86	11/6	U26	10/6	6AC7	6/-	7B7	8/-
DF91	6/-	EF89	7/6	U50	7/6	6AG5	3/6	7C5	8/-
DF96	8/6	EF91	5/-	U52	10/6	6AK5	5/-	7C6	8/-
DH77	6/-	EF92	5/6	UABC80	8/6	6AL5	6/-	7S7	9/-
DK91	7/-	EK32	6/6	UAF42	9/-	6AM5	5/6	7Y4	7/6
DK32	10/6	EL32	5/6	UBC41	8/-	6AM6	5/-	8D3	5/-
DK92	9/-	EL33	10/6	UBF80	8/6	6AQ5	7/6	12A6	5/-
DK96	8/6	EL41	9/-	UBF89	8/6	6AT6	6/-	12AH8	10/-
DL92	5/6	EL42	10/6	UCH42	9/-	6AU6	7/-	12AT6	7/-
DL93	4/6	EL84	7/6	UCH81	8/-	6B7	5/6	12AT7	7/6
DL94	7/6	EL91	5/6	UCL83	12/6	6B8	4/-	12AU7	7/6
DL96	8/6	EM34	8/6	UF41	8/6	6BA6	7/-	12AX7	7/6
EA50	1/6	EM80	7/6	UF89	8/6	6BE6	6/-	12BA6	7/6
EABC80	8/-	EM81	8/-	UL41	8/6	6BJ6	7/-	12BE6	7/6
EAF42	9/-	EM84	10/-	UL84	7/9	6BR7	11/6	12K8	12/6
EB91	6/-	EY51	9/-	UY41	6/6	6BW6	9/-	12J7	9/6
EBC33	6/6	EY86	8/6	VR105/30	6/-	6BW7	7/6	12K7	9/6
EBC41	7/9	EZ40	7/-	VR150/30	6/-	6CH6	10/6	12Q7	9/6
EBF80	9/-	EZ41	7/-	VR91	3/6	6C4	4/6	12SA7	8/6
EBF89	9/-	EZ80	6/3	VS70	4/6	6C5	5/-	12SH7	5/-
ECC40	15/-	EZ81	6/6	VS110	4/6	6C6	7/6	12SK7	5/6
ECC81	7/6	GZ32	10/6	VU111	1/9	6D2	6/-	12SQ7	8/-
ECC82	7/6	KT33C	6/6	Z77	5/-	6D6	7/6	19AQ5	9/6
ECC83	7/6	MU14	8/6	1A7	10/6	6F6	6/-	25L6	9/-
ECC84	9/-	NSP1	5/6	1C5	10/-	6J5	4/6	25Z4	8/6
ECC85	8/6	PCC84	8/6	1H5	9/6	6J6	3/6	25Z5	8/-
ECF80	9/6	PCF80	9/6	1L4	4/6	6J7	5/6	25Z6	9/-
ECF82	10/-	PCF82	10/-	1N5	9/6	6J7M	6/6	35L6	9/6
ECH35	8/6	PCL82	10/-	1R5	7/-	6K7	3/6	35Z4	9/-
ECH42	9/6	PCL83	12/6	1S5	6/-	6K8	6/6	35Z5	9/-
ECH81	7/6	PL36	12/6	1T4	6/-	6L6	7/6	35W4	6/-
ECL80	9/-	PL81	11/-	2D21	6/-	6Q7	6/6	42	8/6
ECL82	10/-	PL82	7/9	3A4	4/6	6SA7	6/-	50C5	8/6
ECL83	12/6	PL83	8/6	3A5	9/-	6SH7	6/-	50L6	8/-
EF36	4/6	PY32	11/-	3Q4	6/6	6SJ7	6/-	75	10/-
EF37A	8/6	PY80	7/-	3Q5	9/-	6SK7	6/-	80	7/6
EF39	5/6	PY81	7/6	3S4	5/6	6SL7	6/-	85A2	10/6
EF40	15/-	PY82	7/-	3V4	7/6	6SN7	4/6	807	6/-
EF41	8/6	PY83	8/6	5U4	7/6	6SQ7	6/6		

Please add postage.

SIEMENS 1700 + 1700 OHM HIGH SPEED RELAYS
H.96e. Sealed type. S/pole c/over contacts. Brand new, 15/6 each. P/P 9d.

FILMS AND EQUIPMENT COAXIAL PLUGS AND SOCKETS 2/6 pr.

MINIATURE PYE COAXIAL PLUGS AND SOCKETS 2/6 pr.

HI-FI RECORDING TAPES

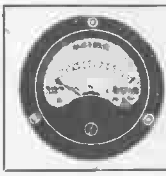
AMERICAN C.B.S. First grade quality. Extended audio range. Brand new guaranteed, completely splice free.

5in.	std. play	600ft.	aetate	13/–
5in.	long play	900ft.	P.V.C.	16/6
5in.	double play	1,200ft.	Mylar	32/–
5¾in.	long play	1,200ft.	acetate	19/6
5¾in.	double play	1,800ft.	Mylar	37/–
7in.	std. play	1,200ft.	P.V.C	21/–
7in.	long play	1,800ft.	acetate	28/6
7in.	double play	2,400ft.	Mylar	47/–

Brand new guaranteed HI-FI tapes in plain boxes

3in. std. play 175ft.	4/3	5in. long play 900ft.	16/–
3in. long play 225ft.	4/9	5¾in. long play 1,200ft.	18/6
5in. std. play 600ft.	12/–	7in. std. play 1,200ft.	19/–

7in. long play 1,800ft.......27/–



BRAND NEW Boxed 100 MICROAMP METERS.

Standard 2½in. flush round, panel mounting. Scale calibrated 0–100 microamps. **42/6** each. P/P. 1/3.

BRAND NEW METER BARGAINS

20 microamp	D.C.	M/coil	flush round	2½in.	69/6
25 microamp	D.C.	M/coil	proj. round	2½in.	59/6
50 microamp	D.C.	M/coil	proj. round	2½in.	49/6
100 microamp	D.C.	M/coil	flush round	3½in.	62/6
1 milliamp	D.C.	M/coil	flush round	2½in.	25/–
1 milliamp	D.C.	M/coil	flush square	4in.	69/6
5/0/5 milliamp	D.C.	M/coil	flush square	2in.	12/6
30/0/30 milliamp	D.C.	M/coil	flush round	2½in.	9/6
4 amp	R.F.	Termo	flush square	2in.	7/6
7.5 amp	D.C.	M/iron	proj. round	3½in.	10/6
100 amps	D.C.	M/coil	proj. round	6in.	65/–
25 volts	D.C.	M/coil	proj. round	2in.	8/6
120 volts	D.C.	M/coil	flush round	3½in.	32/6
300 volts	A.C.	M/coil	flush round	2½in.	25/–
500 volts	A.C.	M/iron	flush round	2½in.	25/–
1500 volts	Electrostatic		proj. round	2½in.	25/–

Please add postage.

L.T. TRANSFORMERS

Suitable for charging or models. All primaries tapped 200/250 volts.

3.5, 9 or 17 v. 1 amp	9/9
3.5, 9 or 17 v. 2 amp	14/3
3.5, 9 or 17 v. 4 amp	16/6
9 or 17 v. 6 amp	26/-
3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 2 amps	18/6
3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 4 amps	30/–

Please add postage.

SELENIUM L.T. METAL RECTIFIERS

Full wave bridge connected, all new and guaranteed.

12/18 v. 1 amp.	4/3	24/36 v. 1 amp	9/6
12/18 v. 2½ amp	6/9	24/36 v. 2 amp	13/6
12/18 v. 4 amp	9/9	24/36 v. 6 amp	22/6
12/18 v. 5 amp	12/6	24/36 v. 10 amp	45/–
12/18 v. 6 amp	13/6	24/36 v. 15 amp	47/6
12/18 v. 10 amp	22/6	36/48 v. 6 amp	32/6
Please add postage.		48/60 v. 10 amp	82/6

COLLINS TCS RECEIVERS

Frequency coverage on 3 bands 1.5 to 12 mc/s. Valve line-up 12SA7, 12SQ7, 2-12A6, 3-12SK7. Power requirements: 12 v. L.T. and 225 v. H.T. Externally store soiled but internally good condition. **£5/10/–** each. Carriage 10/–.

SPEAKER BARGAINS

All new and guaranteed.

2½in. 3 ohm Elac	17/6
2½in. 15 ohm Purdio	17/6
3in. 3 ohm R.A.	17/6
4½in. 3 ohm Plessey	15/6
5in. 3 ohm Goodmans	15/6
6½in. 3 ohm Elac	17/6
8in. 3 ohm R.A.	19/6
10in. 3 ohm Elac	27/6
12in. 3 ohm Plessey	29/6
12in. 15 ohm Plessey	42/6
7 x 4in. 3 ohm Plessey	15/6
8 x 2½in. 3 ohm Goodmans	17/6
8 x 6in. 3 ohm Rola	17/6
10 x 2½in. 3 ohm R.A.	17/6
10 x 6in. 3 ohm Plessey	27/6
13 x 8in. 3 ohm E.M.I.	47/6

Please add postage.

PARMEKO TRANSFORMERS

Primary 115/230 volts. Secondary 350/0/350 volts 150 ma. 6.3 volts 4 amps, 5 volts 3 amp. Brand new, 32/6 each. P/P 2/–.

POTTED TRANSFORMERS

Primary 230 volts. Secondary 350/310/0/310/350 volts 220 ma. Total of 6.3 volt 13 amps, 5 volts 3 amps. 49/6 each. P/P 2/6.

RECORD CHANGERS

B.S.R. UA8 Mono 4 speed	£6 12 6
B.S.R. UA8 Stereo 4 speed	£6 12 6
B.S.R. UA12 Stereo 4 speed	£7 10 0
B.S.R. UA14 Mono 4 speed	£7 19 6
Collaro Studio Mono 4 speed	£6 19 6
Collaro Junior 4-speed single players with pickup	£3 15 0

All new and guaranteed. Post extra.

MINIATURE TRANSISTOR TRANSFORMERS

Size 13/16 x 15/16 x 1 1/16in. Push-pull driver 4.5:1 and push-pull output 20:1 (3 ohm). Supplied brand new boxed with data. **9/6** the pair. P/P 6d.

SPARE PLASTIC SPOOLS. 3in. 1/6, 5in. 2/-, 5¾in. 2/3, 7in. 2/6.

PLASTIC SPOOL CONTAINERS. 5in. 1/6, 5¾in. 2/-, 7in. 2/3, Scotch metal 10¼in. spools 5/-.

Please add postage.

MINIATURE PERSONAL EARPIECES

Available high (crystal) or low (magnetic) impedance. Complete with lead and plug and panel jack. **Brand new only 7/6 each.** P/P 6d.

R.C.A. LOUDSPEAKERS

High quality 8in. 3 ohm speaker housed in black crackle case to match AR88 or H.R.O. receivers. Brand new boxed, 45/– each. P/P 3/6.

PORTABLE PRECISION VOLTMETERS

Brand new moving iron instruments by famous manufacturer. Housed in polished teak case. 8in. mirror scale. 2 ranges, A.C. or D.C. 0 to 160 v. and 0 to 320 v. Accuracy within 2%, **£5/19/6** ea. P/P 3/6.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

SUPERB 6-TRANSISTOR S/HET TABLE RADIO

Printed circuit construction, all components of highest quality. Uses 6 Mullard matched transistors, 1 diode, 2 OC81 valves in push-pull, giving 1 watt undistorted output. I.F. 470 Kc/s. Medium and long wavebands. Ferrite rod internal aerial, high flux 7 × 4in. Loudspeaker. Cabinet with first quality walnut veneer finish and gold embellishments. Size: 18 × 8½ × 5in. deep.

Circuit diagram and full data supplied. Every component available separately.

CAN BE BUILT COMPLETE FOR £9.15.0 P. & P. 4/6

LASKY'S FOR MINIATURE POCKET TRANSISTOR RADIOS!

Add to the pleasure of Summer outings, holidays, camping etc. Wide choice of well-known makes at keenest prices. Call and select or order by post. A few examples.

FIDELITY 6	9½ Gns.
LEECO 6	9½ Gns.
PROGRESS 6	9½ Gns.
SHIRA 6	10½ Gns.
PERDIO 6	11½ Gns.
TOSHIBA 6	12 Gns.
EMERSON 6	14 Gns.
DANSETTE 6	15 Gns.
PHILIPS 7	15 Gns.
BRAUN 7	15½Gns.

Regd. postage and insurance 5/-.

4-SPD AUTO-CHANGERS

New and Unused in Makers' Cartons.

B.S.R. type UA8	£6 19 6
B.S.R. UA8, stereo	£7 19 6
B.S.R. UA12, stereo	£7 19 6
B.S.R. Type UA14	£7 19 6
COLLARO Conquest, wired for stereo, with monaural p.u.	£6 19 6
As above, Stereo	£7 19 6

Post on all above 5/-.

GARRARD

Model 120	£8 8 0
Model 121	£9 9 0
Model 209	£9 19 6
Mdl. 210, Stereo	£11 11 0
Mdl. 210 with monaural and stereo heads	£12 10 0
RC.88	£12 19 6
RC.88 STEREO	£12 19 6
RC.98	£14 19 6

SINGLE PLAYERS

Auto start and stop. Complete with pick-up and crystal cartridge.

GARRARD 4SP	£6 19 6
GARRARD TA Mk. II, wired for STEREO, plug-in head	£8 9 0
E.M.I. 4-spd., wired for STEREO and fitted Acos stereo T.O. cartridge	£6 19 6

Post on all above 5/-.

COLLARO JUNIOR 4-speed motor and separate pick-up 75/-
B.S.R. TU9, non-auto Turntable and separate pick-up 79/6
Post free.

PICK-UP CARTRIDGES

ACOS HGP. 59 or HGP.37 turn over crystal cartridge with L.P. and standard styli. List 39/7. **Lasky's Price 18/-** post free.

ACOS 73-1A STEREO. List 52/6. **Lasky's Price 29/6** post free.

MICROPHONE BARGAINS

ACOS CRYSTAL STICK MIKE Type M.C.39/1, complete with cable. List £5/5/-. 39/6 Post free

Crystal Hand or Table Mike. 15/- Post free.

MINIATURE moving coil dynamic microphone, incorporating switch and pocket clip. As used for the "Fi-Cord" 35/- Post 1/6.

HIGH FIDELITY TAPE RECORDER HEADS

Leading make, new and unused. Upper or lower track. RECORD/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.c. at 7½ i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7½ i.p.s. ERASE, low impedance. LIST £4 PAIR.

LASKY'S PRICE, per pair Post free. **29/6**

Please specify upper or lower track.

SPECIAL OFFER. Set of 4 Heads (upper & lower) 49/6

The "SHERWIN" 6" TRANSISTOR POCKET SUPERHET

The very latest printed circuit, using six matched top grade S.T.C. transistors and germanium diode. Push-pull output feeding 3in. P.M. speaker. Full coverage of medium and long waves. Internal ferrite aerial and provision for car aerial. Housed in attractive leatherette-covered case, size 6½ x 4¼ x 1⅞in. Full point-to-point instructions supplied.

CAN BE BUILT FOR £8/19/6

All components available separately. Circuit diagram and instructions, 2/6 (refunded if you order).

STEREO AMPLIFIER KIT

Twin 4 watt (or 8 watt monaural), employing two ECL82 and EZ80 rect. valves, double-wound mains transformer, etc. Separate panel with bass, treble and volume controls. Indicator lamp, push button on/off switch, elegant gold/cream knobs. Kit comprises two Amplifier Units and one Power Unit, all 5in. × 2in. in size. Fully assembled ready to be wired together. Kit is priced without Loudspeaker so that you can choose the type and size you prefer.

LASKY'S PRICE

Kit complete with new Mullard valves, full data, circuit diagram, assembly instructions and suggested layout. **56/-** Post 5/-.

SPECIAL OFFER OF SPEAKERS WITH THIS KIT
Two 5in. 20/-. Two 6×4in., 25/-. Suitable cabinets callers only.

TAPE RECORDER BARGAINS

ELIZABETHAN "BANDBOX" for A.C. mains 200/250 v., fitted fully self-contained Amplifier and 7 × 4in. Speaker. Clock type face indicator, monitoring and l.s. sockets. 2-speed, 3¾ and 1⅞ i.p.s., fast forward and fast rewind. Record level indicator. Facilities for recording from two inputs. Push-button controls. Plays one hour on one reel of tape. Case, 10½ × 9 × 6in., with detachable hinged lid. LIST 29 Gns.

LASKY'S PRICE, with high quality crystal Mike and one reel of Tape, **£15.19.6** Carr. & Ins. 15/-.

ANOTHER RECORDER BARGAIN! Well-known make using Collaro Studio 3-speed deck, 1⅞, 3¾, 7½ i.p.s. Twin track with pause control, rev. counter, latest type electronic recording indicator. Superimposing switch, volume and tone controls, 7 × 4 Speaker. Takes 7in. spools. 4 watts output. Contemporary design carrying Case, 9½ × 16 × 16in. COMPLETE with Mike, Tape and Spool, Carr. & Ins. 25/-. **29 GNS.**

SPECIAL OFFER RECORDING TAPE

Famous make. P.V.C. base on latest type plastic spools. Brand new, perfect, boxed and guaranteed.

1,200ft. on 7in. spool	20/-
1,800ft. on 7in. spool	32/6
1,200ft. on 5¾in. spool	21/-
850ft. on 5¾in. spool	16/6

SCOTCH PLASTIC TAPE

1,200ft. on 7in. spool	25/-

M.S.S. LONG PLAY TAPE

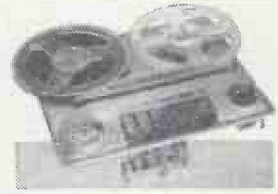
1,800ft. on 7in. spool	39/6
1,200ft. on 5¾in. spool	29/6
850ft. on 5in. spool	25/6
220ft. on 3in. spool	7/11

ALL TAPE POST FREE

PLASTIC TAPE SPOOLS

3in.	5in.	5¾in.	7in.	8¼in.
1/9	2/6	2/6	2/6	5/6

Post extra.



COLLARO STUDIO TAPE TRANSCRIPTOR. 3 motors, 3 speed 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls. **Lasky's Price** complete with Tape and Spool £12/19/6. Carr. & Ins. 12/6.

TAPE PRE-AMPLIFIER. For use with any Tape Deck including Collaro, Motek, etc. Full recording facilities for 1⅞, 3¾ and 7½ i.p.s., multi-position switch gives automatic equalisation by negative feed-back to each speed. 4 valves including magic eye level indicator. Overall dim.: 12 × 4 × 5in. Front panel: 12½ × 3¼in. Attractive gold hammered finish. **LASKY'S PRICE 9 GNS.** Post 3/6.

COMBINED OFFER! The above Collaro Tape Transcriptor plus the Pre-Amplifier, if purchased together, **£20.15.0** Carr. & Insurance 15/-.

COLLARO TAPE TRANSCRIPTOR Mk. IV, fitted digital counter. List £25. **Lasky's Price £16/19/6.** Carr. & Ins. 12/6. Tape extra.

Last few. **MOTEK K10** Deck. 3 motors, 3 speed (1⅞, 3¾, 7½, i.p.s.). Push-button controls. List £22. **Lasky's Price £9.19.6.** Carr. & Ins. 7/6.

TRANSISTOR RECORD PLAYER

CAN BE BUILT FOR £9.19.6

6 volt operation. For all L.P. and standard records. Complete parcel comprises:—

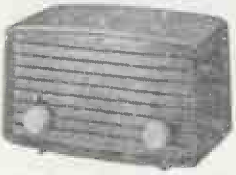
AMPLIFIER. 300 milliwatts output, using two OC71 and two OC72 transistors. Fully assembled. 79/6. Knobs 3/6 extra.
LOUDSPEAKER. 30 ohms, 7×4in. elliptical Speaker matched to amplifier. 25/-.
3-SPEED TURNTABLE with rubber mat and speed adjustment, complete with t.o. crystal cartridge and two sapphire styli. 79/6
CARRYING CASE as illustrated, handsome two-tone finish, size 17in. deep, 14in. wide, 5¾in. high. 49/6.

Batteries extra. All components available separately.

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

LASKY'S MIDGET T.R.F.



CAN BE BUILT FOR ONLY **99/6**
Post & Pkg. 5/-

For A.C. mains 200/250 v. Medium and long wave. Uses 2 latest double-purpose valves EBF89 and ECL80, contact cooled rectifier. 5in. P.M. Speaker. Handsome plastic cabinet in cream, pastel green, pink, blue. Overall size: 8½in. wide, 4¼in. deep, 5in. high.
FULL DATA, instructions, circuit diagram, etc., 1/6. (Free with parcel).
All components available separately.

CAR RADIO COIL PACK

(Superhet, I.F. 465 Kc/s)

As used in many famous makes car radios. A permeability tuned Coil Pack covering medium and long wavebands, with tuned R.F. stage and complete with dial and pointer. Needs no ganged condenser. Its compact construction and small size, 7½ × 5 × 1½in. enables it to be used in the smallest of car radios.
LASKY'S PRICE With circuit diagram and full data. **49/6** Post 2/6

TRANSISTORS

P.N.P. Junction types.

AUDIO, suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. Double spot—yellow and green Each **5/-**

R.F. suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.). Double spot—yellow and red Each **7/6**

Type TS1. Suitable for all audio applications. Post 6d. **3/6**
One dozen 35/- post free.
Special prices for larger quantities.

OC44 15/-; OC45 15/-; OC70 8/6; OC71 8/6; OC78 15/- (Matched Pair 30/-); OC73 14/-; OC16 54/-.

EDISWAN MAZDA TRANSISTORS. The very latest types: XB/102 7/6; XB/103 7/6; XC/101 10/6; XA/101 12/6; XA/102 12/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102, XB/103, 2 matched XC/101. Price 79/6.

CRYSTAL DIODES. General Purpose GEX00, each 1/-. Per doz. 9/-. All other types in stock.

"GOLTOP" POWER TRANSISTORS

All types in stock. Example: V15/10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/-, post free. Suitable Output Transformer for above, correct ratio, matched to 3 ohms, 9/6. Post 1/-.
Driver Transformer, 9/6. Post 1/-.

SEND FOR LASKY'S
COMPONENTS CATALOGUE
OVER 100 PAGES
SIZE 8½in. × 5½in.
COPIOUSLY ILLUSTRATED
Price 2/- Post 6d.
Our latest 12-page "BARGAIN BULLETIN" free with each copy.

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ARMSTRONG	GRUNDIG	ROGERS
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CONNOISSEUR	KORTING	STUZZI
COSSOR	LEAK	SPECTONE
DULCI	LENCO	TANDBERG
E.A.R.	LINEAR	TANNOY
ELIZABETHAN	LORENZ	TELEFUNKEN
FERROGRAPH	LOWTHER	TRUVOX
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GARRARD	PAMPHONIC	WALTER
G.E.C.	PHILIPS	W.B.
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H.P. terms available.

SEND FOR LASKY'S FABULOUS HI-FI CATALOGUE
100 large pages, 11¼ × 8¼in., copiously illustrated. A COMPARATOR-CATALOGUE to enable you to choose from all the latest equipment.
Price 3/6, post 6d. (Refunded on making your first hi-fi purchase.)

LASKY'S F.M. TUNER

PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION

Uses 5 valves, 2 germanium diodes and brand new T.C.C. condensers. The PRINTED CIRCUIT ensures that the I.F. and R.F. amplifiers are extremely stable at maximum gain and results are consistent on all tuners.
CAN BE BUILT FOR (including valves) **7 GNS.**
Post free. Details on request.

MINIATURE EARPHONES FOR POCKET TRANSISTOR RADIOS

High quality and remarkably sensitive, giving clear reproduction of music as well as speech. Complete with transparent ear-insert, 3ft. cord, sub-miniature jack and socket. Fully guaranteed.
Mdl. C.R.5. Crystal Earpiece, high imp. **9/-**
Mdl. M.R.4. Magnetic Earpiece, low imp. **8/-**
Post free.

SUB-MIN. COMPONENTS

As used in the smallest Japanese pocket transistor radios. Coils, Loudspeakers, I.F. transformers, Ganged Condensers, etc., now available from stock at lowest prices. Also in stock, all T.S.L. transistorised Miniature Units.

"LINEAR" AMPLIFIERS

"DIATONIC" 10-14 watts **12 Gns.**
"CONCHORD" 30 watt **15 Gns.**
L45 4-5 watt Amplifier **£5/19/6**
LT45 Tape Deck Amplifier **12 Gns.**
L50 50 watt Amplifier **19 Gns.**
L10 10-12 watt with pre-amplifier **15 Gns.**
L3/3 Stereo Amplifier ...... **7 Gns.**
LP1 Tape Pre-amplifier **9 Gns.**
All other types in stock.

TRANSCRIPTION MOTORS

GARRARD 4HF, stereo or monaural, complete with plug-in head-**£18/9/-**. Carr. & Ins. 12/6.

GARRARD 301	£22 7 3
GARRARD 301 (Strobe)	£23 18 4
GARRARD type A ...	£21 7 8
PHILIPS	£10 10 0

Also Lenco, Connoisseur, etc.

ALL TYPES OF CHASSIS

ARMSTRONG, DULCI, EMPRESS, etc. A.M. (1, m., s.) from... **7 Gns.**
A.M./F.M. from........... **14 Gns.**
A.M./F.M. STEREO from **22 Gns.**

P.M. SPEAKERS

3½in.	4in.	5in.	6½in.	8in.	10in.
17/6	19/6	10/6	16/-	16/6	25/-

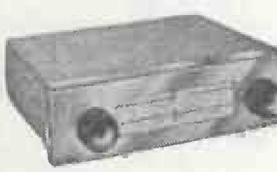
12in. 27/6. **ELLIPTICAL:—**

7×4	9×6	10×2½	10×6	10×7
12/6	22/6	25/-	25/-	25/-

Post extra.

IMPORTANT PRICE REDUCTION

Made possible by the big demand for this very successful model.



LASKY'S
CAR RADIO
CAN NOW BE BUILT ABSOLUTELY COMPLETE
FOR **£9.19.6**
Post free.

- ★ Small size. Will fit any car.
- ★ 12 volt operation.
- ★ New Hybrid circuit.
- ★ Transister output.
- ★ New Type Brimar valves.
- ★ No vibrator 12 volt H.T. & L.T.
- ★ T.C.C. Printed Circuit and Condensers.
- ★ Tuned R.F. stage.
- ★ Medium and long waves.
- ★ Permeability tuning.
- ★ 7in. × 4in. elliptical speaker.

Instruction booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 (returned if you order).

KAPURA Mdl. U1 MULTI-TEST METER

Complete with test leads.
59/6
Post 2/6
Brand new fully guaranteed

Sensitivity: 1,000 ohms per volt A.C. and D.C. **Ranges:** (A.C. and D.C.) 0-10-50-250-500-1,000 v. D.C. current 0-100-500 m/a. 0-1 m/a. (used at 0-10 v. range). **Resistance:** 1-2,000 ohms (centre 24 ohms). 100-200,000 ohms (centre 2.4 k.). **Size:** 5in. × 3in. × 2½in.

20,000 VALVES IN STOCK
Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I., Philips, Pinnacle, Telefunken, etc. Send for our latest Valve List.

SUB-MIN. RESISTORS, ⅛th watt. most values available. Each 3½d, Per doz. 2/6.

CONDENSERS, RESISTANCES. High stability Resistances, Electrolytics. All values and sizes stocked.

★ 12-CHANNEL TURRET TUNERS ★

Large selection, many by famous makers such as Cyldon, Brayhead, Plessey, Cossor, etc., all I.F.s. New and unused. Let us quote you for the model required. Examples: 33-38 mc/s., 29/6, 6-9 mc/s., 59/6, 9-14 mc/s., 59/6, 14-25 mc/s., 59/6.

C.R. TUBE BARGAINS

NEW AND UNUSED

FERRANTI. 12in. types T12/44 or 9in. type T9/3 4 v. heater.
LASKY'S PRICE Carr. & Insur. 12/6. **49/6**

FERRANTI 17in. type TR17/10, 6.3 v. .3 amp. heater. Brand new and unused.
LASKY'S PRICE Carr. and Insur. 12/6. **£6.19.6**

16in. METAL CONE, famous make, type T901/A, 6.3 v., 0.3 amp. heater Carr. & Insur. 21/-. **£6.9.6**

17in. 90 degrees C.R. TUBES
Seconds but in perfect working order and guaranteed.
Carr. and insur. 12/6. **79/6**

RE-GUNNED C.R. TUBES
GUARANTEED FOR 12 MONTHS

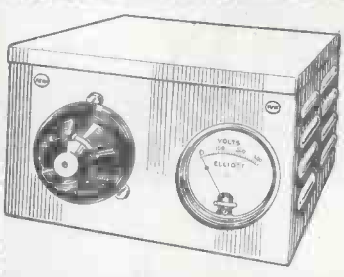
Type	From	Carr. & Ins.
12in. round	£5 10 0	12/6
14in. rect, ...	£5 10 0	12/6
15in. & 16 round	£5 19 6	12/6
17in. rect.	£5 19 6	12/6
21in. rect.	£7 19 6	21/-

207 EDGWARE ROAD, LONDON, W.2
Few yards from Praed Street, PADdington 3271/2

42 TOTTENHAM COURT ROAD, W.1
Nearest station Goodge Street. MUSeum 2605

Both addresses open all day Saturday. Close 1 p.m. Thursday.

PLEASE ADDRESS ALL MAIL ORDERS TO DEPT. W, AT ABOVE EDGWARE ROAD ADDRESS.



BRAND NEW VARIABLE VOLTAGE TRANSFORMER. 230 volt A.C. input. Fitted in steel hammer finish case complete with 0–300 volt M.C. A.C. Meter, fuse and neon indicator light. Output constantly variable from 0–270 volt A.C. Type 1. 2.2 amp. Price £8/10/–, carriage 10/–.

BRAND NEW VARIABLE VOLTAGE TRANSFORMER. For 230 volt A.C. input. In cases as above with meter, fuse and indicator light. Output constantly variable from 0–230 volt A.C. Type 15. 15 amp. Price £22/10/–. Carr. 15/–.

SPECIAL OFFER. TRANSISTORS EX BRAND NEW EQUIPMENT. 2 off XC.101A Push-Pull pair, Output 400 MW. (=OC72) and 1 off X.B103 Driver (=OC71). Set of 3 15/6, postage paid.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm. 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

W. W. RHEOSTAT. New. 3.5K or 5K 25 watts. Price 7/6. P. & P. 1/6.

AUTO TRANSFORMERS. Step up, step down. 110–200–220–240 v. Fully shrouded. New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6.

HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New. In manufacturer's cases. Input 110–260 volt multi-tapped. 50 cycles, single phase. Output 28–29–30–31 volts at 21 ampere. Price £6/15/-, carriage 10/–.

ENGINE SPEED INDICATOR. On the basis of a special ex-R.A.F. meter which we are able to supply and a few small linking parts which can be purchased anywhere, an inexpensive engine speed indicator can be made up which works on simple pulse counting principles in conjunction with the contact breaker on the distributor. Will give direct reading in R.P.M. Full conversion instructions are supplied by us. Additional standard parts required easily obtainable for about 15/–. R.A.F. meter as offered by us 16/6, plus 2/6.

CRYSTAL CALIBRATOR No. 10. A crystal controlled 4-valve high-grade instrument in the same category as the famous B.C. 221. Directly calibrated, does not require cross reference or charts — functions as follows:— (1) A crystal controlled oscillator which provides fixed frequency signals of 500 KC and all harmonics of 500 KC to beyond 10 Meg. and up to 30 Meg.

(2) A variable oscillator from 250 KC to 500 KC, this enables all intermediate frequencies between 250 Kc/s. and 30 Meg. to be produced and modulated.
Supplied complete with 3 spare valves, all leads and maker's instruction book in carrying haversack. NEW. Price £4/19/6. Carr. 3/-.

DESK TELEPHONE SETS, similar to G.P.O. extension telephones. Each complete with automatic dial, internal bell and long connection core and junction box. Used but in perfect working order. Price £2/17/6 each. P. & P. 3/6.

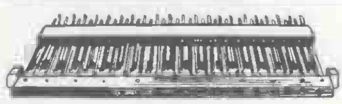
DIALS ONLY FOR AUTOMATIC TELEPHONES. Used but in good condition. Price 14/6. P. & P. 1/6.

FRACTIONAL H.P. MOTOR MADE BY FRACMO. For 230/250 volt A.C. Delivers 1/6th of a H.P. at 5,000 R.P.M. Complete with wire leads and 1in. x ¼in. spindle. Unused. Price 39/6 each. P. & P. 3/-.

S.T.C. RECTIFIER. 36 plates by 120 mm. Bridge connected. Maximum A.C. input 60 volt. D.C. output 15 amp. New, perfect. Price 60/-. P. & P. 3/6.

S.T.C. BRIDGE RECTIFIER. New, perfect. 8 plates each 115 mm. Maximum A.C. input 36 v. D.C. output 5 ampere, 24 volt. Price 20/-. P. & P. 2/-.

BRAND NEW FREQUENCY METERS manufactured by Nalder & Thompson Ltd. Calibrated 45 cycles to 55 cycles per second. 6in. dial. Panel mounting type. In original manufacturer's boxes. PRICE £10/15/- ea. Postage 3/6.



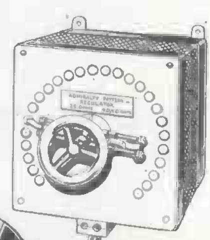
20-WAY STRIP containing standard Post Office tleephone Jack Sockets, overall size 11 x 3¼ x ¾in. New. Price 15/- each. P. & P. 1/6.

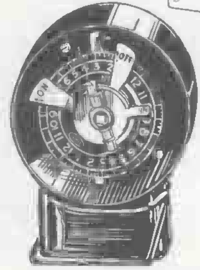
10-WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.

19-INCH RACK MOUNTING 20-WAY P.O. JACK STRIPS with 40 terminals at rear. Price 25/-. P. & P. 3/6.

19-INCH RACK MOUNTING 20-WAY P.O. LAMP STRIPS. Price 25/-. P. & P. 2/6.

ROTARY SWITCH REGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6in. Price 15/-. P. & P. 2/6.

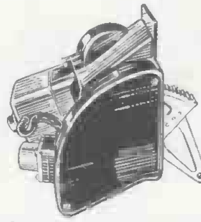




8-day clockwork **TIME SWITCH** Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 2/-.

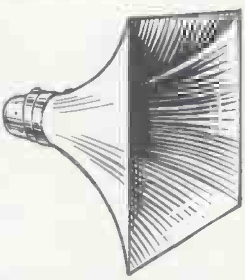
DESK TELEPHONE HANDSETS

Used but perfect. Complete with two-way calling system (buzzer), internal battery. All ready for simple two-wire connection. Price £3/2/6 each or £6 the pair. P. & P. 3/6 each handset.



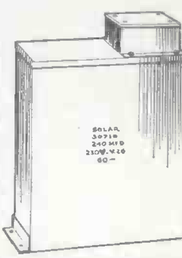
SPECIAL REVERSING 24-VOLT D.C. MOTOR 2 AMPERE. Quadrant moves 90 degrees with limit switches. Ideal for opening doors etc. Price 22/6. P. & P. 2/-.

NEW BALANCED ARMATURE HEADPHONES. TYPE DLR5. Guaranteed perfect. Price 12/6 each. P. & P. 2/-.



TANNOY P.A. LOUDSPEAKER. For outdoor use, metal exponential horn with 20in. square flare. Overall length 30in. Speech coil 15 ohms. Guaranteed in working order and good condition. Price £7/10/-. Carriage 10/–.

SOLAR OIL-FILLED CONDENSER. 240 mfd. for 230 V.A.C. or 600 volt D.C. Overall size 14in. x 9in. x 5½in. plus feet. Weight 46 lb. Brand new. Guaranteed perfect. Manufacturer's packing. Price £7/10/-, carriage 10/–.

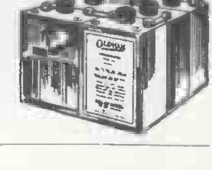


100 YARD DRUMS GLASS BRAIDED FLEX, 10/.010. New. 10/6 per coil. P. & P. 2/–.

18-WAY P.V.C. COVERED 14/36 WIRE, screened overall, covered with P.V.C. all colour coded, 3/6 per yd.; £15 reel of 100 yds.

LEATHER FLYING HELMETS. Used but in good condition. Complete with Harness, Jack Plug and brand new. No. 13466 Earpieces. Price 22/6. P. & P. 2/–.

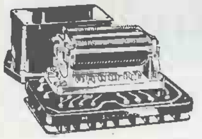
NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 v. separate cells connected by terminal strips. 6 x 5½ x 4¼in. over terminals. Price 19/-, plus P. & P. 2/9.



SERVICE TRADING COMPANY →

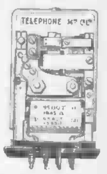
PACKARD BELL BRAND NEW RELAYS, 2 pole c.o. 6 volt 80 ohms. **7/6** each. P. & P. 6d.

MINIATURE RELAYS 250 ohms. Two makes. For operation on 4.5-9 volt. Ideal for transistor circuits. Weight just over 1 oz. Price 12/6 each.



SOLENOID OPERATED MAGNETIC RELAY. Type 5CW/3945, 4 pole changeover, 10 A contacts 24 v. operation. Brand new **13/6.** P. & P. 1/6.

CARPENTER'S TYPE POLARISED RELAYS. 2 x 9,500 turns at 1,685 ohms. Price **22/6** each. P. & P. 1/-.



HIGH SPEED RELAY. Siemens. Two bobbins 1,000 ohms each. New, **10/6** each. P. & P. 1/-.

SIEMENS H.S. RELAY. Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price **16/6 each,** plus 1/- P. & P.

Siemens sealed similar relay to above, but 2.2 ohms plus 2.2 ohms. Minus clips, **12/6** each. Plus 1/- P. & P.

SUPERIOR BRAND NEW RELAY. 7,000 ohms coil. Will pull in at 750 microamps, and out at 450 microamps. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2½ oz. Price **18/6.** P. & P. 1/-.

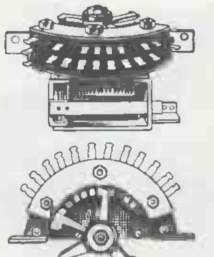
MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each.

Operating current minimum 140 microamp., nominal 400 microamp, maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA at 50 V A.C. or D.C. Size 1¼ x ⅝ x ¾in. Price **22/6** each.

G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil, 6/12 volt. 4 C/O. Brand new. **18/-.** P. & P. 1/-.

MINIATURE OPEN TYPE RELAY. 700 ohms coils. 24 volt. 2 C/O. Ex new equipment. Unused. **7/6.** P. & P. 1/-.

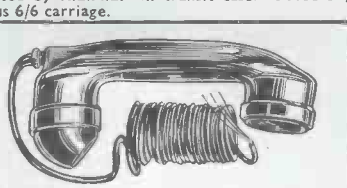
ROTARY RELAY. 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price **7/6.** P. & P. 1/6.



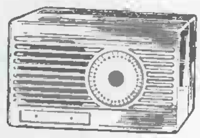
MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price **22/6** each. P. & P. 2/6. As illustrated.

PYE LEVER OPERATING MICRO-SWITCHES. Single pole changeover. Brand new. 4/- each or 42/- dozen, p. paid.

CLASS D WAVE METER. Latest release of these famous Heterodyne wave meters with directly calibrated illuminated dial, most suitable for amateur transmitters, covers two ranges 1.9-8.0 Mc/s. and 4.0-8.0 Mc/s. Complete with reference crystals for zero settings, two valves, 2 x 6 volt vibrators, MAKER'S instruction book and matched set of headphones for monitoring. Designed for 6-volt D.C. operation, can easily be modified for mains and suitable transformer supplied for 7/6. In spot-on condition as tested by R.E.M.E. In transit case. **Price 5 gns.** each, plus 6/6 carriage.

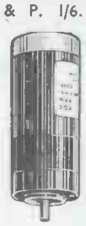


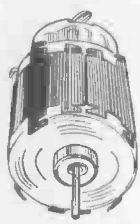
SOUND POWER TELEPHONE HANDSETS. Each couple connected by ordinary 2 core lighting flex will secure instant and reliable intercommunication. No batteries required. **Price per set of 2 33/-, plus P.&P. 3/-.**



MOULDED CABINET suitable for Transistor Set. Dual colour red/black. Size 5¼in. x 3¼in. x 1¾in. Gold metal dial. Price **7/6.** P. & P. 1/6.

CONSTANT SPEED, PRECISION MADE, BATTERY DRIVEN D.C. GOVERNED MOTOR (Elliott Bros.). Commutator/brush incorporating loading ballast resistor 2,470 r.p.m. ± 2% at 12 volt. Loss on 8.5 volt only 4%. Size 1 1/32in. dia. x 2 3/32in. long. Spindle .77in. long x .15575in. dia. Weight 4 oz. New. Price **25/-,** plus 1/- P. & P. Ideal for portable tape recorders.

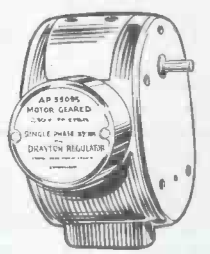


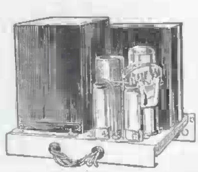


NEW IMPORTED EXTREMELY EFFICIENT MOTOR with tremendous power weight ratio. For 12 volt D.C. but very efficient on 6 volt. Three position switch. Weight 2.1 oz., size 1⅜in. x 1¼in. dia. Speed 7,000 r.p.m. Self lubricating. **15/-,** plus 1/- P. & P.

PRECISION MADE GEARED MOTOR BY DRAYTON REGULATOR CO., for 230 volt 50 cycles A.C.

TYPE R.Q.R., reversible. 37 r.p.m., overall size 5in. x 4in. x 5¼in. Weight 4½ lb. Ex brand new equipment. Unused. Price **£3/17/6.** P. & P. 3/-.





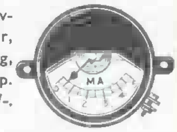
MAINS POWER SUPPLY UNITS. Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6½ x 7¼in., complete with 5Z4 rectifier valve and full smoothing. Input tapped 220-230-240 volts.
Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V. A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price **47/6** plus P. & P. 8/-.

METERS GUARANTEED PERFECT

Charging Types	
2¼ amp. D.C. M.I. 2in. fl. rnd	**7/6**
5 amp. D.C. M.I. 2½in. fl. rnd	**11/6**
7½ amp. D.C. M.I. 3½in. proj. rnd	**12/6**
9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd.	**6/6**
15 amp. D.C. M.C. 2in. rnd	**10/6**
30 amp. D.C. M.C. 2in. fl. sq	**12/6**
100 amp. A.C. M.I. 4½in. fl. rnd	**32/6**
Voltmeters	
20 v. D.C. M.C. 2in. fl. sq	**10/6**
30 v. M.I. 3in. proj. rnd	**10/6**
300 v. A.C. M.I. 2½in. fl. rnd	**22/-**
400 v. A.C. M.I. 4½in. rnd	**35/-**
90-180 v. A.C. M.I. 4½in. fl. iron	**25/-**
Milliammeters	
1 mA. M.C. 2½in. fl. rnd	**25/-**
200 mA. M.C. 2½in. fl. rnd	**12/6**
500 mA. M.C. 2½in. fl. rnd	**12/6**
Microamp	
50 microamp., scaled 0-100, M.C. 2½in. fl. rnd	**42/6**
500 microamp., M.C. 2½in. rnd. F.L. scaled 15/600 volt. NEW	**16/6**

Postage on all meters 1/- each.

Miniature latest type moving coil 0-5 milliamp meter, 1½in. diameter, flush fitting, complete with fixing clip. Price **17/6.** P. & P. 1/-.



MINIATURE LATEST TYPE MOVING COIL MICROAMP METER, F.S.D. 300 microamp, flush mounting, square rim 1¾in. x 1¾in., round dial 1¼in. Ideal as field strength meter or output level recorder or tuning meter. Price **26/-.** P. & P. 1/-.

LATEST TYPE ERNEST TURNER. 0-200 volt A.C. RECTIFIED M.C. METER. Flush mounting, round, 3in. scale. Price **37/6.** P. & P. 1/6.

ROTARY CONVERTOR. Ex-W.D. for 12-volt D.C. input, output 230 volt 50 cycles at 150 watts. Housed in wooden carrying case with lid. Voltage control slider resistance, mains switch and 300 volt A.C. voltage output check meter. Perfect working order. Price **£9/17/6,** carriage 10/-.

PANEL MOUNTING TOGGLE SWITCH D.P.D.D.T. CENTRE OFF. 250 volt 3 amp Price 5/6 each.

EX P.O. MAGNETIC COUNTER. 3 ohm type for 6 V. D.C. operation. 4 figures to 9,999. **Price 6/6.** P. & P. 1/-.

Postage and Carriage shown above are inland only. For overseas please ask for quotation. We do not issue a catalogue or list.

SERVICE TRADING Co.

PERSONAL CALLERS ONLY: **9 Little Newport Street, London, W.C.2** *TEL: GER 0576*
ALL MAIL ORDERS. ALSO CALLERS AT:
47-49 High Street, Kingston-on-Thames
Telephone: KINgston 4585

Each Model incorporates the highly successful HT/TR3 Amplifier (described below), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1,200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them send S.A.E. for fully descriptive leaflets.

Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

MODEL CR3/S. Incorporates the Collaro "STUDIO" TWIN TRACK 3-speed Deck operating at 1⅞", 3¾" and 7½" speeds **£39.10.0**
H.P. Terms: Deposit £7/18/- and 12 months of £2/17/11.

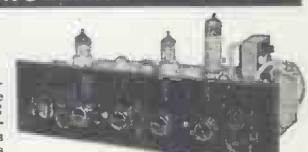
MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck operating at 3¾" and 7½" speeds **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT

The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3-speed treble equalisation by FERROXCUBE POT CORE INDUCTOR. FOR WEARITE—COLLARO—TRUVOX or BRENELL TAPE DECKS. (STATE which when ordering.) Includes separate Power Supply Unit.
KIT OF PARTS .... **£14.0.0** or ASSEMBLED **£17.0.0**
H.P. £3/8/- Deposit and 12 months at £1/4/11.
(Excluding Power Unit £11/15/- and £14/10/- respectively.)

MODEL HF/TR3 Mk. II TAPE AMPLIFIER



(Mullard Type "A" design)
A very high quality Amplifier incorporating 3-speed treble equalisation, by the latest FERROXCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENELL or WEARITE Tape Decks (STATE which when ordering) has GILSEN Output Transformer. Includes separate Power Supply Unit
KIT OF PARTS .... **£13.13.0** or ASSEMBLED .. **£17.0.0**
H.P. £3/8/- Deposit and 12 months at £1/4/11.

FOR THE HOME CONSTRUCTOR SPECIAL "COMBINED ORDER" PRICES

(a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested **£29.10.0**
H.P. Terms: Deposit £5/18/- and 12 months at £2/3/3.
(b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts **£26.10.0**
(c) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" PRE-AMPLIFIER and Power Unit **£40.0.0**
H.P. Deposit £8 and 12 months £2/18/8.
(d) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**
(e) The BRENELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit **£46.0.0**
H.P. Deposit £9/4/- and 12 months at £3/7/6.
(f) As above, but the Type "C" supplied as complete Kit of Parts **£43.0.0**
(g) The WEARITE 4A DECK with Type "C" assembled and tested **£56.0.0**
H.P. Deposit £11/4/- and 12 monthly £4/2/1.
(Carriage and Insurance on above quotes 10/- extra)
EACH OF ABOVE CAN BE SUPPLIED IN PORTABLE CASE FOR £5/10/- extra. THUS FORMING A COMPLETE PORTABLE PRE-AMPLIFIER. SEND FOR DETAILS.

(a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK **£26.0.0**
(b) As above, but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £5/18/-, 12 months of £2/3/3 ... **£29.10.0**
(c) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK **£36.10.0**
(d) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £8, 12 months of £2/18/8. **£40.0.0**
(e) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK **£42.0.0**
(f) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £9/2/-, 12 months of £3/6/9. **£45.10.0**
(g) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc. **£55.0.0**
H.P. Terms: Deposit £11, 12 months of £4/0/8.
(Carriage and insurance on each above is 10/- extra.)

Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—and 1,200ft. SPOOL TAPE—ALL FOR **£9.0.0**
(Carriage and Insurance 5/- extra.)

SPECIAL OFFER OF TAPE

P.V.C. base on latest type plastic Spools. New, Boxed and Guaranteed.

225ft. on 3in. Spool	5/9
900ft. on 5in. Spool	18/6
1,200ft. on 5¾in. Spool	21/–
1,200ft. on 7in. Spool	21/–
1,800ft. on 7in. Spool	32/6

TAPE ACCESSORY KITS

(a) E.M.I., includes 3 reels Leader Tape, Splicer, Jointing Tape and Stop Foil **37/6**
(b) SCOTCH BOY, includes 3 reels Leader Tape, Splicer, and Jointing Tape **29/6**

A LARGE PURCHASE OF BRAND NEW and FULLY GUARANTEED TRUVOX and GARRARD TAPE EQUIPMENT ENABLES THESE OUTSTANDING PRICE REDUCTIONS.

THE "MODEL HF/G2R" PORTABLE TAPE RECORDER (Original Price £33.0.0)

FOR ONLY **22 GNS.** H.P. Dep. £4/14/-. 12 months £1/13/9. (Carriage and Ins. 10/- extra.)
INCORPORATES THE LATEST GARRARD "MAGAZINE" TAPE DECK and MATCHING AMPLIFIER. Based on the successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD DECK. PRICE INCLUDES THE GARRARD TAPE MAGAZINE and 4in. SPOOL OF DOUBLE PLAY TAPE. A Twin Track Recorder operating at 3¾in./sec. providing up to 1 hour 10mins. playing time. The outstanding features being excellent performance and simplicity of operation. Incorporates EXT. SPEAKER SOCKET, also operates as independent amplifier for direct reproduction from P.U., mike or Radio tuner. Weighs only 22lb.
WE ALSO OFFER DECK and AMPLIFIER CONNECTED, TESTED, FOR IMMEDIATE OPERATION, 19 gns. H.P. Dep. £4 and 12 months £1/9/4. Carriage and Ins. 10/- ex. INCLUDES SPEAKER, tape Magazine and 4in. Spool of Double Play Tape. Comprises a complete tape recorder chassis ready for easy fitting into cabinet.

THE "MODEL TK/Mk. IV" PORTABLE TAPE RECORDER (Original Price £49/10/-)

FOR ONLY **£36.10.0** PRICE INCLUDES A 7in. SPOOL OF EMI TAPE.
H.P. Dep. £7/6/- and 12 months £2/13/6.
(Carriage and Insurance 10/- extra.)
INCORPORATES THE TRUVOX Mk. IV TAPE DECK, ROLA/CELESTION 9 x 5in. LOUDSPEAKER and the Truvox Type "K" AMPLIFIER specifically developed by Truvox Ltd. to correctly operate their Mk. IV Tape Deck. This combination affords first-class tape recording facilities.

A Twin-Track Two Speed model operating at 3¾ and 7½in./sec. Incorporates SAFETY BUTTON (prevents accidental erasure). Ext. Speaker. TONE and VOLUME CONTROLS. Also operates as independent AMPLIFIER for direct reproduction from P.U., mike or Radio tuner.
WE ALSO OFFER THE DECK and AMPLIFIER AS FOLLOWS: Mk. IV TAPE DECK, £16/10/-. H.P. Deposit £3/6/-. 12 months £1/4/3. TYPE "K" AMPLIFIER, £15. H.P. Deposit £3. 12 months £1/2/9. COMBINED ORDER FOR BOTH DECK AND AMPLIFIER, £30. H.P. Deposit £6. 12 months £2/4/-.

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E.

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko O/put Trans.).......... **£10.0.0**

Alternatively we supply ASSEMBLED AND TESTED...... **£11.10.0**

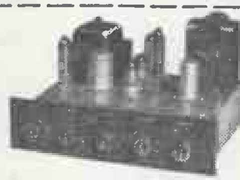
ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER but also perfectly suitable for other makes.
Supplied strictly to MULLARD SPECIFICATION and incorporating:
- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel. ● Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£8.0.0**

COMPLETE MULLARD 5-10 AMPLIFIER



The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction.
Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers.

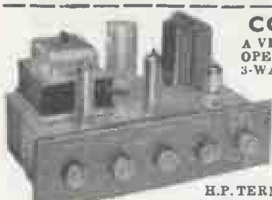
Price: COMPLETE KIT. Parmeko Transformer...... **£11.10.0**

Alternatively we supply ASSEMBLED AND TESTED. **£13.10.0**

Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10.

ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

COMPLETE MULLARD 3-3



A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS **£7.10.0**
(Plus 6/6 carriage and insurance).

Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance).... **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

COMPLETE STEREO AMPLIFIER

Meets the many requests for a low priced but good quality Stereophonic Amplifier. Output power is 4 watts. Inputs for Crystal Pick-ups and Radio Tuner.

KIT OF PARTS .... **£8.10.0** or ASSEMBLED........ **£10.10.0**

Mk. II "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

FOR THE CONSTRUCTOR .... **£10.0.0** or ASSEMBLED.... **£14.15.0**

SPECIAL CASH ONLY OFFER !!

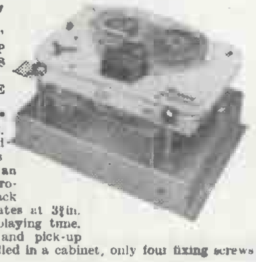
The very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6** (Plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey Colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(b) The PORTABLE CARRYING CASE £3 17 6
(c) 6½in. P.M. SPEAKER ...... 18 9 (Carriage and Insurance 4/- extra)

"Hi-Fi" LOUDSPEAKERS

WE HAVE IN STOCK A COMPLETE RANGE BY GOODMANS—WHARFEDALE—W.B.
ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

THE "ADD-A-DECK"



INCORPORATING GARRARD "MAGAZINE" TAPE DECK and the MATCHED MODEL HF/G2P PREAMPLIFIER. Supplied on ONE CHASSIS (as illustrated) READY FOR USE.
PRICE: Including GARRARD MAGAZINE and a 4in. SPOOL DOUBLE PLAY TAPE (Carr. & Ins. 10/- extra). **18 gns.**
H.P. Deposit £3/16/- and 12 months of £1/7/8.
Provides complete tape recording facilities and designed to operate through the pick-up sockets of the standard type of RADIO RECEIVER, or an AMPLIFIER, from which really first class reproduction is obtained. It consists of a Twin Track Deck connected to the Pre-amplifier and operates at 3¾in./sec. speed, providing up to 1 hour 10 mins. playing time. Only needs connecting to the mains supply and pick-up sockets. Very simple to operate and easily installed in a cabinet, only four fixing screws being required.

H.P. TERMS ARE AVAILABLE ON ALL EQUIPMENT OVER £9. FULLY DESCRIPTIVE LEAFLETS ARE AVAILABLE FOR ALL EQUIPMENT, BUT PLEASE SEND S.A.E

PRICE REDUCTIONS

(a) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit **£15.15.0**

(b) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested **£18.18.0**
H.P. TERMS: Deposit £3/16/- and 12 months of £1/7/8.

(c) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**

(d) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(e) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**

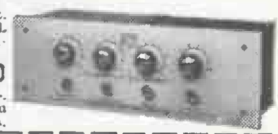
(f) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(g) COMPLETE KIT OF PARTS to build Two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit.......... **£31.0.0**

(h) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£36.0.0**
H.P. TERMS: Deposit £7/4/- and 12 months of £2/12/-. Carriage and insurance 7/6 extra.

Prices quoted are subject to £1/6/- extra for Partridge Trans.

MULLARD FOUR CHANNEL MIXING UNIT



Self powered with Cathode follower output. Incorporates Two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a Fourth for Radio or Tape.
KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£10.0.0**
Terms: Deposit £2 and 12 months at 15/-.
Model I.L. one microphone input matched for moving coil or ribbon mike £1/17/- extra.

STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC and MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 m/v.

Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED and TESTED **£15.0.0**
H.P. Terms on assembled unit: £3 Deposit and 12 months of £1/2/-.

STEREO "3-3" MAIN AMPLIFIER

Comprises two MULLARD 3-3 Main Amplifiers on one chassis. Operates with above MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner
KIT OF PARTS.............. **£10.0.0** or ASSEMBLED...... **£11.15.0**

!! RECORD PLAYERS !!

Many at REDUCED PRICES!!!
Send S.A.E. for ILLUSTRATED LEAFLET

THE EMI 4-speed single record player with separate crystal pick-up ...... **4 gns.**
B.S.R. MONARCH UA8 4-spd. Mixer Autochanger with Crystal Pick-up **£6.19.6**
THE NEW COLLARO "C 60" 4 speed autochanger unit with Studio "O" pickup........................ **£7.19.6**
The NEW COLLARO Model RP594, 4 speed Single Record Player, Studio Cartridge **£9.18.9**
THE E.M.I. 4-speed Single Record Player, incorporating a high output crystal pick-up **£6. 9.6**
B.S.R. MODELS UA12 and UA14. Each a 4-speed Mixer Autochanger with Crystal Pick-up **£7.19.6**
Both available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records **£10.10.0**
GARRARD RC209 4-speed Autochanger fitted with latest Crystal Pick-up **£8.19.6**
The latest GARRARD TRANSCRIPTION MOTOR "301"........ **£22.7.3**
The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.8. Crystal Cartridge **£18.7.6**
GARRARD Model TA/Mk. II Single Record Player fitted with high output Crystal Pick-up, detachable head........................ **£8.10.0**
HIRE PURCHASE TERMS available on all units £8/19/6 and over
Carriage and insurance on each above 5/- extra.

! ! HOME CONSTRUCTORS ! !

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS
Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifier, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required.
Fully illustrated leaflets are available, including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

25½ GNS. Carr. 17/6. OR DEPOSIT £5/7/6 and 12 monthly payments of 42/-. Cash price if settled in 3 months.

Can be assembled in ½ hour.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR, THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER, Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 16 × 13 × 9in., finished in durable and attractive duo-tone Policrome, and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE:
★ 3 SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED. ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS Fast rewind. ★ TAPE MEASURING AND CALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM. ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.
Full descriptive leaflet supplied on receipt of S.A.E.

HI-FI 10 WATT AMPLIFIERS

BRAND NEW CARTONED MANUFACTURERS DISCONTINUED MODEL. A REMARKABLE OPPORTUNITY. **£6.19.9** Carr. 7/6.
Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. Please state speaker matching required when ordering.

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae location. Only 250 v. 15 mA H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.

BASS REFLEX CABINET. Specially designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18×12×10in. Strongly made. Handsome appearance. Ensure superb reproduction for only £3/19/6.

MULTI-METERS

CABY A10 Basic meter, sensitivity 155 micro-amps. A.C. and D.C. ranges. £4/17/6. CABY B20. Sensitivity up to 10,000 ohms per volt A.C. and D.C. £6/10/-

ACOS HI-FI CRYSTAL 'MIKES'

Mic 40 Hand or Desk type **27/9** (Listed 45/-)
39-1 Stick type **39/6** (Listed 5 Gns.)
Limited number.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator, Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.
Type BM2. Size 8×5½×2½in. Supplies 120 v. 90 v. and 60 v., 40 mA and 2 v. 0.4 a. to 1 amp., fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator.
Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

POWER PACK KITS. Only 19/11. Fully smoothed H.T. output of 250 v. 60 mA and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke, Double Electrolytic Condenser. Aluminium Chassis and Circuit.

VALVES! Full range at really competitive prices.

THE SKY FOUR T.R.F. RECEIVER

A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut venecred type. It employs valves 6K7, 8P61, 6F6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

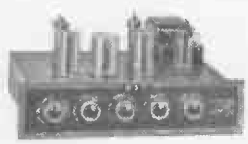
EXTENSION SPEAKERS. Handsome walnut veneered cabinets. All standard 2-3 ohms. 6½in. 29/9; 8in. 35/9.

R.S.C. A12 STEREO AMPLIFIER KIT

4 GNS. Carr. and packing 7/6.

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT



Valves EZ81, ECC 83, ECC83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost." Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch, ganged volume, ganged treble, ganged bass, and balance. Outputs for 3 ohm speakers. Point-to-Point wiring diagrams and instructions. Illustration full wiring details and priced parts list, 1/9. **8** GNS. Carr. 7/9.

POCKET PORTABLE TRANSISTOR

RADIO DESIGN. Employing 2 Brimar R.F. Transistors, 1 output Transistor, and crystal diode, Ferrite Rod Aerial, Miniature Speaker unit. Handsome Plastic Case. Constructional Envelope 1/6. Total building cost 49/9.

SELENIUM RECTIFIERS

L.T. Types		H.T. Types H.W.	
2/6 v. ½ a.h.w.	1/9	120 v. 40 mA	3/9
6/12 v. 1 a.h.w.	2/9	250 v. 50 mA	3/11
Following F.W. (Bridge)		250 v. 60 mA	4/11
6/12 v. 1 a.	3/11	250 v. 80 mA	6/11
6/12 v. 2 a.	6/11	250 v. 250 mA	12/9
6/12 v. 3 a.	9/9	Contact Cooled	
6/12 v. 4 a.	12/3	250 v. 80 mA	6/11
6/12 v. 5 a.	14/6	250 v. 50 mA F.W. (Bridge)	8/11
6/12 v. 6 a.	15/6		
6/12 v. 10 a.	25/9	250 v. 75 mA F.W. (Bridge)	10/11
6/12 v. 15 a.	35/9		

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. bass and treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6×5×5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5.19.6** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

RECORDING HEADS. Baird Record Playback and Erase (housed in one container), 9/6 pair.

Battery Chargers and Kits for 200-230-250 v. 50 c/s. A/C. Mains

VARLEY 2 v. 14 A.H. ACCUMULATORS. New ex-Govt. 5 × 3 × 1½in., 5/9 each, 3 for 15/-.

JASON F.M. TUNER. Type FMT1. All parts including Dial, Punched Chassis, and Valves. Power supply required 180 v. 25 mA and 6.3 v. 1.5 a. £6/19/6

EX GOVT. SMOOTHING CHOKES

60 mA 10 h. 400 ohms	3/11
80 mA 20 h. 900 ohms	5/11
100 mA 5 h. 100 ohms	3/11
100 mA 10 h. 100 ohms	6/9
150 mA 10 h. 100 ohms	10/11
120 mA 12 h. 100 ohms	9/9
200 mA 5-10 h. 100 ohms	11/9
250 mA 5 h. 50 ohms	10/9

HEAVY DUTY CHARGER KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0-7 amp. meter, Variable charge selector, fuses, fuse-holders, panels, plugs, and circuit. Only 59/6. Post 4/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.

0-9-15 v. 1½a.	12/9
0-9-15 v. 2½ a.	15/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

6 v. or 12 v. 1 amp.	24/9
As above, with ammeter	32/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps. (inclusive of ammeter)	42/9
6/12 v. 4 amps.	49/9
6 v. or 12 v. 4 amps., with variable charge rate selector and ammeter	59/9

CHARGER AMMETERS

0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp. 8/9

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only **49/9** Carr. 3/9.

As above, but for 3 amp. charging. Only 59/6. Carr. 3/9

ASSEMBLED 6 v. or 12 v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. **69/9** Carr. 5/-. Or Deposit 13/3 and 5 monthly payments of 13/3.

As above, but for 6 amp charging 4 GNS. Carr. 5/-. Or Deposit 16/- and 5 monthly payments of 16/-. The 6 amp. model only is slightly store soiled and is being offered at well below usual price.

MICRO-AMMETERS

0-50 micro-amp. Diameter 2½in. approx. Scaled 0-100. Flush mounting, 29/6.

EX GOVT. MAINS TRANSFORMERS

Primary 0-110-200-230-250 v. 275-0-275 v. 100 mA, 6.3 v. 7 a. 5 v. 3 a.	22/9
Input 200-250 v. 50 c.p.s. 250 v. 60 mA 6.3 v. 2 a.	10/11
Primary 200-250 v. Sec. 12 v. 20 a.	49/9
Primary 230 v. 400-0-400 v. 200 mA	29/9
Primary 200-240 v. Sec., 3,500 v. 5 mA 2 v. 2 a.	39/9
50 watts, 0-110/120-230/250 v.	8/11

D.C. SUPPLY KITS. Suitable for electric trains. Consist of mains trans. 200-250 v. 50 c.p.s. 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 33/9.

EX GOVT. CASES

Well ventilated, black crackle finished, undrilled cover. Size 14×10×8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

HEAVY DUTY EX GOVT. SELENIUM RECTIFIERS

With large square aluminium cooling fins. 12 v. 15 amp. F.W. (Bridge). Limited number. 19/6.

PRACTICAL WIRELESS SUPER SIX POCKET PORTABLE

6 Transistor Superhet Radio. Full constructional details etc. 1/6. All required parts including attractive plastic case and dial, printed circuit and first grade transistors. Only **£9/19/6**

LINEAR PRE-AMP/TREMOLO UNIT

Suitable for use with any Guitar Amplifier. Controls Volume, Frequency, Amplitude, and switches. Valves: EF86 and EF80. Inputs for Guitar Pick-up or Mike, and Radio or Gram. Power required only 250/300 v. 20 mA 6.3 v. 1 a. **£4/19/9**

RELAYS. Carpenter Type Polarised, 2 × 9,500 turns at 1,685 ohms 13/9. Miniature type G.E.C. 670 M1092, sealed wire ends 4 o/overs platinum, 12/9.

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC33, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams. ONLY **11 gns.** Carr. 10/-. Or Factory built using latest EL34 output valves and with 12 months' guarantee. 14 GNS. TERMS ON ASSEMBLED UNITS. DEPOSIT 33/3 and 9 monthly payments of 33/3. Cover as illustrated Type 807 output valves are used with High Quality Sectionally 18/9 extra. Wire wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response ± 3 D.B. 30-20,000 c/s. Tone Controls ± 12 D.B. at 50 c/cs. ± 12 D.B. to − 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Oversall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS, IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

FULL RANGE OF LINEAR HIGH FIDELITY AMPLIFIERS ALWAYS IN STOCK

GL3A MINIATURE 3 WATT GRAM AMPLIFIERS

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11½×2¼×2½in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 59/6.

R.S.C. AS 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

P.M. SPEAKERS. 2-3 ohms 2½in. Perdio 21/9. 5in. Goodmans 17/9. 7×4in. R.A. Elliptical 19/9. 6½in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 25/9. 8×6in. Elac. with high flux magnet 25/9. 10in. R.A. 28/9. 10×6in. Elliptical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms, 10 watts, 12,000 lines, 59/6.

TWEETERS, 4in. Plessey, 3 ohms 18/9. R.A. 15 ohms 25/9.

R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved & impregnated.

MAINS TRANSFORMERS. Primaries 200-250-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING.

- 250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a. 2½-3-3in. ... 17/11
- 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. ... 27/11
- 300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. ... 27/11
- 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. ... 27/11
- 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. ... 33/11
- 425-0-425 v. 200 mA., 6.3 v. 4 a., c.t. 5 v. 3 a. ... 49/9
- 450-0-450 v. 250 mA., 6.3 v. 5 a., 5 v. 3 a. ... 59/9

TOP SHROUDED DROP-THROUGH TYPE

- 260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. ... 16/11
- 250-0-250 v. 100 mA., 6.3 v. 3.5 a. ... 19/9
- 250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a. ... 21/9
- 350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v, 2 a. ... 18/11
- 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. ... 25/9
- 300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. ... 25/9
- 300-0-300 v. 130 mA., 6.3 v, 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier ... 29/9
- 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. ... 25/9
- 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. ... 29/9
- 425-0-425 v. 200 mA., 6.3 v. 4 a., 5 v. 3 a. ... 47/9

FILAMENT TRANSFORMERS

- 6.3 v. 1.5 a. ... 5/9
- 6.3 v. 2 a. ... 7/6
- 0-4-6.3 v. 2 a. ... 7/9
- 12 v. 1 a. ... 7/9
- 6.3 v, 3 a. ... 8/11
- 6.3 v. 6 a. ... 17/9
- 12 v. 3 a. or 24 v. 1.5 a. 17/9

AUTO (Step Up/Step Down) TRANSFORMERS

- 50-80 watts 110-120 v./230-250 v. ... 11/9
- 150 watts 110-120 v./200-250 v. ... 27/9

OUTPUT TRANSFORMERS

- Midget Battery Pentode 66 : 1 for 3S4, etc... 3/9
- Small Pentode 5,000 Ω to 3Ω ... 3/9
- Standard Pentode 5,000 Ω to 3Ω ... 5/9
- Standard Pentode 8,000 Ω to 3Ω ... 5/9
- Push-pull 8 watts 6V6 to 3 ohms ... 8/9
- Push-pull 8 watts EL84s to 15 ohms ... 8/9
- Push-pull 10-12 watts 6V6 to 3Ω or 15Ω ... 16/9
- Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15 Ω 17/9
- Push-pull EL84 to 3 or 15 ohms 10-12 watts ... 17/9
- Push-pull Ultra Linear for Mullard 510 ... 27/9
- Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., for 3 or 15 ohms ... 23/9
- Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., or 4 or 15 Ω fully shrouded ... 47/9

MICROPHONE TRANSFORMERS

- 120 : 1 High quality, clamped ... 6/9
- 120 : 1 High quality Mu metal screened ... 8/9

SMOOTHING CHOKES

- 250 mA., 5 H., 100 Ω 11/9
- 150 mA. 7-10 H., 250 Ω 11/9
- 100 mA., 10 H., 200 Ω 8/9
- 80 mA. 10 H., 350 Ω 5/6
- 60 mA., 10 H., 400 Ω 4/11
- 1 amp. 0.5 Ω L.T. type 6/6

PARMEKO MAINS TRANSFORMERS. Fully shrouded.

- 500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a. ... 31/9

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES

Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves: ECC83, ECC83, EL84, EL84, EY3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12.9-7in. For A.C. mains 200-250 v. 60 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 51/- extra.) ONLY **8 Gns.** Carr. 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 25/- and 9 monthly payments of 25/-. Send S.A.E. for illustrated leaflet detailing ready-to-assemble Cabinets, Speakers, Microphones, etc., with cash and credit terms.

R.S.C. PORTABLE GUITAR AMPLIFIERS

JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 8in. l/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (size approx. 14×14×7in.). Finished in attractive and durable polychrome and fitted carrying handle. **£8.19.6** Carr. 7/6. Or Deposit £1 and nine monthly payments £1. Send S.A.E. for leaflet.

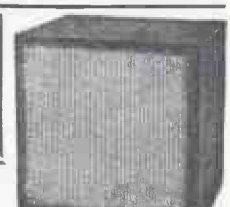
SENIOR 10 WATTS. High-Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated in 12in. P.M. for Bass notes and 1 7×4in. elliptical for Treble. Cabinet is well made and finished as for Junior model. Size approx. 18×18×8in. 15 Gns. Plus 10/- carr. H.P. TERMS DEPOSIT 34/9 and 9 monthly payments 34/9. Both models for 200-250 v. A.C. mains.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. Latest model for 200-250 v. A.C. mains, £6/19/6. Carr. 4/6.

B.S.R. MONARCH AUTO-CHANGERS. Type UA8. 4 speed T/O Pick-up with sapphire stylus £6/19/6. Carr. 4/6.

Any of the above supplied with T/O stereo/monaural head for £1 extra.

COLLARO JUNIOR. 4-speed Single Players with Hi-Fi T/O crystal pick-up head, £3/19/6.



LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4/19/6. Carr. 5/-. TERMS: DEPOSIT 11/- and 9 monthly payments of 11/-.

12in. 20 WATT 15,000 line l/speakers 15 ohms in Cabinet finished as above. Size 18×18×8in. £7/19/6 or Deposit 17/9 and 9 monthly payments of 17/9.

ACOS HGP59 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-Fi 19/9. Garrard GC2 19/9. Acos Stereo/monaural 49/9.

LINEAR TAPE PRE-AMPLIFIER Type LP/1. Switched negative feedback equalisation. Positions for Record 1⅞in., 3¾in., 7½in. and Playback. EM84. Recording level indicator. Designed primarily as the link between Collaro Tape Transcriptor and high fidelity amplifier but suitable almost any Tape Deck. **9 GNS.** Send S.A.E. for leaflet.

R.S.C. Standard Bass Reflex Cabinet for 12in. Loudspeakers, Acoustically lined and ported. Size 20" × 14" × 13". Beautiful walnut veneer finish £5/19/6.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/19/6. Or Deposit 13/9 and 9 monthly payments of 13/9.

R.S.C. (MANCHESTER) LTD.

MANCHESTER, LEEDS, BRADFORD, LIVERPOOL

Personal Shoppers to following branches:—

5-7 County (Mecca) Arcade, Leeds, 1.
54-56 Morley Street (above Alhambra), Bradford.
8-10 Brown Street (Market St.), Manchester, 2.
73 Dale Street, Liverpool, 2.

TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage stated. Trade supplied. Post order to: Mail Order Dept. 29-31 Moorfield Road, Leeds, 12.

CLYNE RADIO LTD.

18 TOTTENHAM COURT RD., LONDON, W.1
MUSeum 5929/0095
ALSO AT: 162 HOLLOWAY ROAD, LONDON, N.7.
NORth 6295/6/7
9, CAMBERWELL CHURCH ST., S.E.5.
RODney 2875
All post orders and correspondence to **162 HOLLOWAY RD., LONDON, N.7.**

Open: Tottenham Court Rd., 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m. Holloway Road and Camberwell, 9 a.m. to 6 p.m. daily, Thurs. 1 p.m., Sat. 5.30 p.m.

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

Our advantageous H.P. and Credit Sale Terms are available on any single item over £5. Your enquiries invited. Please print your name and address!!

NEW BRANCH!!

NOW OPEN

AT

9, CAMBERWELL CHURCH ST., S.E.5.

Telephone: RODney 2875

Situated 25 yards only from Camberwell Green

OPEN ALL DAY SATURDAY

We regret that owing to City roadwidening scheme our branch at Cheapside is now closed for building reconstruction.

THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

400 MILLIWATTS OUTPUT


(43)

To build yourself, Medium and Long waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6¾in. x 4½in. at base tapering to 4in. at top.
Very attractive two-tone grey Vynide covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. ★ Weight—complete with long-life 7½ volt battery—4½lb. ★ Mazda high-grade transistors throughout. ★ High-Flux 7in. x 4in. Elliptical Speaker. ★ Slow motion tuning. ★ Co-axial socket at rear for direct connection to Car Radio Aerial. ★ Improved reception by use of seven-section plated telescopic aerial disappearing into Cabinet when closed, 34in. above Cabinet when fully extended.
Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3). Oscillator Coil, Trimmer, Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. SPECIAL INCLUSIVE PRICE for all required components, full assembly instructions—nothing more to buy—is £10/19/6 plus 3/6 P. & P. Alignment service available. Full assembly instructions and individually priced parts list, all of which are available separately, 2/6, post free.

"OUR REPUTATION IS YOUR GUARANTEE"

TO BUILD YOURSELF

ALL PARTS AVAILABLE SEPARATELY

WE ARE THE EXPERTS IN THIS FIELD AND CARRY THE MOST COMPREHENSIVE STOCKS IN THE COUNTRY.

	All required components at special inclusive price	P. & P.	Instruction Book and itemised price list available separately
(1) New Look "RAMBLER" all dry s'het portable. **NEW LOW PRICE**	£6 19 6	2/6	1/6
(2) "RAMBLER" Mains Unit (suits most portables)	£2 7 6	1/6	9d.
(5) "FAMILY FOUR" T.R.F. Mains Receiver	£3 19 6	2/6	1/6
(7) Standard JASON F.M. Tuner FMT1	£6 15 0	2/6	2/–
(8) Fringe area JASON F.M. Tuner FMF	£7 15 0	2/6	2/–
(9) JASON "MERCURY 2" Switched F.M. Tuner plus ITA/B.B.C. Sound	£10 10 0	2/6	3/6
(11) JASON "ARGONAUT" AM/FM Chassis	£15 5 0	2/6	2/–
(12) JASON "ARGONAUT" AM/FM Tuner	£13 19 6	3/6	2/–
(13) F.M. Power Pack (suitable for most tuners)	£1 17 6	1/6	1/–
(14) R.C. 3/4 watt Amplifier (with Bass, Middle and Treble controls)	£4 5 0	2/6	1/–
(15) 2-amp. Battery Charger	£1 16 6	2/6	3d.
(16) R.C. Transistor/Crystal Receiver ('phones extra)	£1 1 0	1/3	3d.
(18) R.E.P. 1-valve Battery Receiver	£2 2 0	2/–	9d.
(19) "CRY-BABY" ALARM (Baby Alarm)	£3 12 6	2/6	1/–
(20) MULLARD 510 Amplifier (printed circuit) Ultra Linear Version	£9 9 0	3/6	1/6
(21) MULLARD 510 as above plus input selector and spare power supplies	£11 10 0	3/6	2/6
(22) "DE-LUXE" Printed Circuit Superhet	£7 19 6	3/6	1/6
(23) "DE-LUXE" with New Look Cabinet	£8 4 6	3/6	1/6
(24) JASON J.T.V. 2 Tuner	£13 19 6	3/6	2/6
(25) RADIO JACK	19 6	1/6	6d.
(26) MULLARD TYPE "C" Tape pre-amp.	£12 9 6	3/6	2/6
(27) JASON W11 Wobbulator	£14 19 0	3/6	3/6
(28) JASON Valve Voltmeter EM10 (23 ranges)	£18 10 0	3/6	2/6
(29) NEW JASON F.M. TUNER FMT2 with built-in power supplies and cabinet	£8 19 6	3/6	2/6
(30) NEW JASON FRINGE F.M. TUNER FMT3, as above	£10 19 6	3/6	2/6
(32) R.C. Super Personal Portable 1-valve (phone extra)	£1 15 0	2/6	2/–
(33) R.C. Super Personal Portable 2-valve (phone extra)	£2 1 0	2/6	2/–
(34) R.C. TRANSETTE 2-Transistor Personal Portable	£3 9 6	2/–	2/–
(35) JASON EVEREST 6-Transistor 2-wave Portable	£13 19 9	3/6	3/6
(36) JASON EVEREST 7-Transistor 2-wave Portable	£15 18 9	3/6	3/6
(37) CLYNE Cathode Ray Oscilloscope	£12 19 6	5/–	10/–
(38) Compact Multi-range Test Meter	£2 19 6	1/6	1/6
(39) CAR RADIO, Pd. Circuit, 5-valve S'het. **NEW LOW PRICE**	£11 19 6	3/6	2/6
(40) JASON Audio Generator AG 10	£14 5 0	3/6	2/–
(41) JASON Oscilloscope OG10	£22 10 0	5/–	3/6
(42) Super SHORT WAVE RADIO, 1 valve	£1 15 0	2/–	2/–
(43) "WAVEMASTER" 7-Transistor Luxury Portable	£10 19 6	3/6	2/6
(44) "GOLD STAR" De-Luxe 1-valve Portable	£1 17 6	2/6	1/6
(45) "PAGEBOY" 2-Transistor Pocket Portable ('phone extra)	£1 12 6	1/6	2/–
(46) "P.W." POCKET SUPERHET 6 Trans. **NEW LOW PRICE**	£8 19 6 complete, post free		
(47) "POPULAR FOUR" T.F.R. mains receiver	£5 5 0	3/6	1/6
(48) "CITIZEN" Pocket transistor portable	£4 15 0	2/6	1/6

Instruction Books which contain full description, easy-to-follow practical wiring diagrams, theoretical diagrams, itemised price lists etc., are free of charge with all parcels but may be purchased separately as shown above.

PLEASE NOTE.—A selection of the above items are described more fully in this advertisement!!

NEW! "PAGEBOY" 2-TRANSISTOR POCKET PORTABLE

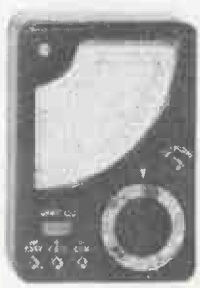

(45)

Completely portable—NO EXTERNAL AERIAL OR EARTH REQUIRED. This is an amazing little receiver with built-in aerial and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. No fiddley tuning!—condenser tuned! Supplied with drilled chassis and colour coded components. Easily assembled with the aid of the easy-to-follow assembly instructions provided. Total cost of all necessary components, including transistors, wiring wire and even solder **ONLY 32/6** plus 1/6 P. & P. Battery 3/- extra. Ardente type deaf-aid earpiece complete with cord and plugs extra at 12/6. Parts price list and Easy Lay-out Plans 2/- post free. Callers welcome to hear this set demonstrated at any of our branches. Our reputation is your guarantee.

OUTSTANDING METER IMPORT!

20,000 OHMS PER VOLT!!

MODEL 200H. Volt-ohm-Milliammeter


Actual size 4½ x 3¼ x 1in.

RANGES:
A.C. VOLTAGE: 10, 50, 100, 500, and 1,000 volts (10,000 ohms per volt).
D.C. VOLTAGE: 5-25, 50, 250, 500, and 2.5k. (20,000 ohms per volt).
D.C. CURRENT: 0-50 micro-amps., 0-2.5 m/a., 0-250 m/a.
RESISTANCE: 0-6k, 0-6 meg. (300 ohm. and 30 k. at centre scale).
CAPACITANCE: 10 pf. to .001 mfd., .001 mfd. to .1 mfd.
DECIBELS: —20 to +22 db.

A fully guaranteed pocket size meter, knife edge pointer, top quality, supplied complete with test prods and full operating instructions at **£6.19.6** ONLY.
Plus 2/6 P. & P.

Optional extra, attractive carrying case 13/6 only. (Bona-fide trade enquiries invited). Leaflet available.

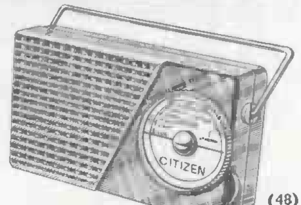
VISIT OUR FULLY EQUIPPED
HI-FI SHOWROOM
AT TOTTENHAM COURT ROAD FOR DEMONSTRATIONS OF THE LATEST
HI-FIDELITY EQUIPMENT
BY ALL LEADING MANUFACTURERS

We stock equipment of Quality by all leading makers: i.e., Leak, Quad, Armstrong, Dulci, Ferrograph, Reflectograph, Vortexion, Tannoy, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco, B.T.H., Pamphonic, Simon, Brenell, Collaro, Telefunken, Fi-Cord, etc., etc. A full range of high quality cabinets to suit all purposes is on show, i.e., "RECORD HOUSING," "W.B." "A.D.," etc. Enquire about our interesting part-exchange scheme for personal callers. H.P. Available.

THE "CITIZEN"

Introducing our new Super-Sensitive 5-Stage (4 transistor plus diode) pocket transistor receiver—for full Medium Wave reception—with the following outstanding features.

- ★ Completely self-contained — No external aerial or earth required.
- ★ Genuine 2½in. High Flux P.M. Speaker.
- ★ Push-pull output—250 milliwatts.
- ★ Genuine Ediswan transistors.
- ★ Socket provided for personal listening.
- ★ Socket provided for connection to Car Aerial.
- ★ Volume Control with on/off switch—Condenser tuning.
- ★ Easy assembly on colour coded pre-tagged circuit board.
- ★ Attractive Red polystyrene cabinet measures 5¾ x 3 x 1⅞in., chrome handle, attractive dial.



(48)

All required components including full instructions, solder, etc. and battery at special inclusive price of **ONLY 95/-** Plus 2/6 p. & p.

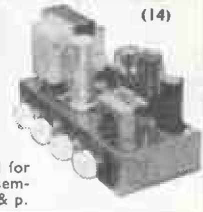
Yes, NINETY FIVE SHILLINGS ONLY! Nothing more to spend.

Suitable crystal deaf-aid type miniature ear-piece fitted with miniature jack plug at ONLY 7/6 extra, if required.

All parts available separately—itemised list and full assembly instructions sent for 1/6 post free.

Hear this amazing little receiver working, at any of our branches.

THE R.C. 3/4 WATT AMPLIFIER

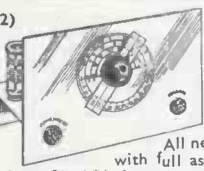

(14)

Compare the advantages. Treble bass AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 6SG7 metal, 6X5GT. Negative feed-back. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1¾in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at £4/5/- only, plus 2/6 p. & p. or Instruction Book fully illustrated for 1/- post free. This amplifier can be supplied assembled, tested and ready for use at £5/5/-, plus p. & p.

"PRACTICAL WIRELESS" POCKET SUPERHET (46)

All required Components for the complete Osmor version as described in November issue of "Practical Wireless," now available at NEW LOW special inclusive price of £8/19/6 complete, including Printed Circuit and Osmor booklet. Overall size 5¼in. x 3in. x 1½in., 6 transistors, 2½in. P.M. Speaker. All items available separately, send stamp for list.

SUPER 1-VALVE SHORT-WAVE RADIO

(42)


World-wide coverage at most reasonable cost. Covers 40–100 metres with the coil supplied. Can be extended to cover 10–100 metres. Provision is also made for the addition of two extra valve stages. Employs the famous Acorn-type 954 valve. All necessary components can be supplied complete with full assembly instructions at **ONLY** 35/- plus 2/- p. & p. Send 2/- for point-to-point wiring diagram and price list.

RADIO JACK (25)

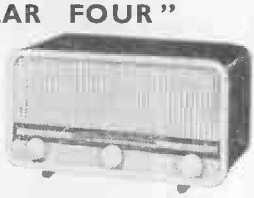
Covers local medium wave stations variably tuned. Compact self contained unit requiring only connection to aerial (no power supplies reqd.) for 1st class reception when used in conjunction with your tape recorder or high gain amplifier. All necessary parts available at a special inclusive price of only **19/6.** p. & p. 1/6.

The CRY BABY ALARM (19)

This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely **SAFE** employing a double wound mains transformer. Attractively finished in Red and Grey (washable) "Lionide" with cream plastic escutcheon. Size only 7½in. x 3⅜in. x 6¾in. Supplied in kit form complete with mike at ONLY **72/6** plus 2/6 p. & p. or assembled and tested **89/6** p.&p. 2/6. Suitable mike flex available at 3d. a yard. Instruction book and price list separately 1/- post free. A.C. 200–250 v.

NEW! "POPULAR FOUR"

IMPROVED APPEARANCE AND PERFORMANCE!


(47)

A new three valve plus miniature contact-cooled rectifier, mains T.R.F. Receiver is now available. New De Luxe Cabinet, polished walnut finish, cream trim, attractive horizontal dial (as illustrated). Quality 5in. P.M. speaker. Specially wound high gain super-sensitive Denco coils. Medium and Long Wavebands. Excellent Continental reception! Overall dimensions: 12in. x 6in. x 5in. A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components, down to the last nut and bolt, are offered at a **SPECIAL INCLUSIVE PRICE OF** £5/5/0, plus 3/6 p. & p. Instruction book available separately 1/6, post free. ALL PARTS AVAILABLE SEPARATELY.

THE P.W. "ROADFARER"

As described in current "Practical Wireless"

Now available the "OSMOR" version at special inclusive price of **£16.19.6**

Plus 2/6 p. & p.

A completely self-contained transistor portable with many novel features. For battery or mains operation, Medium, Long and V.H.F. bands. Full details and individually priced parts list on request.

THE NEW LOOK RAMBLER PORTABLE


(1)

This wonderful little Medium and Long wave battery superhet incorporates 1R5, 1T4, 1S5, 3V4 miniature valves. 5in. speaker and frame aerial. Housed in smart two-tone Red/Grey cabinet. All required components as the NEW LOW PRICE of **£6/19/6**, plus 2/6 p. & p. or with the latest low consumption "96 range" valves at the NEW LOW PRICE of **£7/7/-**, plus p. & p. Uses all-dry batteries AD35 (1/6). B126 (9/-). Full descriptive instruction book, itemised price list, diagrams, etc., available separately at 1/6 post free.

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CLYNE RADIO ELECTRONIC ORGAN

Fibre Glass Console ***now available***

Readers will no doubt be pleased to know that our working model of this amazing organ for home construction, may be heard and seen at our Hi-Fi Showroom in Tottenham Court Road, W.1. For the benefit of constructors all components, keyboards, chokes, etc., are available ready made. Full constructional details are available in book form at 15/- plus 1/6 p. & p. We shall be happy to forward a complete price list on receipt of a stamp. Please address all organ enquiries for the attention of Mr. L. Roche.

PRINTED CIRCUIT CAR RADIO


(39)

(for Home Construction). We are proud to be able to offer this New type Car Radio employing up-to-the-minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. NO VIBRATOR PACK IS REQUIRED. This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special New Low inclusive Price of Only **£11/19/6** plus 3/6 p. & p. Instruction booklet with itemised price list, full description dimensions, etc. available separately at 3/6 post free.

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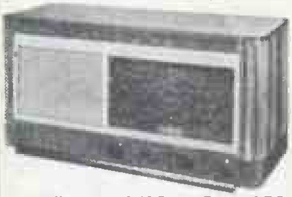
FRUSTRATED EXPORT. Nit repeatable! L., M. and S.W. SUPERHET RECEIVER. Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.



Valve line-up: 6K8G, 6K7G, 6Q7C, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output, P.U. socket Ext. L.S. socket, etc. Tone control. Fitted in polished wood cabinet, size 21¾in. x 10¼in. x 10½in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price **£5/19/6** only plus P. & P. 7/6. plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

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SOLDER. New boxed 1 lb. reels, 16 S.W.G. 50/50 at 8/6 only, plus 1/- P. & P.

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RED SPOT (Audio/Experimental Application) .... 3/6 ea.

WHITE SPOT

R.F. up to 2.5 Mc/s............ 5/- ea.

OC169 VHF P.N.P. JUNCTION TRANSISTOR. Drift-type, Alpha cut-off frequency 80 Mc/s. 18/- ea. Attractive discounts for bulk purchases. The above is a selection only. Full range in stock by all leading manufacturers. Let us have your enquiries. (ALL POST FREE.)

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AERIAL TUNING UNIT ZA0841 This well made ex-W.D. unit contains a host of useful components including: 1 mA. 2in. flush round M/C meter, 1 mA. Westinghouse full-wave meter rectifier. 5-pole 5-way heavy-duty silver plated wavechange switch. 3in. dia. silver plated rotary tuning indicator, 350 pF tuning condenser with insulated coupler and 3½in. calibrated dial (0-180 deg.) etc., etc. Contained in strong metal carrying case 9in. x 9in. x 8in. with hinged lid. **ONLY 27/6,** plus 5/- C. & P.

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12in. RICHARD ALLAN P.M. LOUDSPEAKER. 3 ohm speech coil. Brand new. **ONLY 32/6** plus 2/6 P. & P.

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Full range at usual competitive prices. Interesting H.P. facilities

E.M.I. MODEL 985 4-SPEED SINGLE RECORD UNIT. Very latest type. Heavy 8¾in. dia. turntable, low flutter performance. 200/250 v. with tap at 80 v. for operating amplifier valve filament if required. Complete with matching pick-up with mount and rest. Brand new and fully guaranteed. **ONLY 89/6,** plus 3/6 P. & P. Pick-up available separately, complete with mount and rest **25/-**, plus 1/6 P. & P.

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6 volt operation complete with pick-up **£5/9/6,** plus P. & P. 3/6.

TRANSISTOR AMPLIFIER now available for use with the above battery player. Compact size, 500 milliwatts output, printed circuit construction, tone and volume controls. Supplied complete with 8in. x 2in. 20 ohms matching quality speaker. Price only **89/6** plus 2/6 P. & P.

LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10in. and 12in. records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price **10½** gns., plus 3/6 P. & P.

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Quickly checks Radio, T/V Sound and all forms of Audio Circuits. Functions as a wide-band modulated Signal Generator emitting a signal rich in A.F., I.F., and R.F. Components. Range 2 kc/s to 25 mc/s. Takes the trouble out of trouble-shooting. Actual size 6¼in. long x ½in. diameter. Slips into pocket. Attractive finish, complete with full instructions and long-life Mercury battery. British made. **99/6** only, plus 1/- P. & P. Illustrated leaflet available.

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ANOTHER PORTABLE CABINET! Ex leading manufacturer's battery portable attache type case. Attractive two-tone grey rexine finish. Size closed 13¼in. x 9¼in. x 3¾in. Complete with fittings and handle. Including Medium and Long Wave frame aerial which fits in lid. Limited quantity only at bargain price of **19/6** plus 2/- P. & P. Brand new.

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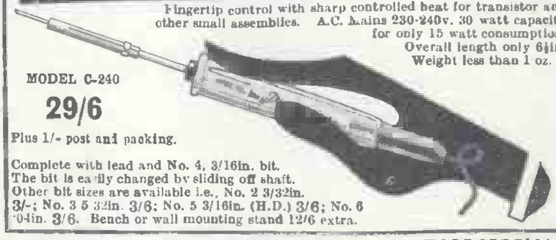
Precision

MINIATURE SOLDERING IRON

Fingertip control with sharp controlled heat for transistor and other small assemblies. A.C. Mains 230-240v. 30 watt capacity for only 15 watt consumption. Overall length only 6¼in. Weight less than 1 oz.



MODEL C-240

29/6

Plus 1/- post and packing.

Complete with lead and No. 4, 3/16in. bit. The bit is easily changed by sliding off shaft. Other bit sizes are available i.e., No. 2 3/32in. 3/-; No. 3 5/32in. 3/6; No. 5 3/16in. (H.D.) 3/6; No. 6 ·04in. 3/6. Bench or wall mounting stand 12/6 extra.

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Famous American Ferrodynamics **"BRAND FIVE"**

An enthusiast's "must." Brand new (NOT SUB-STANDARD) High grade Acetate Base. 5in. 600ft. **16/-**, 5in. 900ft. **18/6**, 5¾in. 1,200ft. **23/6** 7in. 1,200ft. **25/-**, 7in. 1,800ft. **35/-**. Extra quality Mylar Dupont. 3in. 300ft. **13/-**. 5in. 1,200ft. **37/6**. 7in. 1,800ft. **44/-**. 7in. 2,400ft. **60/-**. Each on plastic spool. All Post free. *Trade enquiries invited.*

PLASTIC TAPE SPOOLS. Best quality. 3in. **1/6**, 5in. **2/-**, 5¾in. **2/3**, 7in. **2/6**. **PLASTIC SPOOL CONTAINERS** for spool sizes 5in. **1/6**, 5¾in. **2/-**, 7in. **2/3**. Any single item plus 6d. P. & P. Orders over £1, post free.

LANGUAGE COURSES ON TAPE!

Complete Elementary Course in French, Italian, German or Spanish. Phrase book supplied. 5in. long play tape, 55 minutes at 3¾ i.p.s. Price ONLY 29/6 per course, Post Free!

★ TAPE RECORDER CONSTRUCTORS ★

TELEPHONE PICK-UP COIL. Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for a fully modulated tape recording. Brand new complete with 5ft. shielded cable. ONLY **14/-**. P. & P. 1/6.

COLLARO TAPE PRE-AMPLIFIER AND BIAS OSCILLATOR. Complete with power pack for use with Collaro Mk. IV deck. 4 valve plus EM81 magic eye. 110-240 v. A.C. Input sensitivity: microphone socket 5 m/v., auxiliary socket 500 m/v. Speed equalisation switch gives compensation at all 3 speeds. Full wiring Instructions included. List price £21. Limited quantity only at **£15/19/6.** P. & P. 5/-.

LATEST COLLARO STUDIO TAPE TRANSCRIPTOR. 3 motors, 3 speeds, 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls, **£12/19/6** plus 5/- P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5¾in. spools—3¾ i.p.s. At only **£8/5/-** plus 5/- P. & P.

TAPE RECORDER AMPLIFIER. Suitable for use with either of the above Tape Decks, and most other types. For A.C. mains, 4 watts output. 40–12,000 CPS at 7½ i.p.s. ± 3 db. Facilities for superimpose. Valves: 6BW6, ECL82, 12AX7, EM84, and contact cooled metal rectifier. Radiogram input, microphone input, monitor facilities (can be used as straight through amplifier), volume control and separate treble and bass controls. Chassis measurement 11½ x 3 x 4⅞in. Supplied complete with attractive grey/blue escutcheon plate finished in black and gold. Circuit diagram and connecting instructions included. Price **£11/5/-** only, plus 3/6 P. & P. If purchased with either of the above decks, both items post free!

ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro, Studio deck. Limited quantity only at **79/6** plus 3/6 P. & P.

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SUB-MINIATURE TWO-WAY JACK PLUGS & SOCKETS

Smallest yet available.

3/6 per pair. P. & P. 6d.

SUB-MINIATURE SLIDER SWITCH

Two-pole two-way ONLY **2/6** EACH. P. & P. 6d.

★ Wholesale and manufacturer quantity enquiries invited on both of the above new items. ★

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3-TRANSISTORS 2-DIODES

PERSONAL POCKET RADIO WITH FULL TUNING OF AMATEUR "TOP BAND" AND MEDIUM WAVE (120 to 500 Metres)

- First grade transistors.
- No external aerial or earth.
- Calibrated dial.
- Volume control.
- ★ Personal earphone for quality output.

Size 4⅜ × 3 × 1¼in.

NO EXTRAS TO BUY, EVERYTHING SUPPLIED. All components

AFTER SALES SERVICE 79/6 P. & P. 1/6.

● **New Illustrated Booklet FREE on request.**

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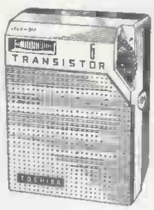
Size 3 × 2¼ × ⅞in.

● **THE WORLD'S SMALLEST RADIO with Speaker**



FITS INTO VEST POCKET OR PURSE

Complete with Batteries, Leather Case, Earphone, in Presentation Box.

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- Superhet Circuit with Push-Pull output on 2in. speaker.
- 540 to 1,600 kc/s coverage.

CASH OR C.O.D.

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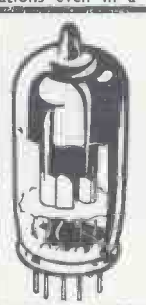
Excellent results from local and Continental stations even in a car!



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NEW **FREE** LIST ON REQUEST.

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LEAFLETS ON REQUEST

- Office or Home 2-way intercom. system. 4 Mullard transistors. 2 5-inch speakers, unique call system. Battery operated. 2 portable rexine cabinets. Built and tested to order £6/19/6. P.P. 2/6.
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ALL UNITS ARE PRE-TESTED AND FULLY GUARANTEED. OTHER UNITS AVAILABLE.

THE "CONTESSA"

● **PORTABLE and CAR RADIO** ●

PROFESSIONALLY DESIGNED: PROFESSIONAL PERFORMANCE: SIMPLE TO BUILD

● **6-TRANSISTOR MEDIUM AND LONG WAVE SUPERHET** ●

SPECIFICATION:

- ★ Peak output 425 mW Push-Pull
- ★ 6 "Top Grade" Ediswan Transistors
- ★ New type Printed Circuit with all component positions clearly marked
- ★ Equally sensitive on Medium and Long Wave Bands
- ★ High "Q" internal Ferrite aerial with car coupling coil
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- ★ Clearly calibrated dial with station names

Full constructional details, double tuned IFT's, AVC, Packaged components. Attractive two-colour cabinet, plus many other features.

● Inclusive price of all parts complete in every detail.

£11.10.0

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- No technical knowledge required
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Excellent results Guaranteed.

● All parts available separately—No extra cost ●

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"PW" 6 TRANSISTOR MEDIUM & LONG WAVE POCKET SUPERHET

- 6 MATCHED MULLARD TRANSISTORS AND DIODE.
- 150mW Push-Pull Output.
- Easy to Follow Printed Circuit with all Components Marked.
- Full Medium and Long Wave Tuning.
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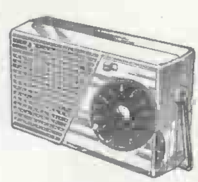

OUTSTANDING APPEARANCE AND PERFORMANCE

- ★ All Parts Sold Separately
- ★ No Technical Knowledge Required.

TOTAL COST OF all NECESSARY ITEMS £8.19.6

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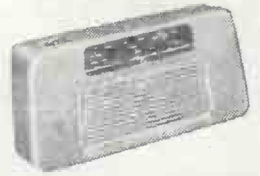
★ 'PW' ROADFARER ★

(as described in April edition of *Practical Wireless*)



A.M. and F.M. 7-transistor mains/battery portable in attractive moulded case. Slow motion tuning; telescopic aerial: 7 x 4in. speaker; Ferrite aerial, etc.

- Full tuning medium wave and F.M. VHF for clear reception of all programmes anywhere in the country.
- 500 mW push-pull output with Mains or Battery supply built in.

All Parts as Specified **£17** P.P. 3/6. All components sold separately. List on request.

- **PRINTED CIRCUIT—SEVEN TRANSISTORS**
- **FULLY ILLUSTRATED BUILDING INSTRUCTIONS.**

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● **MANUFACTURERS SURPLUS** ●

BRAND NEW

OC16	20 watts	25/-
OC28	30 watts	35/-
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V15/10P	10 watts	15/-
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V30/30P	10 watts	45/-
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All brand new and first grade.

WE STOCK THE LARGEST RANGE OF TRANSISTORS IN THE COUNTRY.

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FOR TRANSMITTING, RADIO CONTROL, OSCILLATORS, ETC.

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ALL TYPES FOR ALL PURPOSES

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SAVE POUNDS

- MINI-4, MEDIUM AND LONG 6-STAGE POCKET SUPERHET. Mullard transistors. All parts £6/19/6. Details on request.
- Super-sensitive single or 3 channel 3-transistor 27 mc/s. model control. New design receivers. 69/6. P.P. 1/6 (either type). Suitable relay 24/- or Reed 35/-.

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- Super-3 Three Transistor and Diode Earphone Radio. All components. No extras to buy. 37/6. P. & P. 1/6.

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- Ranger 2. 2-Transistor version of Ranger-3 (see above). Very sensitive. No extras to buy. 59/6. P. & P. 1/6.

★ **BOOKLET FREE ON REQUEST** ★

- Pre-built All-Transistor FM Tuner Unit: Front end (fully tunable 2-OC171's) £5/6/3. 3-Transistor (3-OC170s) I.F. strip, 10.7 Mc/s, pre-aligned. £6/6/-.

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MANY OTHER DO-IT-YOURSELF RADIOS AND UNITS AVAILABLE. DETAILS ON REQUEST.

HENRY'S RADIO LTD.

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Opposite Edgware Road Tube Station. *PADdington 1008/9.* OPEN MONDAY to SAT. 9-6. THURS. 1 o'clock

COMPLETE ILLUSTRATED LEAFLETS OF ALL HOME CONSTRUCTION UNITS *FREE ON REQUEST.*

C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having Heater/cathode short circuit and for C.R. Tubes with falling emission. Full installation instructions supplied.
Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries:

2 volt	12/6 each
4 volt	12/6 each
6.3 volt	12/6 each
10.8 volt	12/6 each
13.3 volt	12/6 each

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity. 10/15 pf.
Optional boost 25%, 50%. 75% .... 16/6 each
Type B. Mains input. Low capacity. Multi-Output 2, 4, 6.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes 21/-.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 4d.; 1 w. 6d.; 1½ w., 8d.; 2 w. 1/-.
HIGH STABILITY. ½ w., 1% 2/-. Preferred values 10 ohms to 10 meg. Ditto 5% 9d., 100Ω to 5 meg.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms.
5 watt 3/-
10 watt 1/6
15 watt 2/-
12,500 ohms.—50,000 ohms. 10 w. 3/-

WIRE-WOUND POTS. 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 10 ohms to 25K. 3/- ea.; 30 K., 50 K., 4/-. Ditto ½ w. Carbon Track, 30 K. to 2 Meg., 3/-.

WIRE-WOUND POTS. 4 w., Standard size Pots. long Spindle High Grade. All values 50 ohms to 50 K. 6/6; 100 K., 7/6.
W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS. Heavy duty 50 mA. 4/6. Multi-ratio push-pull 7/6. Miniature 3V4, etc. 4/6. Hygrade Push-Pull 10 watts, 15/6. Push-pull 20 w. 6 k. or 8 k. 30/-.
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MAINS TRANSFORMERS 200/250 v. A.C.
STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped 5 v. or 4 v. 2 a. Ditto 350-0-350 .... 22/6
MINIATURE 220 v. 20 mA., 6.3 v. 1 a. 10/6
MIDGET, 220 v. 45 mA., 6.3 v. 2 a. 15/6
SMALL, 200-0-200 50 mA., 6.3 v. 2 a. 17/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a. 17/6
HEATER TRANS., 6.3 v. 1½ a., 7/6: 3 amps. 10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A. 22/6
AUTO. TRANS. 150w., 0, 10, 120, 200, 230, 250 v. 22/6

ALADDIN FORMERS and cores, ¼in. 8d.; ⅜in. 10d. 0.3in. **FORMERS** 5937 or 8 and Cans TV1 or TV2 2¼in. sq. × 2¼in. or ⅞in. sq. × 1⅛in., 2/- with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
SOLON. Midget Soldering Iron, 220/40 v. 25 w., 24/-.
MAINS DROPPERS. 3 × 1½in. Adj. Sliders .3 amp. 1,000 ohms 4/3. .2 amps. 4/3. .1 amp. 2,000 ohms 5/-.
LINE CORD. .3 amp. 60 ohms per foot, .2 amp. 100 ohms per foot, 2-way, 6d. per foot, 3-way 7d. per foot.

CRYSTAL MIKE INSERT by Acos 6/6
Precision engineered. Size only ⅞ × ⅞ × $\frac{3}{16}$in.
ACOS CRYSTAL MIKE 40 G .... Bargain 25/-

MIKE TRANSF. 50 : 1, 3/9 ea., 100 : 1 Potted 10/6.
LOUDSPEAKERS PM. 3 OHM. 5in. Rola, 17/6. 8in. × 5in. Goodmans 21/-. 7in. × 4in. Plessey 18/6. 10in. × 6in. Rola 27/6. 8in. Plessey, 19/6. 6½in. Rola 18/6. 8in. Rola, 21/-. 10in. R.A. 30/-.
HI-FI TWEETERS, 4in. 25/-. 12in. Plessey, 30/-.
12in. Baker 15 wt. Stalwart 3 or 15 ohm, 90/-.
12in. Baker ditto., foam suspension 15 ohm, £6.
12in. Baker Ultra Twelve £17/10, 20 c.p.s. to 25 k.c.s.

I.F. TRANSFORMERS 7/6 pair
465 kc/s, slug tuning miniature can 1¾ × ¾ × ⅝in. High Q and good bandwidth. By Pye Radio. Data sheet supplied
Weymouth I.F. Standard size 465 kc/s., 10/6 pair.

CRYSTAL DIODE G.E.C., 2/-, GEX34, 4/-. 40 Circuits 3/-.
H.R. HEADPHONES. 4,000 ohms, brand new, 15/- pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf. Miniature, 1⅞in. × 1⅜in. × 1⅞in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers 8/-. Midget 7/6; Single 50 pf. 2/6; 100 pf., 150 pf., 5/6. Solid dielectric 100, 300, 500 pf., 3/6.
VALVE HOLDERS. Pax. int. Oct. 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin, 1/-.
MOULDED Mazda or Int. Oct. 6d. B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6; B12A, 1/3; B9A with can, 1/9.
CERAMIC, EF50, B7G, B9A, Oct. 1/-. B7G, B9A cans. 1/-.
WAVECHANGE SWITCHES
2 p. 2-way, or 3 p. 2-way; short spindle 2/6
5 p. 4-way, 2 wafer, or 3 p. 11-w. 3 wafer, long spindle 6/6
2 p. 6-way, or 4 p. 2-way, or 4 p. 3-way, long spindle 3/6
3 p. 4-way or 1 p. 12-way, long spindle 3/6
Wave change "MAKITS" 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer 16/-; 4 wafer, 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES. S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-.
MORSE KEYS, good quality, 2/6.
FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a. 11/3; 4 a., 17/6; 6 a., 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. **AMMETERS,** 4 a., and 5 a., 13/6.

THE HI-GAIN BAND 3 PRE-AMP
Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d.
Also Band I version same prices.
(PCC84 Valve if preferred)

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AF/208 AM/FM RADIOGRAM CHASSIS
PRICE 22 GNS. CARRIAGE FREE
- Full VHF Band (87-108 Mc/s). Medium Band, 187-570 m.
- 5 watts Output.
- 15dB Negative Feedback. 7 Valves.
- Separate wide range Bass and Treble Controls
- 2 Compensated Pick-up Inputs.
- Frequency Response 30-22,000 c.p.s. ±2dB.
- Tape Record and Playback Facilities.
- Continental Reception of Good Programme Value.

For 3, 7½ and 15 ohm Speakers

MONARCH RECORD PLAYER

SAVE POUNDS

BUILD IT YOURSELF using
4-SPEED BSR
MONARCH AUTOCHANGER U.A.8
READY BUILT 3W. AMPLIFIER
HANDSOME PORTABLE CASE
HIGH FLUX 6in. LOUDSPEAKER
FULL INSTRUCTIONS supplied
Total Price Carr. and ins. 5/-. **£12 . 10 . 0**

RECORD PLAYER BARGAINS

4 Speed Autochangers, BSR, U.A.8	£6 15 0
Collaro Autochanger	£7 19 6
Garrard RC121 Mk. IID	£8 15 0
Garrard 209 or 210	£10 10 0
4 speed Single Players:	
EMI Stereo or Monaural	£6 19 6
Garrard TA Mk. II	£8 8 0
Garrard 4 HF Transcription	£17 19 6

Garrard Stereo Heads £2 extra.

AUTOCHANGER ACCESSORIES
Suitable player cabinets (uncut boards) 49/6
Amplifier player cabinets with cut boards 63/-
2-valve amplifier and 6½in. speaker for above .. 79/6
Ready mounted on baffle 12in. × 7in., 3in. deep.
MINIATURE 2-STAGE Hi-Fi AMPLIFIER. A.C. only, 200-250 v. Valves ECL82 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved Perspex front panel with de luxe finish. Heavy duty output transformer, 3 ohm and shrouded mains transformer. Stove enamelled chassis size 6 × 5 × 3in. Bargain price £4/10/-. Circuit supplied.

CYLDON TURRET TELETUNER
I.F. 33/38 megs, complete with frame-grid valves. 30C1 and 30L15. (LT 16v. .3a.) With coils for channels 1 to 13. Includes F.M. Brand new, price 45/-, operating data and circuit supplied. Ideal for "P.T." Olympic.

VOLUME CONTROLS
Midget size:
Long spindle. Guaranteed 1 year. All values.
5 K. ohms up to 2 Meg. No switch 3/- D.P. Sw. 4/6
Linear or Log Tracks.

80 ohm Cable Coaxial
Semi air spaced, ¼in. dia. Ideal Band III Losses cut 50% 6d. yd.
FRINGE QUALITY
AIRSPACED .... 1/- yd.

COAXIAL PLUGS .. 1/- **LEAD SOCKETS** .. 2/-
PANEL SOCKETS .. 1/- **OUTLET BOXES** .. 4/6
BALANCED TWIN FEEDER per yd. 6d., 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohms.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes with 2½in. sides 7 × 4in. 4/6: 9 × 7in. 5/9; 11 × 7in. 6/9; 13 × 9in. 8/6; 14 × 11in. 10/6; 15 × 14in. 12/6 and 18 × 16 × 3in., 16/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, coloured, single or stranded 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
CORED SOLDER RADIOGRADE, 4d. yd., ½lb. 5/-.
PAXOLIN 1/16in. × 8in. × 10in., 1/6. **ION TRAPS** 5/-.

AMERICAN MAGNETIC RECORDING TAPE
FERRODYNAMICS "BRAND FIVE"

5in. 600 feet	16/-	MYLAR DUPONT	
5in. 900 feet	18/6	Super High Fidelity	
5¾in. 1,200 feet	23/6	Double Play	
7in. 1,200 feet	25/-	5in. 1,200 feet	37/6
7in. 1,800 feet	35/-	7in. 2,400 feet	60/-

Illustrated leaflet S.A.E.
Spare Reels 3inch 1/6: 4in, 5in, 5¾in, 2/-; 7in, 2/6
"Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C., 27/6. Leaflet S.A.E.

RECTIFIERS, RM1, 5/-; RM2, 6/-; RM3, 8/-; RM4, 16/-; RM5, 20/-; FC31, 27/6; 14A86, 17/6; 14A100, 21/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave 75 m.a., 9/6. 120 mA., 15/-.
COILS. Wearite "P" type 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L. 12/6.
T.R.F. COILS. A/HF, 7/- pair. **H.F. CHOKES,** 2/6.

JASON F.M. TUNER COIL SET. 29/-. H.F. coil aerial coil. Oscillator coil two I.F. transformers. 10.7 Mc/s. Detector transformer and heater chokes. Circuit and component book, using four 6AM6 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves, £6/5/-, or with New Jason Cabinet FMT2, £2 extra.

CONDENSERS. New Stock. .001 Mfd. 7kV. T.C.C., 5/6; 20 kV., 9/6. .1 mfd. 7 kV. 9/6. 100 pf. to 500 pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5 1/9; 0.1/350 v., 9d.; 0.1/1,000 v., 1/9; 0.1 mdf., 2,000 v., 3/6; 0.001 mfd., 2,000 v., 1/9; 500 pf, 20 kV., 9/6.
CERAMIC CONDS. 500 v. 0.3 pf. to 0.01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3.
CLOSE TOLERANCE (1±pf.) 2 pf. to 47 pf., 1/6. **DITTO** 1% 50 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-.
TRIMMERS. Ceramic 30, 50, 70 pf., 9d.; 100 pf. 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Phillips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	50/350 v.	5/6	16/450 v.	5/-
2/350 v.	2/3	100/25 v.	2/-	32/350 v.	4/-
4/450 v.	2/3	250/25 v.	2/6	100/270 v.	5/6
8/450 v.	2/3	500/12 v.	3/-	5,000/6 v.	5/-
8/500 v.	2/9	8+8/450 v.	3/6	8+16/450 v.	5/-
16/450 v.	3/-	8+16/450 v.	3/9	32+32/350 v.	5/-
16/500 v.	4/-	8+16/500 v.	5/6	32+32/450 v.	6/-
32/450 v.	3/9	16+16/450 v.	4/3	50+50/350 v.	7/-
25/25 v.	1/9	16+16/500 v	6/-	64+120/350v.	11/6
50/50 v.	2/-	32+32/350v.	4/6	100+200/275v.	12/6

SUB-MINIATURE ELECTROLYTICS (15 v.), 1, 2, 4, 5, 8. 25; 50 mfd., 100 mfd., 3/- each.
SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-; 25in. × 35in., 10/-. Tygan 54in. wide, 10/- ft., 27in. wide 5/- ft. Brown, Green or Red. Samples S.A.E.

NEW and boxed **VALVES** 90 day guarantee

1R5	7/6	6L6G	10/6	EA50	1/6	EY51	9/6
1S5	7/6	6N7M	6/6	EABC80	8/6	EY86	10/-
1T4	6/-	6Q7G	7/6	EB91	6/-	HABC80	12/6
2X2	3/6	6SA7M	6/-	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SJ7M	6/6	EBC41	8/6	MU14	9/-
3V4	7/6	6SN7	6/6	EBF80	10/-	P61	3/6
5U4	7/6	6V6G	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6X4	7/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X5	6/6	ECH42	10/6	PCL82	11/6
6AM6	5/-	12A6	7/6	ECL80	10/6	PEN25	6/6
6BE6	7/6	12AT7	8/-	ECL82	10/6	PL82	10/6
6BH6	9/6	12AU7	8/-	EF39	5/6	PY80	7/6
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6D6	6/-	12BA6	8/6	EF50	5/6	PY82	7/6
6FG6	7/6	12BE6	8/6	EF80	8/-	SP61	3/6
6H6GT	3/6	12K7	6/6	EF86	14/6	UBC41	9/6
6J5	5/6	12Q7	6/6	EF92	5/6	UCH42	9/6
6J6	5/6	35L6	9/6	EL32	5/-	UF41	9/6
6J7G	6/6	35Z4	7/6	EL41	9/6	UL41	9/6
6K6GT	6/6	80	9/6	EL84	8/6	UY41	8/-
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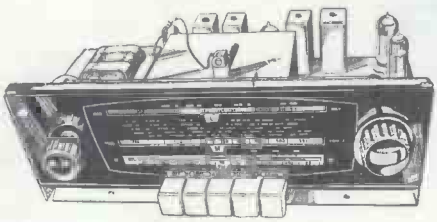
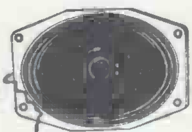
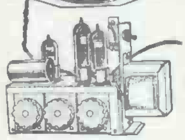
BRAND NEW AM/FM (V.H.F.) CHASSIS AT £14 (Carr. paid)



Tapped input 200-225 v. and 226-250 v. A.C. ONLY.
Chassis size 15 × 6¾ × 5½in. high. New manufacture. Dial 14½ × 4in. in gold and black.
Pick-up Extension speaker, Ae., E., and Dipole sockets. Five "piano" push buttons —OFF, L.W., M.W., F.M. and Gram. Aligned and tested.
With all valves and O.P. Transformer, Tone-control fitted.
Covers 1,000-1,900 M., 200-500 M.; 88-99 Mc/s.
Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker and Cabinet to fit chassis, 47/6 (post 3/6).
10 × 6in. ELLIPTICAL SPEAKER, 20/- to purchasers of this chassis.
TERMS:—(Chassis £5/10/- down and 6 monthly payments of 30/-, or with Cabinet and Speaker £5/17/- down and 7 monthly payments of 32/-.





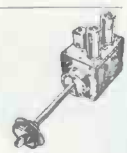
3-VALVE AMPLIFIER (INCL. RECT.)

Capable of giving 4 watts. Mains and output transformer. Valves ECC83, EL84, EZ80, 3 Controls, volume, bass and treble. On/Off switch. Fully guaranteed. Chassis size 6½ × 3 × 2½in.; with 7 × 4in. elliptical speaker of 6½in. round (Goodmans); state which.
ONLY 75/- (3/- P. & P.).

13-CHANNEL TUNER

I.F. 34-38 Mc/s. requires valves PCF80 and PCC84. Removed from chassis but in working order.

7/6 (2/6 P. & P.) Knobs 2/6 extra.



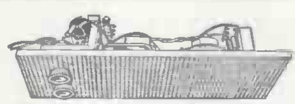
50 SILVERED MICA AND CERAMIC CONDENSERS, 10/-. 50 RESISTORS, 5/-. 144 yds. Imm. P.V.C. flexible sleeving 10/- post paid.

NEW WAXED TUBULARS, 350 v. or above, 3 of each. .001, .002, .005, .01, .02, .05, .1mF, .25, .5mF, Total 21 for 4/6 (post 9d.). Not more than 3 of one type.

AUTOMATIC RECORD CHANGERS

all 4-speed; all with turnover cartridge crystal—all 5/- extra carr.
Collaro Conquest—£7/10/-; B.S.R. UA8—£6/10/-; B.S.R. latest UA14—£7/10/-.

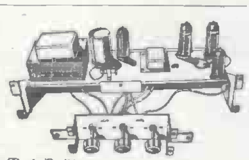
GRAMOPHONE AMPLIFIER



with 5in. SPEAKER. On Fabric-covered Baffle 12½ × 6in. Mains and Output Transformers. EZ40 and EL41 Valves. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed. Two Knobs supplied. Ready to play. Useful for Stereo. ONLY 63/-. Post 3/-.

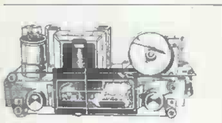
PUSH-PULL AMPLIFIER £4/15/-.

3/- P. & P.



Brand new 200-240 A.C. mains. Bass, treble and vol. controls flying panel. With valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis 12 × 3½ × 3½in. With o.p. trans. for 2-3 ohm speaker.
STEREO VERSION on same Chassis £4/15/- (P. & P. 3/-).

A Quality Tape Recorder. Valves EZ80, ECC83, ECL82, DM70, Record Level Indicator, Acos Crystal Mike. 850ft. Emitape. Extra spool. 3¾in./sec. B.S.R. Monar deck (1) Vol. (2) On/Off Tone. (3) Ext. L.S. (4) Monitor. (5) Radio Input. (6) Mike input. Fast forward and reverse controls. Cabinet size 14 × 11½ × 7in. Today's Best Value at 17 Gns. (10/- P. & P.). Low Interest Terms: £4 down and 5 monthly payments of £3. Write for descriptive leaflet.



SELF-POWERED V.H.F. TUNER CHASSIS

covering 88-95 Mc/s. Mullard permeability Tuner. Dims. 10½in. × 4½in. × 5in. high. ECC85; EF91; EF91 and 2 Diodes. Metal Rectifier. Mains trans. Fully wired and tested. Only £7/10/- (4/- carr.). Room dipole 10/-. 300 ohm twin feeder 6d. yd.

Delivery by return. C.O.D. 2/- extra. Terms: Cash with order or one-third down and balance plus 7/6 (up to £7/10/-) in equal four monthly payments. Balance over £7/10/- add 1/- in £1 and pay in not more than 6 monthly payments. See special terms for A.M.-F.M. chassis. All new goods unless stated. Send 6d. for 20-page catalogue. SATISFACTION GUARANTEED. Posted orders to Camberley.

GLADSTONE RADIO 58A HIGH ST., CAMBERLEY, SURREY. Tel. 22791
56 Stokes Croft, Bristol, 1. (Camberley closed Sat.)
247, New Road, Copnor, Portsmouth, Hants.
(Portsmouth and Bristol closed Wednesday)

BENSON'S BETTER BARGAINS

INDICATORS, Type 101 with VCR530 and 2/EB91, 2/EF91, 2/R10, new cond., 30/- (post 7/-). **Type 1** with VCRX263, 2/EF52, 5/6J6, 1/6V6, 1/EY51, 2/EB91, 3/EF91, RF EHT Generator and 28 kc/s xtal, 45/- (Rail 7/6). **MORSE KEY** with buzzer, on board, wired for 4½ v. battery, 8/6 (p.p. 1/6). **TRANSFORMERS**. Open, upright, input 200/250 v. Outputs: 250-0-250 v., 150 mA., 5 v. 3 A., and 6.3 v. 5 A., 25/-. **CONDENSERS**, block, paper, 8 mfd. 250 Vw. 4/-; 600 Vw. 6/-; 4 mfd. 2 kWV. 7/6; 600 Vw. 3/6. **SWITCH** fuse splitter, OP 15 A. 15/-. **MONITOR 56**, triggered oscilloscope, comprising **Indicator 548** and **Power Unit 675**, 230 v. A.C. input, with cables and circuit. Cathode probe unit extra, 17/6. £8/10/- (Rail 15/-). **HEADPHONES**, CLR, 7/6. **CR100** Noise Limiter assembles with valve, 3/6. **NEW M.C. METERS**, 3½in. round flush, 50μA, 70/-; 200 μA centre zero, 50/-; 1 mA., centre zero, 45/-; 1 mA., 55/-; 2½in. 1 mA., 22/6;. 100 mA., 8/6; 2in. 300 mA., each 8/6; 2½in. M.I. 20 v. A.C., 8/6; 300 v A.C. 2½in., 15/-; 100 v. A.C. 3½in., 45/-; 150 v. A.C., M.I., 6in., in case, 45/-. **VIBRATORS**, Mallory G634C 12 v. 4-pin, 7/6; 6 v. 5-pin reversible, 7/6. **DRIVES**: slow-motion Admiralty 200 : 1 ratio, scaled 0-100 5/6. **R1155 S.M.** "N" type, new, 10/6. **VIBRAPAKS** 6 v. D.C. to 250 v. 60 mA., smoothed cased 22/6; 12 v. input, 25/- (p.p. 3/6). **DYNAMOTORS** (post 3/6). 12 v. to 250 v. 60 mA., 11/6, 6 v. to 250 v. 60 mA., 11/6. **CHOKES**. LF 10 H., 200 mA., 8/6; 100H, 60 mA., 8/6; 9H, 100 mA., 5/6; Potted 10H, 100 mA., 7/6; "C" 10 H., 250 mA., 12/6; 5H, 400 mA., 10/6. **R.F. 27**, fair cond., 16/6 (p.p. 3/6). **RELAYS, "Londex,"** co-axial, small, 12/24 v., 7/6. **SWITCHES**: Wafer, 2 pole, 4 way, 4 bank, 1P6W6B, 4P2W2B, 1P7W3B, 1P11W2B, 4P2W5B, 3/6 each. Ceramic 2P4W1B, 1P5W3B, 1P11W, 3P3W2B, 3/6. STUD, 1P24W2B, 1P8W2B, 3/6; 1P19W2B, 5/6; 1P40W3B in brass case, 12/6. **VALVES**: QQV06/40 (5894), 35/-; QQV04/20 (815), 30/-; VLS389 20/-; VLS631 10/-. **BENDIX** MN26C M/L bands 70/- (carr. 10/-). **Rx78** 2.4-13 mc/s. with 100 kc/s. Xtal 35/- (p.p. 3/6). **Box** with 6 GPO keyswitches and 12 lampholders, 15/- (p.p. 3/-). **MOTORS**, reversing, 24 v. with magnetic brake, 12/6; synch., 3,000 r.p.m. 100 v. 10 vA., 50 ~, 7/6; Octal plugs, 1/6, B7G plugs, 1/-. **AMPLIFIERS**, 195/215 mc/s. 2/CV66, 1/VR136, 1/524, with power unit 230 v. input, 45/- (post 3/6). Osc. unit 207a with Klystron CV67, 524G and 3 neons, 22/6 (post 5/-).

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Callers and post: **W. A. BENSON (W.W.), 136 Rathbone Road, Liverpool, 15.** *SEF* 6853.

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EXPORT ONLY
PROMPT deliveries Mobile V.H.F. Radio Telephones. Frequency ranges on five bands (1) 36-44 Mc/s, (2) 65-78 Mc/s, (3) 78-100 Mc/s, (4) 118-132 Mc/s. (5) 156-174 Mc/s. R.F. output 10 watts. A.M. Single Channel, crystal controlled. To operate from 6 v., 12 v or Mains supply sources. Reconditioned with same as new guarantee. Prices from £55 per complete station FOB U.K. Port, as illustrated.

GENERALLY AVAILABLE
H.F. Radio Transmitters 1½ to 20 mc/s, 300-watts phone output also remote control and C.W.
Collins 18Q (TCS Series) Radio Telephones 1½-12 mc/s. 4-channels 25 watts.
Wireless Sets. Nos. 19, 22, 31, 38, 62 and 68, and spares.
Aerial masts. Telescopic Steel 20ft. and 34ft.
Field Telephones. D. Mk. V, "F," "J," "H," "L," and EE8. Switchboards 10-Line to 100-Line—portable.
Carrier Telephony Systems. 1 + 1 and 1 + 4 Carrier Terminals and Repeaters.
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Rectifiers. Charging Sets 6/12 volt 15 amp. new, £12. Mains supply—115 volts and/or 230 volts mains.
D.C. Supply 24-volt 50 amp., new, £35. 200/240 V. mains. D.C. Supply 80-13 volts 0.7 amp., new, £5. 200/240 V. mains.
Aircraft Radio Compasses. Distance Measuring Equipment, and also 10-Channel V.H.F. Radio Telephones.

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RCA AR88D RECEIVERS

One of the most renowned American Communications Receivers ever manufactured. Widely used by all the Armed Services to maintain World-wide Communications and Monitoring Posts under all conditions. Employs 14 valves, and has 6 switched overlapping wave bands for complete coverage. Refinements include Mechanical Band Spread with Logging Scale, Automatic or Manual Volume Control. Automatic or Manual Noise Limiter, BFO with pitch control, RF and AF Gain Controls. Variable HF Tone Control, Variable Selectivity with Crystal Filter, Aerial Trimmer, Choice of Headphones or Speaker. Has internal mains power pack for nominal 115-230 volts A.C. In Black Crackled Case size 19½in. W. x 11in. H x 19½in. D. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. Covers 500 kc/s-32 Mc/s, price **£45** (add carriage 30/- and 50/- deposit on returnable transit case). S.A.E. brings illustrated descriptive leaflet.

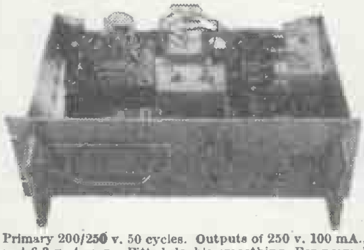
TRAWLER BAND R 1155s

The latest version of this famous Communications Receiver to be released by the Air Ministry. Covers 5 wave ranges 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 3.0-1.5 Mc/s., 1.5 Mc/s., 600 kc/s., 500-200 kc/s. As used by Coastal Command, Air-sea Rescue Launches, etc. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Have had slight use, but are in excellent condition. ONLY £12/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 8in. P.M. speaker £6/10/-. DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

POWER UNITS TYPE 234



Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA., and 6.3 v. 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19in. × 7in. Fitted with 2½in. A.C. volts output meter, ONLY 79/6 (plus carr. 7/6).

H.R.O. SENIOR COMMUNICATIONS RECEIVERS. Complete with all 9 coils, giving coverage of 50 kc/s—30 Mc/s. Checked and in perfect working order. Rack mounting type 18 gns., Standard Table Model 21 gns. (Carr., etc. 22/- either type.)

HRO MAINS POWER UNITS. A.C. Input 115/230 volts, Output D.C. (fully smoothed) 230 volts 75 mA., and 6.3 volts 3.5 amps. Complete in black crackled case ONLY 59/6.

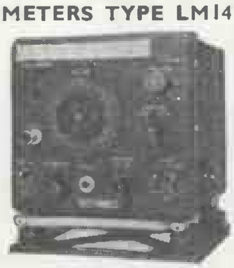
BC 342 RECEIVERS. A few only of these famous American sets covering 1.15-18.0 Mc/s., in six bands. Internal 115 v. A.C. Mains pack. A super receiver in first-class condition and perfect working order. ONLY £25 (carriage 15/-).

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for No. 19 Wireless Set. UNUSED. ONLY 15/- per lead.

P.M. SPEAKERS. 3in. 19/6. 6½in. 17/6, 8in. 21/-. 12in. 29/6.

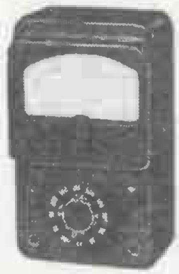
SPRAGUE CONDENSERS. Metal cased wire ends. New, .01 mfd. 1,000 v. and .1 mfd., 500 v. 7/6 per dozen. Special quotes for quantities.

HETERODYNE FREQUENCY METERS TYPE LM14



Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Model of the well-known BC.221 Frequency Meter, but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8½in. × 8in. × 8½in. Full information on request.

UNIVERSAL VOLT—OHM—MILLIAMETER



Reads A.C. and D.C. Volts up to 1,000 in 5 ranges at 1,000 o.p.v., D.C. Current (3 ranges) to 500 mA. Resistance readings to 200 Kohms in 2 ranges. Basic movement 300μA sensitivity. Easily read open scale. Dimensions 5½in. x 3½in. x 2½in. Beautifully made, and fully guaranteed. Complete with leads, prods and internal battery. ONLY **59/6**

BC 221 FREQUENCY METERS

Similar specification to LM 14 Frequency Meter below, but does not have internal modulation or voltage stabilising circuits. Complete with original calibration book, crystal, valves, and instruction book. Used, but in very good condition. ONLY £16. Illustrated descriptive leaflet available on request.

DOUBLE BEAM OSCILLOSCOPE TUBES

Type CV 1596 equivalent to Cossor 09D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at £12/10/-. Our price £2/19/6 (carriage 5/6). Brand new in makers' crates.

METERS

F.S.D.	SIZE AND TYPE			PRICE
25 microamps	D.C.	2½in. Proj.	circular	59/6
50 microamps	D.C.	2½in. Flush	circular	59/6
50 microamps	D.C.	3½in. Flush	circular	80/-
100 microamps	D.C.	2½in. Flush	circular	39/6
1 milliamp	D.C.	2½in. Flush	circular	30/-
1 milliamp	D.C.	3½in. Flush	circular	50/-
200 milliamp	D.C.	2½in. Flush	circular	12/6
20 amps	D.C.	2in. Proj.	circular	7/6
40 amps	D.C.	2in. Proj.	circular	7/6
5 amps	D.C.	2in. Flush	square	12/6
300 volts	A.C.	2½in. Flush	circular	25/-
500 volts	A.C.	2½in. Flush	circular	25/-

HIGH FREQUENCY A.C. VOLTMETER

A First Grade Moving Iron Instrument with 6in. Mirror Scale, reading up to 150 volts A.C. at 400 and 1,200-2,400 cycles. In substantial Oak case with removable lid, overall size 8½in. x 8½in. x 5½in. Recently made for the Air Ministry by Everett Edgcumbe, and in perfect order. Brand New & Unused. ONLY £7/10/-. Can also be supplied for 50 cycles use, either 0-150 or 0-300 volts.

AMPLIFIER N24. As previously advertised. 4 valves, rack mounting, with internal A.C. mains pack for nominal 110/230 volts. Output to 600 ohms. line, provision for 600 ohms. or High Impedance input. A first class job, NEW IN MAKERS' PACKING. ONLY 89/6 (carr. 10/6).

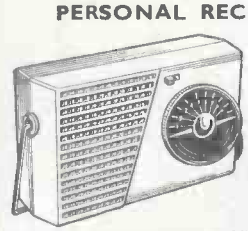
INTERCOM. TELEPHONE SET. Two pairs of Brand New Headphones connected to Breast Microphones, with leads, etc., in fitted carrying cases. Supplied with 4½ volt battery, 10 yards twin flex, and full instructions for connecting to make super intercom. ONLY 27/6. (Post 3/6). Extra flex 3d. per yard.

10,000 OHMS PER VOLT TESTMETER. This latest Caby model is a handy pocket sized tester 5½ × 3½ × 2½in. Reads low D.C. voltages at 10,000 ohms per volt, up to 10,000 v. A.C. and D.C. at 4,000 o.p.v. Resistance to 20 megs. D.C. current to 250 milliamps and also Decibels. Complete with Test Leads, Batteries and Instruction Book. ONLY £6/10/-.

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 mills. Size 5½ × 3½in. diameter. Ideal for running Radio and Electric Shaver etc., from car battery. ONLY 32/6.

MARCONI SIGNAL GENERATOR TF 144G/7. Coverage 85 kc/s.-2.5 Mc/s. and 8 Mc/s.-70 Mc/s. Complete, and in AS NEW CONDITION. ONLY £95.

"P.W." 6 TRANSISTOR PERSONAL RECEIVER



Designed by the technical staff of *Practical Wireless*, easy to build, using printed circuit, and 1st Grade Matched Transistors and Diode. Full Medium and Long Wave coverage to internal speaker. All parts sold separately (new components only) enabling you to buy as required, and full detailed price list will be sent on request. Constructional details 1/6. TOTAL COST INCLUDING BATTERY AND CABINET. £8/19/6.

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PLEASE ADD POSTAGE OR CARRIAGE COSTS ON *ALL* ITEMS

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Kit (including printed circuit and all components)	£5 5 0	P. & P. 2/6
Set of 6 Transistors and 1 Diode.	£2 5 0	P. & P. 6d.
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Special 7in. x 3¾in. 3 ohm speaker available 14/6. P. & P. 1/6.
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RECORD PLAYER BARGAINS Latest 4-speed models

NEW RELEASE by E.M.I.—4-speed Single Player Unit fitted with latest stereo and monaural Xtal cartridge and dual sapphire styli. Auto stop and start. A fidelity unit and bargain buy at only £6/19/6, carr. & ins. 3/6. EMI Junior (Monaural), 89/6.
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Model RC 210 with plug-in GC8 head, 10 gns. Carr. 4/6.
Transcription Auto Changer Model "A"—just released. £18/19/6. Carr. 5/-.
Comprehensive range in stock.

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1R5, 1S5	7/6	ECL80	10/6	PCL83	12/6
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DAF96	9/-	EF86	12/6	PL81	12/6
DF96	9/-	EL84	8/6	PL82	9/6
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COAX 80 ohm CABLE

High grade low loss Cellular Air Spaced Polythene—¼in. diam.

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Designer-approved kits of parts for these quality tuners available as follows:

STANDARD MODEL (FMT1). COMPLETE KIT. 5 gns. P. & P. 2/6. Set of 4 spec. valves, 20/-.

MODEL FMT2. Shelf mounting unit in enclosed cabinet with built-in power supply. **COMPLETE KIT, £7.** P. & P. 3/6. Set of 5 spec. valves, 37/6.

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NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48 hr. Alignment Service, 7/6. P. & P. 2/6.

VOLUME CONTROLS—5K—2 Megohms. ALL LONG SPINDLES. MORGANITE MIDGET TYPE. 1½in. diam. Guar. 1 year. LOG or LIN ratios less Sw., 3/-. D.P. Sw., 4/6. Twin Stereo less Sw., 6/6. D.P. Sw., 8/-.

We manufacture all types Radio Mains Transf. Chokes, Quality O/P Trans., etc. Enquiries invited for Specials, Prototypes or small production runs. Quotation by return.

CONDENSERS—Silver Mica. All values, 2 pf. to 1,000 pf., 6d. each. Ditto, ceramics 9d. Tub. 450 v. T.C.C., etc., .001 mfd.-01 and .1/350 v., 9d. .02-1/500 v., 1/-. .25 Hunts 1/6. .5 T.C.C. 1/9.

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W/W RESISTORS. 25 ohms to 10K. 5W., 1/3, 10w., 1/6, 15w., 2/-.

PRE-SET W/W POTS. T/V Type, 25 ohms—50 K ohms, 3/-. 50K—2 Meg. (Carbon, 3/-).

SPEAKER FRET expanded bronze anodized metal 8in. x 8in., 2/3; 12in. x 8in., 3/-; 12in. x 12in., 4/6; 12in. x 16in., 6/-; 24in. x 12in., 9/-; 36in. x 12in., 13/6; etc.

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Electoolytics All Types New Stock

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25/25 v. 50/12 v.	1/9	8+8/450 v.	4/6
50/50 v. 100/25v.	2/-	32+32/275 v.	4/6
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16+16/450 v.	5/6	60+250/275 v.	12/6
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Comprehensive range in stock

RECORDING TAPE—Famous American Columbia (CBS) Premier quality tape at **NEW REDUCED PRICES.**
Brand new, boxed and full guaranteed. Fitted with leader and stop foils.

Standard		Long Play	Double Play
5in.	600ft. 15/-	900ft. 19/6	1200ft. 31/6
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Post & Pack., per reel, 1/- plus 6d. ea. for additional reels.
SPECIAL OFFER. 3in. mfrs. surplus tape, 225ft. 5/6. P. & P. per reel 6d.
TAPE REELS. Special offer. Manfrs. surplus. Replacement plastic spools. 7in. 3/6, 5¾in. 3/3, 5in. 3/-, 3in. 2/6.

TAPE RECORDER—*BARGAIN OFFER*

Manufacturers' brand new, current production offer. Latest 5-valve circuit based on Mullard's famous design. Magic eye level indicator. Volume and tone controls. T.C.C. printed circuit already wired. Only power pack and controls to assemb e and wire. Valves EF86, ECC83, EL84, EM84 and EZ80. A sensitive quality recorder at Special Unit Prices. BSR Kit:—

Wired printed circuit Amp. control panel knobs, etc. P. & P. 2/-	£4 15 0
Four valves. P. & P. 1/-	£1 17 6
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B.S.R. Monardeck Tape Unit. P. & P. 4/6	£8 10 0
Illustrated Handbook, circuit diagram, etc., 2/6.	
Complete 4-unit Kit, bargain. Carr. 7/6 ..	£16 10 0

COLLARO KIT.—Modified kit version of above for 3-speed Collaro Studio Transcription Deck with freq. compensated switching, etc., now available for £5/10/0 extra.
Send for bargain lists, leaflet, 3d. stamp. Contemporary cabinets available at bargain prices.

Only a few items are listed from our comprehensive stock. Write now for full bargain lists. 3d.

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TBN-3EV. Sensitive Thermistor Bridge. Internally calibrated against D.C.
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LAE1 SIGNAL GENERATOR. 510-1,350 Mc/s., CW and Pulse.
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THE PLESSEY SYNTHESIZER
The Plessey Synthesizer is a crystal-controlled frequency standard having an accuracy of 1 part in 10/6ths. Incorporating its own power unit for operation from 50 c/s mains of 200/250V. It is capable of standardizing frequencies over the range 500 c/s to 10 Mc/s direct and by harmonic extension to 300 Mc/s. It is also arranged to provide an output of at least 0.1 V. across 80 ohms load at any kc/s interval from 2 kc/s to 10 Mc/s with an accuracy of 1 in 10/6ths and a similar output over a continuously variable range of 5 kc/s to 10 Mc/s, with an accuracy of 1 part in 10/6ths. Plus or minus 10 c/s. Mixing and filter arrangements are provided in such a manner that the wavemeter is direct reading and the procedure for obtaining any frequency is reduced to turning switches and tuning filters. The wavemeter consists of seven units incorporated in one framework and is transportable.
VALVE VOLTMETERS.
Balantine model 300. Range 1 Mv to 100 volts. Frequency range 10 cycles to 150 Kc/s. Accuracy 2% below 100 Kc/s and better than 3% above 100 Kc/s. By using the output jack the amplifier section of the voltmeter may be used separately giving a max. voltage gain variable up to 70db. The gain is adjustable by means of the range switch in steps of 20db and finer adjustments in gain are provided by the potentiometer setting.
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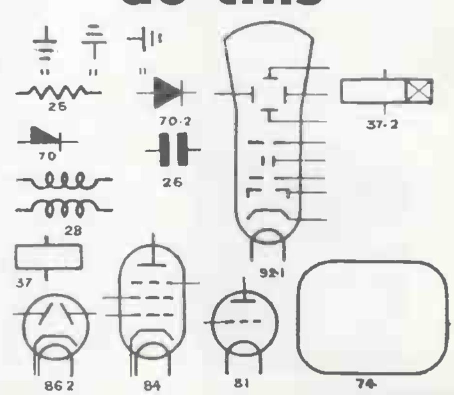

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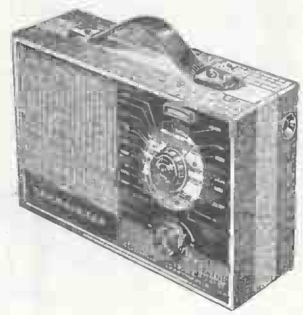

A really remarkable 2-Band 6-Transistor Superhet Kit as displayed at the Radio Hobbies Exhibition.

The Contessa is the professional looking set with the professional performance.

Study these brilliant features which cannot be found in any other kit—

- Waveband coverage of 530 kc/s to 1,620 kc/s and 160 kc/s to 270 kc/s.
- Assured reception of at least a dozen stations in daylight!
- Large clearly-calibrated station-named dial.
- Internal high-gain Ferrox aerial.
- 5 : 1 ratio slow motion tuning.
- Fitted with the latest 12000-line high-flux loudspeaker.
- Power of 410 milliwatts from the single-ended push-pull final stage.
- Specially designed aerial matching coil for use in a CAR.
- Only first grade fully-guaranteed Mazda matched transistors and diodes are used.
- Double tuned IF transformers for maximum gain and knife-edged selectivity.
- Fully drilled printed circuit panel marked with component numbers.
- The two-colour case measures 10 x 7½ x 3½in. and weighs approx. 4 lbs. when assembled.
- Battery lasts 4 months with normal usage.
- Book supplied with detailed assembly instructions, diagrams and circuitry.
- Anyone can build this set—everything supplied—just a soldering iron required.

Inclusive price for all associated components, cabinet and battery, complete in every detail.
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Send for comprehensive descriptive Manual and Parts List, 3/6 post free.

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Plus 3/6 Regd. P.P.

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Small, non-inductive, insulated, high-grade Capacitors' 150 v. Wkg., .15 Mfd. 5% 10d. .22 Mfd. 10% 9d. 2 Mfd. 10% 1/10. 250 v. Wkg., .068 Mfd. 9d. .1 Mfd. 1/1. .22Mfd 2% 1/4. 1 Mfd. 10% 1/7. 500 v. Wkg., 680 pF., 1,000 pF., 1,500 pF., 2,200 pF., 7d. each. 3,300 pF., 8d. 5,000 pF., 6,800 pF., .01 Mfd. 9d. each. 8,200 pF., 1/-. .022 Mfd., .03 Mfd. 10d. each. .047 Mfd. 2% .05 Mfd. 11d. each. .1 Mfd. 11d. .25 Mfd. 1/7. .5 Mfd. 1/3. 750 v. Wkg., 470 pF., 10% 820 pF., 1,500 pF., 2,000 pF., 8d. each. 5,000 pF., 6,800 pF., 9d. each. .022 Mfd. 10d. 1,000 v. Wkg., 1,500 pF., 9d. 6,800 pF., 10d. .01 Mfd., 1,500 v. 1/-. .12 Mfd., .15 Mfd., 1/1 each.

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4 pin UX, 7d. 7 pin Brit. Pax. 3d. 7 pin Brit. Porc. 4d. Int. Octal Pax. 3d. Internat. Octal McMurdo 6d. Mazda Octal Pax. 3d. Loctals Amp. 6d. B7G Pax. 6d. B7G P.T.F.E. 8d. B7G Cer. with saddle and valve retaining spring 1/-. B8A Pax. 4d. B8A Amp. 6d. B8A Cer. 8d. B9A Pax. 6d. B9A Cer. 10d. B9A Cer. with saddle and valve retaining spring 1/-. B9A Cer. skirted 1/-. B9A Cans. 6d. B9A printed circuit 10d. B7G Valve cans 6d. EY86 High Voltage holders 1/3.

VARIABLE GANG CONDENSERS

Twin Gang .0005 Mfd. 2⅜in × 2in. × 1⅞in. Spindle 5/16in. 4/-.
Min. Twin Gang .0005 Mfd. 2⅜in. × 1½in. × 1⅛in. Spindle ¼in. 5/6, with Trimmers 6/6, and Dust cover 7/6.
AM/FM 2-Gang Condensers. 500+20 pF., 3/6.

DISC CERAMIC CONDENSERS 500 v. Wkg

8.2 pF., 470 pF., 500 pF., .001 Mfd., .002 Mfd., .0025 Mfd., .003 Mfd., .005 Mfd., 6d. each. .01 Mfd. 9d.

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SUB MINIATURE ELECTROLYTIC CONDENSERS

Most with sleeves, all at 2/3 each.
.1 Mfd. 50 v., .25 Mfd. 15 v., .5 Mfd. 50 v., 1 Mfd. 25 v., 2 Mfd. 6 v., 15 v., 70 v., 4 Mfd. 12 v., 5 Mfd. 25 v., 6 Mfd. 3 v., 6 v., 8 Mfd. 3 v., 6 v., 15 v., 30 v., 10 Mfd. 6 v., 25 v., 16 Mfd. 3 v., 6 v., 30 v., 20 Mfd. 15 v., 25 Mfd. 12 v., 30 Mfd. 3 v., 6 v., 12 v., 50 Mfd. 6 v.

SUB MINIATURE TRANSISTOR COILS

Set of 3 I.F. Transformers 470 Kc/s plus Oscillator coil.
As specified for Mazda Circuits 23/6 complete.
As specified for Mullard Circuits 23/6 complete.
WTC oscillator Coils for Jackson or Plessey Gang 4/6 each. WTC 470 kc/s. I.F. Transformers 4/- each, 7/6 pair.

SUB MINIATURE CARBON POTS

5K., 50K., 220K., 330K., 1M, 2/-. 5M with switch, 4/6. 5K., 1/6, 500K preset 1/-. 1M Transistor Pots 2/-. 5K Transistor Pots 1/6.

FULLY MOULDED TRACK POTS

(Diameter ⅝in. SHORT SPINDLES) 2/6 each.
100Ω, 250Ω, 400Ω, 470Ω, 500Ω, 1k., 2k., 2.5k., 5k., 10k., 15k., 25.k, 50k., 100k., 250k., 500k., 1M.

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.005 Mfd., .0022 Mfd., .002 Mfd., .001 Mfd., 8d. each. .02 Mfd., .04 Mfd. Price 9d. each.

MIN. POLYSTYRENE CONDENSERS

10 pF., 50 pF., 59 pF., 75 pF., 82 pF., 100 pF., 125 v. wkg. 6d. each. 300 pF., 350 pF., 390 pF., 470 pF., 560 pF., 1,000 pF., 1,200 pF., 4,000 pF., 9d. each.

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Knurled knob and 6BA fixing holes. Diam. 1in. 100Ω 5K, 10K., 25K., 50K., 100K., 200K., 250K., 500K., 1.5M., 2M., 1/3 each. 25K wirewound 1/6.

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Size 1 5/16in. dia., 2in. spindles. Price 2/11 each.
1 pole 10 way. 1 pole 12 way. 2 pole 2 way. 2 pole 3 way. 2 pole 4 way. 2 pole 5 way. 2 pole 6 way. 3 pole 3 way. 3 pole 4 way. 4 pole 3 way.

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Moulded Tracks. Diam. 1⅛in., 2¼in. spindles. 5K., 10K., 25K. Linear only. 50K., 100K., 250K., 500K., 1M., 2M. Log or Linear, less switch, 2/6 each. With switch 4/6.

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Audio Output Types 5,000Ω to 3Ω 3/9. 30,000Ω to 3Ω 4/6. Universal CRT Boosters with tapped primaries 2 v., 6.3 v., 13 v. 25% boost all taps, 10/6. Filament Transformers, centre tapped, 6.3 v. 3 amps. 9/6.

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Ferrox Line O/P Transformers, 16 kV. U25 10/6. (90° Types 12/6). Frame O/P transformers to match 4/6. Scanning Coils to match 10/6. (90° types 12/6.) Panel containing 6 preset pots 5/-. Smoothing Chokes: 2 Hy. 250 mA. 3/11. 1.9 Hy. 250 mA. 2/11. 1.3 Hy. 250 mA. 2/6.
G.E.C. Metal Rectifier 250 v. 250 mA. 10/-. 34 Meg. I.F.T. 1/6 ea. 38 Meg. I.F.T. (link) 2/- ea. Masks 14in., 17in. and 21in. 2/6, 3/6, 4/6 (plus 2/6 p.p.).

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Crocodile clips 4d. Coax. Plugs and Sockets 2/2 per pair. Condenser clips 1in., 1⅛in., 1⅜in., and 1⅞in. 6d. ea. Parmeko Smoothing Choke 8/9 Hy. 100 mA 6/6, 500 pF. 15 Kv moulded Condensers 2/6. WX2s Westector 6d. Transistor Twin gang condensers 387+166 pF. ex. equip. 4/6. Vibrator Hash Chokes 1/-. Ext. Loudspeaker panel with switch 1/-. OA81 3/-.

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All Electrolytic Condensers as advertised in May 1960 issue still available.

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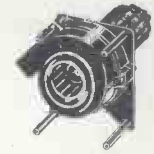

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Type HM/14/1, 115 volts 400 cycles. 50/- each. New.

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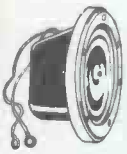

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A.M. Ref. 5U/3294 12 or 24 volt reversing motor. Complete with magnetic brake. 1½in. x ¼in. spindle with worm drive. Extremely powerful. Ht. 2¾in. x width 2in. x depth 3in. (with spindle 4½in.). New 21/- each.

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Made by Hoover. 80 volt D.A. Will operate on 240 volt A.C. with 8 mfd. condsr. in series. **New and cartoned 17/6 each.**

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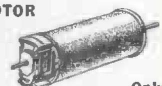
Types available: Plugs: CZ/64662-CZ/64658. Sockets: CZ/64661-CZ/64659. Loading 7 to 10 KV. New and unused. For Radar Stations, T.V. Link-ups and atomic research applications. **8/6 pair or 5/- each**

MINIATURE MODEL MOTOR



(Not Ex-Govt.). Removed from Transistor Tape Recorders and in perfect condition. 3 to 12 volts. Dual spindle, fully reversible, protected bearings. Approx. 3/4,000 r.p.m. Size: 2¼in. long x 1in. wide. Spindle: ⅛in. x $\frac{1}{32}$in. **9/6 Only each**

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Supplied in 2 sections. No. 1 and 2. ZA/26800 and 26286. Each section collapsible down to 1ft., with retaining wire through each section. Ideal also for Radio Control, fishing rod or pennant mast. **7/6 complete. New.**

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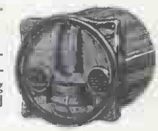
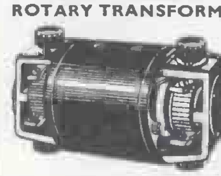
Dismantled from Radio Altimeters. This is a moving coil unit with powerful magnet, coil imp. 5 ohms, also fitted is a ceramic cover divided in 2 and silver plated forming the moving vane, cap. about 5–50 P.F., has possibilities as a Tweeter unit. **7/6 each.**

VISUAL INDICATORS



Type 10 Q/4. New. Containing 2 high grade meter movements 30 micro-amps and 750 micro-amps, for converting to Multi-meter and exposure meter. Incl. 2 neon lamps and holders **17/6 each.**

ROTARY TRANSFORMERS TYPE HT.31.



Input: 11.5 volt, Output: 250 volt at 120 mA. Ex-Units but tested. **35/- each.** Type **HT.32.** Input: 11·5 volt. Output: 490 volt at 65 mA. New, in cartons, **20/- each.**

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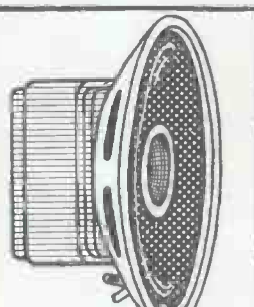

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A super sensitive miniature speaker (face diam. 1¾in.) with 9,500 gauss flux density. Better than ever quality from smaller than ever equipment! Operates from as little as 30-50 mW peak value from class "A" outputs; will accept 200mW from class "B" p/p outputs.

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- ***10 ohms. imp. at 800 c/s***
- ***Ferrite magnet 9,500 gauss***
- ***1.75" dia. x 0.75"***

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115 v. A.C., 1/6th H.P., variable speed box 0-166. Size of unit 14½ x 9½ x 8in. £8/10/-. Carr. 10/-.

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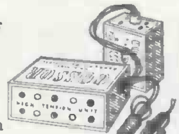

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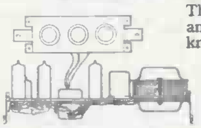
8 WATT AMPLIFIER



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DL94 6/–
DL96 8/–
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EBC91 3/9
E1232 5/6
E1323 25/–
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EA50 1/6
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EB34 1/6
EB91 3/9
EBC33 5/–
EC52 3/–
ECC81 5/6
ECC82 6/6
ECC83 7/–
ECC84 7/–
ECC85 8/–
ECC91 4/–
ECL80 8/–
EF22 7/3
EF32 5/–
EF36 3/6
EF37A 8/–
EF39 4/3
EF50 2/6
EF54 3/3
EF55 6/–
EF70 4/–
EF73 6/–
EF80 5/6
EF85 6/10
EF86 9/–
EF89 7/9
EF91 3/6
EF92 4/6
EF95 7/6
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EL33 8/–
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EL41 8/3
EL42 9/–
EL81 6/–
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EL85 10/–
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KT32 8/–
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KT44 6/3
KT63 6/–
KT66 11/–
KTW62 7/6
KTW63 6/6
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MH41 5/–
ML4 4/–
MS/PEN 6/–
NT37 (4033A) 10/–
OD3 5/–
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PEN220A 3/–
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PG7/5 15/–
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PY82 8/–
QP21 6/–

QP25 5/3
QS75/20 6/9
QS95/10 6/9
QS108/45 6/9
QS150/15 6/9
R3 8/–
R10 12/6
REL21 25/–
RK34 2/6
RX235 10/–
SP2 4/–
SP4B 7/6
SP13C 4/6
SP41 2/6
SP61 2/–
STV280/40 12/–
SU2150A 4/9
T41 7/–
TP25 15/–
TT11 3/–
TZ20 16/–
U17 5/–
U18 6/6
U27 8/–
U52 5/–
UL41 7/–
UL84 7/6
UL85 7/–
UU9 5/6
VP23 3/6
VP41 5/6
VR78 4/–
VR99 8/–
VR105/30 7/6
VR150/30 7/3
VT4C 25/–
VU39 6/–
VU111 3/3
VX3138 12/–
W31 7/–
Y63 5/–
Y66 8/–
Z31 6/–
1A3 3/–
1A5GT 5/–
1C5GT 7/6
1D8GT 6/–
1E7GT 7/6
1G6GT 12/–
1L4 3/6
1LD5 3/6
1LN5 4/9
1R5 6/–

1S5 5/9
1T4 4/–
2A3 8/–
2A5 8/–
2A6 7/–
2C34 2/6
2D4A 4/–
2X2 4/–
3A4 5/–
3B7 5/–
3B24 3/–
3E29 (829B) 60/–
3Q5GT 9/–
3S4 5/–
3V4 7/3
5T4 9/–
5U4G 5/–
5Y3GT 6/–
5Z3 8/6
5Z4G 8/–
6AB7 4/–
6AC7 3/–
6AG5 3/6
6AG7 6/–
6AJ7 4/3
6AK5 5/–
6AK7 8/–
6AM5 5/–
6AM6 6/3
6AT6 5/–
6B8 5/6
6B8G 2/6
6C4 3/6
6C5 6/–
6C6G 4/3
6C8G 5/–
6D6 4/6
6E5 5/–
6F6G 4/–
6F8G 6/6
6F12 4/6
6G6G 3/–
6H6M 2/–
6J5 3/6
6J7 7/6
6J7G 5/–
6J5G 3/–
6J6 4/3
6K6GT 3/6
6K7G 2/3
6K7GT 4/9
6K8G 5/9

6K8GT 8/3
6K8M 8/6
6L5G 6/–
6L6 9/–
6L6G 6/6
6L34 4/6
6N7G 5/9
6N7GT 6/–
6Q7G 6/–
6R7G 6/–
6R7GT 8/–
6SA7 6/–
6SC7G 5/6
6SC7GT 6/–
6SG7 5/–
6SH7 4/6
6SJ7 6/9
6SF5 8/–
6SJ7G 5/9
6SK7 5/3
6SL7GT 6/6
6SN7GT 4/6
6SQ7 6/–
6SR7 6/6
6SS7 6/–
6U6G 5/6
6V6GT 6/–
6X4 5/–
6X5GT 6/–
6Y6G 8/–
7C7 6/6
6Z4 5/6
7Q7 7/–
7V7 5/–
7Y4 6/–
7Z4 6/–
8D2 2/6
9D2 3/–
12A6 5/–
12AH7 7/–
12AT7 5/6
12AU7 6/–
12AX7 7/–
12C8 3/–
12E1 22/6
12H6 2/–
12K8M 9/–
12J5GT 3/6
12SA7 7/6
12SC7 4/6
12SG7 6/6
12SH7 3/–
12SJ7 6/–

12SK7 4/–
12SL7 7/–
12SN7 8/–
12SR7 6/–
15D2 6/–
15E 8/–
15R 7/6
20A2 7/6
21B6 9/–
30 5/–
35T 30/–
35Z4GT 7/–
37 4/–
38 4/–
58 6/–
59 6/–
75 8/–
76 5/–
77 6/–
78 7/–
80 6/3
82 8/–
83V 12/–
84 8/–
85A1 12/–
89 6/–
210LF 3/–
210VPT 7 pin 2/6
705A 17/6
715B 97/6
717A 8/6
801 6/–
803 22/6
804 55/–
805 30/–
807 AMER. 7/–
807BR 5/–
808 8/–
810 80/–
811A 25/–
813 67/6
815 40/–
816 30/–
826 10/–
829A 30/–
832 15/–
832A 35/–
843 7/4
866A 10/–
872A 35/–
930 8/–
954 2/–
956 2/–

958A 5/–
1619 5/–
1625 6/–
1626 4/6
1629 4/6
6120 4/–
7193 1/9
7475 5/–
8013A 25/–
8020 6/–
9001 4/6
9002 5/6
9003 5/6
9004 4/–
9006 4/–

Cathode Ray Tubes:
CV1596 (O9J) 55/–
5BP1 35/–
5CP1 42/6
5FP7 45/–
7BP7 40/–
12DP7 60/–
VCR97 15/–
VCRX258 (with scanning coil) 45/–
VCR138 30/–
VC139A 35/–

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CMG8 9/–
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GS16 12/6
931A 50/–

Special Valves:
2J31 45/–
3A/1481 45/–
3J/170/E £35
3J192/E £37/10
723A/B 50/–
725A 30/–
726A 27/6
ACT6 200/–
ACT17 75/–
ACT25 40/–
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KR3 45/–
LS7B 30/–
V1924 22/6
VX7110 15/–
WL417A 15/–

AND MANY OTHERS IN STOCK including Cathode Ray Tubes and Special Valves.

All U.K. orders below 10/- P. & P. 1/-; over 10/- 1/6; orders over £3 P. & P. free. C.O.D. 2/- extra. Overseas Postage extra at cost.

MARCONI SIGNAL GENERATOR. TF 144G, 85 Kc/s—25 Mc/s. Made up to new standards, **£70.** Delivered free.

TELEPHONE HANDSET. Standard G.P.O. type new, **12/–.** P. & P. 1/6.

TRANS-RECEIVER No. 22. 2 megacycles to 8 Mc/s. Built almost exactly as Number 19. Set much more economical in battery consumption. Complete in fully working condition with power pack for 12 volts, head-gear and microphone assembly, key. **£9/19/6.** Carriage 15/–.

U.H.F. SIGNAL GENERATOR TYPE TS14 3,200–3,370 mc/s., power measuring range 20–200 mW., R.F. output power —20 to —100 dbm below 1 mW. Power supply 115 w. A.C. Price **£15.** Carriage 15/–.

SCR 522 RECEIVERS (BC624), 100–156 Mc/s., no valves, **7/6.** P. & P. 5/–.

H.T. CHOKES made by Bendix Radio (U.S.A.) 3 henrys .600A D.C. 25 ohms D.C. resistance, 18 volts R.M.S. 60 cycle test, **£1/12/6.** P. & P. 6/–. Ditto 10 henrys 250 amps. D.C. 90 ohms D.C., resistance 1500 R.M.S. 60 cycle test **16/6.** P. & P. 3/6.

MINIATURE RELAYS. Changeover 12–30v. D.C. supply, 5 amps. contacts, **5/–.** P. & P. 2/–.

PRE-SET DOUBLE POTENTIOMETERS, 2 x 3,000 ohms linear 4 w., **5/–.** P. & P. 1/6.

CARBON INSET MICROPHONE, G.P.O type, **2/6.** P. & P. 1/–.

SPECIALLY BUILT POWER PACK for TCS receivers, 230 volts A.C. mains, including 6X5GT valve, **£3/10/–.** Carriage 5/–.

VACUUM CONDENSER. 32,000 v., 50 pF., **12/6.** P. & P. 3/–.

SUPPLY UNIT RECTIFIER No. 21. Fully sealed enabling all sets built for 6 v. (R209, R109, etc.) to work from A.C. mains. Input 90 v.–260 v. A.C. (taps at 10 v. intervals); output excellently smoothed up to 10 amps with meter indicating exact output voltage. Measurements 12 x 9 x 10in. Price **£8.** Carriage and packing 15/–.

BRAND NEW ORIGINAL SPARE PARTS FOR AR88 RECEIVERS.

I.F. TRANSFORMERS. 1st, 2nd, 3rd, 4th (for type D), **12/6** each, or complete set of 6, **60/–.**

I.F. Transformers. Crystal Load, **12/6** each.
Plates escutcheons (for D and LF), **15/–** each.
Dials (for type D), **10/–** each.
Logging dial (for D and LF), **10/–** each.
Filter Chokes (for D and LF), **22/6** each.
Output Transformers (for LF), **30/–** each.
Antenna Trimmers (LF and D), **2/6** each.
Filter Condenser 3 x 4μF, **£2/10/–.**
Condensers, 3 x .25μF (D and LF), **2/6** each; 3 x .01μF (D and LF), **2/6** each.
RF Antenna Inductors (D and LF), **7/6** each.
Mains Transformers (LF), **£3** each.
Small Mica Condensers, various values, **1/6** each.
Instruction Manual for AR88D, **£1.**

MARCONI CR-100 COMMUNICATIONS RECEIVER. 60 Kc/s–30 Mc/s, with noise limiter. Completely reconditioned, **£25.** Carr. 25/–.

LABORATORY PRECISION VARIABLE CONDENSER. Manufactured by General Radio Co., U.S.A. 50–1,500 pF with micrometric drive and calibration chart. Overall dimensions of case 9 x 8 x 7in. Price **£15.** Carriage 15/–.

P. C. RADIO LTD.
170, GOLDHAWK RD., W.12 SHEpherds Bush 4946

R209 RECEPTION SET. A 10-valve high-grade Super Hetrodyne Receiver with facilities for Receiving R/T (A.M. or F.M.) and C.W. frequency 1 Mc/s-20 Mc/s. Hermetically sealed. Built on miniature valves and incorporating its own vibrator power supply unit driven by a 6 v. battery (2-point connector included). The set provides for reception from rod, open-wire or dipole aerial with built-in loudspeaker or phone output. Overall measurements: Length 12in., width 8in., depth 9in. Weight 23 lbs. In as new, tested and guaranteed condition, **£23/10/–,** including special headphone and supply leads. Carriage £1.

19-SET OWNERS. To increase output of your set six to ten times use RF AMPLIFIER No. 2 with built-in rotary converter for 12 v. input. Four 807 valves output. Simple connection with transmitter. Fully tested condition, **£9/15/–** including necessary connectors and instructions. Carriage and packing 15/–.

AR 88's. Completely rebuilt with new PVC wiring. Type "D," **£75;** Type "LF," **£70.**

COMPLETE SET OF STRONG AERIAL RODS (American). Screw-in type MP49, 50, 51, 52, 53, total length 15ft. 10ft. top diameter. 0.615in., bottom diameter 0.185in., together with matched aerial base. MP37 with ceramic insulator, ideal for car or roof insulation, **£2/10/–.** Post free.

R109 RECEIVERS. 1.8 Mc/s–8.5 Mc/s working from 6 v. D.C. Complete with all valves and built-in speaker. In excellent, guaranteed working condition, **£5/5/–.** Carriage & pkg. 15/–.

TCS RECEIVERS made by Collins of U.S.A., in fully guaranteed working condition. 1.5–12 Mc/s. Line-up: 12S7 (1), 12SQ7 (1), 12A6 (2), 12SK7 (3), power requirements 12 volts L.T., 225 volts H.T., **£11/10/–.** Carriage 12/6.

VARIOMETERS for W/S No. 19. Fully tested and working, **12/6.** P. & P. 2/6.

PERSONAL CALLERS WELCOME

Bulk Buying means DELIVERY EX-STOCK LOWEST PRICES

HEAVY DUTY 20 AMP. L.T. SUPPLY UNIT

by S.T.C.

Normal cost over £100

Essential equipment for Electronic Engineering, research laboratories, schools. Ideal for battery charging, etc.

Guaranteed for 20 amps.

Output: D.C. Variable up to 20 amps. and 24 v. or trickle charge 125/350/700 ampere hours. **Input:** A.C. 100/260 v. 45/65 cycles.

Size: 16 x 24 x 32in. high.

In attractive Grey Cabinet.

£22 - 10 - 0

ex Warehouse

(Circuit diagrams and instructions loaned for 10/- deposit)

VARIABLE TRANSFORMERS

Brand New

Quantities up to 100 delivered by return of post.

Supplied New and Boxed.

Output: (1.3kVA.) Completely Variable 0 to 260 volts 5 amps. **Input:** 230 volts, 50/60 ~

A SHROUDED FULLY VARIABLE TRANSFORMER FOR BENCH OR PANEL MOUNTING.

Size: approx. 6in. cube.

Weight: approx. 13lb.

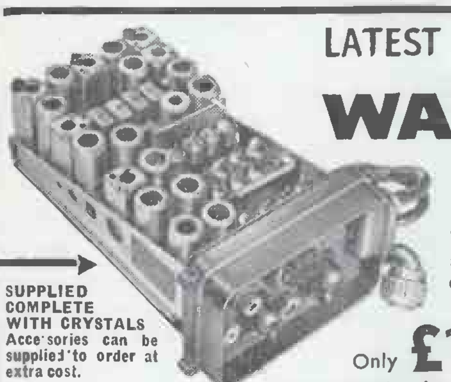
PRICE: RIDICULOUS ONLY

5 amps **£9 - 0 - 0**

10 amps **£18 - 5 - 0**

20 amps **£32-10-0**

LATEST miniature WALKIE TALKIE



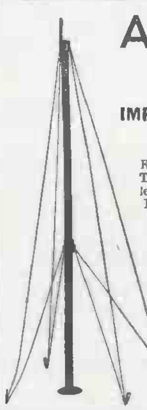
SUPPLIED COMPLETE WITH CRYSTALS Accessories can be supplied to order at extra cost.

"88" sets **just released by Ministry of Supply.** Produced to exacting specifications by leading manufacturers E. K. Cole & Co., this Transmitter/Receiver weighs only 5½lb. (approx.) and measures 3½in. x 5½in. x 9½in. It is a 4 frequency channel set, **crystal controlled,** 38-40/40-42 Mc/s., and operates from a Standard Dry Battery—HT/LT. 94/1. 3 v. (i.e. Ruben Mallory Type 1). 14 of the current series of B7G valves are employed: 1-3A4, 6-1L4, 4-1T4, 1-1S5, 2-1A3. Each set is in first-class condition.

Only **£10** Each.

Special quotations for quantities up to 3,000 sets. **"22" SETS** ALSO—300 available only. New condition **£10** each.

AERIAL MASTS



IMPROVED TYPE 50 Mk.II

36ft. HIGH

Kits comprise—six 2¼in. dia. Tubular Steel Sections of 6ft. length, top-section and base Pickets, Guys and Fittings. YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for Tx., Rx., F.M. and TV (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 17/6 per section.

£8.10.0 only Carr. 15/6.

U.S.A. Type 45ft. TELECOM. AERIAL MAST. (7 sections, 6ft. 8in. x 2¼in., guys etc.). This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for **£25.** Carr. extra. *British Manufacture only.*

ARMY TYPE 32FT. MASTS similar to above but 10 1in. screw-sections, suitable for permanent lightweight installation. Kit in, canvas bag. £5/15/-. Carr. 7/6.

World Famous TELEPHONES "F" TYPE in Attractive Case

£7-10-0 per pair carr. 9/-

The best portable telephone ever made. Original cost £40! Range up to 5 miles. Ideal for FACTORIES BUILDING SITES, FARMS, OFFICES. 2 perfect case sets with batteries, 100ft. cable, etc.

D3 STRANDED TELEPHONE CABLE. New Mile Drum 85/-. Carr. 17/6.

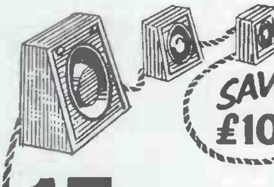
Limited Quantity

36ft. TELESCOPE MASTS

Finest quality brass. Non-rusting. Base diameter 2¼in. Complete with hand-winding winch for easy, rapid extension; and cable-wire bracing stays. One of the best masts ever produced. Winds down to 9ft.

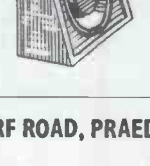
£35 each Carr. £1/10

A COMPLETE EX-GOVT. PUBLIC ADDRESS SYSTEM FOR OFFICES, FACTORIES, WHAREHOUSES & CARS



SAVE £100

15 GNS CARR 30/-



Manufactured by TRUVOX, etc. Complete with Amplifier, four Loudspeakers, Heavy duty mic., Leads, etc. 6 or 12 v. D.C.

Irongate (M.O.) COMPANY

Dept.(ww18), 2, IRONGATE WHARF ROAD, PRAED STREET, LONDON W.2

PADDINGTON 2231/2/3

CRYSTAL CALIBRATOR No. 10
A crystal controlled heterodyne wavemeter covering 500 Kc/s. to 10 Mc/s. (Harmonics up to 30 Mc/s.). Requires 300 V. 15 mA. and 12 V. 0.3 a. D.C., but can be easily modified for 120 V. and 1.4 V. working. Size 7 x 7½ x 4in. Good condition, complete with valves, crystal, instruction manual and circuit. ONLY 59/6. Post 3/6. This item available complete as above.
BRAND NEW and with spare set of valves. £4/10/-. Post 3/6.

CANADIAN CRYSTAL CALIBRATOR. Uses double crystal and multivibrator circuit to give "pips" at 1 Mc/s., 100 Kc/s. and 10 Kc/s. Incorporates Modulator. With book. 79/6, post 2/6.

TRANSMITTER TYPE 36. A complete 50 watt TX for phone or CW. Covers 10-40 Mc/s. (10-15-20m.). Crystal or stabilised VFO. Push-pull 807's plate and screen modulate parallel 807's. Tested and ready to plug into AC mains. Complete with 16 valves, handset, operating instructions and circuit. Wooden cabinets may be somewhat damaged. £15. Carr. England and Wales £2.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 1/6.
MATCHING TRANSFORMER (for Hi impedance) i.e. for HRO, CR100, etc., with standard jack plug. 4/6.

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. Input 45 v. RMS. D.C., output 30 v. 10 amps. BRAND NEW. Boxed. 45/-, post 3/6.

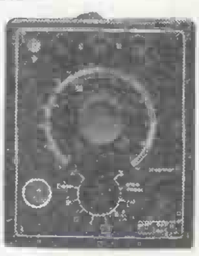
"C" CORE TRANSFORMERS. Pri. 230 v. 50 c.p.s. 510-0-510 at 275 mA. 375-0-375 at 83 mA. 6.3 v. at 9 A. 6.3 v. at 2A. (twice), 6.3 v. at 1A. (twice), 6.3 v. at 1.5A. 6.3 v. at 0.5A., 5 v. at 3A. 6½ x 6 x 7½in. high. Weight 25 lb. Removed from equipment but in perfect condition. 32/6. Carr. 5/6.

ADMIRALTY HT TRANSFORMERS Pri. 230 v. 50 c/s. Secs. 620-550-375-0 375-550-620 v. (620 and 550 v. 200 m/amps. 375 v. 250 m/amps.), plus two 5 v. 3 amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25lb. Made 1953. **BRAND NEW.** Original boxes, 45/-. Carr. 5/-.

CO-AXIAL RELAYS. Simultaneously switch two separate inputs to alternative outputs. 24 volt D.C. coils (can be hand operated). Size (approx.) 5 x 3 x 3in., 8/6, post 1/6.

PRECISION RESISTORS. One Megohm 1% 1 watt wire wound, ex-U.S.A. BRAND NEW. 10/6 per dozen.

MULLARD C. & R. BRIDGES. 0.1 ohm to 10 Megohms in 4 ranges; 10 pFd. to 10 mFd. in 3 ranges; Calibrate, Open Bridge, and % ranges. For 100/250 v. A.C. mains. Tested and guaranteed. £6/15/-. Post 3/6.



AR-88D RECEIVERS

A recent release enables us to offer these superlative receivers at most advantageous prices. In addition to those which have been completely overhauled, re-aligned and recalibrated to our usual high standards, there will be some available to personal shoppers who may have their own facilities for overhaul. Prices will be very reasonable. Customers contemplating mail order purchase can obtain full details on request. (S.A.E. please.)

RCA AR-88 SPEAKERS

A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10½ x 11½ x 6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker. CR 100, etc. In original cartons. BRAND NEW, 45/-. Post 3/6.

RECEIVERS R-1155B

A first-class 10-valve Communications receiver, covering 75 Kc/s. to 18 Mc/s. (16.2-4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy and the R.F. stage and 2 I.F. stages ensure world-wide reception. All the receivers we sell have been thoroughly overhauled, completely realigned and in first-class working order. ONLY **£9/19/6.**

A.C. MAINS POWER PACK OUTPUT STAGE. In handsome black crackled steel cabinet to match the R-1155. Fitted with RCA 8in. speaker. Just PLUG IN and switch on! Only the finest quality components are used and we guarantee OUR power packs for 6 months. ONLY **£6/10/-.** Deduct 10/- when purchasing receiver and power unit together. Send S.A.E for further details or 1/3 for 10-page illustrated booklet giving technical data and circuits etc. (Free with each receiver.) Add 10/6 carriage for receiver, 5/- for power unit.

MARCONI VALVE VOLTMETERS

Ranges: 0 to 1.5, 5, 15, 50, and 150 volts. Fitted with probe unit for RF measurements.

A.C. mains operation. In good condition and working order. A laboratory instrument for ONLY **£8/19/6.** Carr. 7/6.

LOUD-HAILER EQUIPMENT

IDEAL FOR CROWD CONTROL, FACTORIES, FETES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT. COMPLETE WITH MICROPHONE, HEADPHONE AND SPARES. OPERATES FROM 12 VOLTS D.C. (OR 6 VOLTS A.C. WITH SLIGHTLY REDUCED OUTPUT) CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS. ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. £4/19/6, CARRIAGE 25/6.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1¾ x 5in. high. **BRAND NEW.** Boxed 8/6 each, post paid.
4 mfd. 600 v. wkg. CP 130T, 4/6 each, post paid.

MINIATURE RELAYS (ALL BRAND NEW and BOXED)

G.E.C., sealed, wire ends, 670 2M2B H/D M1095	8/6
G.E.C., sealed, wire ends, 670 Ω, 2 H/D makes, M1099...	15/-
G.E.C., sealed, wire ends, 5,000Ω 2 c/o., plat., M1052	17/6
Siemens High Speed 1K + 1KΩ, 1 c/over..................	10/6

GIANT COMPONENT PARCEL

Contains 100 ½ and 1 watt resistors, 50 Hi Stab resistors, wire wound resistors, carbon and W/W pots, 100 capacitors (mica, paper, Sprague, bias, variable, etc.), valveholders, tag strips, metal rectifiers, sleeving, etc. All components are unused. GUARANTEED VALUE, 25/- plus 2/6 post.

QQVO6-40 37/6

PV1-35 32/6, 2D21 7/6, OC3 6/-, PT15 12/6, CV51(Y65) 5/-, 6F33 5/-, 2050 W. 7/6, 5126 £10, 5670 5/-, FW4/500 7/6. BRAND NEW in Individual cartons. Bulk enquiries invited.

CHARLES BRITAIN (Radio) LTD.

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LONDON, W.C.2 ☎ *TEMple Bar 0545*
Near Leicester Sq. Station. (Opposite Thorn House)
Shop Hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday.

SANGAMO-WESTON VOLTMETERS

S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed 27/6. Post 2/6.

BC221 FREQUENCY METER 125 kc/s. to 20 mc/s.
This crystal controlled heterodyne frequency meter is too well known to need further description. Those we offer are complete with correct individual calibration book and are carefully tested and guaranteed. Condition is very good. **£16/-/-**

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We have a large number of items which are remnants of lines previously advertised. The quantities remaining are either too few to warrant a further advert. or the articles may be slightly incomplete or require some servicing. We aim to dispose of these at give away prices.

Examples:—Multimeters from 50/-. A.C. mains power packs from 10/-. Valve testers from £5. Receivers from 50/-.

DON'T MISS THIS CHANCE

MARCONI IMPEDANCE BRIDGE. Type TF373. Measures, L, C & R at 1,000 Cycles. Accuracy 1%. 0-100H; 0-100μF; 0-1MΩ each in 5 ranges. Power Factor and "Q." Guaranteed £35.

PHILIPS RADIATION MONITOR. Type 1092C. A portable self-contained instrument for measuring radio-activity, uses the Mullard MX-115 Geiger counter tube, and is scaled 0-10 milli-Rontgens per hour. Supplied complete with carrying haversack. BRAND NEW. £17/10/-. Carr. 5/-. *Other types of radiation monitoring equipment in stock.*

MARCONI TF987/1 NOISE GENERATORS. Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply A.C. mains operation. Brand new and in original boxes. £15. Carr. 7/6.

D.C./A.C. CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. £9/19/6. Carr. 10/6.
24 v. Input 230 v. A.C. 50 c/s. 100 watts output. In grey metal case. BRAND NEW. 92/6. Carr. 7/6.

SANGAMO WESTON ANALYSER E772. A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. £7/10/-. Carr. 4/6.

MICROAMMETERS

R.C.A. 0-500 microamps. 2½in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. BRAND NEW. Boxed. 15/-.
American 0-100 microamps. 2½in. square flush panel mounting. BRAND NEW. Boxed. 42/6.

MULTIMETERS

1,000 Ω/Volt A.C. and D.C. volts 0-10, 50, 250, 500 and 1,000 D.C. current 0-10, 0-100 mA. Ohms 0-2,000, 0-200K. Bakelite case size 5¼ x 3¼ x 2¼in. Fully guaranteed with test leads, prods and internal battery, 59/6

PREMIER RADIO

23 Tottenham Court Rd., London. W.1. Tel: MUSeum 3451/2

AND AT 309 EDGWARE ROAD, W.1. TELEPHONE PADDINGTON 6963

4-SPEED PORTABLE SINGLE RECORD PLAYER

MAY BE BUILT FOR ONLY **9 GNS.** Plus 6/6 P. & P.

Consisting of:

The New EMI 985 4-speed single Player	£4 9 6
2 valve Printed Circuit Gram. Amplifier	£2 15 0
8in. × 2½in. Elliptical Speaker	£1 1 0
Portable Case—finished rexine covered red and white polka dot	£1 15 0

All items available separately if required.

The SUPER 60

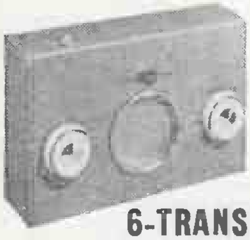
6-Transistor Battery Receiver

MAY BE BUILT FOR **£9.15.0** plus 4/6 P. & P.

Ever-Ready PP10 Battery Extra 11/-.

★ STAR FEATURES—
★ Six 1st grade Mullard Transistors and one Diode.
★ Internal Ferrite Rod Aerial.
★ 7in. × 4in. Elliptical Speaker.
★ Printed Circuit.
★ 500 mW Push-pull Output.
★ Full medium and long waveband coverage.
★ Calibrated Direct Drive Dial Drive Assembly.
★ Full point-to-point instructions supplied.
★ Dimensions 18in. × 7¾in. × 5¾in.

The Receiver is housed in an attractive contemporary mahogany finished cabinet trimmed with gilt, supported by gilt stands.
The Receiver will operate for months on one 9-volt long-life battery.
Instruction Book separately at 2/6 p.p.



6-TRANSISTOR POCKET SUPERHET

MAY BE BUILT FOR **£8.19.6** Plus 2/6 P. & P.

PP3 Battery extra at 2/6.

This Receiver uses the most up-to-date printed circuit method and construction is simplicity itself with the aid of the point-to-point instructions supplied, using 6 Transistors and one Diode and internal Ferrite Rod Aerial, with provision for Car Radio Aerial. Full medium and long waveband coverage and when constructed the Receiver is housed in an attractive leatherette Case size 6½in. × 4¼in. × 1¾in.

THE NEW MODEL EP—10K POCKET MULTI-METER

10,000 O.P.V. ON A.C. & D.C.

Out-performs instruments many times its size and price.

PRICE **£5.19.6** plus 2/6 P. & P.

FULL SCALE RANGES
DC Volts: 0-6; 0-30; 0-120; 0-600; 0-1200.
AC Volts: 0-6; 0-30; 0-120; 0-600; 0-1200.
DC Current: 0-120μA; 0-12M; 0-300M.
Resistance: 0-20K; 0-3 meg.
Decibels: −20 to +63 in five scales.
Capacity: 50μF to .01μF and .001μF to .15μF.
Output Ranges: 0-6; 0-30; 0-120; 0-600; 0-1200.

Unbelievable bargain. Revolutionary new Multi Tester incorporating extra large 3½in. Meter Face, unique slide range selector switch which can be appreciated by the novice and engineer alike and can be carried conveniently in the pocket, also featuring an unusually sensitive 10K ohm per volt AC/DC Meter, 1% precision resistance, and largest Meter ever placed on an instrument of this size. Complete with Test Leads and Battery, size 4¼ × 3¼ × 1in.

TRANSISTORISED BATTERY AMPLIFIER

This exceptionally reliable 4-transistor printed circuit Amplifier is designed with full use of package components, it is complete with volume and tone control and will mount into almost any type of Cabinet, operating on a 9-volt Battery and giving an output of 1 watt. Specifications: sensitivity 120 millivolts 3dB for 50 milliwatts output, sufficient for lowest sensitivity Crystal Pickup, frequency response 50 cycles to 10 Kcs., input impedance 330 K. ohms minimum, negative feedback 6dB average. Loudspeaker impedance required 20 ohms, size 6¾ × 3 × 1¼.

PRICE **89/6** incl. 8" × 2½" 20 ohms speaker plus 2/6 P. & P.

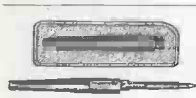
THE Petite PORTABLE

MAY BE BUILT FOR **£7** P. & P. 3/-.

Batteries extra.
H.T. 10/- (Type B126) or equivalent).
L.T. 1/6 (Type AD) 35) or equivalent.

- High Q frame aerials.
- High sensitivity on both wavebands.
- Medium and long wave superhet circuit.
- Instruction book 1/6.
- Size only 8 × 8 × 4¼in.
- Weight including batteries 5½lb.
- 4 valves of the economy type.

PORTABLE SOLDERING IRON



Model No. SP-1 30 watt Portable Hand Soldering Iron, the latest—smallest—coolest 30-watt iron available especially suited for precision wiring. Highly stable, long life and safety is assured. Features a removable handle that may be used to cover the top and barrel to permit the Iron to be carried safely, even whilst hot.
Supplied complete with Vinyl Bag, Lead and Plug only **18/9** plus 1/3 P. & P.

Introducing The NEW EMI 985

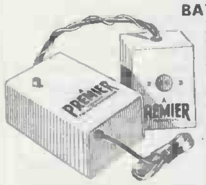
4-SPEED TURNTABLE UNIT COMPLETE WITH PICKUP

PRICE **89/6** Plus 3/6 P. & P.

An extremely reliable and inexpensive Unit suitable for Record Players, and Radiograms, a heavy 8¼in. dia. Metal Turntable with low flutter performance, 5-position Switch, 4 speeds and off, ivory finish with red T/T mat.

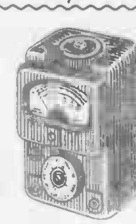
9 volt Battery-operated version available, identical to the above unit in appearance, £5/9/6, plus 3/6 P. & P.

BATTERY ELIMINATOR



Housed in two containers which are to replace AD 35 and B126 Batteries.
MAY BE BUILT FOR **37/6** Plus 2/- P. & P.
Only suitable for use with DK96 Series valves.

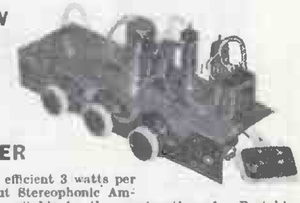
OUTSTANDING BARGAIN OFFER



The Kapura Model UI Multi-meter for only **59/6** (complete with Test Leads), P. & P. 2/6.

A truly efficient Meter for the enthusiast: sensitivity 1.000 ohms per volt. A.C. and D.C. ranges (AC/DC) 0-10-50-250-500-1,000 v. D.C. current 0-100-500 m/a., 0·1 m/a. (at D.C. 0-10 v.). Resistance 1·2,000 ohms (centre 24 ohms), 100-200 K. (centre 2,400 ohms). Size 5in. × 3in. × 2¼in. Brand new in manufacturers' original boxes.

THE NEW LOW PRICED STEREO-PHONIC AMPLIFIER



An extremely efficient 3 watts per channel output Stereophonic Amplifier, ideally suitable for the construction of a Portable Stereo Record Player. Specifications: 3 watts per channel output, valve line-up 2 X ECL82 and one ECC83, Metal Rectifier, ganged controls, tone on/off, balance and volume, suitable for Speakers of 3 ohms impedance and supplied complete with attractive cream with gold centre knobs and gilt control escutcheon, speaker leads fitted with non-reversible sockets, suitable for use on 200/250 v. A.C. mains. Size 12½ × 3¾ × 4½in. PRICE **£5.19.6** plus 4/- P. & P.

AMERICAN C.B.S. RECORDING TAPE

Brand new, fully guaranteed and with Leader Tape:—

600ft. on 5in. Spool	16/6
1,200ft. on 5¾in. Spool	25/-
1,800ft. on 5¾in. Spool D.P.	42/6
1,200ft. on 7in. Spool	25/-
1,800ft. on 7in. Spool L.P.	32/6

Plus 1/- per Spool P. & P.

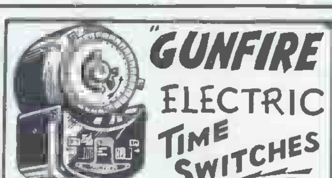
SAMSON'S SURPLUS STORES LTD.

LONDON'S GREATEST DEALERS IN RADIO AND ELECTRONIC EQUIPMENT

No. 1. Pri. 240 v. Sec. tapped 4, 6, 11 v. 200 amps. **£9/15/-.** Carr. 7/6.
No. 2. Pri. 240 v. Sec. 20 v. 30 amps., **£6/15/-.** Carr. 5/–.
No. 3. Pri. 240 v. Sec. 20 v. 20 amps., **£4/15/-.** Carr. 5/–.
No. 4. Pri. 240 v. Sec. 24 v. 30 amps., **£8/10/-.** Carr. 7/6.
No. 5. Pri. 200-240 v. Sec. 8.4 v. C.T. 10 amps., **27/6.** Carr. 3/6.
No. 6. Pri. 240 v. Sec. tapped 12 v.–18 v. 10 amps., **52/6.** Carr. 4/–.
No. 7 Pri. 240 v. Sec. tapped 6 v.–12 v. 20 amps., **72/6.** Carr. 4/–.
No. 8. Pri. 200–240 v. Sec. tapped 10 v.–17 v.–18 v. 10 amps., **57/6.** Carr. 4/–.
No. 9. Pri. 200–240 v. Sec. tapped 30 v.–32 v.–34 v.–36 v., 5 amps., **57/6.** Carr. 4/–.
No. 10. Pri. 240 v. Sec. 6 v.–12 v. 10 amps., **47/6.** Carr. 4/–.
No. 11. Pri. 230 v. Sec. 24 v. 7 amps. and 32–30 v. 2 amps., **52/6.** Carr. 4/–.
No. 12 Pri. 200–240 v. Sec. tapped 48-56-60 v., 1 amp., **27/6.** P.P. 3/6.
No. 13. Pri. 200–240 v. Sec. 12–20–24 v. 2 amps., **22/6.** P.P. 3/6.
No. 14. Pri. 230 v. 6.3 v. 5 amps. and 6.3 v. 1 amp. and 65 v. 85 mA., **15/-.** P.P. 3/6.
No. 15. Pri. 200–240 v. Sec. tapped 3, 5, 12, 20, 30 v. 2 amps., **25/-.** P.P. 3/6.
No. 16. Pri. 200–240 v. Sec. tapped 9–15 v. 4 amps., **22/6.** P.P. 3/6.
No. 17. Pri. 230 v. Sec. 6 v. 5 amp., **12/6.** P.P. 2/6
No. 18. Pri. 220–240 v. Sec. four separate windings, 3 x 5 v. C.T. 4 amp., 4 v. 4 amps., Potted type, **32/6.** Carr. 4/–.
No. 19. Pri. 200–2 0 v. Sec. tapped 3–60–66–70 v. 1.2 amps., **35/–.** Carr. 4/–.
No. 20. Pri. 200–250 v. Sec. 26 v., very conservatively rated at 36 amps., **£9/10/–.** Carr. 10/–.

EXCLUSIVE PURCHASE OF A.M. HEAVY DUTY TRANSFORMERS
Tapped to give the following specifications: Pri. 440–400 v. S.P. Sec. 220 v. or 110 v. 600 watts.
Pri. 220 v. Sec. 220 v. or 110 v. 600 watts. Pri. 220 v. Sec. 55 v. 10 amps. All winding. Double wound, **£5/19/6.** Carr. 7/6.

SPECIAL OFFER. BRAND NEW PARMEKO SEALED TRANSFORMERS. Pri. tapped 200–220–240 v. Sec. 4 volt C.T. 36 amps. Tropically rated. 25 kV. D.C. insulation. Size 9 x 8 x 8 inches plus 4 inch terminals. Offered at a fraction of maker's price. **£9/10/–.** Packing and carriage 15/–.



A.C. 200–240 v. 20 amp. switch contacts, make and break once every 24 hours. Complete with mounting bracket, and earth strip. Supplied brand new at a fraction of maker's price, **69/6.** P.P. 2/6.

VENNER 14 DAY CLOCKWORK TIME SWITCHES. 5 AMP. SWITCH CONTACTS. One make one break every 24 hours. Complete with two pin **Mounting bracket** and key, **32/6.** P.P. 2/–.

AMERICAN HIGH VOLTAGE CAPACITORS. 2 mfd. 10,000 volts wkg., **£8/10/–.** Carr. 7/6. 1 mfd. 20,000 volts wkg., **£7/10/–.** Carr. 7/6. 0.25 mfd. 25,000 volts wkg., **£6/10/–.** Carr. 7/6. Supplied brand new in maker's cartons at a fraction of original price. 16 mfd. 400 v. wkg., **8/6.** 10 mfd. 16 mfd. 660 v. wkg. A.C., **15/–.** 10 mfd. 1,500 v. wkg., **15/–.** 10 mfd. 600 v. wkg., **10/6.** 8 mfd. 1,500 v. wkg., **12/6.** 10 mfd. 300 v. wkg. A.C., **7/6.** Please add 2/– postage on all capacitors.

BRITISH TYPES. Nitrogol. 15 mfd. 250 v. wkg. A.C., **12/6.** Wego 10 mfd. 1,000 v. wkg., **12/6.** T.C.C. 8 mfd. 1,500 v. wkg., **10/6.** 8 mfd. 500 v. wkg., **8/6.** 8 mfd. 250 v. wkg., **5/6.** G.E.C. 8 mfd. 600 v. wkg., **6/6.** T.C.C. 4 mfd. 1,500 v. wkg., **10/6.** A.M. 4 mfd. 1,000 v. wkg., **5/–.** 4 mfd., 800 v. wkg., **4/6.** Dubilier 8 mfd. 400 v. wkg., **6/–.** 2 mfd. 600 v. wkg., **3/6.** 1 mfd. 5,000 v. wkg., **17/6.** 0.5 mfd. 10,000 v. wkg., **17/6.** 0.25 mfd., 5,000 v. wkg., **12/6.** A.M. 1.5 mfd. 4,000 v. wkg., **10/6.** T.C.C. 0.1 mfd. 5,000 v. wkg., **10/6.** 0.5 mfd., 2,000 v. wkg., **4/6.** 0.5 mfd. 500 v. wkg., **2/–.** 0.01 mfd. 5,000 v. wkg., **2/6.** Please add 2/– P.P. on all capacitors.

SPECIAL OFFER A.M. CAPACITORS. Tubular metal case size Dia. 3½in., length 9in. 30 mfd. 400 v. wkg., 26 mfd. 500 v. wkg., 20 mfd. 500 v. wkg., **15/–** each. P.P. 2/6.

SUNVIC ADJUSTABLE THERMOSTATS TYPE T.S.1. Suitable for control up to 300 deg. C., **27/6.** P.P. 3/6.

TANGENT HEAVY DUTY ALARM BELLS. 6 inch gong. A.C. 200–240 v., **35/–.** Carr. 4/–. 8-12 v. D.C., **27/6.** Carr. 4/–.

ADMIRALTY THERMOMETERS. 20–210 deg. F. Built-in metal cylindrical case, length 12ins., dia. 1in. Ideal for the lab., workshop or the home. Brand new at a fraction of maker's price, **7/6.** P.P. 1/6.

Manufactured by Crompton Parkinson MI 50 cycles, supplied new and guaranteed, **32/6.** P.P. 3/6.

EXCLUSIVE PURCHASE EXIDE 12 v. 4 A.H. UNSPILLABLE LEAD ACID BATTERIES. Size 4¼ x 4 x 3¾in. Weight 4½ lbs. Latest type. Specially designed for Rocket Electronic equipment. Maker's price £9 each. Supplied brand new with charging instructions, **52/6** each. P.P. 2/6.

1/10 H.P. A.C. MOTORS. 220–240 v. Cap. start. Reversible. 2,850 r.p.m. Cont. rating. ¼in. dia., Spindle length 1in., **55/–.** Carr. 4/–.

P.V.C. ADHESIVE INSULATING TAPE. 25 yard reels ½in. wide. Five different coloured reels for **10/–.** P.P. 1/6.

BRAND NEW W.D. TELEPHONE CABLE. TWIN D8, 1 mile drums, **£7/10/–.** Ex. warehouse. **TWIN D3,** 500 yard drums, **49/6.** Carr. 7/6. **SINGLE D3,** 1 mile drums, **85/–.** Carr. 7/6. Also 1/3 mile drums, **32/6.** Carr. 5/–. **COMMANDO ASSAULT TELE. CABLE.** P.V.C., 1,000 yard drums, **8/11.** Carr. 4/–. **EQUIPMENT WIRE.** P.V.C. 1/036, 100 yard coils, **6/6.** P.P. 1/6. 14/0076, 100 yard coils, **10/6.** P.P. 2/6.

G.P.O.

3,000 TYPE. 5000Ω 6H.D.C.O., **17/6.** 2,000Ω 4 H.D.C.O., **15/–.** 6,500Ω 1.C.O. 1B, **12/6.** 500Ω 1 C.O. 2B, **10/6.** 5,000Ω 1 H.D.B., **10/6.** 2,000Ω 2 M, **8/6.** 2,000Ω 1M., **7/6.** 100Ω 1CO. 1MB/F.B., **8/6.** 22,000Ω, 2M., **15/–.** 250Ω 4M., 4B, **10/6.** 100Ω 3M., **8/6.** 6,000Ω 2M., **10/6.** 6,000Ω, 4M., 2B., **12/6.** 10,000Ω 1 C.O., 1 H.D.B., **15/–.**

600 TYPE. 4,200Ω, 2 C.O., 1M., **9/6.** 400Ω 1 C.O., 1M., **7/6.** 750Ω, 1M., **5/6.** 400Ω 1 C.O., 1M. slugged, **7/6.** 150Ω 1B., **5/6.**

AMERICAN TYPE. 235Ω 2 C.O., **7/6.** 400Ω 2 C.O. sealed, **10/6.** 10,000Ω 1 C.O., 1M., sealed, **10/6.** 1/– P.P. on all relays.

AMERICAN LEACH CONTACTORS. 110 v. A.C. 3 pole, 20 amp. 230 v. Contacts, size 4½ x 4 x 3in. Brand new in maker's cartons, **25/–.** P.P. 3/6. A.M. Contactors, 12 v. D.C. 2 H.D.C.O., 1 C.O., 1 B. Brand new, **10/6.** P.P. 2/–.

AMERICAN HEAVY DUTY AUTO TRANSFORMERS. "C" core winding. Completely enclosed in metal container, 7½ kVA. 115–230 v., **£17/10/–.** Ex. warehouse. We have London's largest selection of auto transformers, 110–240 v. available from stock. Let us know your requirements.

SPECIAL OFFER: LATEST A.M. RELEASE. Isolation Transformers. Pri. tapped 100, 200, 220, 240 v. Sec. **225** v. **1.1** Amps. Tropically rated. Guaranteed **£3/5/–.** Carr. 7/6.

S.T.C. F.W. RECTIFIERS. Supplied brand new at a fraction of maker's price.
No. 1. Max. A.C. input 200 v. D.C. output 6 amp., **£8/10/–.** Carr. 7/6.
No. 2. Max. A.C. input 45 v. D.C. output 8 amps., funnel cooled, **59/6.** Carr. 4/–.
No. 3. Max. A.C. input 36 v. D.C. output 36 amps., **£8/10/–.** Carr. 4/–.
No. 4. Max. A.C. input 75 v. D.C. output 1.5 amps., **18/6.** P.P. 1/6.
No. 5. Max. A.C. input 32 v. D.C. output 2 amps., **15/–.** P.P. 2/–.
No. 6. Max. A.C. input 40 v. D.C. output 0.75 amps., **10/6.** P.P. 1/6.
No. 8. Max. A.C. input 18 v. D.C output 10 amps., **35/–.** P.P. 3/–.
No. 9. Max. A.C. input 18 v. D.C. ouput 4 amps., **15/–.** P.P. 2/–.

DOUBLE READING, MOVING COIL. 0–3 v. and 0–30 v. D.C. Centre zero. Offered at a fraction of maker's price, **12/6.** P.P. 2/–. **250-0-250 MICROAMMETERS.** Latest design 2½in. square, flush. By Ernest Turner. Brand new and guaranteed, **42/6.** P.P. 2/6.

SPECIAL PURCHASE !!
NIFE ALKALINE BATTERIES
6 VOLT 75 A.H. TYPE LR7
SUITABLE FOR ENGINE STARTING
Five 1.2 v. cells crated and connected to give 6 v. Brand new and fully guaranteed. Size of crate 15½in.x 12in. x6½in. **£7/10/–.** Carr. 15/–.

169-171 EDGWARE RD., LONDON, W.2. Telephone PAD 7851, AMB 5125

NEW—Quality Tools at cut prices. **ENGINEERS 12in. ADJUSTABLE SQUARE WITH SPIRIT LEVEL 9/6. 5in. VERNIER CALIPERS WITH DEPTH GAUGE 9/6.**
WHIT. OPEN END SPANNERS, drop forged and plated, set 6, 3/16in. to 1/2in., 13/6. **POCKET NEON TESTER,** with retractable screwdriver, 5/-. **5in. SIDE CUTTERS 5/6. 5in. PLATED ROUND NOSE TAPERED PLIERS, 5/6. 7in. FLAT NOSE BOX JOINT TAPERED PLIERS, 8/6. 7½in. COMBINATION PLIERS, 6/-.**
TUB. HACKSAWS (Eclipse type), **11/9.**
H.S. TWIST DRILLS. Set of 7. 1/16in. to 1/4in. 4/-. Full size in wallet, 6/-. Set of 13—9/6. Set of 17, 1/16 in.- 5/16in. in wood case. 15/6. Double Geared 5/16in. Chuck hand drill 24/-.
OUR FAMOUS TRANSFORMERS. Input 200/250 v. Output tapped 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 v., 2 amp., 24/6. 17, 11, 5 v., 8 a., 27/6. 5 a., 24/6. 3.5 v., 9, 17 v., 1 a., 13/-. P.P.
ACOS CRYSTAL MIKE INSERTS 1⅜in. Dia. 7/6.
12in. SPEAKERS WITH 5in. TWEETERS by leading makers, 75/-. Less than half list price.
NEW 12in. SPEAKERS, 12 watt (list price £12/12/-). £6/17/6.
NEW CELESTION OVAL SPEAKERS. 8½ × 5¾in. 24/-.
RELAYS. Single make contacts, 24 v. 25 amp., 15/-.
RELAYS. 4,000 ohm, S.M. or S.B., 6/-.
LAVOIS LABORATORY MICRO WAVE FREQUENCY METER. 300-600 Mc/s., £25.
B.C. 604 F.M. TRANSMITTER. Push button and manual tuning, 20-28 mc/s. Complete with 80 Freq. Crystals in 100 kc/s. stages. 24 v. power supply incorporated and with B.C. 603 Receiver for same, **£30.**
P.V.C. Recording Tape. Finest Quality. 850ft. reels, 19/-.
Hi-Fi CRYSTAL MICROPHONES in Grey Bakelite case, 15/6.
G.B. ELECTRONIC CRYSTAL STICK MICROPHONE in polished steel case, 4in. x 6in., complete with lead and plated Bulgin jack plug, 42/6. Weight 5 ozs.
F.W. METAL RECTIFIERS. 12/6 volt, 1 a., 7/6; 3 a., 13/-; 4 a., 17/6; 6 a., 27/6; 24 v. 2 a., 23/6; 12 v. 6 amp., 30/-; 12 v. 16 a., 45/-.
TOGGLE SWITCHES DPDT 3/6. SP 1/9.
MICRO SWITCHES, spring leaf, Make and Break, 5/6.
MAINS TRANSFORMER AND RECTIFIER giving 12 v. 1 a. D.C. Output, 19/6. And with Output 30 v. 2 a., 33/6.
NICKEL NIFE BATTERIES. 1.2 volt. 2.5 amp. Size 3×2¾×1in. Practically everlasting. 6/- or 3 for 16/-. 4 for 21/-.
Ex W.D. MORSE KEYS. 3/6, 6/- and 8/6.
1,000 NEW S.T.C. FREQ. CRYSTALS. 10,555 kc/s. to 19,872 kc/s., 5/6 each. Plus 6d. postage. Lists available.
PAXOLIN PANELS 12×6×⅛in., 3/6. P.P. 4ft. × 3½in. × ⅛in. 10/6.
W/W RHEOSTATS 12 v. 1 a., 2/6; 5 a. 4¾in. Dia. 10/6.
12 v. MINIATURE RELAYS. 1½×1½× 1in. Wgt. 1½ ozs. S.P.C.O., 8/6. S.P.C.O. and 3 M. 9/6.
12 v. D.C. RELAYS. 2 make 6/-; 2 for 11/6.
BENCH GEARED HAND-GRINDER. 5 × 1in. stone 31/6. 6 × 1in. 33/6.
BENCH VICE. 2½in. with clamp. 15/6.
EX. W.D. 12 v. D.C. Reversible Geared Motors. 2½×1¼in. Ideal for all model use, 16/6. Wgt. 10 ozs.
Amazing Miniature 6-8 v. D.C. motor. 1½×1⅛in. with built-in reversing switch. Wgt. 3 oz. 15/-.
Lists sent on request. All post paid.

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VERY HIGH SPEED
TENSIONING & DE-REELING

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14,500 turns, 46½ s.w.g. copper. Bobbin 8,000 r.p.m., final dia. 1in.
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SOUND SYSTEMS
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A new and complete range of
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(6 Ediswan Transistors and 2 Diodes)
6½ x 4½ x 1½in. approx.

Medium, Long Wave and Trawler Band to 80 metres. XC101's (350Mw) in push-pull for good quality output. 2 R.F. stages for super sensitive all band coverage. 3in. (full size) top grade speaker. Ferrite rod aerial. Pale blue polystyrene case with speaker grilles in red. Uses 4½ volt flash-lamp battery for long life. May be built for **£6/19/6.**
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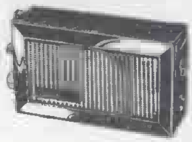

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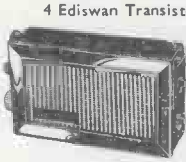
4 Ediswan Transistors and 1 Diode



Two S.W. coils free. Covers Medium and Long Waves. Bias sensitivity volume control. 3in. moving coil speaker. XC101's (350 Mw) push-pull output for fine tone. Uses 4½ volt battery. May be built for **£4/7/6.**

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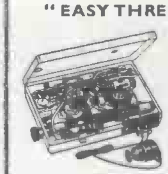

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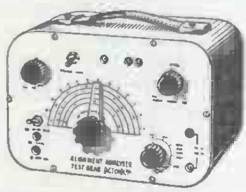

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Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series) I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied).
Complete with knobs.

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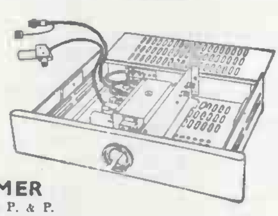

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To suit the above, 200-250 v. 6/- plus 1/6 P. & P.

B.S.R. MONARCH UA8 with FUL-FI HEAD

4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12½in. × 10¾in. Space required above baseboard 4¾in., below baseboard 2½in. Fitted with Ful-Fi turnover crystal head. £6/19/6. Plus 5/- P. & P.

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With built-in line and width control. 14 KV. Scan coil, 90° deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes.

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As Above, but for 625 lines **£2.10** Plus 4/- P. & P.

FOCUS MAGNET suitable for the above (state tube), 10/-. 2/6 P. & P.

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All with tapped primaries 200-250 volts

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100% AUDIO TRANSISTORS

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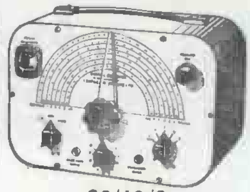

£6/19/6

Covering 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. × 6½in. × 5¼in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.
Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/- extra.

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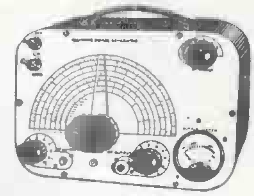

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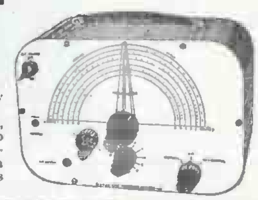
Coverage 7/6 Mc/s.-210 Mc/s., in five bands, all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.



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I F 34/38 Mc/s. Brand new complete with biscuit for channels 2, 4, 8 & 9.

less valves **10/-** plus 2/6 P. & P.
(Valves required P.C.C., 84 & P.C.F. 80.)
Pair of knobs to suit above, 3/6.

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INCORPORATING MINIATURE SPEAKER Plus GERMANIUM DIODE and PRINTED CIRCUIT

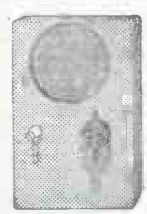
Size 3¼ x 4 x ⅞in.

Incorporating Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tunable over medium and long waves.

To build yourself **39/6** Plus 1/6 P. & P.

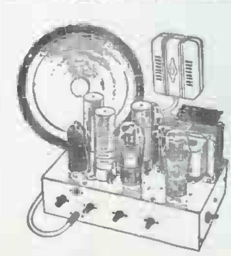
ALL PARTS SOLD SEPARATELY

Circuit diagram 1/6, free with kit.



All transistors guaranteed 100%

8 WATT PUSH-PULL AMPLIFIER



COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

A.C. mains 200/250 v. Size 10½in. × 6½in. × 2½in. Incorporating 6 valves. H.F. pen., 2 triodes, 2 output pens., and rectifier. For use with all makes and types of pick-up and mike. Negative feed-back. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 Kc/s. ± 2db.; 4 db. down to 20 Kc/s. Output 8 watts at 5% total distortion. Noise level 40 db. down, all hum. Output transformer tapped for 3 and 15 ohm speech coils. For use with Std. or L.P. records, musical instruments such as Guitars, etc.

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On printed circuit for A.C. Mains 200/250 v. Size 4in. × 3in. with tone and volume control. Valves: ECL82 and EZ80, 39/6. P. & P. 2/6.

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to join their computer maintenance team.

Applicants should be in the age range 25-40 years, with experience in the maintenance of computers or electronic equipment.

Preferably they should be qualified in telecommunications or radio at the level of H.N.C. or Final City & Guilds.

The work will be on a shift basis.

It may be necessary to give specific training but it is expected that the Engineer will be able to take over a shift within a period of six months.

The Company's conditions of employment include a generous Sickness Scheme and contributory Pension and Life Assurance Scheme.

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Candidates should be between 25 and 30 years of age and have either O.N.C. Electronics, City and Guilds Telecommunications (Intermediate) or an equivalent qualification.

Preference will be given to those applicants with experience in the installation, testing and servicing of electrical/electronic equipment.

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A.E.I.

Associated Electrical Industries, Ltd., Electronic Apparatus Division, Trafford Park, Manchester 17

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MATHEMATICIANS.
ELECTRICAL ENGINEERS:
(Electronics) Radar.
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required as:—
SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS.

QUALS.: Must have 1st or 2nd Class hons. degrees or equiv. (and S.S.O.'s have had min. 3 years post-grad. exp. and be not less than 26 years of age). Must normally be natural born British subjects of natural born British parents.

Appointment unestab. (with F.S.S.U. benefits) but opportunities for those between 21 and 32 to compete for estab. posts.

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Applications are invited from draughtsmen with some diagram experience for progressive junior and intermediate positions within our Design Department.

They will join an existing team who, in conjunction with Design Staff, produce operational diagrams for control systems involving industrial electronic techniques. Some knowledge of electronics would be of advantage.

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A leading Electronic Valve Manufacturer in the London area has vacancies for:

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Aged 25-40 years with experience in the following fields of electronic valve manufacture:

1. MICROWAVE VALVES.
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Apply to Box No. 4089 Reference S.E./61.

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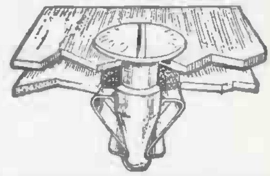

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MECHANICAL Instrument makers and general machinists with bench fitting and machine shop experience for construction of experimental and prototype electronic equipment.

BASIC PAY £9 18s. 2d. plus merit pay in the range of 10/- to 100/- per week. Merit pay will be assessed at interview, based on ability and the necessary basic qualifications.

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We have vacancies for men with electronic experiences for testing. Radar and Radio Technicians with fault finding experience would be suitable.

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City and County of Bristol Education Committee
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Placing on scale dependent on approved industrial and teaching experience.
Details and application forms, returnable as soon as possible, from the Registrar, Bristol Technical College, Ashley Down, Bristol, 7.
Please quote reference number of post when applying.

City and County of Bristol Education Committee
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Applications invited for new post of ASSISTANT, GRADE B, to teach in courses leading to the Aircraft Radio Maintenance Engineer's Licences (categories A and B).
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PLEASE QUOTE BTC 61/3

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to lead a small team engaged in the development of commercial communication equipment. Applicants should have a degree or equivalent qualification and some years experience as Project Engineers. Preferred age range: 30/35 years.

NON-CONTRIBUTORY PENSION SCHEME AND LIFE INSURANCE.
5 DAY WEEK.
EVENING INTERVIEWS ARRANGED.

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Apply to **CROWN AGENTS, 4 Millbank, London, S.W.1,** for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M2A/51200/WF.

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GUARANTEED satisfaction.—A. Marshall & Son, Ltd., 18, Cricklewood B'way, London, N.W.2. Gladstone 0161-2. [9253

FOR SALE AND WANTED ADVERTISEMENT FORM TURN TO PAGE No. 169

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★ Portable Ph. Meters	£22 10
★ Tinsley AC/DC Rack Potentiometers	£65 0
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VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A., Boxmakers, 75a, Godwin St., Bradford, 1. [0172

RECLAIMED valves, all tested and perfect, modern and obsolete, huge stocks, all one price, 5/-, plus 6d postage each; delivery by return; also surplus new valves, guaranteed; s.a.e. for list.—Lewis, 46, Woodford Ave., Ilford, Essex. [9463

VALVES for all purposes at bargain price; all valves advertised last month at 12 for 20/- still available; in addition we have very limited numbers of the following types at 6 for 25/- post paid; we regret only 3 of any one type can be supplied on each order. Please state alternatives:—
IT4, IR5, 1S5, 1A5/GT, 1LN5, 1LD5, B36, DH77, EBC41, EB41, EC54, EC91, ECC91, ECL80, EF42, EL38, EL41, EL91, EY51, KTW62, KTZ63, PL81, PL82, PL83, PL33, PY80, PY81, PY82, PY31, PZ30, UB41, UF42, U31, U281, UL44, UAF42, Z63, 6CH6, 6BX6, 6BG6, 6F12, 6F13, 6F14, 6F15, 6L18, 6LD20, 6V6G, 6N7, 6SL7, 6SN7, 10C2, 10P13, 10P14, 20F2, 20P1, 20P3, 726A, 210VPT, KT44, X66, ATP4, ECC31, ECC33, ECC35, EL81, 12J5, 12SG7, 12A6, 12A8, 2A3, 884.
ALL these valves are boxed and are new or ex equipment in which case they are electronically tested before despatch.—Waltons Wireless Stores, 15, Church St., Wolverhampton. [0105

VALVES WANTED

WANTED, new 12A7 valve or second-hand in good condition.—Regent 2283 between 9 and 12. [9495

NEW valves wanted, any quantity, best cash price by return.—Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [9180

ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. Tel. Euston 1636-7. [9124

WANTED, EXCHANGE, ETC.

A PROMPT cash offer for your surplus brand new valves, speakers, components, test instruments, etc.—R.H.S., 155, Swan Arcade, Bradford, 1. [0190

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0163

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris 93, Wardour St., W.1. Gerrard 2504. [9171

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc.; estab. 18 years.—Call, send or 'phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Square, W.C.2. [9173

PROMPT cash for the purchase of surplus stocks of televisions, tape recorders, radios, amplifiers and domestic electrical appliances of every description, substantial funds available.—Spears, 14, Watling St., Shudehill, Manchester. Blackfriars 9432 (5 lines). Bankers: Midland Bank, Ltd. [0216

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LOUDSPEAKER, pressure unit, and microphone repairs, D.C.B., cone assemblies and field coils in cartons, service and satisfaction guaranteed. —D. C. Boulton, 134, Thornton Rd., Bradford, 1. Tel. 22838. [0171

MAINS transformers wound to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship, fully guaranteed.
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WE undertake the manufacture of transformers singly or in quantities to any specification; all work guaranteed for 12 months.
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The solder with a small percentage of copper that gives ten times longer life to your soldering iron bits is available in the popular size one carton. It is supplied in three specifications: 53 ft. of 18 s.w.g., 30 ft. of 16 s.w.g., or 20 ft. of 14 s.w.g.: 5/- each (subject).

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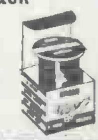
Contains 19 ft. of 18 s.w.g. 60/40 alloy wound on a reel or, for soldering printed circuits, 40 ft. of 22 s.w.g. 60/40 alloy also wound on a reel. 2/6 each (subject).



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Contains 3 ft. of 40/60 Ersin Multicore 5-Core Solder—enough for about 200 average joints. 6d. (subject).

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A real tin/lead solder containing cores of Ersin Flux. Needs no soldering iron or extra flux. Sufficient solder for 100 average joints. 1/-.

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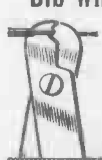

This efficient tool strips insulation, cuts wires cleanly and splits plastic twin flex. It is adjustable to most wire thicknesses. 3/6 each (subject).

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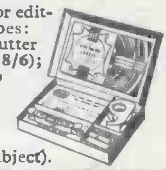
Contains everything for editing and classifying tapes: Bib tape splicer and cutter (available separately, 18/6); 6 spare cutters: 24 Bib tape reel labels (available separately, 2/6); spool of splicing tape; Bib data card: Complete Kit 28/6 (subject).



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EXTENSIVE RANGE OF CABINETS FROM £4-7-6

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Price £11.11.0

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This cabinet can be fitted with any of the latest Hi-Fi units.

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This elegant cabinet is available in veneered figured walnut and polished to a high gloss in a medium shade. Gold embellishments are an attractive feature of the design. 9in. black legs are normally fitted. A three sliding door system reveals ample storage room and space for equipment.

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TRANSFORMERS to any specification, singles, small or large batches, quick and efficient service, competitive prices, estimates.—Messrs. Newman & Son, 1, Grove Crescent, South Woodford, E.18 [0330

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METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar.
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E.M.I. Industrial Mark 6 camera, complete with control unit, tripod, channels 1 to 5, R.F. modulating unit, standard f/.9 lens, Som Berthiot f/2.4 to f/22 Zoom lens (with view finder), 11 months old, perfect condition, will work with standard T.V. receiver, cost £700; will sell £450 o.n.o.—Box 4202. [9507

NOTICES

THE ASSOCIATION OF PROFESSIONAL RECORDING STUDIOS, Ltd. To protect and encourage the interests of member studios engaged in electrical sound recording.—Write to the General Secretary, A.P.R.S., Flat 4, 34A, Arterberry Rd., London, S.W.20. [0173

CAPACITY AVAILABLE

RADIO components made to order.—Bel Sound Products, Marlborough Yard, N.19. [0185

DESIGN and draughting team seeks problems to solve, prototype manufacture undertaken, let us quote you.—Box 4058. [9490

COMPETITIVE quotations given for prototype and production runs with quality control.—Cave, Smith & Co., Ltd., Hereford. [9350

N.W. Electronic Sub-contractor, with spare capacity, seeks extra work; electronic and light electrical and mechanical assembly work undertaken to customer's specifications.—Box 3586. [9456

SITUATIONS VACANT

SPACE research.

TWO physicists (male) required as experimental officers (min. age 26), for Royal Aircraft Establishment's space research programme at (a) Aberporth, Cardiganshire, and (b) Bramshot, nr. Aldershot, Hants. Quals.: Pass degree, H.N.C., Grad. Inst.P or equiv. Must be experienced in handling and use of precision mechanical instruments; interested in astronomy and with ability to deal with simple electrical and electronic equipment. Work involves irregular hours and observations at any hour of night. Duties: To organise and carry out, with assistance, routine observations of artificial satellites with high precision photogrammetric equipment including harmonization of observations with Universal Time to high accuracy. In addition, at Bramshot, to assist in research and development of appropriate photogrammetric methods. Salary range: £1,057-£1,296 (provincial).—Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A142/1A. [9526

ELECTRONIC research.

ELECTRONIC Engineers and Physicists required for interesting research work in a variety of fields at a small research establishment, with the backing of a large industrial organisation. The work is centred on a country house ideally situated for easy access to the New Forest and a large part of the South Coast as well as to London. Very pleasant working conditions, an active Social Club with many indoor and outdoor facilities and a wide choice of types of residential area are additional features.
FIELDS of interest include general circuit work, microwaves, digital and analogue computer and storage techniques, data reduction and analysis, semiconductor applications and noise and information theory.
SALARIES are related more to ability and originality than to direct responsibility and for the right type of person compare favourably with those obtainable elsewhere. In the first instance they will lie in the range £750 to £2,000 p.a. depending on age, experience and qualifications.
APPLICATIONS giving this information should be forwarded initially to: The Personnel Manager, The Plessey Co., Ltd., Roke Manor, Romsey, Hants. [9501

LOUIS NEWMARK, Ltd.

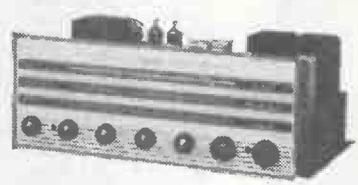
LEADING company in the design of auto pilots for helicopters are expanding their facilities at their development laboratories at Croydon and have the following vacancies to be filled immediately.
ENGINEERS and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering electronics, electro mechanical devices or semi conductors, to work on the development, installation and flight testing of automatic pilots. Salary commensurate wih experience. Pension scheme.—Apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. [0333

CENTRAL London firm requires competent organiser of postal and equipment sales. Age immaterial, refs. wanted. Part-time application considered.—Box 2462. [0133

Armstrong

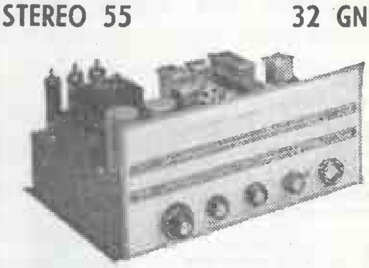
HIGH QUALITY RADIOGRAM CHASSIS

STEREO 12 Mk. 2 42 GNS



The most complete chassis ever produced, combining AM and FM Tuners, a Stereo Control Unit and two High Fidelity Amplifiers in one compact unit. Eight watts push-pull output from each amplifier provide a total of 16 watts for both mono and stereo. Other features include automatic frequency control on VHF; ferrite aerial, two IF stages and miniature tuning indicator for medium and long waves; inputs for tape recording, playback, pick-ups and stereo radio (should this come about); separate wide range bass and treble controls and balance control; booster units available for low output pick-ups; alternative matching for any loudspeakers.

STEREO 55 32 GNS



A junior version of the Stereo 12 Mk. 2 providing ten watts output, five watts from each amplifier and covering the VHF and medium wavebands. Ideal for a complete hi-fi system where the higher power output of the Stereo 12 Mk. 2 is not required. Like the Stereo 12 Mk. 2 it can be used for mono only/and a second loudspeaker added at a later date.

JUBILEE Mk .2 29 GNS

A hi-fi mono chassis giving eight watts push-pull output and covering VHF, medium and long bands. Tape recording and playback inputs.

AF 208 22 GNS

An AM/FM chassis providing 5 watts output and covering the full VHF and medium wavebands. Tape recording and playback inputs.

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SITUATIONS VACANT

ASSISTANT to the Chief Engineer.

PAINTON & Co., Ltd., manufacturers of high quality components for the electronics industry, are expanding their activities and wish to appoint an Assistant to the Chief Engineer. Applicants must be graduates in Physics or Electrical Engineering, have experience in the design and development of Electronic Components and be able to carry executive authority. This is a staff appointment with superannuation scheme.—Applications to the Personnel Officer, Kingsthorpe, Northampton. [9500

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE.

PRINCIPAL: E. Bailey, B.Sc., F.R.I.C., A.M.I.Chem.E.

REQUIRED, as soon as possible, Assistant Lecturer Grade A for Radio Officers' courses with opportunities for taking other radio and electrical courses within the Electrical Engineering Department. Candidates should hold a First Class P.M.G. Wireless Telegraphy Certificate and M.o.T. Radar Maintenance certificate. Sea-going and/or teaching experience are added qualifications.

SALARY, Burnham Scale, £520×£27/10 to £1,000 per annum with additions for approved experience, qualifications and training.

FORMS and particulars (s.a.e.) from Clerk to the Governors, Education Offices, Cobourg St., Plymouth, to whom they should be returned as soon as possible. [9523

CENTRAL ELECTRICITY GENERATING BOARD, Eastern Division.

APPLICATIONS are invited for the following appointments in the Divisional Electrical Department:—

FOURTH Assistant Engineers (Telecommunications) (S.V. No. 1468).

SALARY N.J.B., Class AX, Grade 9, Scale 9, £1,005-£1,245 per annum. The applicants appointed will be based at either Cockfosters (North London), Bedford, Ipswich or Luton The salary for the post at Cockfosters will be subject to an addition of £50 per annum in respect of London Weighting. Applicants should preferably possess qualifications leading to Graduate Membership of the British Institution of Radio Engineers, or the Institution of Electrical Engineers. Consideration will, however, be given to candidates well advanced in studies for Higher National or City and Guilds Certificates. The successful applicants will be required for installation, maintenance fault clearance, testing and commissioning of a variety of telecommunications equipment, including auto-telephony, telemetering, remote control systems, power line carrier equipment, V.H.F. radio, etc. Experience in one or more of these fields is desirable. A knowledge of the Generating Board's standardised system of indications, telephony and telemetering would be an advantage. Applications, quoting Reference S.V. No. 1468. and indicating the location of the post for which they wish to be considered. stating age, qualifications, experience and present position, should be sent to the Controller, Central Electricity Generating Board. Eastern Division, West Farm Place, Chalk Lane. Cockfosters, Barnet, Herts., to arrive not later than 6th May, 1961. [9518

CENTRAL ELECTRICITY GENERATING BOARD.

SOUTH Western Division.

VACANCY No. WW/AV/31/61.

ASSISTANT Engineer (Instruments) required at Berkeley Nuclear Power Station.

SUPERANNUATION Scheme. Salary, N.J.B. Class M, Grade 12. Scale 9. £1,115-£1,245 per annum.

APPLICATIONS are invited for the above post from men with a thorough theoretical and practical knowledge of electronic equipment and its servicing. The successful applicant will be engaged on high-grade servicing of all electronic and semi-conductor devices associated with nuclear reactors. The duties will also include assisting in the training of Instrument Mechanics in the electronics field. Opportunities will be provided for gaining experience in conventional power station equipment.

APPLICATIONS on Form A.E.6/ACT obtainable from the Divisional Secretary, 26, Oakfield Rd., Bristol, 8. should be completed and returned by 11th May. 1961. [9508

INSPECTORS (elec. and mech.) required urgently for light electro-mechanical engineering establishment, staff conditions.—Apply to Elliott Brothers (London), Ltd., Borehamwood, Herts. Tel. Elstree 2040, ext. 353. [9494

ELECTRICAL test personnel are required by a well-known audio equipment designers and engineers; good all-round knowledge and previous experience essential.—Apply Tannoy Products, Ltd., Norwood Rd., S.E.27. [9520

SOUND recording studio requires an Assistant Engineer, knowledge of electronics required, preferably some experience of mixing music tapes from discs. Write stating age, qualifications, experience, salary required to—Box 4099. [9499

AIRCRAFT radio engineers and mechanics required with specific workshop experience of one or more of the following: VHF, HF/MF, ADF, ILS, VOR, X-band radar; 42-hr. week, top basic wages. Engineers: £15 p.w. Mechanics: £14 p.w. Pension scheme after 12 months satisfactory service; overtime and bonus system in operation.—Apply in writing, stating experience, to The Managing Director, Air Transport (Charter) (C.I.), Ltd., 7, Willow Rd., Poyle Trading Estate, Colnbrook Slough, Bucks. [9527

SITUATIONS VACANT

ELECTRONICS engineers: Men or women with at least O.N.C. or equivalent experience to do final tests and inspection on a wide range of high accuracy instruments. These are permanent staff positions with pension fund and club room facilities.—Electronic Instruments, Ltd., Richmond 6434. [0124

OPERATOR is required for a geophysical playback centre, incorporating multi-channel magnetic recorder/reproducers; applicants should have H.N.C. with electronics, or exceptional practical experience; geophysical, field or playback experience, would be an advantage. Hayes-Orpington area.—Box 4188. [0335

RADIO mechanics skilled in workshop maintenance required to overhaul airborne radio and electronic equipment at Stansted Airport; N.J.C. rates of pay, sick payment, paid holidays, contributory superannuation schemes.—Apply Personnel Officer, Skyways, Ltd., 7, Berkeley St., W.1. [9510

JUNIOR Designer required by electrical component manufacturers in N.W. London; good knowledge of radio frequency circuits and experience in electronics, radio and/or television industry would be an advantage; write giving full details of experience, age and salary required to—Box JD4897. AK Advg. 212A, Shaftesbury Ave.. London, W.C.2. [0036

EXPANDING lively company requires young man with proven experience in the maintenance and operation of modern cinematograph, P/A and recording equipment, for interesting and varied work in connection with mobile Audio-Visual units; applicants should possess a clean driving licence, have good appearance and be willing to work occasional irregular hours.
A GOOD salary is offered to the right applicant. Write in first instance, giving full details of qualifications and previous experience. Residence in the N. London area an advantage.—Box 4241. [9509

SENIOR electronics technician required now for the development, construction and maintenance of a wide range of electronic research equipment in University Laboratory. Commencing salary in the range £800-£1,000. Apply giving full details of training and experience to the Secretary, Physical Chemistry Laboratory. South Parks Rd.. Oxford. [9524

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications. receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details to Personnel Officer, Redifon. Ltd., Broomhill Rd., S.W.18. [0252

UNUSUAL opportunity with exceptional prospects for young man with initiative and intelligence, managing director of technical studio specialising in preparation and production of technical literature needs assistant, experience of publicity and printing, together with experience or genuine interest in radio/electronics, coupled with precise and methodical mind.—Write fully to Knight-Clarke, Ltd., 23, Radnor Mews, W.2. [9492

LABORATORY Senior Technician (Physics), Queen Mary College (University of London), Mile End Road, E.1. Salary placing on scale £690×£25—£815 p.a. according to ability. London Weighting up to £45 and possible qualifications supplement of £30 or £50. Pension scheme; 5-day week; 4 weeks' annual leave. The person appointed will, if found suitable, be in charge of the electronics workshop. Letters only to the Registrar (PST), stating age, full details experience and present work. [9514

OVERSEAS. Electronic technicians are required by an oil exploration company with headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle and swamp. The equivalent of an H.N.C. with practical experience in electronics, is essential. Tours overseas are of up to two years, followed by home leave.—Write with full particulars, covering any time spent in the Forces. to Box 2228. [0331

ELECTRONIC Engineer, interesting, varied work on scientific instruments, small, rapidly expanding company provides friendly and informal conditions with good opportunities for advancement; essential qualifications: a thorough understanding of electronic valve circuitry at d.c. and low frequencies, both theoretical aspects and practical application; experience of transistors, printed circuits and/or magnetic amplifiers an advantage; state fully career details and salary required to—Technical Director, Shandon Scientific Co., Ltd., 6, Cromwell Place, S.W.7. [9419

INTERNATIONAL AERADIO Ltd., has periodic vacancies overseas for Radio Technicians, City and Guilds Intermediate Telecoms. an advantage but not essential if applicant has considerable experience installation/maintenance H.F./V.H.F. low/medium power comms. Equipment; applications ex-service personnel of fully skilled categories welcomed; posts are permanent and pensionable; normally accommodation is provided with tax free emoluments equated to local conditions; additional marriage and child allowances; free air passages and insurance; kit allowance; generous U.K. leave; apply in writing.—Personnel Manager, 40, Park St., W.1. [0262

SITUATIONS VACANT

AN electronics engineer is required by the Department of Engineering Production, the University of Birmingham. The work for which he is required includes the maintenance and development of existing timing, measuring and recording apparatus and the design and manufacture of new research apparatus, amplifiers and recorders; final City and Guilds Certificates in the appropriate subjects is a minimum qualification for the candidate's further advance, together with experience in similar fields of work. There is the prospect of early promotion to a senior grade.—Further particulars from Professor N. A. Dudley, The University, Edgbaston, Birmingham, 15. [9496

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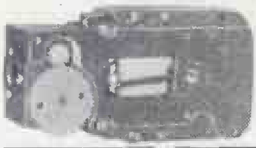

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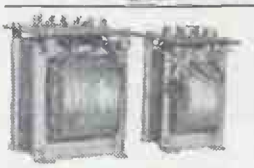

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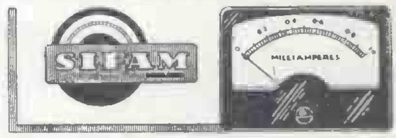

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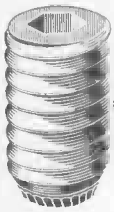

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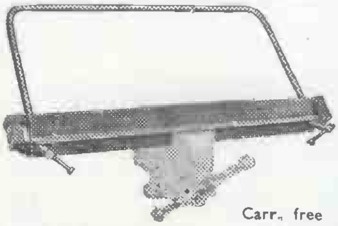

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Measurement signal generator Model 80		450.00
Model 84		750.00
Power Supplies		
Radar Pulsers to test Magnetrons		695.00 Up

KLYSTRONS

2K22	25.00	2K50	99.00
2K23	25.00	2K54	24.00
2K25	12.00	2K55	35.00
2K26	35.00	2K56	50.00
2K28	27.50	D1788461	60.00
2K29	29.50	X12	475.00
2K33A	200.00	V23	350.00
2K39	170.00	V45	450.00
2K41	99.00	V270	225.00
2K42-4	170.00	5721	110.00
2K48	55.00		

and others.

MAGNETRONS

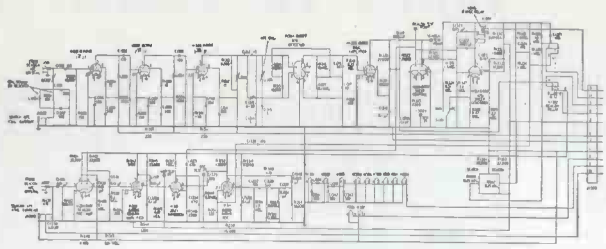
Sorensen Power Supplies		Selenium Rectifiers	
Furst Power Supplies		Various Semiconductors, Transistors,	
Inverters		Diodes X Band Wave Guides, Misc.	
Thermistors 167332		Microwave Plumbing etc.	
2J21	12.50	2J56	110.00
2J30	37.50	2J61-62	35.00
2J31	12.50	2J61A-62A	75.00
2J32-34	17.50	3J21	50.00
2J36	17.50	3J31	60.00
2J37/39	22.50	4J31/39	135.00
2J42	90.00	4J52	45.00
2J48/50	25.00	4J57-9	135.00
2J51	99.00	4J60-62	135.00
2J51A	150.00	QK59-62	27.50
2J55	145.00	and others.	

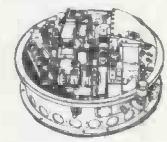
STANDARD LABORATORY RECEIVERS

APR4	$195.00	APS4	$228.00
APR4 (w/5 tuning units)	895.00	APS10	695.00
APR5	180.00	APS23 (trans)	195.00
APR5A	180.00	APS32 K band radar	875.00
APR10	180.00	APS23 Receiver	
APT2	75.00	Transformer	245.00
APT5	180.00	APS31 PARTS	

A MICROWAVE & TUBE GOLD MINE

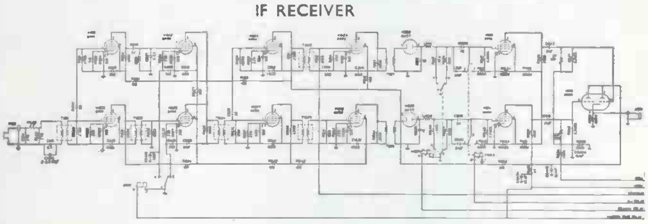
AFC CONTROL



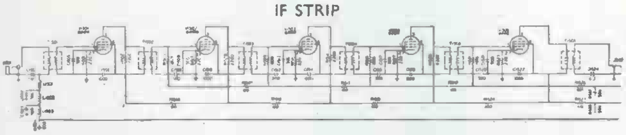


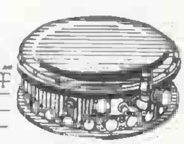
OPEN and CLOSED VIEWS of APS-23 and circuit diagrams illustrated

IF RECEIVER



IF STRIP

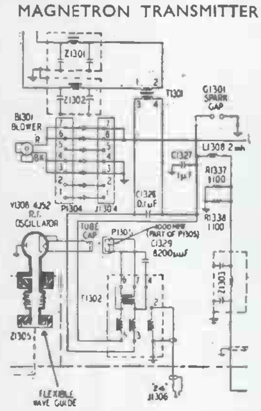




IF STRIPS COMPLETE WITH TUBES

60 mc - 10 mc wide - 24.00 **30 mc - 4 mc wide - 36.00**

MAGNETRON TRANSMITTER



3 Cm RF HEAD of the APS23

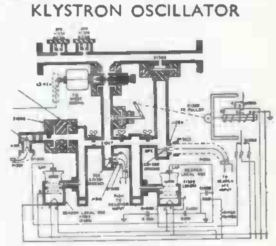
RADAR

Consisting of:

Microwave Plumbing including 35 TUBES including 4J52 Magnetron 2 Klystrons also 3 Silicon crystals, 2 Germanium diodes 7 Relays and countless other parts.

Motor with blower, various transformers, 60 megacycles IF Strip, 10 MC bandwidth etc.

KLYSTRON OSCILLATOR



(Government cost for tubes alone over 500 dollars.) Your price with all tubes as above

$195.00

Complete with 6510 Magnetron and all other tubes. Ruggedized type $245.00.

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Infra-red Viewers
Thermistors
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C.R. Tube Sockets
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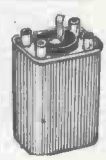

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Printed in Great Britain for the Publishers, ILIFFE ELECTRICAL PUBLICATIONS LTD., Dorset House, Stamford St. London, S.E.1, by CORNWALL PRESS LTD., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; William Dawson & Sons (S.A.), Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street New York 14.

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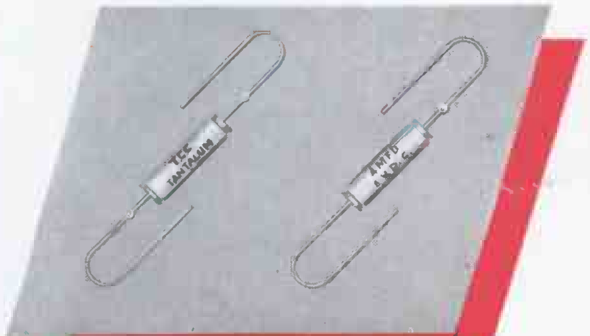
The extended shelf life of Tantalum Condensers is such that preliminary re-ageing is unnecessary, even after long dormant periods, and the reliability remains unimpaired.

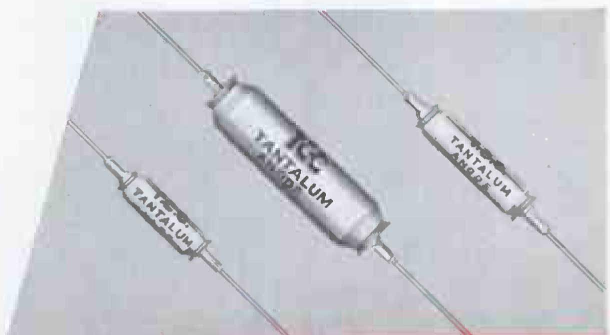


MINIATURE RANGE

MINIATURE RANGE (– 40°C to +85°C)

Capacities from 4 µF at 6v. to 0·2 µF at 150v.

Small size, light weight and reliability, particularly with regard to long shelf life. Suitable for Transistor circuitry, Airborne equipments, communications, high quality Hearing Aids and Timing Circuits.



STANDARD RANGE

STANDARD RANGE (–50°C to +85°C)

Capacities from 200 µF at 6v. to 15 µF at 150v.

For equipments where low temperature conditions are met, and for apparatus working for prolonged periods without the need for servicing. Airborne and miniature transistorised assemblies are some of the latest applications.

HIGH TEMPERATURE RANGE (–55°C to + 125°C)

Capacities from 16 µF at 6v. to 16 µF at 150v.

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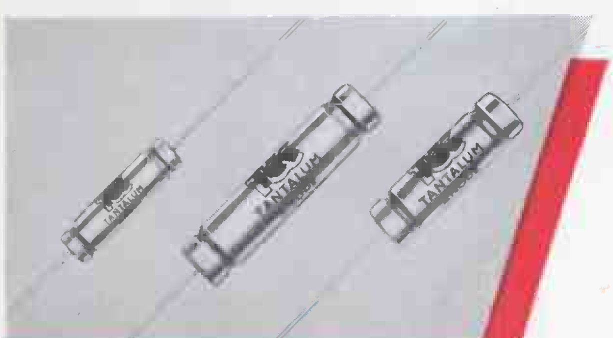

HIGH TEMPERATURE RANGE

General Characteristics

Type of construction: Polarised or non-polarised plain foil.

Capacity tolerance: –20% +50% (Miniature) ±20% elsewhere.

Power factor: 8% at 50 c.p.s. but 12% below 15v. working.

Max. leakage current: 2 µA after 10 mins. at working voltage (Miniature); elsewhere ·01 µA/µF/Volt, or 2 µA, whichever is the greater.

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