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Wireless World

ELECTRONICS, RADIO, TELEVISION

FEBRUARY 1961

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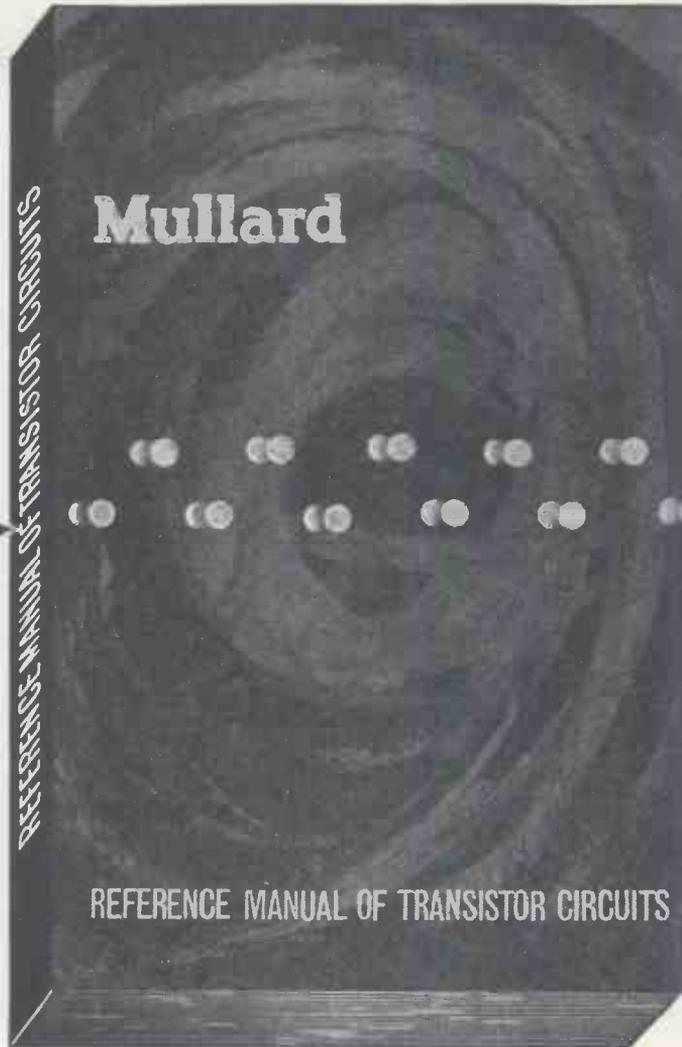
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COMMUNICATION VIA SATELLITES

THE idea of long-distance communication by reflection from or relay by artificial earth satellites has been with us now for at least 15 years. At first it was treated as a rather pleasant exercise in speculation, and even today it is often difficult not to regard it as still part of science fiction. But the hard facts are that commercial interests in all parts of the world are putting teams of engineers and scientists to work on the detailed design of systems which are now feasible, thanks to advances in rocket propulsion, u.h.f. and s.h.f. generation and the techniques of noise reduction in receivers. In America ground stations have been built and satellites of both the passive ("Echo") and active ("Score" and "Courier") kinds have been put into orbit to prove the merits of alternative methods.

Quite apart from the natural reaction of those nations who can afford to meet the scientific and technological challenges of space exploration, the military advantage of reliable communication and the commercial gains awaiting increased traffic handling capacity are sufficient justification for the present expenditure on satellite communications.

In the band width available a million telephone channels could in theory be provided for about the same cost (£88 M) as the proposed Commonwealth round-the-world cable, which has a capacity of only 80 telephone (3kc/s) channels. That is not to say that the Commonwealth telephone cable project should be scrapped. It is based on a proved system and one which will fit into any future scheme of world communications.

Before satellite communication systems can carry the load of daily traffic, many years of testing and development lie ahead. There is no lack of feasible ideas and many have been worked out in considerable detail. The case for one type of active satellite system is stated in an article published in this issue, and equally detailed analyses of other proposals can be read in *Proc.I.R.E.* for April 1960. No doubt fresh ideas will appear in the Brit. I.R.E. Communications and Space Research Convention, which is to be held in Oxford next July.

Everything is in a state of flux but, as things stand at present, passive satellites in 24-hour orbits, and thus apparently fixed 22,300 miles above points on the equator, would seem to offer the best solution. The reflection process is linear and no problems arise from cross-modulation; but a large structure, preferably spherical, is required to return an adequate and constant signal. No one yet knows whether such a reflector can be placed exactly in the right orbit, and if so how long it will stay there under the influence of sun and moon gravitational perturbations, radiation pressure or meteor impacts.

A better short-term policy would seem to be to use several lower-altitude, shorter-period reflectors spaced so that at any time at least one was above the horizons of both transmitting and receiving stations. Such reflectors can be placed in orbit (with relatively few misfires) by rocket vehicles at present in quantity production, but the system presents difficulties in location and tracking, in following Doppler frequency shifts and in smooth transition from one satellite to another to maintain a continuous service.

Active satellites simplify problems of signal-to-noise ratio and, being more solid and compact structures, are probably less vulnerable to meteor damage than thin metallized balloon reflectors. Being equipped with solar cells they can no doubt find the energy for position and attitude correction under ground control, if enough ejection matter can be included in the payload to provide the necessary reaction. Attitude stabilization can be neglected or reduced if less directional aerials (of lower gain) are employed—but at the price of high transmitter power and more weight. In low-altitude active satellites, which travel for a large part of their time in the earth's shadow the problem of energy storage is important and there is room for the development of batteries of even higher capacity/weight ratio which will work for long periods when sealed.

Thanks to parametric amplifiers and masers, noise in receivers is no longer a limiting factor and a limit to performance in this respect is now set by cosmic background noise. The selection of suitable modulating systems under the guidance of information theory has further extended the distance at which reliable signals can be exchanged. Much has been learnt from experience with telemetry, and the successful communication with Pioneer V out to a distance of 23 million miles gives the measure of present-day performance.

Looking to the future and assuming that one or more of the available communication systems is put into service, there still remains the very big problem of interference. Passive reflectors are aperiodic and will return to earth any u.h.f. and s.h.f. signals which would otherwise have penetrated the ionosphere and been lost in space. Active satellites will add their quota to a rising interference level and will themselves be vulnerable to interference. The whole future of satellite communications will depend more than anything else on the decisions of an Extraordinary Administrative Radio Conference of the International Telecommunication Union to be called in 1963, and on the readiness of all concerned to abide by the decisions then to be taken on frequency allocation.

ACTIVE SATELLITES

By L. POLLACK *

PROSPECTS FOR WORLD-WIDE COMMUNICATION SYSTEMS

Paper presented at the U.R.S.I. XIII General Assembly, London, September, 1960

THE subject of earth satellites as radio relays has received great attention in the communication industry during the past several years. The need for such satellites to extend the capacity of commercial long-haul systems has been well documented, and it is now a generally accepted fact, to us who are close to the subject at least, that the capacity of international communication routes may be most economically increased by an artificial satellite relay system.

Various systems of satellites such as passive and active, at low altitude orbit and synchronous altitude orbits, have been analysed for application as multi-channel communication relays, by several authors, e.g., Pierce and Kompfner in *Proc. I.R.E.*, March, 1959. As a result of similar studies at I.T.T. we have concluded that an active satellite repeater in a synchronous orbit will prove to be the most economical system.

Development of this active system, however, will probably progress from the low-altitude type to the synchronous orbit "real time" repeater.

General System Constraints

Factors such as choice of operating frequency and modulation scheme apply with equal weight to all satellite relay systems. With respect to the operating frequency, operation must be in the 1 to 10 kMc/s band as determined by cosmic noise and atmospheric absorption, considerations which have been described elsewhere† and are summarized in Fig. 1. In active systems where weight of the satellite is so important, two further factors are considered in determining the optimum frequency: (a) satellite r.f. components, particularly power amplifiers, duplexers and antennæ decrease in size and weight with increasing frequency; and (b) the efficiency (d.c. power input, r.f. output) of radio-frequency amplifiers seems to improve with the number of applications for such amplifiers; at present substantially higher efficiency is available at lower frequencies.

This question of transmitter efficiency is the more important in determining the weight of the satellite and the cost of placing it in orbit. Improvement in efficiency decreases the weight of power supplies rapidly, particularly in present supplies using solar cells and rechargeable batteries. In addition, with increased efficiency, the problem of heat dissipation is ameliorated and the weight of heat sinks or radiators will be less.

The selection of an operating frequency, then, becomes a matter of determining which of the fre-

quencies between 1000 and 10000 Mc/s can be generated and transmitted most efficiently. At the present state of the art this seems to be in the 2000 to 4000 Mc/s band.

Since satellite power is limited, the modulation method that will yield the desired channel signal-to-noise ratio, say 50 to 55 dB, with the least transmitted power is preferred. Therefore, a type of modulation is indicated which will yield substantial improvement of the channel signal-to-noise ratio over the carrier-to-noise ratio at the expense of bandwidth.

For the active relay the choice of modulation is further limited by the peak-to-average ratio of the multichannel modulated carrier or carriers, particularly if a beam type amplifier such as a travelling-wave tube is used in the output stage of the satellite.

System Description

Let us consider two systems which may illustrate the instrumentation that will be used:

(a) **Delay Repeater Type.**—The first system, a delayed repeater type known as project Courier, has been in operation since the launching of the satellite on Oct. 4, 1960.

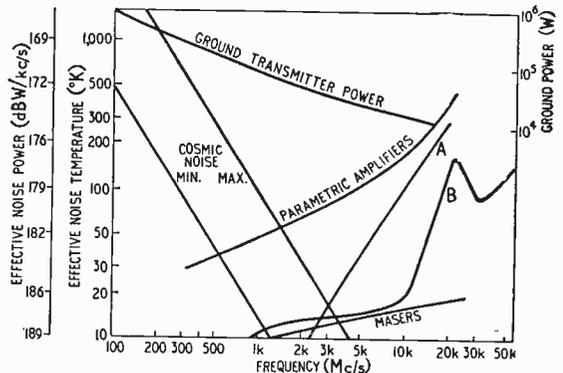


Fig. 1. "Noise"-frequency curve. The effective noise power scale is in decibels referred to 1 watt per kc/s bandwidth. Curves A and B show respectively absorption during heavy rains and clouds, and oxygen-water vapour absorption above 10° antenna elevation.

The programme (directed by the U.S. Army Research and Development Laboratory) brought together the efforts of the I.T.T. Corporation for the ground stations, the Philco Company for the satellite, and Radiation, Inc., for the tracking antennæ. Two stations were linked during the first experiments, one

* I.T.T. Laboratories, Nutley, N.J., U.S.A.
† Radio Communication Using Earth-Satellite Repeaters. L. Pollack, *Electrical Communication*, Vol. 36, No. 3, 1960.

at Ponce, Puerto Rico, and the other at Deal, New Jersey.

In the Courier concept, each ground station can accommodate the output of 20 teleprinter machines operating continuously at 100 w.p.m. The messages are recorded at slow speed on magnetic tape (about 1.6in/sec) during the time the satellite is not in view. When the satellite, which is in a 650 nautical mile orbit at 28° inclination, comes into view, the ground station transmits the recorded signals at higher speed, 60 in/sec, and the satellite stores them on magnetic tape. Simultaneously, previously stored messages are transmitted to the ground, on another frequency, and later played back at the 1.6in/sec speed to a paper tape punch for eventual teleprinter machine read-out. The klystron recorder and control console are shown on the right of Fig. 2. Each of the four digital types of satellite tape machines can record 15 million bits. A fifth machine is an analogue recorder.

The satellite normally transmits a 50 mW v.h.f. beacon signal for acquisition and tracking. When it comes within range of a ground station, a coded command from the v.h.f. ground transmitter to the v.h.f. receivers in the satellite will activate the satellite u.h.f. transmitters and receivers.

Operating in the 1700 to 2400 Mc/s band, the four satellite message transmitters permit reception at the ground of horizontal and vertical polarization at two frequencies. The H- and V-polarized transmissions at each frequency are combined prior to

detection in the ground receiver at i.f. The two base band outputs are further combined, yielding a four-fold diversity system which will resist signal variations caused by satellite tumbling and nulls in the antenna pattern.

The 1-kW ground transmitter, through orthogonal illumination of a 28-foot parabolic reflector, directs a circularly-polarized signal to the satellite receivers. The 4-watt satellite transmitter output and ground receiving system noise figure of 3 dB should yield a signal-to-noise ratio of better than 21 dB at the maxi-



Fig. 2. Control console, klystron recorder and tape machines in the control van for the Courier project.

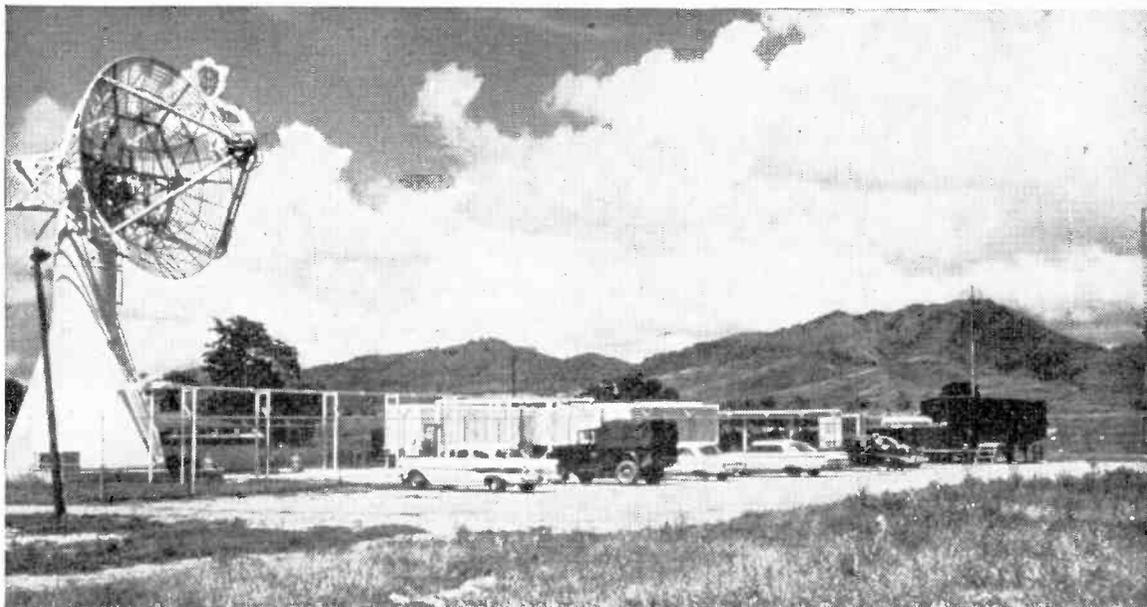


Fig. 3. The Ponce, Puerto Rico, ground station for "Courier."

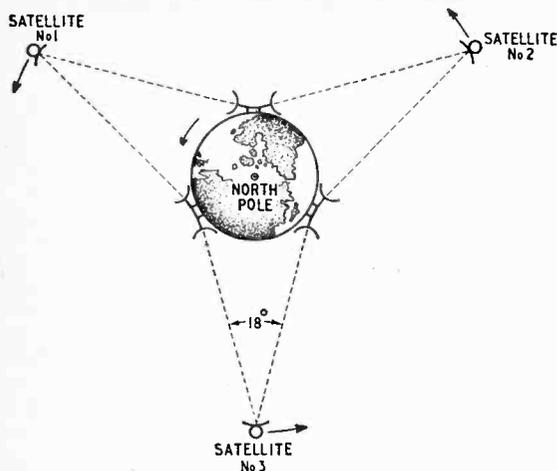


Fig. 4. Synchronous-orbit satellite system. The vehicles are in an equatorial orbit at 22,300 miles. Their orbital speed and the rotational speed of the earth are 2π radians per 24 hours so that they maintain a constant position relative to the earth.

mum slant range. This corresponds to an error rate of better than 1 part in 10^5 at 2700 miles. A photograph of a complete ground station is shown in Fig. 3.

(b) **Synchronous Orbit Real Time Repeater.**—The single delayed repeater satellite may be the economical method for teletype or other digital transmission when a delay of as much as 12 hours can be tolerated. However, it is the synchronous orbit repeater which is expected to meet economical telephone standards.

The commercial system that we have designed for early implementation would operate in the 2 to 4 kMc/s band. The satellite would weigh less than 450lb to use available booster rockets, e.g., the Atlas-Agena, and would carry a simple wideband repeater with an assured operating life of at least one year.

A three-satellite synchronous-orbit system, shown in Fig. 4, would furnish communication to most of the inhabited areas on earth. §

The satellite vehicles would be attitude and position controlled to keep station at points in space above the mid-Atlantic, mid-Pacific and Indian Oceans.

The maximum gain satellite antenna has a beam width of 24° which allows a margin of $\pm 3^\circ$ for attitude control error in addition to the 18° required for hemispherical

§ This system was first suggested by A. C. Clarke in *Wireless World*, October, 1945.—ED.

coverage. The radio repeater block diagram shown in Fig. 5, is a simple ultra-high frequency translator using all solid state components except for a single travelling-wave tube which will amplify the translated signal and simultaneously generate the translating frequency.

The command and control signals, for operating the propulsion system and turning on a spare u.h.f. translator, should this be required, plus the telemetry signals, which indicate operating conditions in the satellite, will be radiated over a separate v.h.f. transmitter.

By frequency-modulating the carrier with the multi-channel information in pulse code form, the travelling-wave tube can be operated at power output saturation with good efficiency (perhaps 25-30%).

The ground station would use 60-ft diameter reflectors and parametric converters, with a receiving system noise temperature of 95° . If we take, for example, the usual p.c.m. case of a 6-bit code at a voice channel sampling rate of 8 kc/s the base-band bandwidth for the assumed 960 channel system is 2.3×10^7 c/s. To transmit the information with the least power, a gaussian shaped band-pass response is used.

The 3-dB bandwidth of the overall system would be 46 Mc/s to obtain an acceptable inter-channel cross-talk ratio. Since the pulse information frequency-modulates the f.m. threshold, the r.f. carrier must be exceeded. In addition, there is a p.c.m. threshold below which noise improvement fails; this point is reached when the pulse signal cannot be separated from noise with great certainty. An r.m.s. base-band signal to r.m.s. noise of 9 dB is an acceptable threshold value.

The carrier power required (in dB referred to 1

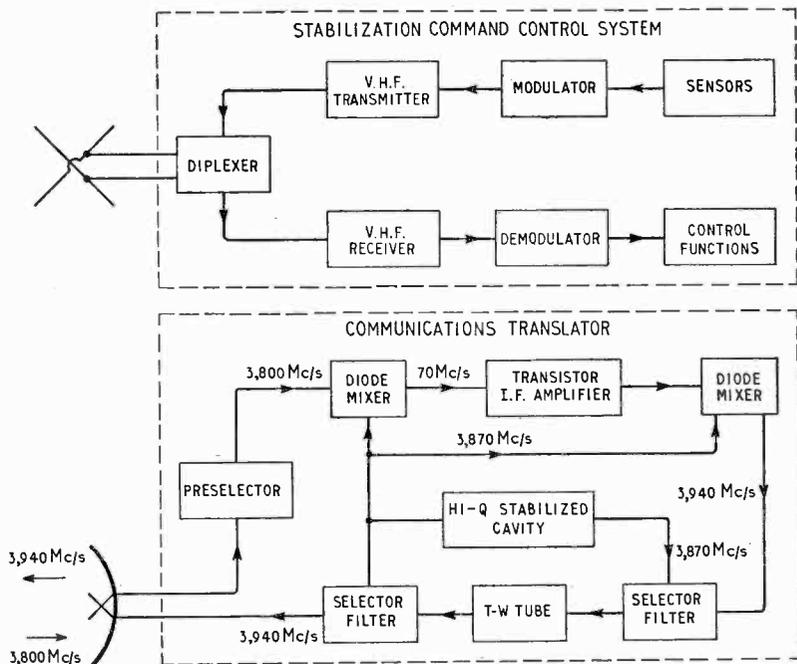


Fig. 5. Schematic of satellite communication equipment using solid-state components and one travelling-wave tube.

watt), neglecting for the moment the f.m. threshold, is:

$$P_{tr} = -10 \log \frac{1}{KT} + 10 \log B - 20 \log \frac{\sqrt{3}\Delta f}{f} + 9 + L$$

B=I.f. bandwidth

L=fath loss in dB (the sum of receiving and transmitting antenna gain and free space loss)

K=Boltzmann's Constant 1.38×10^{-23}

T=Effective temperature of the receiving system, i.e., receiver noise temperature+antenna temperature.

If in addition we use a synchronous demodulator, the p.c.m. threshold of 9 dB will determine the system breaking point.

With such a receiving system a satellite power output of five watts would allow a 9 dB margin above the system threshold. The satellite's overall dimensions are:—length 5ft and diameter 3ft. The major portion of the weight of 450lb is due to the station-keeping propulsion equipment, the control system, and the vehicle frame. The electronic equipment weighs only 80lb. The 5-watt translator, operating on 3.7-4.2 kMc/s, with a bandwidth of 50 Mc/s, has a capacity of 500 channels.

In the particular case considered here, small solid fuel rockets such as used in the Tiros weather satellite will correct initial orbit injection velocity and position errors. Once the satellite is in proper orbit propulsion along the three axes for station keeping will be accomplished with gas jets.

The satellite attitude reference system consists of an infra-red horizon sensor to determine the earth vertical and horizontal. A sun sensor will provide orientation of the solar collectors and the third plane of reference. Corrective torques are applied whenever the satellite attitude or position drifts beyond specified limits. Thus, the satellite will slowly oscillate about a nominal position between pre-set limits.

Traffic Requirements

Initially, a world-wide system channel allocation could be arranged as shown in the Table. The Atlantic satellite would link Western Europe, Africa, all of South America and Eastern United States. This satellite would handle the greatest traffic, with a total of 960 voice channels. These allocations are based on traffic studies for the immediate future rather than long-term estimating. The channel allocations for the Pacific and Indian Ocean satellites are based on linking small as well as large countries where growth in communications has been hampered by natural barriers.

By initially designing a wide-band system with sufficient channel capacity to apportion traffic to all interested countries through international agreement, it is hoped the problem of unauthorized use of the satellite will be avoided.

Problems

It is recognized that several factors in the ultimate establishment of the satellite system require development to achieve a fully operational commercial system. The life of the satellite repeater has been mentioned. The life of components can reach ten to twenty years, as demonstrated by submerged repeater experience. We have proposed a time division system; however, the synchronization accuracy required has not been achieved. The launching

VOICE CHANNEL ASSIGNMENTS

Atlantic Satellite			Pacific Satellite		
England ...	...	144	Hawaii ...	...	48
Germany ...	...	96	New Zealand ...	...	36
France ...	...	72	Australia ...	...	72
Italy ...	...	24	Japan ...	...	72
Switzerland ...	...	24	Philippines ...	...	48
Belgium ...	...	12	Eastern U.S.S.R. ...	...	48
Denmark ...	...	12	New Guinea ...	...	12
Netherlands ...	...	24	Alaska ...	...	12
Norway ...	...	12	Inter-Sector ...	...	36
Sweden ...	...	12			
U.S.A. ...	...	288			384
Cuba ...	...	24			
Bahamas ...	...	12			
Puerto Rico ...	...	24			
Argentina ...	...	24	Indian Ocean Satellite		
Brazil ...	...	24	Central U.S.S.R. ...	...	96
Venezuela ...	...	36	China ...	...	36
Colombia ...	...	24	Borneo ...	...	12
Bermuda ...	...	12	Saudi-Arabia ...	...	6
Dominican Rep. ...	...	6	Turkey ...	...	6
Ethiopia ...	...	6	Israel ...	...	6
South Africa ...	...	6	Greece ...	...	6
Belgian Congo ...	...	6	India ...	...	36
Morocco ...	...	6	Pakistan ...	...	6
Nigeria ...	...	6	Afghanistan ...	...	6
Egypt ...	...	6	Iran ...	...	6
Inter-Sector ...	...	18	Inter-Sector ...	...	18
		960			240

vehicles and the space tracking networks to control orbit injection have been developed to a high state of perfection by the Defense Department and National Aeronautical and Space Administration as part of our weapons and space science programme. Attitude control devices which must cycle on and off many thousand times during a one-year life must be proved. The operating frequencies for the satellite system must be allocated and international agreement obtained.

A 960 channel system, such as envisaged for the Atlantic satellite, would occupy a 50 Mc/s band for the duplex transmitting and receiving channels.

The useful bands available for a common carrier system under present F.C.C. allocations are 2110-2200; 3700-4200; 5925-6425; and 10700-11700 Mc/s.

If for the moment we assume we can share frequencies with common carrier line-of-sight stations, the bands 3700-4200 or 5925-6425 Mc/s would appear attractive since these fall close to the optimum frequency for communications through a satellite radio repeater and a 500-Mc/s band, well in excess of our requirements, is available.

The line-of-sight transmitters in common carrier service operate at less than 10 watts output with antenna beam widths of less than 10° . At the synchronous orbit altitude the interference of these line-of-sight transmitters with the satellite is certainly negligible. Similarly, the 10 watts or less radiated by the satellite will not interfere with the line-of-sight receiver by a margin of 30 to 40 dB. The problem then is with the satellite system ground transmitter possibly interfering with the line-of-sight receiver and alternately the line-of-sight transmitter interfering with the satellite system ground receiver. It has been shown that by restricting the elevation angle of the satellite system antenna to not less than

10° above the horizon, a prerequisite to avoid noise due to the hot earth, and the choice of site to areas where low man-made noise conditions prevail, will avoid, ground-terminal-to-ground-terminal interference. A calculation of a typical system at 3 kMc/s would show that a separation of 30 miles between competing stations would assure that the interference level is 20 dB below the desired signal.

These thoughts consider the immediate future, perhaps the next ten years; however, thinking of the long-range growth of communication requirements, several common carrier trunks will be required across the oceans. To accommodate the expansion ten to twenty additional 50-Mc/s bands will be required. The provision of a frequency allocation for the exclusive use of these earth-space-earth relaying services will indeed be a difficult problem.

The time delay in transmitting from one ground station through the satellite to another ground station is about 0.5 sec. Operational tests of the disturbance caused by this delay to the conversing parties indicate that it is not serious. In fact, the observers participating in the tests were not aware of the delay until it was called to their attention. Delays longer than 0.5 sec, with appreciable echo present, were annoying. Increased attention to echo suppression at the subscriber terminals will be necessary.

It is interesting to consider the economic potential

of the 24-hour satellite system. The estimated cost of a small ground station (6-12 channels) is \$400,000 and that of a large station (70-280 channels) \$1M. The first cost of the ground system and operation for ten years allowing for twenty high-capacity and twenty low-capacity stations is estimated at \$50M, based on an annual operating cost of \$1M for the large stations and \$500,000 for small stations. Assuming four misfires in placing the first satellite in orbit and using existing government launching facilities, the cost of the first satellite in orbit is expected to be \$30M. With time, misfires should decrease, and in a ten-year period, the satellites would be replaced four times at an approximate total cost of \$130M. The over-all cost of the system, then, is \$180M—an average of \$18M per year over the ten-year period. F.C.C. statistics for communication carriers for the year 1957 indicated a gross revenue per overseas telephone channel of approximately \$85,000. Considering the transatlantic satellite with 960 channels, with the present channel utilization factor and the same message charges, the gross income would be in excess of \$80M per year.

Comparing this income of the single Atlantic satellite with the estimated cost of \$18M per year for the system indicates that it would certainly pay for itself and suggests the strong possibility of a substantial reduction in the tariff charge per message.

With this note of optimism I conclude.

Electronic Railway Signal-Interlocking

THE Western Region of British Railways are to install at Henley-on-Thames what they believe to be the first electronic signal-interlocking system in the world.

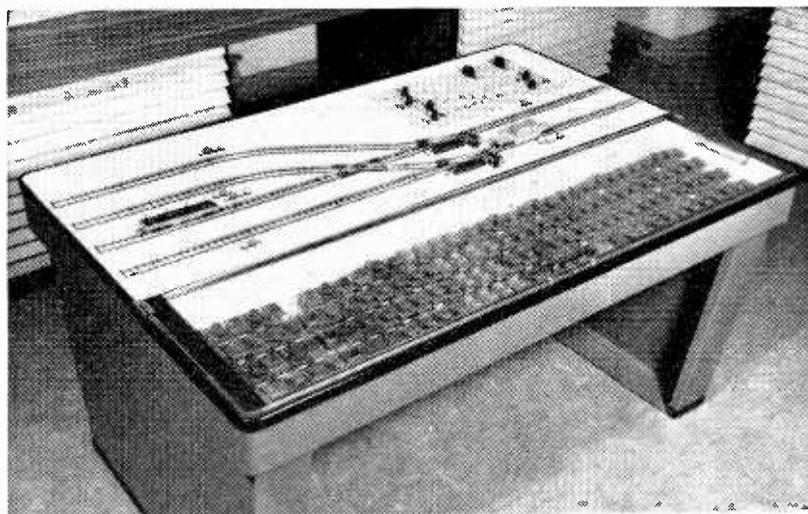
The plant, developed by Mullard Equipment, Ltd., employs solid-state circuitry exclusively, the avoidance of mechanical components introducing great economies in maintenance costs.

The logic of the system is composed, in the main, of "AND" gates with inputs from the track circuits. The signal controls are of the "switch entrance, push-button exit" type, and the state of each route is indicated by

appropriately coloured lights in the signal-box. Inputs from all track circuits and points are required by a succession of "AND" gates before the exit push-button can conclude the logical sequence initiated by the entrance switch. If any part of the route is in the wrong state, the route cannot be cleared, and the signals remain at red. When a train has passed the first track circuit of its cleared route, the entrance signal is automatically returned to red, and the route cannot be used again until the logical sequence has been repeated.

The system is arranged to "fail safe"; any fault occurring in the logic circuitry causes all signals to return to red. In addition, a route set up incorrectly by the signalman may not be corrected immediately. All signals must first be set to red, and the route set up correctly after a sufficient time-delay to allow the train to stop has been imposed automatically.

The plug-in logic units, employing semiconductors and ferrites, are capable of operating reliably over a wide temperature range.



Simplified demonstration model of the signal-interlocking system to be installed at Henley-on-Thames signal-box.

Applications of Frequency-Sweep Oscillators

1.—DIRECT TEST AND MEASUREMENT

By R. BROWN

The basic principle of the frequency-sweep oscillator is that its r.f. output, whilst remaining constant in amplitude, is changed in frequency at an a.f. rate. This variation of frequency may be accomplished, in the electrically-simplest units, by a motor-driven tuning capacitor or some other form of mechanical modulation. In more recent instruments, however, the wide-band frequency modulation or sweep is accomplished electrically, typical means being a back-biased semiconductor junction, a reactance valve or a section of ferrite material whose effective permeability is varied by an a.c. passed through a winding. These devices are connected in the frequency-determining circuits of an oscillator and the voltage or current used to vary the frequency of the oscillator also deflects a c.r.t. spot, so forming a line. Points along this line then represent frequencies, rather than times, as they would on the x-trace of a normal c.r.o.*

ONE of the most time-consuming and boring tasks that have to be carried out in the construction or repairing of electronic equipment is the adjustment and measurement of frequency-response curves. It is here that the frequency-sweep oscillator, wobulator, or sweep generator, as it is variously called, comes into its own. Its use always brings about a very great saving in time, and in most of its numerous applications the skill required is very much less than would be required were other types of instrument or techniques used.

Perhaps the best known application of this instrument is the alignment of intermediate-frequency amplifiers. The block diagram of apparatus set up for displaying the response curves of such amplifiers and similar equipment is shown in Fig. 1. A time-base is used to sweep the frequency of the oscillator across the passband of the equipment under test. The output from the tested equipment is detected and displayed as y-axis deflection of an oscilloscope. The oscilloscope timebase is synchronized with the sweep of the oscillator, so that distances along the horizontal axis of the display are a function of oscillator frequency. Distances along the vertical axis of the display will, of course, be proportional to the output of the equipment, that is to the gain or response. The trace thus represents curve of the gain/frequency characteristic of the tested equipment.

Calibration

This displayed response curve is very informative; but if the aim is accurate alignment some means of calibrating the x and y axes, that is frequency and gain scales, must be included in the instrument. The first necessity is a datum or horizontal line corresponding to zero gain and, therefore, no output from the equipment under test. This datum line can be produced by pulse modulation of the frequency-sweep oscillator, so that it is switched off during each alternative oscilloscope scan. The oscilloscope will

thus display the response curve on one scan, and the datum line on the next scan.

Frequency calibration can be carried out by mixing the output of the frequency-sweep oscillator with the output from a separate marker oscillator: or, alternatively, by connecting an absorption-type wavemeter to the output of the frequency-sweep oscillator. The markers produced by the first method are known as "active" markers, whilst

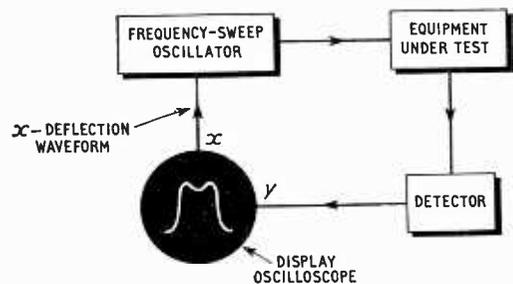


Fig. 1. Typical arrangement of apparatus for displaying amplitude/frequency response curves.

those produced by the second method are described as "passive". The source of markers can be a variable-frequency calibrated oscillator—a signal generator for example—or it can be a crystal oscillator. The output from the frequency-sweep oscillator will beat with the marker oscillator and when their frequencies approach synchrony, this beat will show up on the displayed response curve. If a crystal is used, its frequency can be chosen so that the frequency-sweep signal will beat with the individual harmonics of the crystal and produce a series of markers at fixed intervals.

Active markers would, if produced as described above, be required to pass through the equipment; but some may well occur at frequencies outside the

* See, for instance, *Wireless World*, Vol. 62, p. 252 (June, 1956).

equipment's passband and thus not visible: they might also be difficult to see on the skirts of the response curve. This defect can be avoided if part of the swept-frequency signal is tapped off and mixed separately with the output from the marker oscillator; the beats so produced can, after passing through a low-pass filter to limit their width, be mixed with the detector output and displayed.

The beats produced by both of these methods of producing active markers do distort the trace to some extent. A better approach is to shape the beat produced by this secondary process into a narrow pulse. This narrow pulse is then used to modulate the intensity of the oscilloscope beam so that the spot is extinguished when a beat occurs. The blank point produced can be made very sharp, and it gives a very distinct marker which does not distort the response curve.

Passive markers are produced, as has been said, by connecting an absorption wavemeter across the output of the frequency-sweep oscillator. The wavemeter will absorb some of the energy in the signal when the signal frequency coincides with the wavemeter frequency, so a dip will appear in the displayed response curve. This type of marker is sometimes difficult to see, particularly on the skirts of the response curve or near the cross-over point of an f.m. demodulator. If the equipment under

test includes an efficient limiter, the marker may not appear at all.

Relative amplitudes within the response curve can be roughly estimated from the display. If, however, an attenuator is fitted to the frequency-sweep oscillator the oscilloscope graticule can be calibrated accurately. This can be done in the following manner:—

A horizontal line is first drawn on the graticule at the height of the top of the response curve; the oscillator output is then reduced by a convenient amount, say 1dB, and a second line is drawn at the new position of the top of the response curve. The oscillator output is then reduced in level in further steps of 1dB, a horizontal line being drawn at the height of the top of the response curve at each step. When the oscillator output is restored to its maximum level, the relative levels of the different points on the displayed response curve can be accurately determined by making use of the series of 1dB lines that have been drawn.

Some typical response curves are shown in Fig. 2. The various types of frequency marker are shown, and also two methods of assessing relative levels within the displayed response curve.

In some applications such as equipment alignment on a production line a large number of similar items have to be aligned and checked. A considerable saving in time and skill can be achieved by displaying the response of the equipment under test and a correctly adjusted equipment simultaneously. Fig. 3 shows a suitable arrangement. Two detectors and a double-beam oscilloscope are used: on one beam of the oscilloscope is displayed the response curve of the equipment under test, while on the other beam is displayed the response curve of the standard correctly-adjusted equipment. All the operator has to do is adjust the components in the equipment under test until the two response curves are identical. There is no need then to refer to any frequency or amplitude calibration.

Sources of Error

There is a tendency for the frequency-sweep generator to be used only for the initial alignment of amplifiers, filters etc. and reliance to be placed on well proved point-by-point methods for making the final adjustments and for carrying out precise measurements on the equipment under test. Yet, if reasonable precautions taken, sweep-generator measurements will be found to yield results which are quite as accurate as point-by-point measurements.

Sweep Rate.—One of the most important points over which care should be taken is the rate at which the frequency of the generator is swept¹. It is essential that the sweep rate is slow enough to allow the voltages in all the circuits in the network under test to reach their full amplitude. The circuit time constants are not important when making measurements at one frequency, for there is then ample time for all the circuits to reach their steady-state condition; but if these time constants are not taken into consideration when using sweep-generator techniques serious errors can occur. The effects of having too fast a sweep rate are unfortunately not easily recognizable except in extreme cases, and these cases are not often met in practice.

In the event of the sweep rate being too high

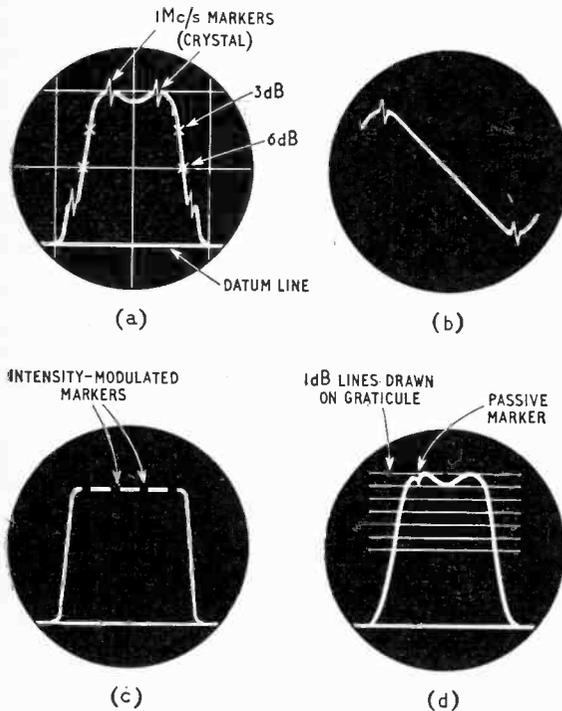


Fig. 2. Typical displays: (a) response curve of bandpass amplifier showing active crystal markers at 1Mc/s intervals and datum or zero-output line. -6dB and -3dB points are estimated on the display, -6dB being half way (half output) between zero and top of curve. (b) F.m. discriminator showing crystal markers. (c) Wideband amplifier response curve with intensity modulation of c.r.t. beam for markers. (d) Bandpass amplifier curve with passive (absorption wavemeter) marker. Lines drawn at 1dB intervals enable amplitude measurements to be made.

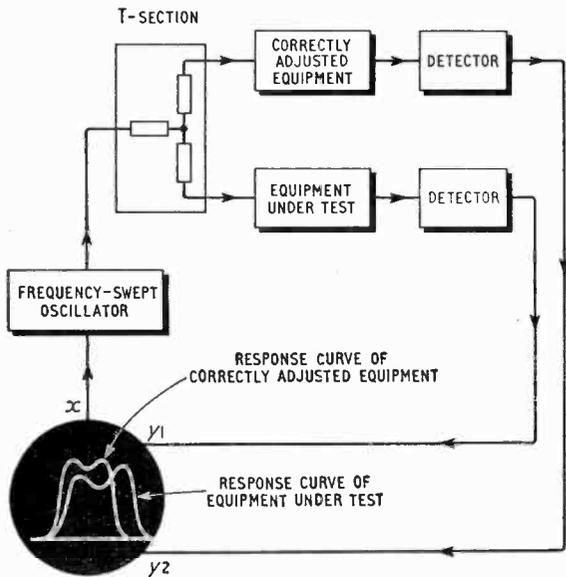


Fig. 3. Arrangement of equipment for use on repetitive work. Double-beam c.r.o. displays, superimposed, both desired (from previously adjusted equipment) curve and that obtained from equipment under test.

there will not be sufficient time to allow the voltages in the circuit to reach their normal maximum value, the response curve displayed will have a lower amplitude than the actual response curve. Also, even after the frequency of the sweep generator has been swept past the top end of the passband of the network under test there will still be some output from the network as the circuits slowly return to the no-signal condition. These effects produce in addition to a reduced amplitude, an apparent increase in bandwidth, a displacement of the displayed response curve in the direction of the sweep, and an asymmetrical response curve with the trailing edge stretched out more than the leading edge (Fig. 4). In extreme cases a damped oscillation can be produced after the trailing edge of the response curve; but long before this effect becomes apparent the other effects will have produced very serious errors.

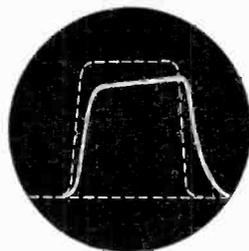
There is luckily a very simple method which can be used to determine approximately, for any given circuit, the maximum permissible sweep rate. This is based on the response, to a swept-frequency signal, of a resonant circuit of bandwidth B_0 which has an amplitude characteristic approximating to a gaussian error-distribution curve. The relationship between the sweep time t (sec), the sweep width w (c/s), and the bandwidth B_0 (c/s) of such a circuit can be expressed by the following formula:—

$$A = 1 + 0.195 (w/tB_0)^2 - \frac{1}{4} \dots \dots \dots (1)$$

where A is the ratio of the displayed amplitude to the amplitude that would be measured were point-by-point methods of measurement used. From this it would appear that correct results will only be obtained with point by point measurements; but small errors can be accepted and for most purposes an error of less than 5% is not serious. This allows the simplification of Equation (1):—

$$B_0 = \sqrt{(w/t)} \dots \dots \dots (2)$$

Fig. 4. Effect of sweep rate too high. Dotted curve is true response, full line shows display with asymmetrical, low-amplitude curve displaced in direction of sweep.



B_0 now gives the minimum bandwidth that can be correctly displayed for any given sweep rate.

These two equations are correct where the rate of change of frequency is linear with time—a condition which holds when the waveform of the voltage used to control the sweep is a sawtooth. In some sweep generators, however, the sweep-control voltage is sinusoidal as it is obtained from the a.c. mains supply. Thus the rate of change of frequency will vary throughout the sweep and, where this is the case, it is necessary to use the maximum sweep rate as the basis for obtaining the minimum bandwidth that can be correctly displayed. A sine wave is steepest at the point where it crosses the zero axis and, at this point, the frequency will be swept at 1.57 times faster than would be the case were a sawtooth waveform used. Hence for a sinusoidal sweep waveform Equation (2) must be changed to:—

$$B_0 = \sqrt{1.57w/t} \dots \dots \dots (3)$$

In many cases the shape of the response curve of networks does not conform to a gaussian error-distribution curve, and there does not seem to be any simple means of determining directly with the fastest permissible sweep rate. The most common type of response curve which does not conform to a gaussian error curve is shown in Fig. 5. This has a flat top with very steep sides, and is typical of the response curves of many filters and wideband amplifiers. The critical portions of such a response curve, as far as maximum sweep rate is concerned, are the leading and trailing edges, the width of the flat top being of no importance. One way out of the difficulty is to draw the expected response curve, and then draw the response curve of a resonant circuit (with a gaussian error-distribution curve) which has the same steep side as the response curve of the equipment under test. The sweep rate must then be chosen so that it is slow enough to display correctly the response curve of this equivalent resonant circuit.

In generators using a sinusoidal sweep from the mains supply the duration of the sweep is fixed at 10msec—the time of one half cycle of the mains frequency—and this is the period used in almost all commercial instruments. Alterations in the

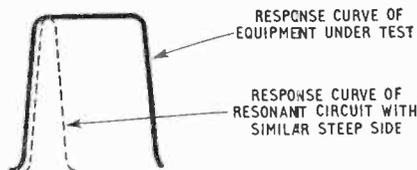


Fig. 5. Determination of maximum permissible sweep speed for circuit with response other than that of gaussian error curve.

sweep width are then achieved by altering the rate at which the frequency is swept. Fig. 6 shows a graph relating sweep width to minimum bandwidth for a generator with a sweep duration of 10msec. As an example of the use of this graph, consider a wideband i.f. amplifier having steep sides and a passband of three-and-a-half megacycles. A sweep width of, say, 5Mc/s would have to be used in order to display completely the skirts of the response curve. The graph shows that for such a sweep width the sides of the response curve will be displayed correctly provided that they are not steeper than the sides of the response curve of a resonant circuit which has a response curve corresponding to gaussian error distribution curve and a bandwidth of 28kc/s.

Harmonic Distortion.—Harmonics of the frequency-swept signal, produced either in the sweep generator itself or by non-linearities in the characteristic of the equipment under test can be a serious source of error. This is particularly so when testing equipment which has a response in which the passband is very wide compared with the centre frequency. With a response curve of this type the second and third harmonics of the frequency-sweep signal may well be within the passband for part of the sweep. Fig. 7 shows the response curve of an equipment which has a passband extending from 500kc/s to 3.5Mc/s, the full line shows the actual response while the dotted line shows the effects of the presence of the second and third harmonics. From the leading edge of the response curve at 500kc/s to 1.17Mc/s the second and third harmonics, as well as the fundamental, are within the passband of the equipment and the displayed response has an amplitude which is the sum of the three components. At 1.17Mc/s the third harmonic passes outside the passband of the equipment, and the displayed amplitude is then the sum of the second harmonic and the fundamental. At 1.75Mc/s the second harmonic passes outside the passband of the equipment and the true amplitude is displayed. The harmonics will also produce a response on the display at frequencies below 500kc/s, where the fundamental is outside the passband.

Perhaps the most serious type of error encountered as a result of harmonics being present is that which occurs when measurements are made on the response of the high-selectivity trap circuits which are often included in broad-band equipment. These circuits are designed to suppress unwanted signals, often

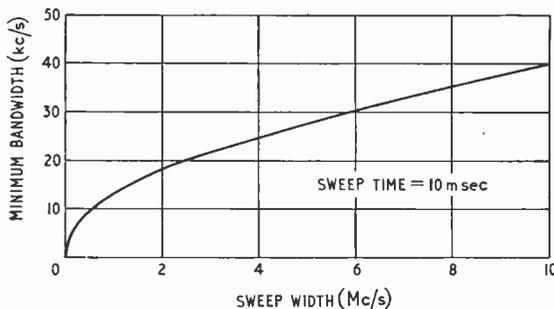


Fig. 6. Relation between sweep width and minimum bandwidth that can be displayed correctly, for a sweep time of 10msec.

by as much as 40 to 50dB. With a correctly-adjusted trap the fundamental of the frequency-swept signal will be suppressed by this amount, but if there are any harmonics present which fall within the passband of the main equipment, they will be passed through without any suppression and will be displayed.

Matching.—It is most important that the cable connecting the sweep generator to the equipment under test is correctly matched. The result of any mismatch will be that some of the energy from the sweep generator will be reflected at the input of the equipment under test and standing waves will be set up on the cable. As the frequency is being varied continuously, the number

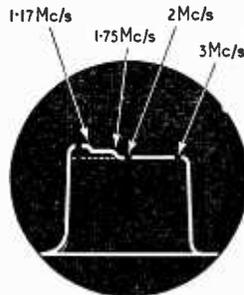


Fig. 7. Effect of harmonic distortion in generator when harmonics fall within passband of equipment under test.

of standing waves in the cable will vary throughout the sweep. This results in the voltage at the input to the equipment under test varying throughout the sweep—if the sweep width is wide enough this voltage will pass through a number of maxima and minima.

The actual errors produced will depend upon the degree of mismatch, the electrical length of the cable and the width of the frequency sweep. The maximum possible error will occur when the sweep width and the electrical length of the cable are such that the voltage at the equipment under test varies at least from one voltage maximum to the next voltage minimum.

Oscillator-output Variation.—Even with the most careful work, it is practically impossible to build a frequency-sweep oscillator in which the output level remains constant throughout the sweep. With any of the methods commonly used to sweep the frequency—reactance valve or ferrite modulator, motor-driven tuning, etc.—the sweep voltage has some effect on the oscillator output. 0.25 to 0.5dB is a common variation and the output change can be even greater. This, however, can be reduced considerably by including in the instrument some form of automatic level control. One way of doing this is to connect a detector across the output of the swept oscillator. The detector output, which will be proportional to the sweep-oscillator output, is used to control the gain of one of the amplifier valves in the instrument, and so tends to reduce the variations in oscillator output. With such an automatic level control in circuit, the variations in oscillator output can be reduced to something like ± 0.1 dB.

Applications

The frequency-sweep oscillator has a multitude of applications additional to the direct display of

the amplitude/frequency curve. Much greater accuracy of amplitude/frequency alignment, for instance, can be achieved if, instead of displaying the amplitude/frequency characteristic, the first derivative of the amplitude/frequency is displayed; or the difference between the input and output of the equipment under test, instead of simply the output, can be displayed. These two applications, together with several others, will be described in later parts of this article.

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1. H. Lucius. The Polyskop., Rhode und Schwarz-Mitteilungen. Vol. 10 (1958), p. 145 and Hor. Gunner, Response of Linear Resonance Systems to Excitation of a Frequency Varying Linearly with Time. *J. App. Phys.* Vol. 19 (1948), p. 242.
2. D. G. Haley. 20Mc/s Sweep Generator Type TF 1099. *Marconi Instrumentation*, Vol. 6 (1958), p. 166.

(To be continued)

Electronic Nerve Cell

FOUR-TRANSISTOR CIRCUIT ANALOGUE

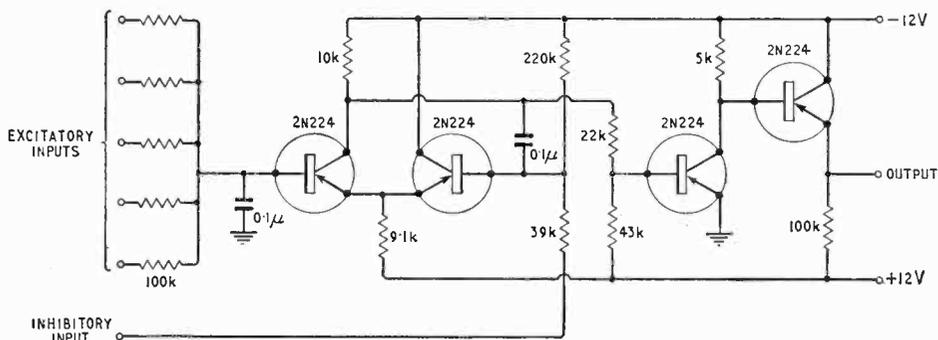
By MICHAEL LORANT

SCIENTISTS of the Bell Telephone Laboratories in the United States have recently developed a new and simple electronic circuit that simulates some functions of the individual biological nerve cell, or neuron. Numbers of these artificial cells are being combined into experimental networks that are roughly analogous to the nerve systems of the eye or ear.

The main function of the nerve cell which has been simulated by this circuit is the transmission of electrical pulses in response to those stimuli that meet certain conditions. The neuron circuit fires electrical pulses of standard amplitude and duration, just as a biological cell usually does. If the circuit is driven by a constant stimulus trains of pulses are emitted, simulating receptor cells as in the eye or ear. A higher intensity of excitation increases the frequency of pulsing. When the neuron circuit is excited continuously the frequency of the pulses can be made to decrease with time, exhibiting accommodation like a living nerve cell. Input excitation must, as in a biological cell, surpass a threshold value, and the circuit will integrate two or more input pulses below the threshold value to cause firing. A particular input connection can also, while energized, inhibit firing of the neuron circuit by other inputs. Similarly, immediately after firing, the electronic neuron's threshold rises to a very large value and for a few milliseconds no input signal can fire the neuron circuit again.

The circuit includes four transistors, thirteen resistors, and two capacitors. The pulse length it delivers, about six milliseconds, is considerably longer than that of a biological nerve cell, but can be shortened if desired. The circuit has an integrating time constant of two milliseconds and a refractory time constant of about ten milliseconds, approximating the time constants of the biological neuron. Because the electronic inputs and outputs are compatible, the circuits can be assembled into chains and networks.

Electronic neurons can be combined with photoresistive cells to simulate simple functions of nerves in the retina. Some receptors, known as "on" receptors, fire only when the light intensity they receive is increasing; "off" receptors fire only when the light is decreasing; and "during" receptors fire only while they receive a steady light. Flicker-fusion phenomena have also been produced. In the human eye, these can cause a sequence of flashes to be seen as continuous illumination; this property of vision is exploited in motion pictures and television. Mutual inhibition of cells in an array has also been demonstrated experimentally. Some animals have been observed to possess this arrangement, in which a cell receiving a greater light intensity inhibits the firing of nearby cells that receive less light. This results in local sharpening of image boundary detail.



Circuit diagram of electronic nerve cell analogue developed at Bell Telephone Laboratories.

WORLD OF WIRELESS

R.I.C. Backs 405 Lines

THE Radio Industry Council, which speaks for the set-making industry, has come out strongly against a change to 625-line television standards in this country in its representations to the Pilkington Committee, which have now been made public. The difficulties of planning receiver production over the next 15 or 20 years, when the demand for v.h.f. and u.h.f. sets of either or both 405- and 625-line standards would fluctuate unpredictably, are emphasized. It is pointed out that new dual-standard sets with v.h.f. and u.h.f. to cover the transition period would cost from £15 to £20 more than at present, and that the 405-line components would ultimately become redundant. Such sets would have no export value.

The advantage of 405 lines in allowing in the available bandwidth at least one more alternative programme than would be possible with a 625-line standard* is underlined and the Council concludes that "... because it would appear that if a change were made to 625-line standards a period of 15/20 years would be required to give National coverage to more than three programmes, during which the public would suffer confusion and additional cost, the Council can do no other than recommend the maintenance of 405-line standards in Bands I and III and their extension into Bands IV and V."

The Council would like to see the introduction of a colour TV service, but supports the T.A.C. report in saying that this should be deferred until the question of line standards is settled. It would also welcome an extension of sound broadcasting to cater for local interests, and the introduction of stereo sound broadcasting provided that this can be transmitted over single radio channels.

*See *Wireless World*, July 1960, pages 322 and 313

Westward TV

FULL-POWER test transmissions will begin from the I.T.A. Caradon Hill station near Liskeard, Cornwall, on February 1st. They will consist primarily of Test Card C and will begin at 10 a.m. daily except Sundays. The station will radiate vertically polarized signals in Channel 12.

Caradon Hill, which will have a vision e.r.p. varying from 10kW to 200kW according to direction, is the first U.K. station to operate in this channel. The actual carrier frequencies will be 209.74325Mc/s (vision) and 206.23Mc/s (sound).

Estimated service areas of the two transmitters to serve S.W. England are shown dotted on this map, giving the service areas of existing I.T.A. stations in Southern England and Wales.

It is planned to bring the station into service toward the end of April. The programme contractors for this station and the sister station being built at Stockland Hill, near Axminster, Devon, are Westward Television Ltd.

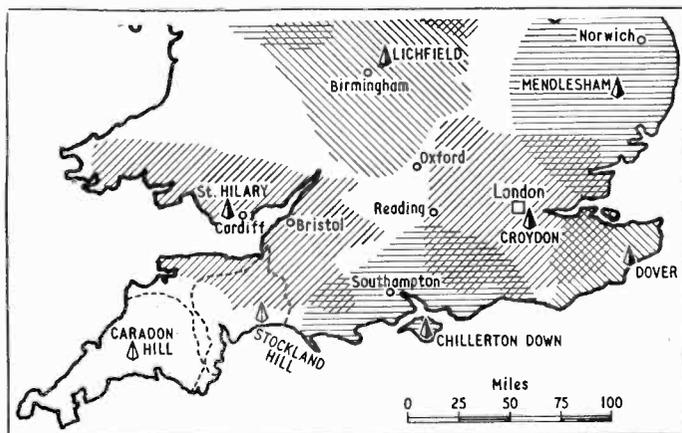
Research Council

THE appointment of three new members of the Council for Scientific and Industrial Research gives an opportunity to publish a list of the present members of the council which was set up in November, 1956, under the "Department of Scientific and Industrial Research Act" to be in executive charge of the D.S.I.R. The newly appointed members are Professor B. Bleaney, F.R.S., Professor of Experimental Philosophy at the University of Oxford since 1957 prior to which he was for ten years Fellow and lecturer in physics at St. John's College, Oxford; Dr. J. W. Cook, F.R.S., the research chemist who has been vice-chancellor of the University of Exeter since 1955; and Frank Cousins, general secretary of the Transport and General Workers Union.

The present constitution of the Research Council, of which Sir Harry Jephcott is chairman and Sir Harry Melville secretary is:—Prof. C. E. H. Bawn, Prof. B. Bleaney, Prof. C. F. Carter, Dr. J. W. Cook, F. Cousins, Sir Walter Drummond, Sir Willis Jackson, Vice-Admiral Sir Frank Mason, Sir Harold Roxbee Cox, Dr. C. J. Smithells and L. T. Wright.

Licensing Anomalies

A CLAUSE in the licence granted to operators of relay exchanges makes it obligatory for them to make a return to the Post Office of particulars of the broadcast receiving licence held by each subscriber. This, they feel, is unreasonable as no such demand is made upon the ordinary radio retailer when supplying a sound or television receiver irrespective as to whether the set is purchased outright, is on hire purchase or rented. At the annual luncheon of the Relay Services Association, at which Miss Mervyn Pike the Assistant P.M.G. was a guest, the chairman, J. W. Kinsman, asked the Post Office to "sort out" the matter.



Hirst Research Centre

THE reorganization of the General Electric Co. Ltd. has now extended to the Wembley Research Laboratories which will in future be known as the Hirst Research Centre as a tribute to the memory of the founder of G.E.C. A number of research units will be formed. The first, dealing with fundamental research, will be known as the Central Research Laboratories and the other groups will have a call on its advice and services. The second will be the Telecommunications and Engineering Research Laboratories and later the five operating groups of G.E.C. (Domestic, Installation, Lighting and Heating, Osram, and Radio and Television) will have the opportunity of setting up their own research units, thus securing a closer integration of applied research and technical development with production and sales.

O. W. Humphreys, C.B.E., continues as Director of Research, V. J. Francis will be deputy director in charge of central Research and R. J. Clayton, O.B.E., deputy director in charge of Telecommunications and Engineering.

Technical Education

BETTER educational opportunities for technicians are foreshadowed in a Government White Paper (Cmd 1254) which the Minister of Education has described as "a charter for technicians." The White Paper sees the last years of school and the first years of work as a continuous period of co-ordinated education. It is planned to "broaden" the courses in technical colleges by including more mathematics, more scientific principles and more English.

It was recently stated by the Minister of Labour that the proportion of technicians to other employees was higher in the electrical and electronics industry (11.6%) than in any other.

Phys. Soc. Prize Winners

EACH year a competition to encourage craftsmanship and draughtsmanship in the scientific instrument industry is held in connection with the Physical Society Exhibition. John S. Palmer (Marconi's W/T) has won the Silvanus P. Thompson prize and the first prize in the senior section for scientific instruments and components with his reset motor assembly. Other prize-winners include:—

V. S. Marchant (Cambridge Insts.), reflecting electrostatic voltmeter
R. Croucher (Mullard), vernier measuring microscope
Peter Shrivess (Hilger & Watts), measuring microscope workstage unit
J. Carrier (Elliot Bros.) rotary standing-wave indicator
Allan E. Pembroke (Mullard) impedance for 3-cm waveguide
Peter J. Perry (R.R.E.) simple oscilloscope
John Cross (Marconi's W/T) blanking and sync. mixer
John G. Wray (N.P.L.) transistor audio oscillator
Jack L. De'ath (Marconi's W/T) translator
William G. Payne (Hilger & Watts) pre-amplifier
Stephen S. Martin (Hilger & Watts) signal generator.

"**Beam Indexing Tubes**".—On page 7 of the first part of this article in the January issue it is regretted that a line of type was dropped. The sentence starts on line 7 and should read "This idea is based on the fact that whilst the phase of the chrominance signal is proportional to hue, the amplitude is proportional to saturation."

R.I.C. Appointments.—J. W. Ridgeway, O.B.E., commercial director of A.E.I. (Woolwich), has been elected chairman of the Radio Industry Council in succession to E. E. Rosen (chairman of Ultra Electric Holdings). Mr. Ridgeway was chairman of the Council from 1948 to 1952 and has also served for some years as chairman of the British Radio Valve Manufacturers' Association (B.V.A.). The new vice-chairman in succession to H. V. Slade (Garrard Engineering) is A. L. Sutherland (director of Philips Electrical) who is also chairman of the British Radio Equipment Manufacturers' Association. R. Kelf-Cohen, C.B., acting-director of the Council since the death of Sir Raymund Hart last year, has been appointed director and secretary.

Components Show.—Over 240 manufacturers have already booked space at the Components Show which will be held for the first time at Olympia from May 30th to June 2nd. It is being organized on behalf of the Radio and Electronic Component Manufacturers' Federation by Industrial Exhibitions Ltd.

International Instruments Show.—B & K Laboratories are once again organizing an international instruments show in which 50 exhibitors will participate. It will be held at their premises in Park Lane, London, W.1, from June 19th to 23rd.

TV Translators.—An experiment in the use of a very low-power translator to improve the television service in areas of unsatisfactory reception is being conducted by the B.B.C. in Hastings. The translator, of a new type developed by B.B.C. engineers, picks up the Crystal Palace Channel 1 transmissions and re-radiates them with horizontal polarization in Channel 4. Higher-powered equipment is being used at the new Sheffield station which re-radiates the Holme Moss Channel 2 transmissions in Channel 1 using horizontal polarization.

Television Centre.—The second of the large studios (No. 4) at the B.B.C. Television Centre in West London was brought into use on January 8th. It is equipped with E.M.I. cameras which, like the Marconi cameras in Studio 3, employ the English Electric 4½in image orthicon tube.

Space Electronics.—Decca Radar, Ltd., have formed a space electronics group to inaugurate the company's research and development effort in this field. The group will be set up in new laboratories at Somerton Airport, Cowes, Isle of Wight.

Licence Figures.—The November 30th figure for combined television-sound licences in the U.K. was 11,027,821. The month's increase was 64,954. Sound-only licences totalled 4,147,310 including 461,726 for car radio sets. The figures for West Germany (including West Berlin) on December 1st were 4,497,936 television sets and 15,854,319 sound radio receivers. Sweden reached her millionth television licence in the middle of December.

Computer Memories.—The Information Systems Branch of the U.S. Navy is holding a symposium on large-capacity memory techniques for computing systems in Washington, next May. Further details and a preliminary programme are obtainable from Miss J. Leno, Code 430A, Office of Naval Research, Washington 25, D.C.

Electronic Digital Computers.—A course of six lectures on the application of electronic digital computers to control problems will be given at the Norwood Technical College, Knight's Hill, London, S.E.27, on Tuesday evenings, commencing February 14th (fee 10s).

Personalities

Dr. Lloyd V. Berkner, the new president of the Institute of Radio Engineers, is immediate past president of the International Scientific Radio Union. After graduation in 1927, Dr. Berkner, who is 56, joined the first Byrd expedition to the Antarctic (1928/30) and then served for three years on the staff of the National Bureau of Standards. From 1933 to 1941 he was in the department of terrestrial magnetism of the Carnegie Institution of Washington. In 1941 he headed the radar section of the Bureau of Aeronautics. After holding other Government appointments he became in 1951 president of Associated Universities Inc., New York, an educational institution operating a number of research establishments including the National Radio Astronomy Observatory. A few months ago Dr. Berkner was elected president of the Graduate Research Centre, Dallas.

A. G. Wray, M.A., A.M.Brit.I.R.E., who has been chief of Marconi Instruments' advanced development group since 1956, is appointed deputy chief engineer. A graduate of Emmanuel College, Cambridge, he joined the company in 1944 and in 1952 became company physicist. For the past four years he has been responsible for the design and development of multi-channel microwave test equipment and atomic power instrumentation. Mr. Wray has also been a joint editor of the company's technical house journal, *Marconi Instrumentation*, since 1952.



A. G. Wray.

Marconi Instruments have announced three other engineering appointments. **R. L. Gilbert, Ph.D., M.A.**, who joined the company in 1958 after three years as a geophysicist in the Dominion Observatory, Ottawa, becomes advanced product engineering manager. **A. Haviland** and **D. R. Willis, A.M.Brit.I.R.E.**, have been appointed Proprietary Engineering Managers. Mr. Haviland has been with the organization since 1931. In 1943 he was made chief of the development test section. Mr. Willis, who has been with the organization 21 years, was for part of the war responsible for the engineering and production of radar test equipment.

N. Elson, technical director of Cossor Communications Co. which he joined a few months ago, has been appointed general manager in succession to **K. P. Wood, B.Sc., A.M.I.E.E.**, who has resigned. Mr. Elson was chief engineer of the instrument division of Racal prior to joining Cossor. Other appointments to the boards of Cossor companies are **B. C. Scott** (Cossor Radar & Electronics Ltd. and Cossor Instruments Ltd.) and **J. S. Gilks** (Cossor Communications Co. Ltd.), **Lea Bridge Cabinet Works Ltd.**, and **Best Products Ltd.**

N. L. Lupton, M.A., A.F.R.Ae.S., is the new contracts manager of Plessey's Electronics and Equipment Group which embraces the domestic equipment, electronics, and telecommunications divisions at Ilford and the subsidiary Hagan Controls Ltd. In 1941 he joined the Sperry Gyroscope Company as a service engineer and since 1958 has been with Microcell Ltd.

L. Gosland, B.Sc.(Eng.), M.I.E.E., research manager of the British Electrical and Allied Industries Research Association (E.R.A.) has also been appointed to the post of deputy director. He joined the Association in 1925. Mr. Gosland is chairman of the Commission Mixte Internationale pour la Protection des Lignes de Telecommunications et des Canalisations Souterraines (C.M.I.) and also of the C.I.G.R.E.* study committee on radio and telephone interference. The appointment of two assistant directors of the E.R.A. is also announced; they are **C. G. Garton, M.I.E.E., F.Inst.P.**, who is head of the Materials Department, and **E. W. Golding, O.B.E., M.Sc.Tech., M.I.E.E.**, head of the Rural Electrification Department, and also overseas liaison officer. They will each continue in their present positions. Mr. Garton, who joined the E.R.A. in 1937 after four years with the All-Union Electrotechnical Institute, Moscow, is this year's chairman of the Measurement and Control Section of the I.E.E. Mr. Golding joined the E.R.A. in 1945 prior to which he was senior lecturer in electrical engineering at Nottingham University.

* Conférence Internationale des Grands Réseaux Electriques.

J. A. Mason, C.B.E., M.M., M.I.E.E., C.G.I.A., production director of Automatic Telephone & Electric Co. since 1950, has been appointed deputy managing director. He joined the company as a draughtsman in 1911. After military service in the First World War he went into the company's electrical engineering department where he subsequently became assistant chief engineer. Mr. Mason, who is 63, is also director of the associate company British Telecommunications Research Ltd. He is succeeded as production director by **F. O. Morrell, B.Sc., M.I.E.E.**, who has been director (engineering) since 1956.

Barry Rogel, B.Sc.(Eng.), A.M.I.E.E., who led the microwave design team of Wayne Kerr Laboratories, has gone to America to become managing director of a recently formed subsidiary of Rosemount Engineering Company, of Minneapolis. He will, however, act as a consultant to Wayne Kerr and as such joins **Dr. A. L. Cullen**, Professor of Electrical Engineering at the University of Sheffield, and **Dr. V. S. Griffiths**, reader in spectroscopy at the Battersea College of Technology.

Anthony S. Pudner, M.B.E., A.M.I.E.E., A.M.Brit.I.R.E., has been appointed an additional assistant engineer-in-chief by Cable & Wireless. He joined the company in 1934 at the age of 17. Four years later he went to the company's Bermuda station as assistant engineer. He went to Korea in 1950 to be assistant engineer in charge of the company's field wireless unit. Since 1958 he has been area engineer, West Indies.

L. A. Sawtell, Comp.Brit.I.R.E., since 1945 manager of the valve division of Mullard's, which he joined in 1929, has retired. Mr. Sawtell, who is a past chairman of the Radio Industries Club, has been over 38 years in the radio industry.

George H. Russell, Assoc.Brit.I.R.E., a former senior development engineer with Bush Radio who has been with Arks Publicity for several years, has joined Taylor Advertising Ltd. as an associate director. Mr. Russell, who has contributed a number of articles to *Wireless World*, handled the publicity for several radio and electronics companies whilst with Arks.

Victor Thomas, press officer for Philips Electrical Ltd. since 1952, has taken up an appointment with **N. V. Philips Gloeilampenfabrieken, Eindhoven**. Among other duties he will be concerned with the editing of the company's international house magazine *The Announcer*, which is printed in English. He has been with Philips since 1948.

S. E. Allchurch, O.B.E., secretary of the British Radio Equipment Manufacturers' Association since 1946, has been appointed to the newly created post of director of the Association. For the time being he will combine the duties of director and secretary. Before joining B.R.E.M.A. he was assistant director of a department in the Ministry of Aircraft Production concerned with the fitting of radar and communications equipment to Service aircraft.

In announcing in our last issue **B. M. Lee's** appointment as manager of Belling and Lee's industrial group it should have been made clear that he is responsible to, but has not actually joined, the executive board.

OUR AUTHORS

L. Po'lack, whose paper on active satellites for world-wide communications presented at the London meeting of U.R.S.I. we reproduce in this issue, has been with I.T.T. Laboratories, New Jersey, since 1943. Mr. Pollack, who is 40, is now project manager of space communication systems and communication systems for anti-submarine warfare.

NEW YEAR HONOURS

Among the recipients of Knighthoods in the New Year Honours List are the following:—

Gerald C. Beadle, C.B.E., Director, Television Broadcasting, B.B.C.;

Cecil Dannatt, O.B.E., M.C., D.Sc., M.I.E.E., Vice-chairman, Associated Electrical Industries, Ltd., and also a director of a number of companies in the A.E.I. Group;

Edward R. Lewis, chairman, Decca Navigator Company and Decca Radar Ltd.; and

Alfred C. B. Lovell, O.B.E., F.R.S., Professor of Radio Astronomy, University of Manchester and director of the Nuffield Radio Astronomy Laboratories. Professor Lovell is a member of the National Committee on Space Research and is chairman of the U.R.S.I. commission on radio astronomy.

W. H. Stephens, Director-General of Ballistic Missiles, Ministry of Aviation, is appointed a Companion of the Order of the Bath (C.B.). He was head of the Guided Weapons Department, R.A.E., Farnborough, where he later became deputy director (equipment).

Among those appointed Commanders of the Order of the British Empire (C.B.E.) are: **F. E. McGinney**, M.Sc., M.I.E.E., Director General of Inspection in the

R. Brown, the first part of whose article on frequency sweep oscillators begins on p. 57, recently joined Leland Instruments where he is responsible for Government contracts and technical liaison with Government departments. Immediately prior to joining Leland he was for four years with Marconi Instruments. After completing his National Service in 1950 he spent five years as a marine radio officer.

OBITUARY

Sir Godfrey Ince, G.C.B., K.B.E., chairman of Cable and Wireless Ltd. and its associated companies since 1956, died on December 20th. He was 69. Sir Godfrey had an outstanding career in the Civil Service from which he retired in 1956. He was Director General of Manpower from 1941 to 1944 when he became permanent secretary to the Ministry of Labour.

W. R. Metca'fe (G3DQ), president of the Radio Society of Great Britain for 1960, died on Christmas Day. He had been a member of the Council since 1955.

Ministry of Aviation, who was at the Signals Research and Development Establishment of the Ministry of Supply from 1929 to 1954; **J. R. Pheazey**, vice-chairman and joint general manager of Standard Telephones and Cables, who has just completed 50 years with the company and is also a director of Kolster Brandes; and **A. J. Young**, B.Sc.(Eng.), M.I.E.E., managing director of the English Electric Valve Company.

Newly appointed Officers of the Order of the British Empire (O.B.E.) include: **H. W. Baker**, Superintendent Engineer, Television, London Studios, B.B.C.; **S. J. Giffen**, senior assistant telecommunications controller, Northern Ireland, G.P.O.; and **C. W. Sowton**, assistant staff engineer, G.P.O., who is secretary of the technical sub-committee of the Television Advisory Committee.

Among the new M.B.E.s are: **R. B. Dickinson**, executive engineer, G.P.O.; **F. J. G. Haines**, engineer-in-charge (sound), Cardiff, B.B.C.; **J. F. Lucas**, principal station radio officer, Government Communications Headquarters; **J. W. Murray**, chief engineer, Nigerian Broadcasting Corporation; and **L. S. Pinder**, chief engineer, Nuffield Talking Book Library for the Blind, who played a major part in the development of the tape-reproducer for the blind.

Recipients of the British Empire Medal include:—**O. C. Baldock**, radio operator, Government Communications Headquarters, Foreign Office; and **W. F. Young**, radio technician, Royal Air Force, North Weald.



E. R. Lewis
(Knighthood)



A. C. B. Lovell
(Knighthood)



A. J. Young
(C.B.E.)



C. W. Sowton
(O.B.E.)



L. S. Pinder
(M.B.E.)

News from Industry

G.P.C. Record Year.—The Gas Purification and Chemical Co. announce a group profit before taxation of £811,034. This is over £300,000 above the previous year's figure and the highest in the history of the group, which includes A.B. Metal Products, B. & R. Relays, Grundig (Great Britain), E. G. Irwin and Partners, Greencoat Electronics (formerly Staar Electronics) and Wolsey Electronics. Since the a.g.m. the chairman, Vice-Admiral Sir Charles Hughes Hallett, and a director, W. J. Arris, have resigned.

Radio Rentals announce a group trading profit for the year ended last August of £2.3M after allowing £3.4M for depreciation. Taxation absorbed a further £728,000 leaving a net profit of £1,573,987 compared with £1,098,616 the previous year.

Marconi Instruments are to manufacture in this country transistor electronic counters to the design of Computer-Measurements Company, of Sylmar, Cal. The 10-year agreement under which M.I. has world selling rights outside North America and Japan, also provides for the exchange of engineering information.

Blue Spot.—The agreement with A. Prince Industrial Products Ltd. for the marketing in this country of Blue Spot sound and television receivers has been terminated by Blaupunkt Werke G.m.b.H. The sale and service of Blue Spot receivers will now be handled by Bosch Ltd., 205/207 Great Portland Street, London, W.1.

U.K. Agents.—Among the eight "exclusive foreign representatives" appointed by Stoddart Aircraft Radio Co., Inc., of Hollywood, Cal., is Aveley Electric Ltd., of South Ockenden, Essex, for England.

British-made Tektronix 'Scopes.—Livingston Laboratories announce that two types of Tektronix oscilloscopes (515A and 545A) are now being made in Guernsey, Channel Islands, and are therefore duty-free under the Commonwealth Preference regulations.

Mullard's component division has been sub-divided, under its divisional head, A. F. T. Marner, into four commercial product groups. These groups, and the managers, are:—Permanent Magnets (B. C. Foreman); Ferrites (W. A. Everden); Computers (K. R. Patrick) and Radio & Television (W. K. Bailiff).

Furzehill Laboratories Ltd., of 57 Clarendon Road, Watford, Herts., have taken over the production, sales and service of the range of stroboscopes previously manufactured by Watford Instruments under the trade name of "Strobolyser." Paul D. Tyers will continue to be associated with the design of the "Strobolyser."

M.F. beacon/telegraph transmitters have been supplied (in duplicate) by the International Marine Radio Company for each of three new ocean weather ships.

United Mercantile Company Ltd., U.K. distributors of Zenith receivers, have moved to Sovereign House, 13-14 Queen Street, London, W.1 (Tel.: Grosvenor 4901).

Magnavox have opened a service department at 20/22 Corsica Street, London, N.5 (Tel.: Canonbury 5041).

Texas Instruments Ltd. have moved from Dallas Road to Manton Lane, Bedford (Tel.: Bedford 67466).

Ultra-Miles Link.—Ultra Electronics Ltd. have purchased a one-third share in Miles Electronics Ltd. A. V. Edwards and L. R. Crawford, Ultra directors, are joining the board of Miles Electronics. The two companies jointly designed and manufactured the aircraft and radar simulator for the de Havilland Sea Vixen and are now developing similar equipment for the Blackburn Buccaneer.

Derritron.—Three more companies, making a total of 10, have joined the Derritron group which was formed in January, 1960, under the chairmanship of V. G. P. Weake. The newcomers are Beulah Electronics Ltd., Direct TV Windings Ltd., and Direct TV Replacements Ltd. Alfred Rose, who previously headed these companies, will be managing director.

British Electronic Industries Ltd., is the name of the company formed to acquire the shares of Pye Ltd. and E. K. Cole Ltd. The chairman of the company is C. O. Stanley, chairman and managing director of Pye, with Eric Cole as deputy chairman.

Wo'sey Electronics have recently entered the closed-circuit television system field. The equipment operates on either a video or r.f. camera output, and in the case of a video output will employ an r.f. modulator to enable standard receivers to be used. A system has been installed at Goodwood Racecourse.

Air Navigation Equipment.—Orders worth over £650,000 have been placed by the Ministry of Aviation with Marconi's for the supply of Doppler navigators and automatic direction finders. The equipment, which includes ancillary gear and spares, is for use in Argosy C. Mk. 1 aircraft of R.A.F. Transport Command.

Telecommunications Test Equipment.—Contracts worth £100,000 have been awarded to Marconi Instruments Ltd. by S.H.A.P.E. for test gear for use on the "Ace High" radar project. It comprises white noise test sets, signal generators, and universal bridges.

EXPORTS

Television transmitting equipment for Mexico and Venezuela has been ordered from Marconi's. The Venezuelan equipment comprises three vision and three sound transmitters and the Mexican eleven Mk. IV camera channels, with associated equipment.

High-altitude u.h.f. airborne emergency transmitter-receivers to the value of £50,000 are to be supplied by W. S. Electronics to the Danish Government. A fully-transistorized power supply and extremely light weight are features of the equipment. It is intended to provide emergency contact between pilot and ground in the event of aircraft electrical-system failure.

Decca weather radar is being installed at five airports in Western Germany. Equipments are nearly complete at Frankfurt and Hamburg, and will, in addition, be installed at Hanover, Munich and Schleswig.

High-power radio communication equipment has been ordered from Marconi's by the British Government on behalf of the Pakistan Posts and Telegraphs Department. The equipment, consisting of two 30-kW h.f. i.s.b. transmitters, their drive units, and five telegraph h.f. receivers, is to be installed near Karachi.

TRANSISTOR SIGNAL GENERATOR

DESIGN COVERING 100kc/s TO 25Mc/s

By C. BAYLEY

MANY advantages are gained from the use of transistors, particularly in test equipment, where the major points are that it can be small, portable and independent of mains supplies, although a mains power unit, simpler than the conventional valve supply, can be used. Lack of dependence on mains, small size and low weight are a great benefit to the field service engineer. Isolation from the mains improves performance as far as both hum and interference are concerned and is also an advantage when working on "live" equipment. Waste power dissipation is very low: the economy in running such equipment is obvious and deterioration of components by heat is reduced to the minimum. Also the equipment is ready for use immediately after switching on—a wait whilst temperatures and thus frequency become stable is not necessary. The radiation from oscillator circuits is reduced considerably and therefore screening precautions might not be so severe.

The signal generator is one of the most commonly used pieces of test equipment and it is one in which the benefits accruing from the use of transistors are most marked. It was thus decided to design a transistor signal generator.

Choice of Basic Circuit

There are many circuits for transistor oscillators, so it would be as well to consider carefully the factors affecting their use in signal generators.

Firstly, transistors are current-operated devices having low impedances, thus matching is more critical than in a valve circuit where the valve is often regarded as having such a high impedance that its effect can be ignored. Most h.f. oscillators use an L-C tuned circuit whose dynamic impedance is high, usually of the order of a fraction of a megohm. Thus a low-impedance transistor, although capable of producing large currents at low voltages, could be so mismatched that it could not drive sufficient current into some tuned circuits to keep them oscillating (Fig. 1 (a)). Improvement of the matching of transistor and tuned circuit can be achieved by reducing the L-C ratio or by tapping the coil, as in Fig. 1 (b).

In the first case, though, the tuning capacitor becomes inconveniently large—too large for a standard variable type to be used—and in the second case the circuit impedance varies too widely to enable a good match to be achieved over the tuning range of the capacitor. The dependence of circuit impedance on tuning capacity (and therefore frequency) is clear from an examination of the expression for impedance at points A and B in Fig. 1 (b): $Z = (L/r - 1/C) + \omega^2 L_2$. The approximate formula for the dynamic impedance of the circuit in Fig. 1 (a)

is $Z = L/Cr$, i.e., there is no direct dependence on frequency. Thus version (b), although convenient from the point of view of tuning capacitance, has to be limited in frequency range.

Beat Oscillator Techniques

The use of two oscillators whose frequencies beat together to produce the desired output has advantages for lower radio, supersonic and higher audio frequencies. For higher radio frequencies a straight oscillator is preferable; also a lower ratio of maximum to minimum frequency is acceptable, thus the matching problem can be successfully solved by the limiting of the frequency swing.

In the conventional b.f.o. the fixed and variable-frequency oscillators usually operate at frequencies

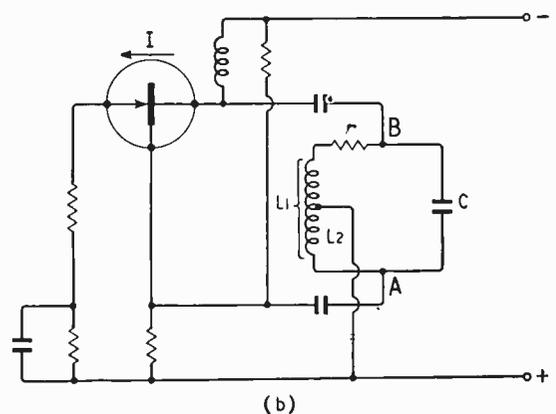
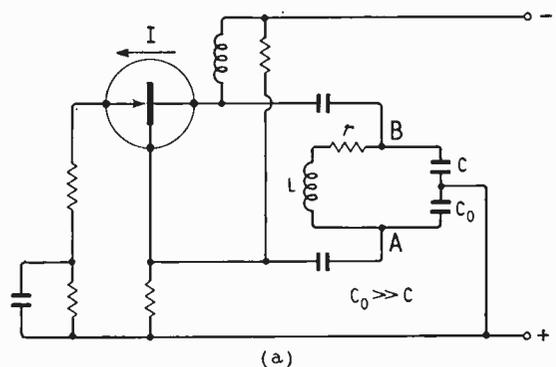


Fig. 1. Two oscillator circuits. In (a) the current I may be insufficient to maintain oscillation, but in (b) I is three or four times greater when $L_1 = 4L_2$.

five to ten times those of the beat. This makes easy the filtering out of the unwanted frequencies after detection of the beat and would also satisfy the requirement that the frequency range should remain small. However, this would, for our purposes, demand the beating of frequencies above a reasonable maximum figure for f_α , the alpha cut-off frequency.

Generally the best solution seems to be to design a b.f.o. for the lower band of frequencies—say 50 to 500kc/s—and above that to use a straight oscillator. For the higher frequencies the desired lower L/C ratio can be obtained conveniently by using the same tuning capacitor. The best choice of b.f.o. frequencies seems to be rather close to the beat frequency, e.g., for an output at 500kc/s the fixed-frequency oscillator (f_1) could be at 1,200kc/s and the variable (f_2) at 700kc/s. As the top limit of frequency f is to be 25Mc/s (for short-wave band coverage) it might be thought that it would be possible to use higher beating frequencies, but this would demand that both oscillators use transistors with high f_α . If, of course, short-wave coverage is not required then this section could be dropped and transistors of lower f_α used. Table 1 lists some high alpha-cut-off transistors.

Naturally the use of low beating frequencies makes their filtering from the output more difficult, but this can be achieved satisfactorily by the proper design of low-pass filters. Unwanted components could occur on some ranges but in practice these are quite harmless.

Further important considerations when choosing an oscillator circuit are good frequency and amplitude stability. To achieve both these ends care must be taken with biasing and stability measures. Looking at the circuit of Fig. 2 it will be seen that the base-biasing resistors, R_1 and R_2 , are of much higher values than are commonly used*. High values for these resistors are necessary to prevent excessive damping of the tuned circuit. The collector-to-emitter potential should be chosen as high as possible to reduce internal capacitance and maintain collector current at a low value. This reduces internal power

* See: The Junction Transistor and its Applications, by E. Wolfendale, pp. 123-135

dissipation and, hence, avoids effects due to a rise in temperature. Amplitude modulation is not applied directly to the oscillator because here it can cause frequency modulation.

Some slight modifications from the Colpitts valve oscillator circuit have to be made: for instance, the base-emitter coupling capacitor C_1 has to be several times larger than the collector capacitor, C_2 . This is understandable as C_1 has to pass a large current into the tuned circuit whilst C_2 is in a position where the impedance is much higher.

The oscillator output is taken from the tap on the emitter resistor R_3 , R_4 . Provided that R_3 is high in relation to the impedance at the tap the frequency of oscillation is not affected by changing the load at the tap. However the output is reduced to about 30 to 50mV and an amplifying stage is essential to obtain sufficient input to the attenuator.

The amplifier is a conventional common-base circuit and its output is taken from the step-down transformer to the low-pass filter which matches the 75-Ω attenuator. This attenuator is arranged to give six 20-dB steps of attenuation and a "fine" continuous variation of the output over a 20-dB range is obtained by variable negative feedback to the base of the amplifier stage.

If short-wave operation is desired the amplifier transistor would, of course, have to be of the high alpha-cut-off variety. A type with an f_α no lower than 100Mc/s would be suitable. Alternatively the output could be taken directly from the tap on the oscillator emitter resistor but this would preclude the use of modulation, and, of course, result in a much lower maximum output.

Modulation

Three methods of applying modulation to the amplifier were considered:—

1. In a Class-C amplifier high-level modulation can be applied in the common-base or common-emitter circuits by varying the collector supply. This is similar to the Heising method of modulating a valve amplifier.
2. Low-level modulation can be achieved by placing the source in the emitter-base circuit.

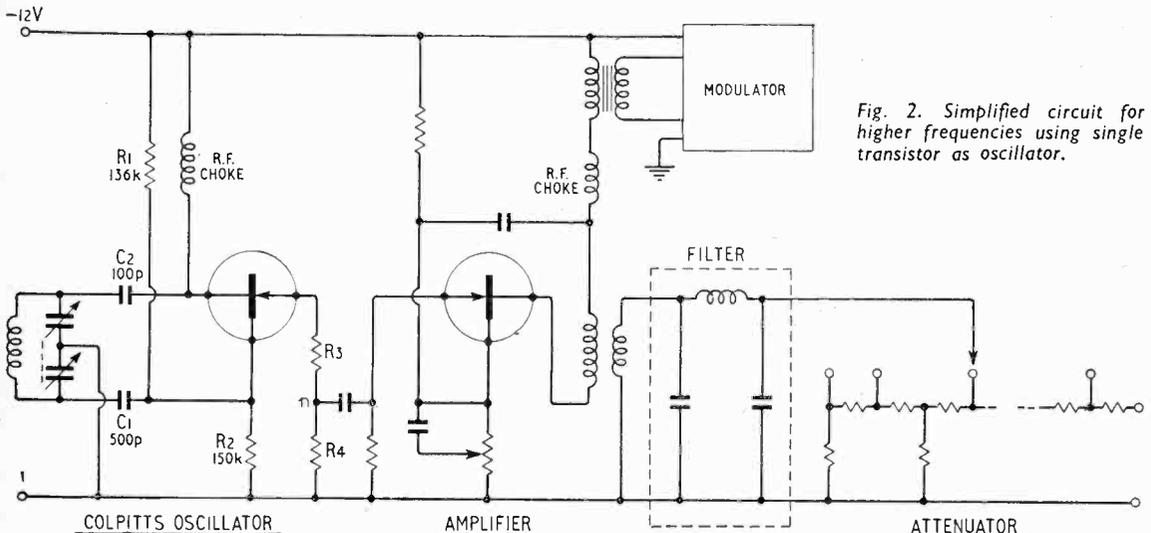


Fig. 2. Simplified circuit for higher frequencies using single transistor as oscillator.

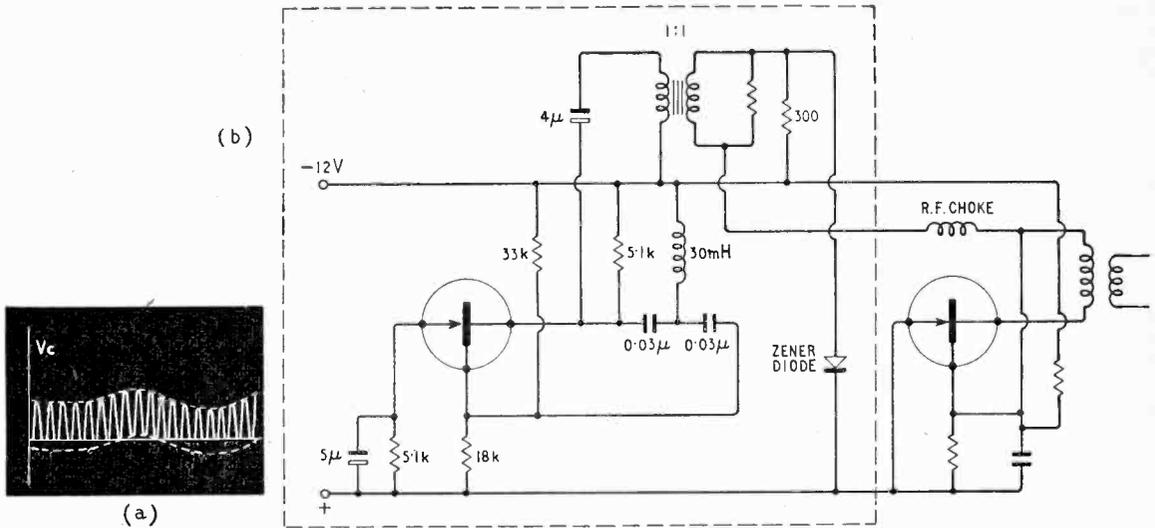


Fig. 3(a). Result of applying modulation by chosen method. Note "clipping" of sine wave. (b) shows simple 1kc/s oscillator and connections to amplifier stage.

3. By adjusting the bias and r.f. drive voltage the modulating current can be made, in an arrangement similar to that described in (2), to change the input impedance of the stage. This is analogous to square-law modulation of Class-B valve circuit.

In our case, deep modulation is not required—30% is normal for a signal generator—and the amplifier

does not necessarily have to work in "pure" Class C. The method given in (1) was thus chosen, and Fig. 3(a) shows the output when modulated by a sine wave. In Fig. 3(b) a simple 1-kc/s oscillator is shown. This is a convenient circuit as the 1:1 modulation transformer could be employed as the output transformer of an a.f. stage should modulation from an external source be desired.

It is clear from Fig. 3(a) that distortion of the output takes place and, to avoid the presence of harmonic frequencies in the output some form of filtering is essential. Another tuned circuit ganged with the oscillator could be used but this would demand an extra section on the tuning capacitor. Thus low-pass filters, switched from range to range, are employed.

To obtain proper modulation in the amplifier the initial collector bias has to be chosen carefully. Correct operation is achieved when this is approximately equal to half the supply, i.e. about -6V with a 12-V supply.

B.F.O. Signal Generator

Remembering that a b.f.o. design is advantageous for the lower r.f. bands we may arbitrarily choose the b.f.o. output ranges as within, say, 100 to 500kc/s.

With the variable-frequency oscillator (v.f.o.) ranging from 800 to 1,000kc/s it is possible to achieve the chosen coverage with fixed-oscillator frequencies of 1,100kc/s and 1,300kc/s. Thus the first range is 1,100-1,000 = 100kc/s to 1,100-800 = 300kc/s, and this satisfies the requirement that the tuning range of the v.f.o. should be kept small.

The low-pass filters following the frequency-changing circuit have to be multi-range types if it is desired to employ modulation. It would be inconvenient to have a separate switch for these, so the number of positions of the range switch depends on the design of this part of the circuit. Thus our

TABLE I

Makers	Type	f_{α} (Mc/s)	Description
Associated Transistors	AP11	30	Germanium alloy p-n-p diffused base
Mullard	OC 170	70	Germanium alloy p-n-p diffused (graded) base
Newmarket	V15/20R	30	Germanium alloy p-n-p drift transistor
Semi-conductors	MA 393	60	Germanium p-n-p "micro-alloy"
Texas Instruments	2N1142	600	Germanium p-n-p diffused-base mesa type
	2N1143	480	Germanium p-n-p diffused-base mesa type
	2S005	30	Silicon n-p-n grown diffused
	2S014	20	Silicon n-p-n grown diffused

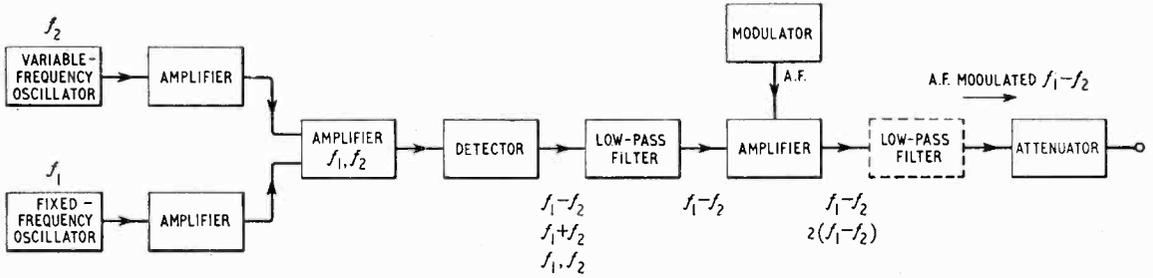


Fig. 4. Block diagram of signal generator when operating as a beat-frequency oscillator.

signal generator when operating as a b.f.o. takes on the outline shown in Fig. 4.

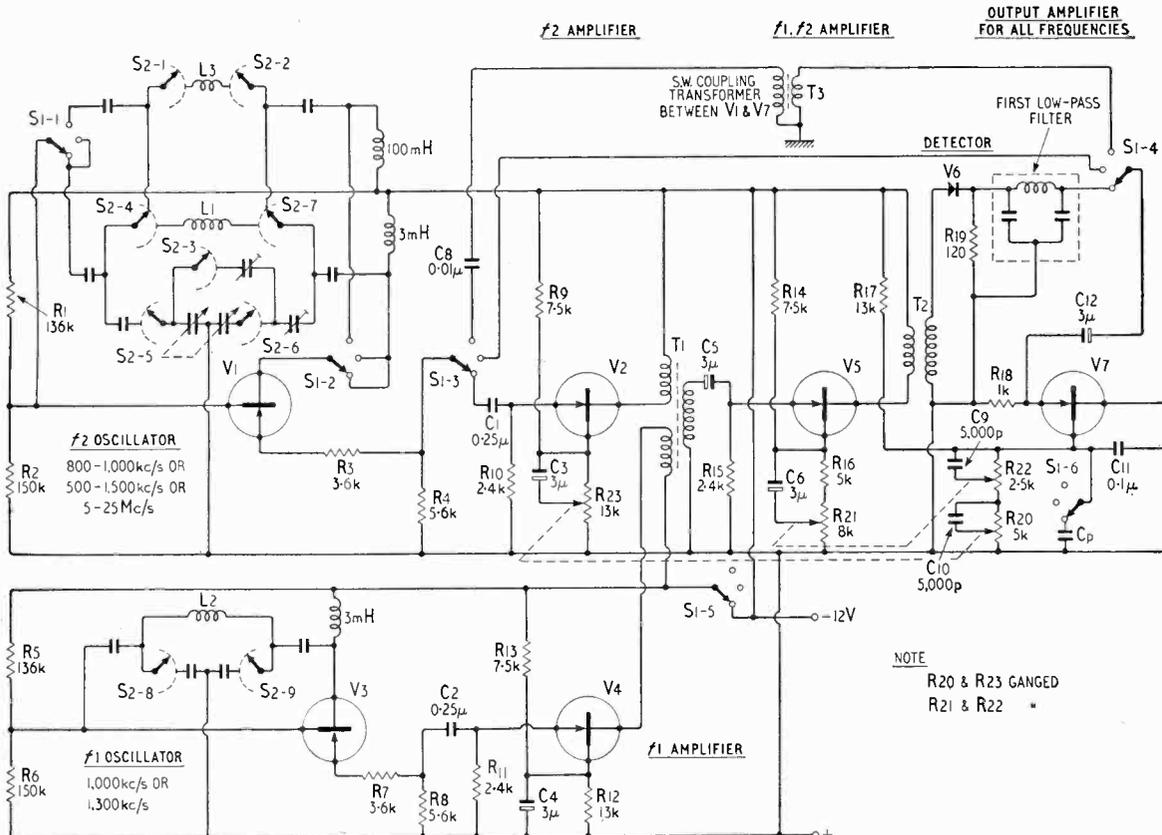
Complete Design

At the left-hand end of Fig. 5 are shown the oscillators: they are basically similar to ensure good frequency stability. The mixing of the beat oscillator outputs is carried out in the triple-wound step-down transformer T_1 (impedance ratio about 3,000 Ω to 100 Ω), then both signals are amplified by V5. Sum and difference frequencies are produced at the detector V6 which is a mixer-type diode with a low forward resistance and capacitance. The output passes into the first low-pass filter which removes the original fundamental and sum frequencies. S_{1-1} selects the output from either the b.f.o. (V1 to V4)

or the v.f.o. (V1). Two positions are provided in the v.f.o. position so that, on short waves, the coupling transformer T_1 and the amplifier V5 are switched out of circuit and are replaced by the short wave coupling transformer T_3 .

V7 is the final amplifier, and, it will be remembered, this produces second-harmonic distortion when modulation is applied. Thus another low pass filter follows the output transformers T_4 and T_5 .

So that the input to the step attenuator may be set accurately (0.1V r.m.s. is the chosen level) a level-monitoring meter can be connected at this point. For convenience a second gain control R_{21} is fitted for setting-up: this, of course, is done with the normal "fine" output control R_{23} at maximum output.



NOTE
R20 & R23 GANGED
R21 & R22 "

TABLE 2

Oscillator Frequency (kc/s)	Cut-off frequency f_c (kc/s)	Frequency Bands on Tuning Capacitor
800-1,300	650	B.f.o. filter
100-170	185	100-300 kc/s
170-300	320	
300-500	550	300-500 kc/s
500-850	925	500-850 kc/s
850-1,500	1,600	850-1,500 kc/s
5-9 } 8-15 } 14-25 } Mc/s	No filter used	5-9 Mc/s 8-15 Mc/s 14-25 Mc/s

$L = 10^3 2R_t / 2\pi f_c$ mH
 $C = 10^6 / 2\pi f_c R_t$ μ F
 $R_t \approx 75 \Omega$ (terminating impedance).

The range switch S_2 has eight positions, three of which cover the b.f.o. ranges 100 to 170kc/s, 170-300kc/s and 300 to 500kc/s. No change is made in the v.f.o. circuit between the 100 to 170kc/s and 170 to 300kc/s ranges—only the low-pass filters are switched. For clarity the coils associated with the v.f.o. are shown separately in Fig. 6 (a) and that for the b.f.o.—Fig. 6 (b).

For frequencies higher than 500kc/s a straight oscillator is used as the source, so that the supply to

the beat oscillator V3 and V4 is interrupted by $S_{1.5}$. Other sections of S_1 change the coupling transformer, r.f. chokes and capacitors to appropriate values for the low, medium and high-frequency ranges. It is not important to use an output low-pass filter on short waves as the harmonics are suppressed sufficiently by stray capacities in the attenuator network. On short waves only V1 and V6 (apart from the modulator) are operating, thus only these two transistors need to be of high f_a type. R_{22} and R_{20} perform the "set level" and "fine output" control functions, but as these are ganged to R_{21} and R_{23} respectively only two knobs are required on the front panel. R_{22} and R_{20} have no effect when the b.f.o. section is in use as they are by-passed by C_p , say 0.1μ F, switched in by $S_{1.6}$.

Monitoring Unit

At the h.f. end of the s.w. band the maximum oscillator output falls to about 50mV. Thus, when using the 14 to 25Mc/s band the meter has to give a clear indication at 50mV. At all other frequencies the output is set at 100mV. A sensitive meter (50 or even 25μ A f.s.d.) is thus required and two diodes are connected in parallel as the rectifier.

This combination, shunted by a $270\text{-}\Omega$ resistor has an impedance of about 150Ω and is substituted for the first $150\text{-}\Omega$ shunting resistor in the attenuator so that maximum power is available to work the meter without causing a mismatch. The output level should be set with the step attenuator switched to 1μ V and, of course, the "fine" control set to maximum output. For 50-mV level the current flowing through the meter is 4.5μ A and for 100mV, 15μ A. The frequency response of the unit is practically flat up to 30Mc/s.

Low-Pass Filters

A π -network has been used for the low-pass filters and the terminating impedances are, for the first filter 50 to 150Ω (input impedance of V7) and for the second 75Ω . Thus the value of 75Ω can be assumed for both filters; but it is advisable to check the input impedance of V7 under operating conditions. Table 2 and Fig. 7 show data needed for the calculation of the values for the low-pass filters, f_c being the cut-off frequency. On the lower ranges, using the b.f.o., the highest frequency to be passed by the first filter is 500kc/s and the lowest to be cut is 800kc/s, thus 650kc/s is a suitable frequency for design purposes. The other filters are the second or output filters, which remove the second harmonic generated by modulation; consequently these have to cut off below twice the lowest frequency on each range and this limits the ratio between mini-

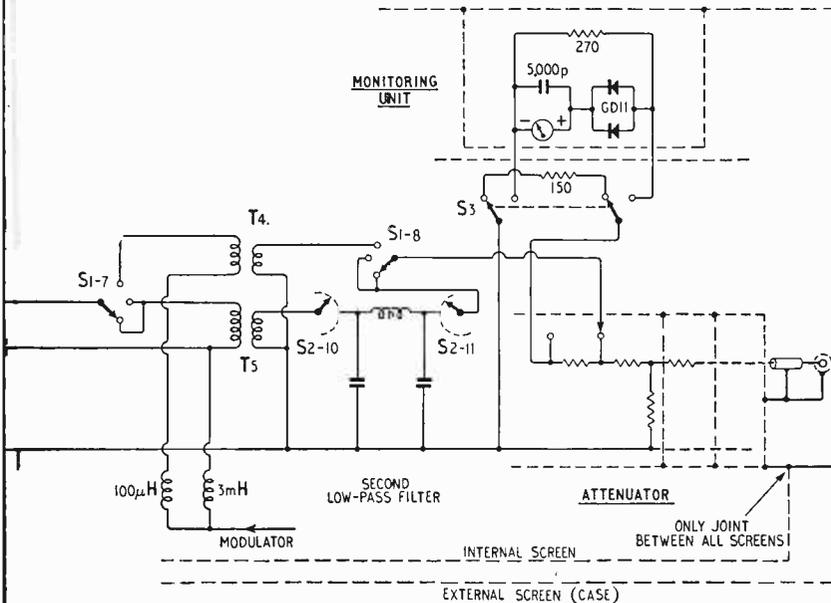


Fig. 5. Signal Generator: Detail of modulator is shown in Fig. 3(b), attenuator, Fig. 8, coil details and switching, Fig. 6(a) and (b); filters, Fig. 7. Transformer details: T_1 , $\frac{1}{2}$ in dia. former pri $\approx 30\mu$ H, 100 turns, spaced to 0.5in; sec $\approx 3\mu$ H 30 turns spaced to 0.5in; dust core of former fully in. T_2 , T_5 , pri 80mH; sec 3mH; impedance ratio 2000:75. T_3 , pri 6.5mH; sec 0.5mH. T_4 —as T_1 but without dust core.

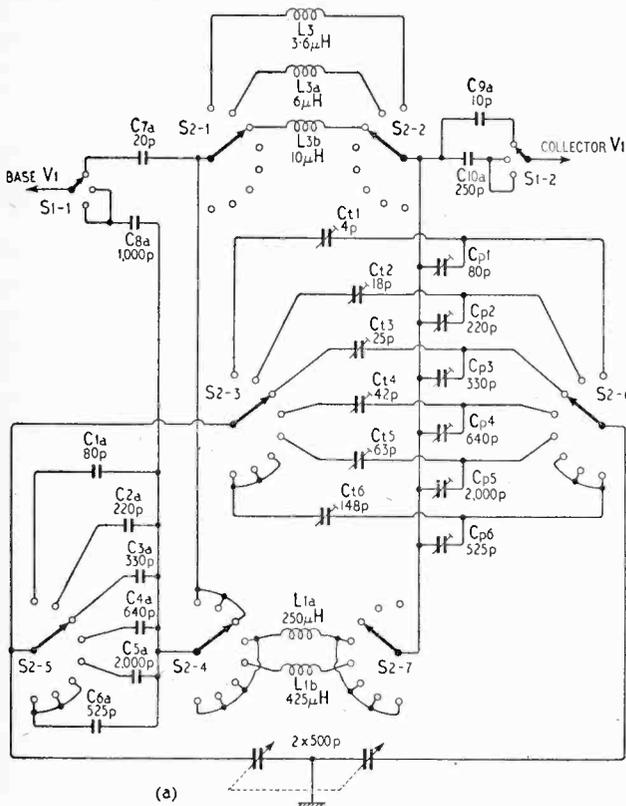
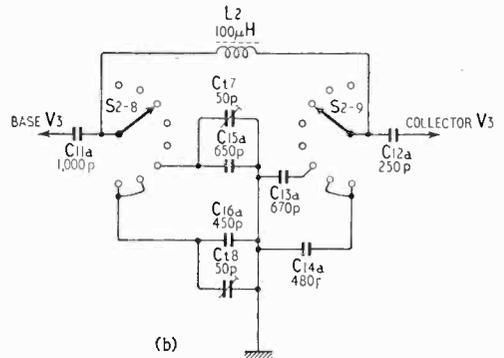


Fig. 6 (a). Variable-frequency oscillator (f_2) coil switching; (b) beat frequency oscillator (f_1) coil switching.



mum and maximum frequencies to less than 1:2. Thus the first b.f.o. range has to be divided into two, i.e., 100-170kc/s and 170-300kc/s and provided with the appropriate filters.

Some adjustment of the filters may be necessary after construction; for instance, if it is found that a filter is reducing output at the high-frequency end of its band, then the inductance of the coil should be reduced. This obviously calls for adjustable iron-dust cores, and, to achieve high efficiency, Litz wire and low-loss capacitors, such as polystyrene-dielectric types, should be used.

It will be noticed that the range switch (Figs. 5 and 6) has eight positions, although seven continuous-tuning ranges are provided—this extra posi-

tion changes the first low-pass filter halfway through the lowest-frequency tuning range.

Attenuator

100mV is usually sufficient signal for testing purposes, and it is convenient to use 20dB steps, thus the attenuator steps run: 100mV, 10mV, 1mV, 100μV, 10μV, 1μV.

Fig. 8(a) shows the attenuator circuit and the way in which the values given for R_1 and R_2 are calculated. The use of a single-wafer switch would be convenient, but the capacities between the rotor and stationary contacts would shunt the attenuator resistors and render the whole useless for the higher ranges. Thus several wafers, individually screened and connected so that stray capacities do not bypass the resistors, have to be used and Fig. 8(b) shows how these are arranged. Assuming that the stray capacities C_p are about 0.1pF and the capacity to earth, C_s , is 3pF, the leakage attenuation will be 30 times per stage, i.e., three times the loss in the resistor. At the high-level end of the attenuator C_s is deliberately increased by adding small capacitors to improve the performance further.

The accuracy of attenuation should be reliable down to say 10μV at 5Mc/s. Outside these limits the screening of the oscillator must be very good if the calibration is to be within $\pm 10\%$. The transistor signal generator has a very definite advantage here as no ventilation is needed (it is always difficult to screen holes!) and the power supply (battery) can be screened with the generator. Even so, careful construction is necessary.

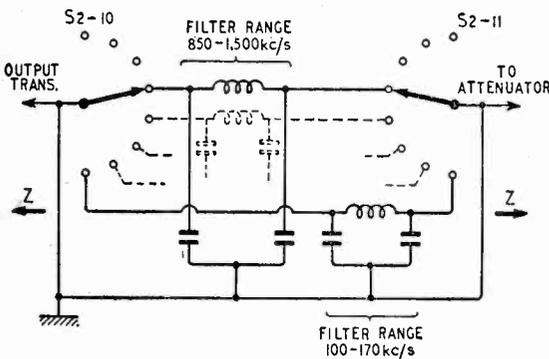


Fig. 7. Low-pass filter switching.

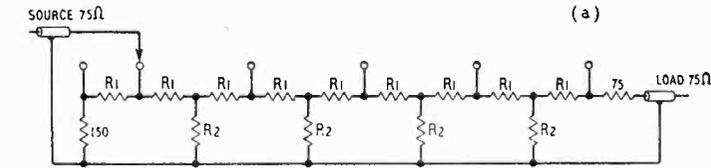
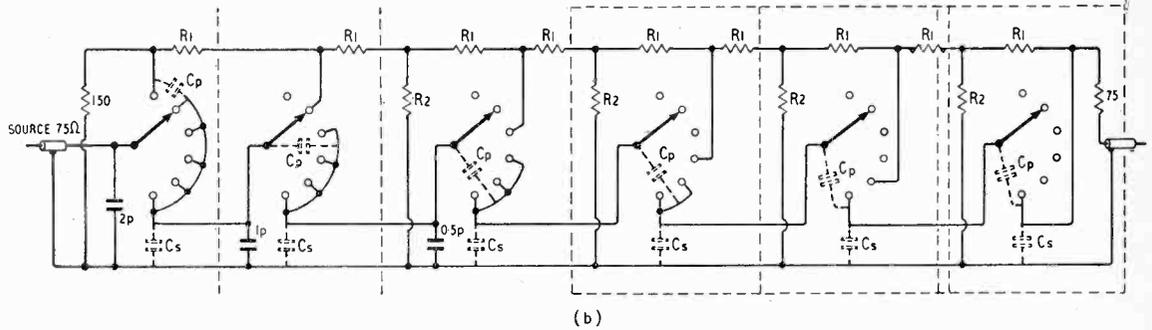


Fig. 8 (a). Attenuator theoretical circuit; (b) practical arrangement to reduce stray couplings.

$$R1 = 75 \left(\frac{P + 1}{P - 1} \right) - R2$$

$R2 = 2.75 \sqrt{P / (P - 1)}$
 where P is the power ratio of input to output per section. In this case $P = 100$, so values for R1 and R2 will be:—
 $R2 = 150.10/99 = 15.15 \Omega$
 and $R1 = 75 - 15.15 = 59.85 \Omega$



Construction

The front-panel controls are:—

1. Tuning (for ranges see Table 2).
2. Range switch (S_2).
3. Function switch (b.f.o., m.w., s.w.) (S_1).
4. Monitor meter and switch (S_3).
5. Level set (R_{21} and R_{22} , ganged).
6. Coarse attenuator (20-dB steps).
7. Fine attenuator (20-dB variation) (R_{23} and R_{20} , ganged).

Fig. 9 shows a suggested layout and the position of internal screens. It is essential to avoid loops or double paths between points on the screens; thus the internal screens are insulated from the case proper and are connected to the case and each other at only one point—the earthy connection of the output socket. The monitor or level-set meter circuit is enclosed in a screen which is secured only to the front plate, this forming its sole "earth" connection. The tuning dial should be outside the case, the front panel

continuing behind it. Similarly no cut-outs should be made in the internal screening. The components are mounted on tags on a sheet of insulating material placed behind the front piece of the internal screen: the wiring should naturally be point-to-point, as short as possible, and in general follow roughly the theoretical circuit.

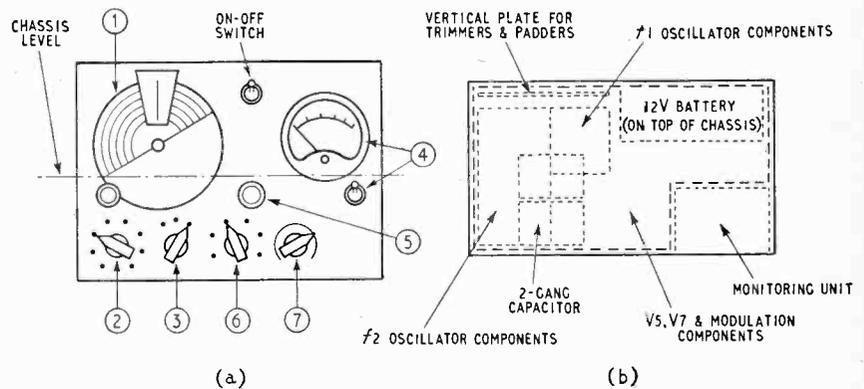
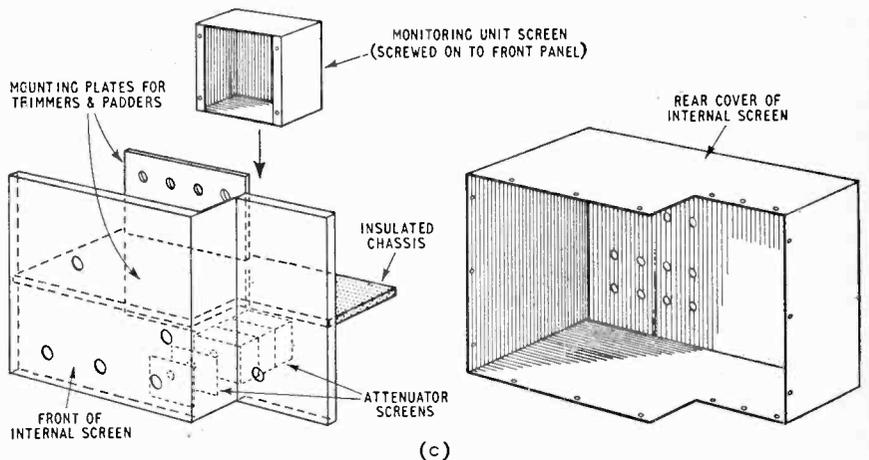
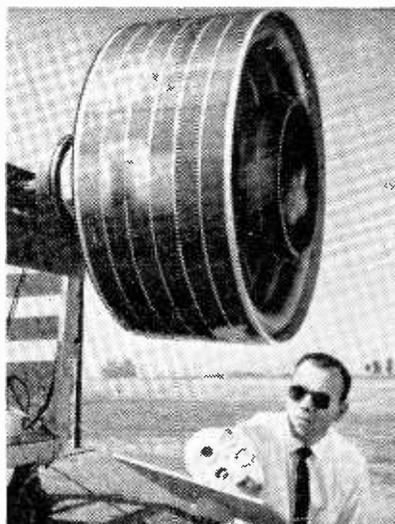
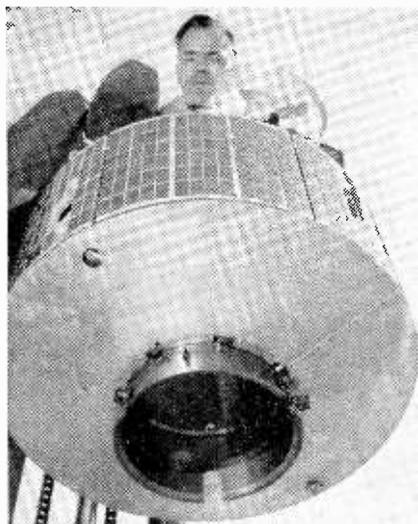


Fig. 9. (a) Front panel; (b) layout; (c) screening arrangements.





(Left) The Hughes spin-stabilized communication satellite is powered by 2,700 solar cells and is seen (right) undergoing centrifugal tests.

“FIXED” SATELLITE

HUGHES Aircraft Company in the United States have developed a communication satellite designed to orbit at a radius of 22,300 miles, and so to appear “fixed” above any selected point on the earth. Over the mouth of the Amazon, for instance, it would be “visible” to ground communication stations throughout most of North and South America, Western Europe and the Western half of Africa. The new design is 29 inches in diameter and weighs only 32 pounds, of which a mere 5 pounds is accounted for by the “electronics.” It can be launched economically by a Scout

rocket and weight has been reduced by adopting spin stabilization, with the axis parallel to that of the earth. Auxiliary nitrogen jets are used for final trim.

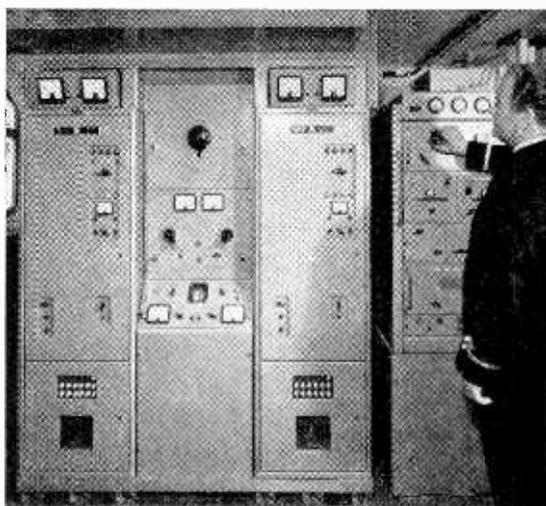
Since a pencil beam is not feasible with spin stabilization the aerial system is arranged to give a circular radiation pattern. The repeater consists of a transistorized u.h.f. receiver and L-band (2kMc/s) transmitter using a travelling-wave tube with a power output of 2.5 watts. Single-sideband is used to increase the number of available channels and the repeater also serves as a command receiver and telemetering transmitter.

Wideband Transmitter Output Amplifier

PART of the Marconi radio equipment installed in the G.P.O.'s cable-laying ship H.M.T.S. “Monarch” consists of two wideband transmitter output amplifiers, Type NT203, covering 1.5Mc/s to 24Mc/s and which do not require retuning whenever the transmitting frequency is changed. These can be used singly in conjunction with suitable drive units, such as the low-level drive stages of the NT201 independent-sideband transmitters included in the “Monarch's” equipment, or in parallel to give a peak envelope power output of 2.8kW (s.s.b. operation).

The NT203 is a linear distributed amplifier consisting of a penultimate stage and a power output stage. The former has 9 pairs of E180F valves in push-pull with anode and grid circuits consisting of “lumped-impedance” type transmission lines, while the final amplifier has 8 push-pull pairs of 4X250B air-cooled tetrodes, also with transmission-line circuits. The output impedance is 50Ω.

Although no tuned circuits are employed the discrimination against second harmonics throughout the frequency band covered is said to be generally better than -40dB and inter-modulation products are of about the same order. Included in these equipments are p.e.p. output indicators, feeder s.w.r. meters and facilities for remote control. Further details can be obtained from Marconi's Wireless Telegraph Co., Ltd., Chelmsford.



Marconi Type NT203 transmitter amplifiers in G.P.O. cable-laying ship “Monarch.”

Electricity Direct from Heat

By "CATHODE RAY"

AS I said only the time before last, a main aim of power engineers is to generate electricity direct from heat, instead of going through the tiresome sequence of using the heat to boil water and making the steam impinge upon blades in a turbine, causing it to move strong magnets past an array of conductors. This procedure is particularly irksome in nuclear power stations, where it locks incongruously old-fashioned alongside the modernity and scientific elegance of the nuclear part of the system. I am sure many people who know roughly how electricity is generated in ordinary fuel-burning stations imagine that steam-raising and turbines have been abolished in nuclear stations, and are surprised when they find them still in use. Even boilers are there, only they are called "heat exchangers."

Now I know that this sort of thing is none of our business, but—transistors notwithstanding—we rely upon it for most of our business. Besides that, we are finding ourselves moving closer to the successors of the old heavy electrical power engineers as we both converge towards a common centre—atomic physics. At the moment, the generation of electricity direct from heat looks like having more impact at first on our light electronic applications than on large-scale supplies.

The thing itself is nothing new. My last two instalments have been on undesired electrical manifestations of heat—as "noise" in valves and transistors. But electricity has been usefully generated direct from heat for ages. The fact that heating a joint between wires of different metals generated an electric current was discovered by Seebeck as long ago as the year Napoleon Bonaparte died. That electricity can be generated in a single piece of metal by heating one end of it (Thomson effect) is less

familiar. But I suppose we all know that an ordinary diode valve acts as an electric generator when its cathode is heated. We may not all know that we know it, but it follows from the familiar fact that the characteristic curve of a diode extends slightly into the negative voltage region, as in Fig. 1(a). A load line can be drawn from the zero voltage point, representing a resistance R connected to the diode without any applied voltage; and the point at which it cuts the curve marks the current that will flow (I_0) and the voltage (V_0) across R . As the circuit diagram (b) shows, the generator of this current is indeed the diode, and of course its power output is I_0V_0 watts.

The issue here is perhaps confused by the fact that the heating of the cathode, without which no anode current would flow, is invariably done electrically. In the days when the cathode was always a directly-heated filament, there was some excuse for assuming that this anode current was somehow directly due to the filament battery. With an indirectly-heated cathode, that is impossible, and precisely the same result would be achieved in the anode circuit however that cathode was heated, so long as it was brought to the same temperature. It could for example be done with a bunsen burner, or by focusing the sun's rays on it with a lens.

The fact that (purely for convenience) cathodes are heated electrically does at least mean that the input and output power are both of the same kind so that it is easy to calculate the efficiency. And it is not impressive. Typically, for an input of 1.4V, 0.15A (210,000 microwatts) the output might be 0.5V, 0.5 μ A (0.25 microwatt), or an efficiency of 0.00012%. Even heat from the sun is not so plentiful—in Britain, anyway—that it can be thrown away like that. All the same, the principle is established, and one must remember that normally this generator effect is discouraged by the valve designer. It is a major nuisance in low-reading valve voltmeters, because it shifts the zero to an extent that varies steeply with the cathode temperature. Can this despised weed be cultivated into a valuable plant?

Intensive cultivation has certainly been going on, and reports emerge from time to time claiming progressively higher efficiencies. Whatever I quote will probably be out of date by the time you read it, but an experimental efficiency of 12% has been claimed and 30% confidently predicted.

Even granting these figures are reliable, some readers (aware that electric generator efficiencies are in the upper nineties) may still not be impressed with their practical value, remarkable though the progress must be admitted to be. If so, then they must be confusing the efficiencies of the electrical machines alone (i.e., mechanical to electrical) with the overall efficiencies of generating stations, and the latter are subject to a serious limitation at the heat-to-mechanical stage. Any sort of heat engine is presented with a fluid, such as steam or burnt gas or oil, at a relatively high temperature. The energy the fluid possesses by virtue of this temperature drives the engine, and at

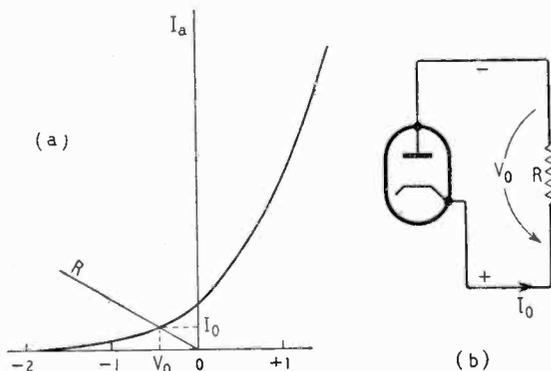


Fig. 1 (a) Enlarged view of the part of a diode characteristic curve near zero anode voltage, showing that some current flows even when the voltage is negative. (b) Basic circuit of a diode as a heat-to-electricity converter, the load resistance R being represented in (a) by the line marked R .

the exhaust the fluid is cooler and therefore has less energy. The difference is energy available for useful mechanical work. Naturally there are some losses, such as heat radiated from the engine and mechanical work lost in friction. But the efficiency of the engine, reckoned as the ratio of useful work to the drop in fluid energy between inlet and exhaust, can be quite high. This basis of reckoning takes no account of by far the biggest loss of energy—that thrown away in the fluid at the exhaust. The greater the ratio of maximum to minimum absolute temperature, the greater the amount of mechanical work theoretically

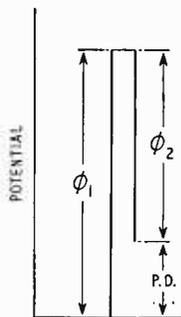


Fig. 2. When electrons pass from a conductor having a work function ϕ_1 to one with a work function ϕ_2 , a potential difference is set up between them equal to $\phi_1 - \phi_2$.

available. So in power stations the temperature at which the steam enters the turbines has been pushed steadily higher as engineering techniques have progressed. But even in the most modern power stations only about one-third of the heat energy of the fuel is utilized. And of course the overall efficiency of small electric generating units, such as those used in country houses, is far lower. So the 12% of the "thermo-electron engine" begins to look more significant.

Note the rather surprising name, for a device with no moving parts—"engine." This has been given to it by Dr. Kaye and Dr. Hatsopoulos of U.S.A., leading workers in this field. They did so because they regard it as essentially a heat engine, like a steam or petrol engine. Just as steam flows from a hot body (the boiler) to a relatively cold body (the condenser) and back as water, so an electron "gas" flows from the hot cathode to the relatively cold anode and back via the load circuit. Only in doing so it gives (instead of mechanical energy) electrical energy. This analogy could no doubt be profitably followed into greater detail if we were mechanical engineers, well up in the theory of thermodynamics and heat engines. But I for one am not, so it would be a case of explaining the obscure in terms of the still more obscure. I just drop the hint in case any A.M.I. Mech. Es reading this would like to approach from that angle. As for the rest of us, we would probably be safer to stick to our electronics.

One of the facts thereof is that any electron requires a certain amount of energy to make it emerge from a conductor. This energy is curiously named the "work function" and denoted by ϕ , and is conveniently specified in electron-volts (eV) because that indicates the potential difference in volts that has to be overcome. If two pieces of exactly the same metal are brought into contact, their work functions—being the same—cancel out when an electron current flows out of one into the other. So (apart from any resistance drop) there is no difference of potential between the two sides of

the contact. If however two metals with different work functions are brought into contact, a potential difference will be set up between them, equal to the difference between the work functions, as shown in Fig. 2. If you attempt to measure this with a voltmeter you will not succeed, even if you take the precaution of using a valve voltmeter drawing negligible current. That is because somewhere in the circuit there is bound to be at least one other junction between different metals, the net work function of which will cancel out the p.d. set up at the first junction.

Fig. 3 is a potential diagram for a diode connected as in Fig. 1(b). Beginning at the cathode, there is first a p.d. due to the cathode work function, ϕ_K . Because the direction of the electrons at the anode is inward, instead of outward as at the cathode, ϕ_A is set off downwards. But not from the level where ϕ_A left off. There is the p.d. caused by heating the cathode, which gives many of the electrons greater energy than is barely necessary to emit them. They are therefore able to climb a potential hill between ϕ_K and ϕ_A . In an ordinary diode the space charge due to the electrons between the electrodes makes this hill steeper, so that the number with enough spare energy to climb over it is a mere trickle—often less than $1 \mu A$.

The difference of potential between cathode and anode is marked V_A , and this is the voltage available for driving the anode current through a load. To make it as large as possible, not only should the difference between cathode and anode temperatures be as large as possible but ϕ_K should be as much larger than ϕ_A as possible. And the space-charge hill (δ) should be reduced—preferably eliminated altogether. Unfortunately, increasing the current increases it! So the cure must be pretty drastic.

In a vacuum diode, the obvious but by no means easy way is to get rid of the gap. No space, no space charge. Of course, there must be some gap, otherwise cathode and anode would be at the same temperature and all one would get would be the thermo-electric e.m.f. Experimentally, it has been made as small as 0.01 millimetre—an impressive achievement with an emitting surface.

Another way in which the "engine" differs from an ordinary diode is that for the latter one wants as large an emission at as low a temperature as possible, an aim that is promoted by using an oxide coating to reduce ϕ_K . But here one wants a high temperature, which looks after the emission without the need for a low ϕ_K . So tungsten, which has a high ϕ and high melting point, is indicated.

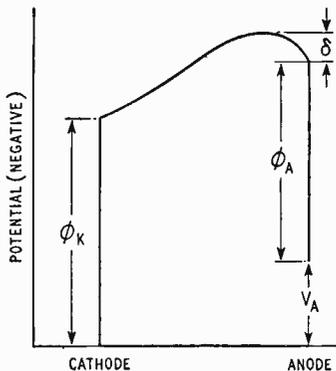


Fig. 3. In a diode the cathode and anode have their work functions, ϕ_K and ϕ_A ; there is also a p.d. due to the heating of the cathode. The net p.d. between anode and cathode is marked V_A . A crowd of electrons between cathode and anode constitutes a space charge, which raises a potential barrier δ , severely restricting the flow of current.

There are obvious difficulties in maintaining such a minute gap, especially with such large temperature changes, and alternative solutions have been looked for. One of them is the control of the electrons by a third electrode, as in Fig. 4. Although the names "cathode" and "anode", meaning the electrodes where the electrons respectively leave and arrive, are correct by definition even when the anode is negative relative to the cathode, the inventor of this tube evidently felt they weren't altogether appropriate and substituted the transistor terms "emitter" and "collector". The accelerating plate is held at a positive potential of the order of 100V. By itself this would obviously draw off all the electrons and cause a heavy current to flow through the battery—not at all what is wanted. So a permanent magnet is also fitted, to provide a magnetic field B, at right angles to the electric field E. Directly the electron starts off towards the positive plate, it crosses the magnetic field, and in accordance with the right-hand rule is whisked around into a curved path that takes it (if everything has been correctly calculated) to the collector, and thence through the load R to the starting point. So, although a relatively high voltage is needed for the accelerator, there should be no current in that circuit and therefore no expenditure of power in providing the two fields.

It has been calculated that a device of this kind is potentially capable of a higher efficiency than the diode "engine", but a snag is that if the current density in the tube is large the field strengths have to be large—perhaps impracticably so.

I am more impressed with the possibilities of a third variety, which is analogous to the gas-filled diode, the great advantage of which is the neutralizing of the negative space charge by positive gas ions, so that the voltage drop between cathode and anode is greatly reduced. This, of course, is just the sort of thing we want, and allows of a reasonable engineering clearance between cathode and anode. In fact, it can be more than that, allowing the designer better scope for keeping the heat where it is needed.

In order to be of any use for neutralizing the electronic space charge, the gas atoms have to be ionized, by knocking away at least one electron from each. In the ordinary "soft" rectifier this is done by the applied anode voltage accelerating the emitted electrons to a velocity that renders them capable of inflicting this bodily harm on the gas atoms. But in the "engine" there is no applied voltage, and the velocity of emission is not enough. One idea is to provide an auxiliary ionizing electrode held at an appropriate voltage. But there are obvious objections to that. It has been found possible to ionize them with the work function voltage of the cathode, if that exceeds the ionizing voltage of the gas. With most combinations it doesn't, but with the exceptionally high work function voltage of tungsten (4.52V) and the exceptionally low ionizing voltage of caesium vapour (3.89V) it does. The voltage is brought to bear when the caesium atoms hit the cathode.

Besides performing this essential duty, the caesium has the convenient effect of reducing the work function of the anode to 1.81V. So the difference between ϕ_K and ϕ_A is exceptionally large, and consequently so is the output voltage—in an experimental "engine", 2.5V at 1A. This quite high output current required a very high cathode

temperature, 2,910°K (=2,637°C), and yielded an efficiency of 10.4%.

In this experiment, with $2\frac{1}{2}$ watts output, the load resistance was 2.5Ω. Much higher power would mean correspondingly lower load resistance. Even in these days of transistors there isn't very much call for such low-voltage d.c. as that. It is possible to step up the voltage to some extent by arranging several diodes in series. But often one wants a.c. A very ancient joke was to send some sap to buy an a.c. battery. One might think it equally naive to ask for an a.c. version of the kind of current generator we have been considering. But their developers have no such inhibition and have pointed out that by suitably modulating their output in accordance with known techniques they can be made to provide a.c.

In experimental work so far reported, the cathodes have for convenience been heated electrically, the idea presumably being to establish the essential principles before complicating the issue by the practical problems of applying non-electrical heat. That these problems are rated by the developers as mere routine can be guessed from the confidence with which they have announced that thermo-electron engines can be built to use conventional, nuclear or solar heating. In view of the exponential relationship between output and temperature (this is yet another place where $e^{1/kT}$ comes in; see "k" in the last November issue) I would expect control of temperature to sufficiently narrow limits to be quite a formidable problem on its own. But they know more about what they are doing than we do.

The thermo-electric effect has already been mentioned. Has it been considered as a source of

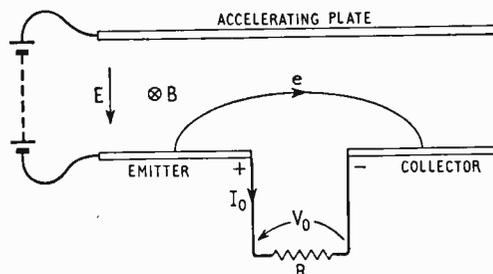


Fig. 4. In this diagram, E represents an electric field from accelerator to emitter, and the conventional symbol marked B is the rear of an arrow pointing into the paper, indicating the direction of a magnetic field. Under the influence of these fields, electrons leap across to the collector without causing space-charge effects.

power, as distinct from instrumental applications such as thermometry? It has not only been considered but actually used, I believe on a commercial scale, a good many years ago. One form, if memory serves me (if it doesn't, "Free Grid" will no doubt come to the rescue) was seen in this country, for bringing the offerings of the B.B.C. to the considerable proportion of British citizens who at that early date had a gas supply but no electricity. Another recollection of about the same period concerns a paraffin powered radio for bringing news of the exploits of stakhanovites and similar inspiration to dwellers in the remoter parts of the People's Republics. There would seem to be scope for more and smaller

"WIRELESS WORLD" INDEX

The index to Volume 66 (1960) is now available price 1s (postage 3d). Cloth binding cases with index cost 9s including postage and packing. Our publishers will undertake the binding of readers' issues, the cost being 25s per volume including binding case, index and return postage. Copies should be sent to Associated Iliffe Press Ltd., Binding Department, c/o 4 Iliffe Yard, London, S.E.17, with a note of the sender's name and address. A separate note, confirming despatch, together with remittance should be sent to the Publishing Department, Dorset House, Stamford Street, London, S.E.1.

devices of this kind now that transistors have displaced valves, for situations (if any) where batteries are not readily obtainable. (What about a combination radio and petrol lighter?) Compared with thermo-electron engines, they are less efficient at high temperatures, say about 1,000°K, but more efficient at lower temperatures. Their maximum efficiency is lower. And the voltage per thermo-junction is much lower even than that per diode, but it is rather easier, I would think, to arrange a lot of them in series, as in fact is usually done.

Development of semiconductors is having its impact on thermo-electric devices, as on so much else, but that is a subject (and a very involved one) of its own.

Another kind of generator altogether is the magnetohydrodynamic, considerably abbreviated to mhd. It makes another whole subject, but perhaps I can just indicate the broad idea by saying how it compares in principle with the conventional power station. In a turbo-generator set, a fluid (steam) is used to generate mechanical energy, which in turn generates electrical energy by causing relative motion between conductors and magnetic fields. In the mhd generator these two stages are telescoped into one by using a conducting fluid. The possibilities would seem to be very big indeed.

But a great deal of development will be needed before they can displace such highly developed and well established units as turbo-generators.

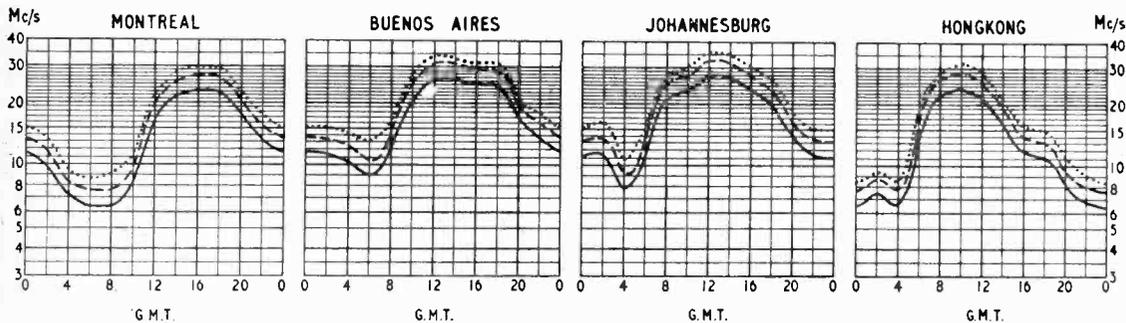
Another kind of device that is sometimes included under our title, though it would be more correct to call it a generator of electricity *instead* of heat, is the fuel cell. If a supply of hydrogen gas is ignited it will burn, just like commercial gas, by combining with the oxygen of the air to form water vapour. This is simply a rearrangement of the electrons in the hydrogen and oxygen atoms. When rearranged, their total energy at their original temperature is less, so the surplus is given off as heat. However, by arranging a sort of middleman to keep the two parties to the transaction separate, this surplus energy can be made to come in potential form, as an excess of electrons at one electrode and a deficiency at another, these electrodes therefore becoming negative and positive respectively.

This is precisely what happens in an ordinary chemical battery cell, the only difference in a fuel cell being that the materials can be fed in continuously instead of being used up irreplaceably. In the Bacon cell—which we heard a lot about, over a year ago—hydrogen and oxygen are fed in through porous electrodes in a solution of caustic potash, and the chemical reactions cause electrons to accumulate on the hydrogen electrode and be withdrawn from the oxygen electrode—which therefore becomes about 1 volt positive. The efficiency is much higher than in the best heat engine, and the possibilities are tremendous.

All this may seem to have been a maximum hotch-potch of information for a minimum of accomplished practice. We have so often been let down by popular news of what was "just round the corner." And however promising the experimental results, the new methods of generating electricity will have a tough fight before they can displace the firmly established methods. Perhaps at first they will be limited to exotic applications such as satellites. But I shall be surprised if some of the conventional sources of electricity are not seriously challenged before many more years have rolled.

SHORT-WAVE CONDITIONS

Prediction for February



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 February.

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

The Bootstrap Follower

2.—MEASUREMENTS IN PRACTICAL CIRCUITS

By G. W. SHORT

IN the first part of this article the properties of the "bootstrap follower" were discussed and a high-gain cascade amplifier combination of a pentode and bootstrap follower was analysed. We now pass to a consideration of practical design details and some measurements of performance.

Effect of Output Capacitance.—The effect of the capacitance c_{s2} across the output of the amplifier has so far been ignored. One reason for this is that c_{s2} is unknown—it depends on what you connect to the amplifier. Another is that the effect is complex, because c_{s2} affects the load seen by the pentode. Clever people could no doubt calculate the performance with c_{s2} included, but the writer gave up at this point, and made some measurements instead.

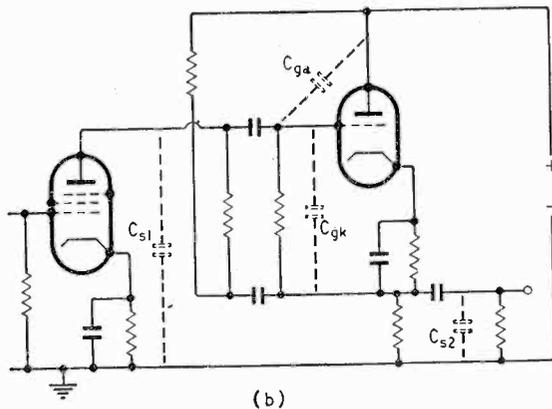


Fig. 8(b).—Bootstrap follower combination showing stray capacitances. (Repeated from Part 1 of this article).

The circuit used is shown in Fig. 9, which is based on Fig. 8(b). Care was taken to keep the anode strays of V1 down to a minimum. R_4 and R_5 were connected "close up," coupling capacitor C_2 was a small type (TCC Metalmite) and the valve holders were just far enough apart to accommodate it. A small earthed screening plate was put between the grid and anode tags of the triode valve holder, which are adjacent. The rest of the circuit was arranged so that it could quickly be changed from a bootstrap follower amplifier to a cascade amplifier and vice versa. For the cascade amplifier, C_3 was disconnected, R_8 was shorted, and R_6 was unshorted. The output was taken to a voltmeter via another bootstrap follower stage, made up from the other section of the ECC81 double triode. The meter was calibrated by applying the output of the audio oscillator used for measuring frequency responses directly to this second bootstrap follower stage.

The cascade amplifier had a gain of 6000 at 1 kc/s, and a -3dB bandwidth of about 10 kc/s. The gain of the bootstrap follower amplifier at 1 kc/s was 1700.

Some reduction was to be expected, because, first, in the circuit used only half the pentode load is subject to impedance multiplication, and, second, the triode gain (V_{out}/V_{gk}) is reduced because the load is halved. Despite the lower gain, the high-frequency response was poorer than that of the cascade circuit (see Fig. 10) because of the ill effects of c_{s1} . This stray capacitance is made up of the output capacitance of the EF86 (5.5pF) plus strays, which might be expected to add up to 10 pF in a carefully wired-up circuit. In the cascade circuit, the triode should have a gain of 38, and in the bootstrap follower circuit a gain of 32. The value of c_{s1} is 1.6 pF, while c_{gk} is 2.2 p.F. These values yield a calculated ratio of gain-bandwidth products of 6, which agrees with the measurements (ignoring the l.f. responses).

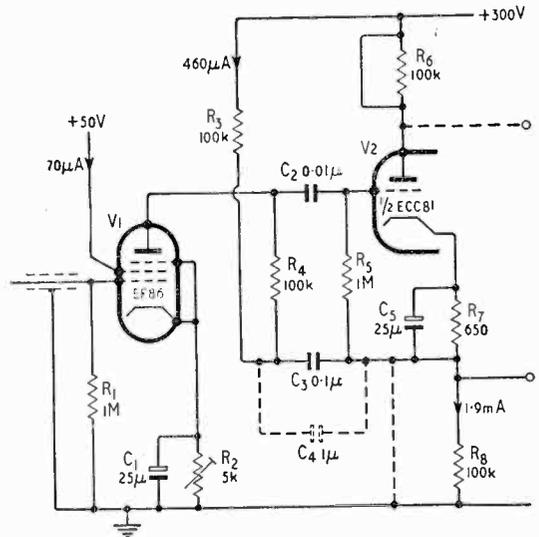


Fig. 9.—Practical pentode-b.f. combination circuit, based on Fig. 8(b). This can be turned into a cascade amplifier by disconnecting C_3 , shorting R_8 , and unshorting R_6 . R_2 was adjusted to provide 1.5 V bias for V1.

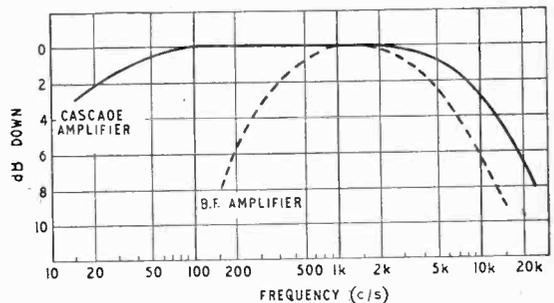


Fig. 10.—Frequency responses of the cascade and bootstrap follower amplifiers.

The effect of a capacitive triode load is shown in Fig. 11, which shows how the cut-off frequency (-3dB) varies with this capacitance. As might be expected, the effect is worse for the cascade amplifier, which has a higher output resistance, but it is not very serious for normal values of load capacitance.

Low-Frequency Response.—The falling-off of l.f. response in the cascade amplifier due to the $0.01\mu\text{F}$, $1\text{ M}\Omega$ interstage coupling should produce a 3dB loss at about 16 c/s , and this will be made slightly worse by the triode cathode-bias circuit. The measured response agrees with this. In the bootstrap follower amplifier, however, the lower cut-off frequency is about 330 c/s , which is twenty times greater.

Why should there be such a great discrepancy between the two circuits? The obvious difference between them is that the bootstrap follower amplifier

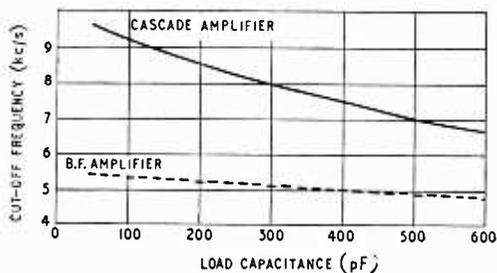


Fig. 11.—Effect of load capacitance on upper cut-off frequency.

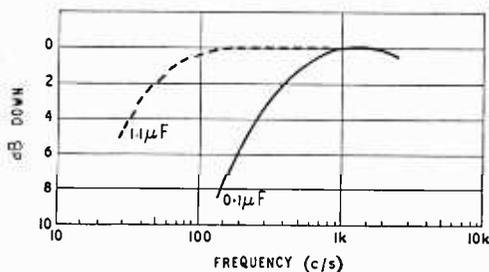


Fig. 12.—Effect of lower coupling capacitance on l.f. response of bootstrap follower amplifier.

has two couplings, C_2R_5 and C_3R_3 , instead of one. In Fig. 9, these have equal time-constants, so on the face of it one would expect merely a further 3dB loss at 16 c/s compared with the cascade amplifier. Indeed even this would be pessimistic, since R_5 is impedance-multiplied to about $33\text{ M}\Omega$ in the bootstrap follower.

It seemed reasonable to leave the upper coupling network C_2R_5 as it was, and make measurements with an increased C_3R_3 . An extra $1\mu\text{F}$ capacitor C_4 was strapped across C_3 and the response measured again. The result, shown in Fig. 12, was to bring down the cut-off frequency to 40 c/s , which is a marked improvement, though the cascade amplifier is still superior. The best thing to do would be to make C_3 infinitely large by connecting the lower end of R_4 directly to the other end of R_5 . This kind of direct connection is used in Bailey's circuit.* Unfortun-

ately, a direct coupling of this kind puts the two valves in series across the h.t. line and so imposes restrictions on their d.c. operating conditions. The h.t. voltage must be shared between the two stages, and the anode currents of the valves must be equal. An a.c.-coupled circuit is more versatile in this respect and, fortunately, adequate l.f. response can be ensured by using a suitable electrolytic capacitor for the lower coupling. A small leakage current is permissible since it does not seriously affect the operating conditions of the triode.

In a circuit like that of Fig. 9, there are signal-voltage drops across C_2 , R_7 and C_5 , and C_3 . All of these reduce the voltage fed back to the lower end of R_4 , and so reduce the amount by which R_4 is multiplied by bootstrap action. If, for example, the transmission of each coupling were 0.9 , then the overall transmission would be 0.9 cubed or 0.73 , which would result in nearly 3dB loss of gain. At lower frequencies the transmission of each coupling would be smaller and the situation would get rapidly worse. The loss of l.f. signal across the triode cathode-bias network is particularly bad, since any signal-frequency voltage lost here reduces the impedance multiplication of the grid resistor R_5 , which in turn reduces the response of the C_2R_5 coupling; so once the rot sets in it spreads rather rapidly. Moreover, it is only the in-phase part of the fed-back voltage which produces impedance multiplication. Because of this, in a CR network such as C_3R_3 , the effective part of the output voltage is $1/(1 + X^2/R^2)$ times the input, X being the reactance of the capacitor. Thus when $X = R$, which is the normal condition for a 3dB loss, the actual loss is 6dB .

Single-Ended Bootstrap Follower Amplifiers.—The foregoing results show that, as a single-ended amplifier, the pentode-bootstrap follower combination is inferior in gain to a normal cascaded amplifier. Another disadvantage is that it cannot deliver as great an output voltage.

There may be circumstances in which these disadvantages are unimportant, and there may be reasons why the bootstrap follower combination is still an attractive proposition. Possible grounds for preferring the bootstrap follower combination to a normal cascade amplifier are component economy, stability, and greater suitability for use in feedback circuits. Let us see if there is a niche in which the bootstrap follower circuit fits.

An examination of Fig. 9 shows that, in this particular bootstrap follower combination, there is no component economy compared with a cascade amplifier. Indeed, one extra resistor and one extra capacitor are required. To reduce the number of components some degree of direct coupling must be resorted to. A completely direct-coupled circuit would look very like Fig. 7 (Part 1). The trouble with this is that the pentode load R_a is also the cathode-bias resistance for the triode. It must therefore be small (no more than a few thousand ohms) and the gain is therefore small. Readers will recognize this kind of circuit as one variety of "single-ended push-pull" output stage. In a power output stage one does not look for high gain so much as high output power, and the comparatively low gain is not important. Somewhat similar arrangements have also been used in video-frequency amplifiers which must work into low-impedance loads. The load R_l is connected via a block-

* *Wireless World*, January, 1960

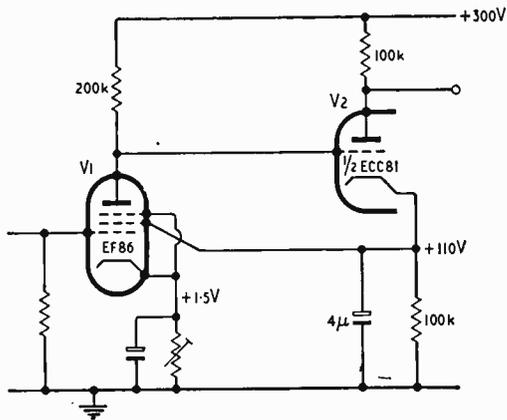


Fig. 13.—Partially direct-coupled cascade amplifier designed for economy in components.

ing capacitor, or returned to a tap on the h.t. supply such that there is no direct current through it.

A circuit which is not completely direct-coupled and is capable of furnishing much more gain has already been mentioned in connection with low-frequency response. Naturally, it uses fewer components than an a.c.-coupled circuit. But if direct coupling is to be permitted, one must compare like with like: that is to say, one must compare a bootstrap follower combination having some degree of direct coupling with a cascade amplifier also with some degree of direct coupling. Such a cascade amplifier is shown in Fig. 13. Astute readers will realize that the circuit of Fig. 9 can be converted into that of Fig. 13 with the minimum of trouble on the part of the experimenter! With this circuit the gain was about 8000, with an upper cut-off frequency of 8.5 kc/s. The lower cut-off frequency was 110 c/s: this indicates that the triode cathode capacitor was too small. Although this circuit is very economical in components, it does not represent quite the limit in economy. With some combinations of valves it should be possible to do without the triode cathode resistor. To be able to do so, the anode current of the triode must be the same as the screen current of the pentode, and the pentode must be capable of working satisfactorily with a screen voltage slightly in excess of its anode voltage. The best bet is to use a high-slope pentode such as the EF91, but unfortunately this kind of valve is not really suitable for use in low-level a.f. stages, because of hum and microphony. In general, it is much better to use a proper audio valve like the EF86 and stand the expense of the one extra resistor.

Readers who like using unorthodox-looking circuits may care to experiment with a combination of valves such that the screen current of the pentode is *greater* than the anode current of the triode. The triode cathode resistor must then be returned to h.t. positive.

The bootstrap follower combination does possess one characteristic which sometimes makes it more suitable than a normal amplifier. This is that there is only one phase reversal, so that the input and output voltages are in anti-phase. This can be useful in feedback circuits for getting the polarity right.

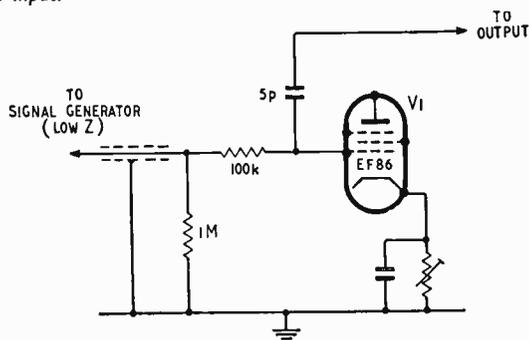
In certain circumstances, the bootstrap follower combination may produce less phase shift than a cascade amplifier. This is because the triode has a lower output resistance in the bootstrap follower circuit and so the high-frequency phase shift caused by capacitance across the output will be less than in the triode stage of the cascade amplifier. The writer suspects, however, that claims about reduced phase shift for this kind of circuit are usually based on an assumption that the output resistance of the triode is as low as that of a true cathode-follower. If this were so, then for audio applications the high-frequency phase shift introduced by load capacitance would be negligible. Unfortunately, as we have seen, this is not true of circuits in which the triode is driven from a high-impedance source, and these are the very circuits which produce high gain. In such circuits there are two important h.f. cut-offs, as in a cascade circuit. While Fig. 11 suggests that there may well be more h.f. phase shift in the cascade circuit, one could always reduce it in the latter by using a smaller triode load and possibly still end up with a high overall gain.

On the matter of stability, it is obviously true that stray coupling from output to input of the bootstrap follower combination is not likely to cause oscillation, since it completes a negative feedback loop. Such coupling could only give trouble of this kind if phase shifts elsewhere in the loop were large enough to bring the total phase shift to 180°. It does not follow that the effect of stray coupling is harmless. Since such a coupling takes place by way of a capacitance of, at the most, a few pF, it is in itself frequency-selective and introduces considerable phase shift. It can therefore affect the frequency response considerably.

To illustrate this the frequency response was measured with a 5-pF capacitor connected from output to input. Measurements were made on the Fig. 9 bootstrap follower combination with the input circuit modified as shown in Fig. 14. Since the 1-MΩ grid resistor was virtually shorted by the signal generator, the effective signal-source resistance was 100 kΩ.

The effect of the 5-pF feedback capacitance was to change the frequency response to that shown by the solid-line curve of Fig. 15. The gain at the peak was 1200, and the response was 3dB down at about 1.5 kc/s. Even this is better than might be expected on simple theory. If one regards the boot-

Fig. 14.—Modification of bootstrap follower amplifier input circuit to measure the effect of stray coupling from output to input.



strap follower combination as a sort of composite single-valve amplifier, then the 5-pF capacitance is its anode-grid capacitance and gives rise to Miller effect. Since the gain without feedback was previously found to be 1700, a 5-pF capacitance must look like 8500 pF between the input grid and earth, and with this value of capacitance one would expect a 3 dB drop at about 200 c/s.

The 100-k Ω grid stopper by itself, without the 5-pF feedback capacitance, has some effect on the high-frequency response. This is shown by the dotted-line curve of Fig. 15.

Bootstrap Follower Phase Splitters.—In general, then, the single-ended bootstrap follower combination is inferior to ordinary cascaded stages. In phase-splitting circuits of the "concertina" type, however, it can be used with advantage to obtain a higher overall gain than one would get from a straight pentode followed by a normal triode concertina phase-splitter.

Fig. 16 shows the frequency response of a modified Fig. 9 circuit. The modifications consisted of adding a 50-k Ω anode load resistor and using a 4- μ F electrolytic capacitor for C_3 . The gain to either output was 1250. The deterioration in h.f. response is probably the result of Miller effect in the triode, which approximately doubles the effect of the grid-anode capacitance.

This type of circuit is clearly very useful. The h.f. response could be improved by reducing the load of the pentode. The gain would fall, but it would still be greater than that of a normal circuit with no impedance multiplication. One way of reducing the gain is simply to remove C_5 . This reduces the impedance multiplication and introduces some local negative feedback. Another method is to reduce R_4 , and yet another is to use a low- μ triode for V2.

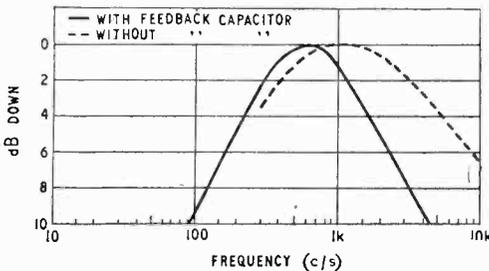


Fig. 15.—Effect of 5pF coupling capacitor (solid line). The dotted line shows the response without the capacitor but with a 100-k Ω grid stopper.

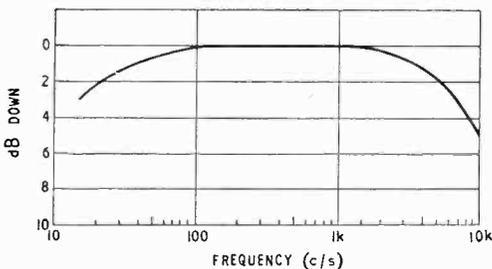


Fig. 16.—Frequency response of bootstrap follower phase-splitter combination.

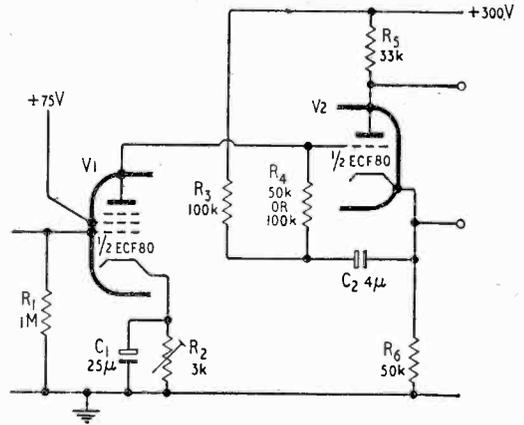


Fig. 17.—Experimental high-gain phase-splitting circuit using a triode-pentode valve. R_2 was adjusted to provide a bias of 1.5V. R_4 is the only component which adds stray capacitance to the sensitive part of the circuit.

In many cases, an impedance multiplication of 10-20 will be as much as can be made use of without running into h.f. response difficulties, and almost any triode will provide this amount. It then becomes an attractive proposition to use a triode-pentode of the television frequency-changer type as a single-valve bootstrap follower phase-splitter combination, to give high gain together with adequate bandwidth.

Whichever circuit is used, care should be taken to minimize the wiring stray capacitance in the pentode anode and triode grid circuit. The best way of doing this is to connect these two electrodes directly, since a short piece of wire has a lower capacitance to earth than a coupling capacitor. In addition, the number of components in the vulnerable part of the circuit should be kept as small as possible, since each one adds its quota of stray capacitance. The components should be soldered to the valve-holder tags, using short leads, and not mounted on tag boards some distance from the valve holders.

These considerations lead to the kind of circuit shown in Fig. 17. With $R_4 = 50$ k Ω , this had a gain of 750 to each output, 3 dB down at 14 c/s and 30 kc/s, and provided about 25 V peak from either output into a 300-k Ω load. With $R_4 = 100$ k Ω , the gain was 1000, the bandwidth was 15 kc/s, and the peak output was about 35V. No attempt was made to optimize component values (this applies to all the circuits used in making measurements for this article) and it may well be possible to do a bit better than this.

A valve designed for r.f. applications is not likely to have very low hum and microphony, but it should still be possible to use such a valve where the signal level is fairly high. The usual high-slope output pentodes require round about 10V grid drive, so that the input to a typical pentode bootstrap follower phase-splitter would be about 10 mV. This is a bit too low for comfort, but in many amplifiers 20 dB of negative feedback is used, and the required input would then be 100 mV. Under these conditions one might hope to get away with it. However, the writer would like to emphasize that the circuit of Fig. 17 has not been tried out by him in an actual audio amplifier. It may be full of hidden snags, and, as this article has endeavoured to illustrate, with these types of circuit you can't be too careful.

Symbolic Circuit Description

A USEFUL FORM OF SHORTHAND FOR COMPLEX SYSTEMS

By P. RAILTON and H. JEFFERSON, M.A.

THE increasing complexity of electric and electronic circuits has brought in its train an increasing mass of paper describing the operation of the circuits. Where the descriptions are intended to be used for maintenance and fault-finding they are of necessity detailed and as the equipment grows in size the study of the handbook becomes itself a task of formidable proportions. This is especially true of switching circuits. In the linear circuits, amplifiers, modulators and the like, there is commonly a single path to be followed throughout the units of the system with perhaps an entrant side chain from an oscillator to a modulator or a separation into a number of parallel and similar tracks at a filter system. In switching circuits we no longer have this simplicity. The operation of a relay may close six circuits and open half-a-dozen more. Sometimes, though this is usually deprecated, two circuits may race against each other and the designer's skill becomes his skill as a handicapper. As each stage in the operation is completed a whole new set of functions is initiated. All this must be described.

To facilitate the understanding of repetitive but

non-linear circuits a practice has developed of showing a small diagram at important points of the circuit diagram to indicate the waveform which will be seen on an oscilloscope connected to any of these points. This practice, not surprisingly, is very frequently adopted by the manufacturers of oscilloscopes, but it has also been found useful by others whose judgment can be assumed to be free of any trace of special interest. It is a clear admission that a lengthy description of the functioning of the device is not really sufficient.

An interesting method of dealing with the circuit description of switching circuits has been suggested by M. M. Bonell in the official journal of the Spanish Posts and Telecommunications, *Revista de Telecomunicacion* (Vol. 12, No. 53, pp 2-7, September 1958). The author is concerned with the functioning of automatic telephone exchanges and his paper is devoted to a description of a symbolic method of cataloguing the stages involved in setting up a call. He claims that on four pages of normal size he has provided all the information normally requiring a book of more than one hundred pages. Obviously the information has become much more accessible: at the same time it has become easier to understand and in consequence easier to remember.

Bonell's diagrams appear to be of much wider application than he suggests and they deserve wider publicity. This article has been prepared to ensure the latter and to encourage the former. Its merits are those of Bonell, its defects must be attributed to the authors.

In order to demonstrate the method we have

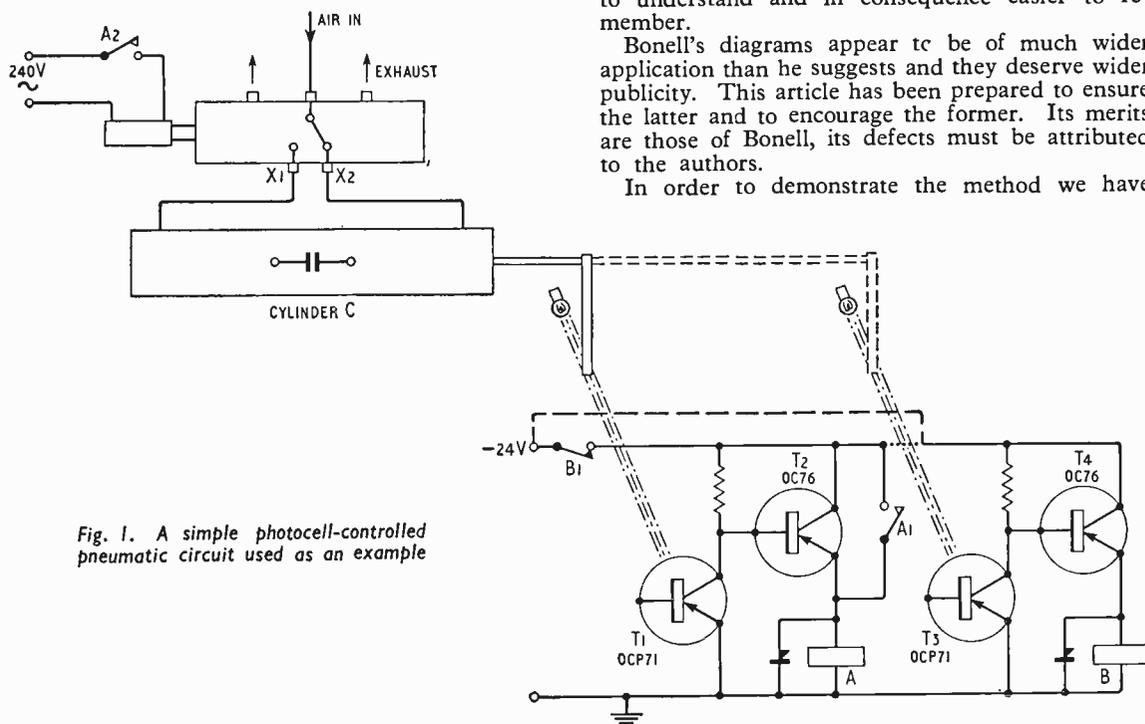


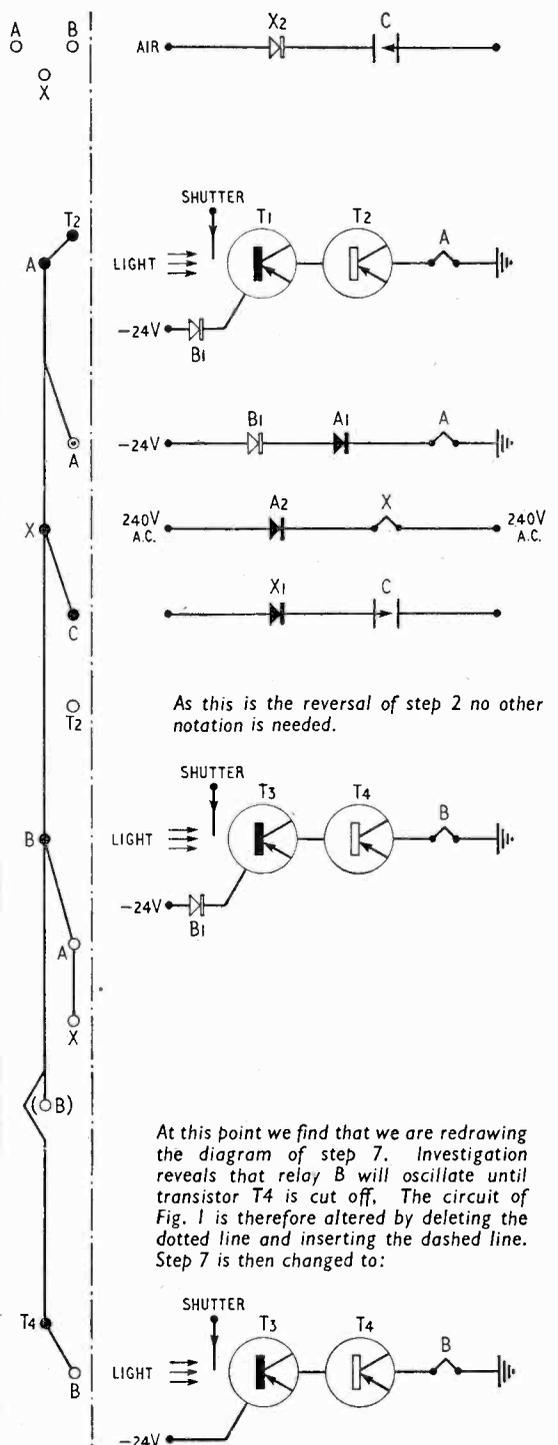
Fig. 1. A simple photocell-controlled pneumatic circuit used as an example

devised a simple reciprocating circuit in which air pressure is used to drive a shutter to the point at which it intercepts the light falling on a phototransistor. A second transistor then operates a relay

to reverse the motion which continues until the shutter reaches a second light beam. The complete arrangement is shown in Fig. 1. It will be seen that in this relatively simple system we have on-off

- (1) When first switched on with the piston in some arbitrary central position light will fall on both phototransistors which will then conduct, cutting off the second transistor of each pair. Neither relay will be operated. The air valve X will not be energized so that pressure will be applied through the path X2 to the cylinder and the piston will be driven to the left.
- (2) When the piston has travelled far enough to the left the shutter will intercept the light falling on the normally conducting phototransistor T1. In consequence T1 will be cut off, bringing the normally non-conducting transistor T2 into conduction and operating relay A. The -24 volt supply for this action is provided through the normally closed contact B1.
- (3) Relay A now locks on through its own holding contact A1.
- (4) Contact A2 is operated and applies the 240 v a.c. mains supply to the solenoid of air valve X.
- (5) When the solenoid is energized air pressure is applied through the path X1 to the cylinder, while the other end is opened to atmosphere through X2. The piston is driven to the right.
- (6) As soon as the piston moves light again falls on the phototransistor T1, cutting off the transistor T2 but leaving A operated through the holding contact A1.
- (7) On the completion of its stroke the piston causes the shutter to intercept the light reaching phototransistor T3. As in step 2 transistor T4 conducts and relay B is operated.
- (8) The operation of B opens contact B1 so that relay A releases.
- (9) The release of relay A opens the holding contact and also contact A2, so that X releases.
- (10) The operation of contact B1 also releases B
- (11) The release of B closes contact B1.

With the change thus made necessary steps 10 and 11 disappear. A new stage in the centre indicates the re-illumination of T3 and consequent events.



As this is the reversal of step 2 no other notation is needed.

At this point we find that we are redrawing the diagram of step 7. Investigation reveals that relay B will oscillate until transistor T4 is cut off. The circuit of Fig. 1 is therefore altered by deleting the dotted line and inserting the dashed line. Step 7 is then changed to:

The system is now in the original state with relays A and B and solenoid X all de-energized. This is the opening condition of step 1 and the cycle will now be repeated

Key to Symbols

-  Contact normally made or air path normally complete
-  Contact made or air path completed when device is energized
-  Relay or solenoid coil
-  Non-conducting transistor
-  Conducting transistor
-  Relay energized
-  Relay de-energized
-  Relay held

actions in light paths, air paths, electric circuits through transistors and electric circuits through relay contacts. It is now necessary to describe in detail the functioning of the circuit. This is done in the table, which contains in parallel columns the conventional description in words and the symbolic description of the Bonell diagram.

As will be seen the Bonell diagram is in two parts, the one on the left indicating the successive operations, for example the energizing of relay A in step (2), while on the right the skeleton of the circuit which produces the operation is given in a form which tells us what happens without excessive detail.

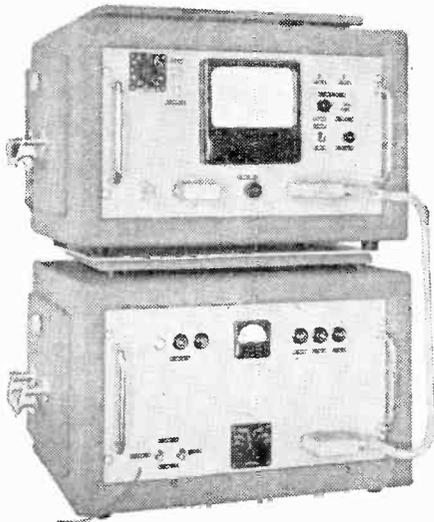
We do not, at this stage, require to know just how much light must be cut off from the phototransistor in order that the second transistor emitter current will rise to the operate current of the relay. This is a matter which must always be referred back to the original and detailed circuit.

The preparation of the Bonell diagram is in itself a useful tool in the detection of circuit errors. Such an error which results in a race between the piston movement and relay B has been introduced into the symbolic circuit, in order that it might be detected at step (10). It is probably always more difficult to gloss over racing sequences and similar circuit aberrations in a highly formalized language, which is what the diagram in fact is, than in a flow of words.

In the manuscript a conservative estimate is that the Bonell diagram occupies only one-third of the length of the conventional description. This is a much smaller improvement than is claimed by Bonell. There are two reasons for this: the circuit itself is simpler than Bonell's circuits and the conventional description is rather abbreviated. For example, in step 3 no mention is made of the -24V supply, nor of the fact that the normally made B1 contact is in the holding path of relay A. This sort of abbreviation becomes much less pardonable in complex circuits.

The symbols used for relays are those introduced by Bonell, while the others are those which we have found convenient. It is, of course, vital to the success of a symbolic form such as this that a uniform system should be adopted and that once adopted it should be protected from the hands of the improvers who can produce a maximum of confusion for a minimum of merit.

Permanent Noise Factor Measurement



A METHOD of centimetric radar receiver noise measurement, which provides a permanent meter indication of noise factor under true working conditions has been developed by C.S.F. (Compagnie Générale de Télégraphie Sans Fil, 79, blvd. Haussmann, Paris 8).

The limited output of a noise discharge-tube, pulsed at half the recurrence frequency of the radar equipment, is fed to the transmission waveguide via a directional

coupler. The noise pulses are employed as a standard, and are delayed to avoid interference from clutter.

The amplitude of the receiver output is proportional, during "even" pulses, to receiver noise added to that of the noise diode, and to receiver noise alone during "odd" pulses. The two outputs are compared in a differential amplifier, the output of which is proportional, after standardization, to the difference in amplitude of the two inputs. A meter connected to the output of the amplifier gives noise factor in decibels.

An additional rack enables measurement of noise factor to be made on one or more radars, readings being presented on separate meters.

CLUB NEWS

Bradford.—"Transistors, Pirates, and Direction Finding" is the title of the talk to be given by A. R. Bailey (G3IBM) at the February 14th meeting of the Bradford Amateur Radio Society. The club meets on the second and fourth Tuesdays of each month at 7.30 at Cambridge House, 66, Little Horton Lane, Bradford 5.

Cleckheaton.—Dr. N. H. Chamberlain, of Leeds University, will deal with industrial electronics in a lecture to the Spen Valley Amateur Radio Society on February 1st. Meetings are held on alternate Wednesdays at 7.30 at the Labour Rooms, Cleckheaton.

Halifax.—Transistors is the subject of the lecture to be given by E. C. Bell, of Bradford Technical College, at the February 7th meeting of the Halifax and District Amateur Radio Society. Meetings are held at the Sportsman Inn, Ogdon, at 7.30.

Leeds.—The February programme of the Leeds Amateur Radio Society includes a transmitting evening (1st) and a lecture by D. Watson on amateur television (15th). The club meets each Wednesday at 7.45 at 3 Woodhouse Square, Leeds 3.

Elements of Electronic Circuits

22.—Multiplication and Division

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ARITHMETIC multiplication and division form an important part of mathematical operations on wave-forms and a variety of methods for achieving these functions have been devised.

Multiplication

Three common methods of achieving multiplication use the characteristics of valves, "take logarithms" almost as one would using log. tables or employ a pulse generator of variable width and amplitude.

Valve Characteristics.—If it is desired to achieve multiplication with valves at least two inputs should each, independently, be proportional to the output. With a triode, this means that the anode characteristic (I_a/v_a) must be linear. In other words the output current must be proportional to the anode voltage and the grid voltage:

$$I_a = k v_a v_g$$

Although this relationship is very difficult to achieve in practice, if some types of output tetrodes or pentodes strapped as triodes are used and the range of variables is restricted, an output approximately proportional to the product of two input voltages may be obtained. Fig. 1(a) shows a circuit using two tetrodes strapped as triodes. V2 is a cathode follower with V1, the multiplier valve, as the cathode impedance. $v_{k2} = v_{a1} = v_2$ by cathode follower action. As the valves have been arranged to have linear I_a/v_a characteristics, variation of v_2 causes a linear variation in current through the valves; as does v_1 . Thus the common valve current I_a and consequently v_{out} is proportional to $v_1 v_2$.

A similar method uses a multi-grid valve, with the voltages to be multiplied applied to different grids (Fig. 1(b)). This is the process commonly known as "multiplicative mixing" nearly always

used in a.m. superheterodyne radio receivers, where the anode current $= k v_{g1} v_{g3}$. Here v_{g1} is the signal voltage applied to the first (control) grid and v_{g3} is the local oscillator voltage applied to the third grid of the mixer valve.

A similar process occurs in amplitude modulation where the carrier amplitude after modulation is proportional to the modulating signal and to the amplitude of the carrier input.

Logarithmic Devices.—Let us consider the expression $\log a + \log b = \log ab$. Some forms of diode can be operated under conditions which produce a practically logarithmic voltage/current characteristic; hence this can lead to their use for multiplication purposes. After converting the inputs, the two logarithms are added and the antilogarithm derived, either directly from an exponential characteristic or by methods which involve the use of feedback circuits. Rectifiers of the copper-oxide type have a forward-impedance law which is approximately logarithmic (of the form $v = R \log I$) and can be used for multiplication. Fig. 2 shows a simple circuit employing a rectifier.

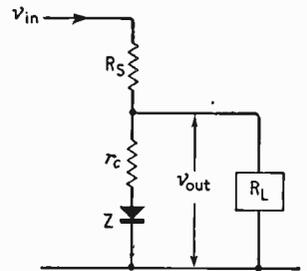


Fig. 2

Z—the dynamic-forward or "characteristic" resistance of the rectifier.

r_c —the ohmic resistance of the rectifier—this represents the resistance of the assembled component parts of the device and is quite small.

R_s —the resistance of the source—this is made large compared with Z.

R_L —the load resistance which is also made large compared with Z.

An improvement on this simple circuit is the non-linear bridge circuit employing identical rectifiers (Fig. 3). First of all let us consider what happens when R_1 and R_2 are fixed and R_3 and R_4 are varied. For low values of R_3 and R_4 it is possible to balance the bridge, i.e. $v_{out} = 0$. As the values of R_3 and R_4 are increased the

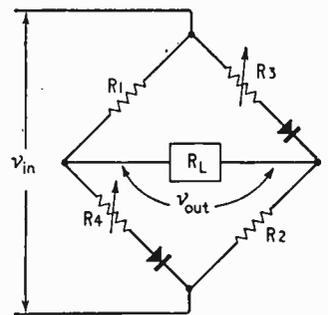


Fig. 3

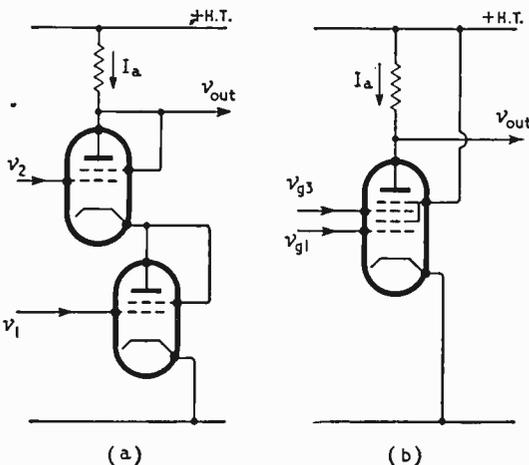


Fig. 1

input voltage v_{in} must be made larger in order to balance the bridge. Ultimately a condition is reached when v_{out} can no longer be zero, regardless of the value of v_{in} , and when $R_3 = R_4 = R_1 = R_2$ the output current (and hence v_{out}) rises logarithmically with an increasing v_{in} .

Variation of Waveform.—The average value of a waveform is proportional to the product of its amplitude and duration, provided that the negative excursion is clamped to zero. This is pressed into service by making the amplitude of the waveform follow one input and the duration the other. Methods based on this principle are quite often used in computers with a comparatively high degree of accuracy.

Division

Naturally, circuits carrying out this function are sometimes required and the simplest of these need not use valves or semi-conductors.

Passive Circuit Elements.—A very common example of potential division is the arrangement of resistors, capacitors or inductors in simple potential-divider configurations. The volume control is perhaps the most familiar divider; with this the input represents one variable, the rotation another. Of course, for "mathematical" use the potentiometer must have an accurately-known law.

Logarithmic Division Devices.—The expression $\log a - \log b = \log (a/b)$ enables us to use the logarithmic devices which were described in the section on multiplication.

Suppose we wish to find the quotient of two voltages $v_1 \div v_2$. We apply these voltages to two non-linear bridges and connect the bridges in series. The output currents are fed to a meter

which records their difference $I_1 - I_2$. Then since $I_1 = k \log v_1$ and $I_2 = k \log v_2$, $I_1 - I_2 = k \log v_1 - k \log v_2$ which by definition is $k \log (v_1/v_2)$ therefore the difference in output currents is proportional to the logarithm of the ratio of the two inputs.

Feedback Techniques.—With the aid of a high-gain amplifier together with a subtractor circuit it is possible to convert any multiplying circuit into a dividing circuit. Let us examine the block diagram of Fig. 4.

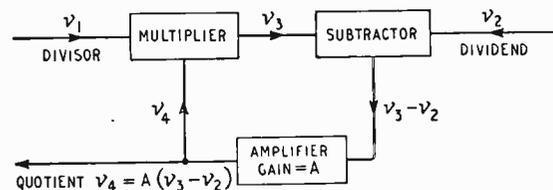


Fig. 4

It is required to derive the result $v_4 = v_2/v_1$. The equations to be considered are:—

$$v_3 = kv_1 v_4 \dots \dots \dots (1) \text{ (from the multiplier)}$$

$$v_4 = A(v_3 - v_2) \dots \dots \dots (2) \text{ (from the amplifier)}$$

substituting in (2) for v_3 we have

$$v_4 = A(kv_1 v_4 - v_2)$$

$$v_4 - A kv_1 v_4 = -A v_2$$

$$v_4 (1 - A kv_1) = -A v_2$$

$$v_4 = A v_2 / (A kv_1 - 1)$$

$$= v_2 / (kv_1 - 1/A)$$

If we make the gain (A) of the amplifier very high $1/A$ becomes very small. Then $v_4 = v_2/kv_1$ which is the required ratio (k can be made equal to one).

TECHNICAL NOTEBOOK

Tunnelling through Insulators has recently been demonstrated by Ivar Giaever of the American General Electric Research Laboratories. The quantum tunnelling process by which electrons can pass through an energy barrier which they have insufficient energy to surmount has already been demonstrated and made use of in semiconductor tunnel diodes, but had not so far been observed in insulators. In Giaever's experiments the insulator was only ~ 10-100 atoms thick and was sandwiched between two metal plates. Giaever also found that, if both of the metals were made superconductive, then the tunnelling voltage/current characteristic exhibited a negative-resistance region. Since superconductivity can be removed by applying a magnetic field, this offers a method of controlling the characteristics of such a device. It could in fact be made to function as a capacitor, resistor, diode, negative-resistance diode, switch or triode. The device can be made simply by depositing the metal and

insulating layers on a suitable substrate. It could thus be made extremely small and with a very low power consumption and dissipation. Since the tunnelling current depends on the electron density in the energy levels in the two metal plates, information about these levels can be obtained from measurements of the tunnelling current.

Photographic Memory has been recently developed by Bell Telephone Laboratories for an experimental electronic telephone switching system. In this memory switching instructions and directory information are permanently stored in the form of many small clear spots in an otherwise opaque photographic film. Each store contains over 2×10^6 spots or "bits" of information. This is read out by a flying-spot scanner, a 68-bit word taking only $2.5 \mu\text{sec}$ to read. The flying-spot electron beam is also used to initially develop the film by stopping the beam briefly at positions where a spot is desired.

A photographic emulsion is used which is fast enough to be exposed when the beam is stopped, but slow enough not to be exposed by a moving beam. Two million spots can be exposed in about ten minutes in this way. The photographic developing process—which may involve as many as fifteen steps and which takes in all about half an hour—has been made completely automatic in this equipment.

Thermoelectric Cooling Unit—the BT4—has been introduced by Salford Electrical Industries. This unit utilizes the Peltier effect in which heat is absorbed or generated when an electric current is passed across the junction of two dissimilar metals or semiconductors. (This effect occurs only at the junctions, and is in addition to the normal Joule electrical heating in the metals or semiconductors.) In this unit four pairs of junctions formed between p- and n-type bismuth telluride are used since this semiconductor exhibits a

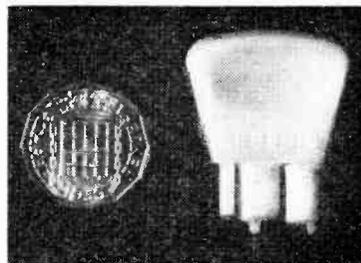
large Peltier effect. In use the unit is clamped between the object to be cooled and a heat sink (for absorbing the heat produced from four of the junctions). The cooling power increases with decreasing temperature difference between pairs of junctions up to a maximum, for this unit, of about 3W for a 10°C junction temperature difference. The cooling power can also be continuously varied or even reversed simply by varying the value or direction of the input current, so that such units can readily be incorporated in automatic control systems. Other advantages of this cooling unit over conventional units are that the actual junctions occupy only about a ½-in cube, it is silent and reliable (since no moving parts are used) and finally, it is unaffected by vibration or attitude.

Microwave Modulator using n-type germanium diodes has been developed by E. T. Harkless and R. Vincent of the Bell Telephone Laboratories. The operation of the device depends on the fact that such diodes, when suitably mounted in a waveguide, can be changed from nearly perfect absorbers to almost complete reflectors simply by switching the d.c. bias on them. The modulator uses a pair of such suitably-mounted diodes combined with a hybrid junction. With a reverse bias of about 7V on the diodes they reflect nearly all of the radiation incident on them and the microwave signal is transmitted with an attenuation of only 1 to 2dB. When the bias is switched to about 40mA in a forward direction nearly all of the radiation incident on the diodes is absorbed and the microwave signal is attenuated by 30 to 40dB. In this way up to 1W of 35kMc/s radiation has been successfully switched on and off at a repetition rate of 10Mc/s and with pulse rise and fall times of less than 2mμsec. Pulse lengths as short as 5mμsec have also been achieved.

High-Voltage Line Fault Locator introduced by Ferranti detects faults by means of the signal reflections these faults produce. The locator produces signals at a frequency of 1Mc/s in the form of 400V peak-to-peak 5μsec pulses spaced at 5msec intervals. These pulses are capacitively coupled to the 132 or 275kV high-voltage line. Any discontinuity in the electrical characteristics of the line due to a fault or the proximity of a tower then produces reflections of the pulses which are detected in the locator. The reflections produced by faults are larger and so may be distinguished from the reflection produced by towers. The delay between a pulse and its reflection determines the distance along the line to the discontinuity to an accuracy of 1% or 3000 ft, whichever is the greater, and faults can be detected at distances from 1 to 100 miles. This new

locator should replace the old time-consuming method of visually searching the line for faults.

Tape Cleaning Attachment for use with the Grundig TK24 four-track recorder on fast forward or rewind is shown (with a threepenny bit to indicate its size) in the photograph. The attachment has three prongs which are fitted into three corresponding holes on the tape deck when it is desired to clean the tape. Dust and other foreign particles are removed from the tape as it bears on the felt pads which cover two of the attachment prongs. Such cleaning



reduces the number of "drop outs" and this can be particularly beneficial with four-track reproduction.

TRANSISTOR BATTERY TAPE RECORDER

MARKETED in this country by E.M.I. Sales and Service, the German Protona "Minifon Attaché" dictation tape recorder measures only 7in by 4in by 1½in and weighs only 2 lb 6 oz. With the tape magazine used with this recorder, an overall playing time of 2×15 minutes can be obtained. The response is within ±3dB from 200c/s to 3000c/s at the single tape speed used (1½in/sec). Fast rewinding is at 30 times this record/playback speed. A useful dictation facility is that the last few syllables can be repeated. This recorder is transistorized and runs from a 12V battery.

A 34kc/s bias and erase supply is provided from a single OC308 transistor. A permanent magnet can also be used to erase both tracks simultaneously while fast winding.

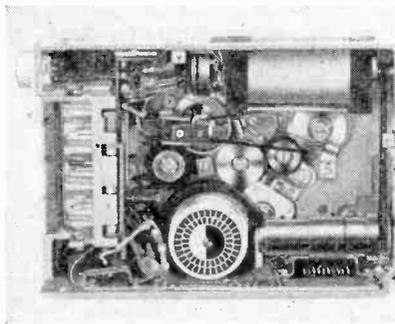
As the battery supply runs down, the motor speed and amplifier supply voltage are kept constant by means of an electrical centrifugal governor and transistor voltage stabilizer respectively. The transistor

stabilizer also suppresses electrical motor noise.

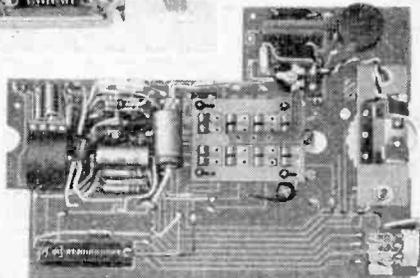
To reduce possible sources of flutter, a structure consisting of two heavy cylinders joined by a spiral spring is used to connect the motor transmission belt to the capstan. The capstan is not connected to the tape take-up and supply spools during recording or replaying; the supply spool is instead driven by the motion of the tape past the capstan. Take-up tape tension is provided by connecting the take-up spool to the supply spool by means of a slipping clutch and belt of suitable transmission ratio. For fast forward or rewind the capstan is connected to the take-up or supply spool via one or two idler wheels respectively.

The motor is automatically stopped at the end of each reel by cutting off an OC307 transistor which is in series with the motor battery supply. This is done by using the metal foil on the end of the tape to join the emitter and base of the OC307.

The tape is housed in a magazine which automatically positions it correctly relative to the tape-deck drive mechanism. This magazine may be removed and replaced regardless of how much of the tape has been played.



The Protona "Minifon Attaché" dictation recorder is constructed on two chassis: that shown on the left contains the mechanics and that on the right the electronics.



LINEAR PASSIVE FOUR-TERMINAL NETWORKS

By G. de VISME*, B.Sc.

USE OF SUPERPOSITION AND RECIPROCITY TO DETERMINE ELECTRICAL CONSTANTS

ASSOCIATED with linearity, either in the field of mechanical, electrical, magnetic, or even electro-magnetic systems, there are two quite fundamental and—but for special cases—unprovable axioms: Superposition and Reciprocity.

The first principle asserts that the effect of a number of independent causes acting together within a linear system is the sum of the effects produced by each cause acting on its own.

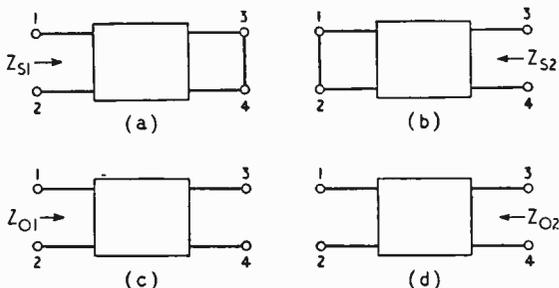


Fig. 1. Definition of short-circuit and open-circuit impedances of a four-terminal network.

The second principle states that if a cause at one point in a linear system produces an effect at another point, then the same cause acting at the second point produces the same effect at the first. In a sense, this principle expresses the fact that a linear system behaves in the same way in both directions.

The linear passive four-terminal network is a very important type of linear network. It can be represented as a box with four terminals, 1, 2, 3 and 4, between which some form of coupling exists. The box itself contains no separate sources of voltage or current, and the elements coupling the four terminals are all linear.

Using only the principles of superposition and reciprocity, and without specifying the contents of the box, we derive the coupling between any two pairs of terminals in terms of externally measurable properties of the four-terminal network, namely the

open- and short-circuit impedances measured across these two pairs of terminals.

Define short-circuit and open-circuit impedances Z_{S1} , Z_{S2} , Z_{O1} and Z_{O2} as in Fig. 1(a), (b), (c) and (d).

1. Let us short-circuit terminals 3 & 4 and connect to terminals 1 & 2 an a.c. generator of zero impedance whose voltage is representable by the complex number V_1 .

Sinusoidal currents, representable by complex numbers I_1 and I'_1 , will flow in the left-hand and right-hand circuits respectively, as in Fig. 2.

The signs and arrows in this diagram, as in all subsequent diagrams, indicate the positive directions of voltages and currents.

We have therefore, by definition,

$$V_1/I_1 = Z_{S1} \dots\dots\dots (i)$$

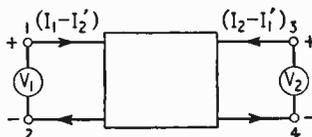
The ratio V_1/I_1 also has the dimensions of impedance; let us call this ratio Z_{T1} .

2. Now let us short-circuit terminals 1 & 2 and connect to terminals 3 & 4 an a.c. generator of zero impedance, whose voltage is representable by the complex number V_2 .

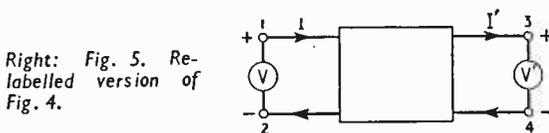
Sinusoidal currents, representable by complex numbers I_2 and I'_2 , will flow in the right-hand and left-hand circuits respectively, as in Fig. 3.

As before, we have, by definition,

$$V_2/I_2 = Z_{S2} \dots\dots\dots (ii)$$



Left: Fig. 4. Superposition of Figs. 2 and 3.



Right: Fig. 5. Re-labelled version of Fig. 4.

And we may define an impedance Z_{T2} equal to V_2/I_2 .

The principle of reciprocity then requires that $Z_{T1} = Z_{T2} = Z_T$, say. Thus we have

$$V_1/I_1 = V_2/I_2 = Z_T \dots\dots\dots (iii)$$

3. Suppose we now connect the generators V_1 and V_2 at the same time to terminals 1 & 2, and 3 & 4 respectively. Then the principle of superposition requires that the currents flowing in the left-hand and right-hand circuits be respectively $(I_1 - I'_1)$ and $(I_2 - I'_2)$, as in Fig. 4.

For convenience, let us relabel the voltages and currents, calling V_1 V , V_2 V' , $(I_1 - I'_1)$ I , and $(I_2 - I'_2)$ I' , as in Fig. 5.

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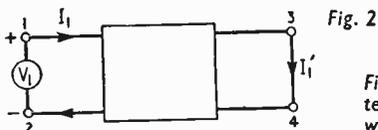


Fig. 2

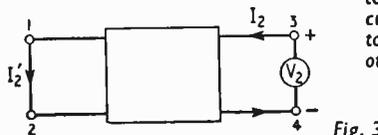


Fig. 3

Figs. 2 and 3. Four-terminal networks with one pair of terminals short-circuited and a generator connected to the other pair.

Then,

$$I = V/Z_{S1} - V'/Z_T, \text{ from (i) and (iii) } \dots \dots \text{ (iv)}$$

$$I' = V/Z_T - V'/Z_{S2}, \text{ from (ii) and (iii) } \dots \dots \text{ (v)}$$

These equations are entirely general, irrespective of the values of V and V'. They relate the currents flowing in the input and output circuits with the voltages *actually present* across terminals 1 & 2 and 3 & 4.

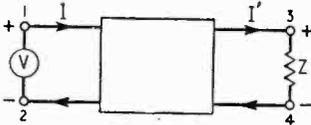
Suppose we now adjust the voltage of the generator across terminals 3 & 4 so as exactly to prevent any current from flowing in the right-hand circuit. To do this we have to make $V' = (Z_{S2}/Z_T)V$, from (v).

As a result, V/I becomes

$$\frac{V}{(V/Z_{S1}) - (Z_{S2}/Z_T)V/Z_T}, \text{ from (iv)}$$

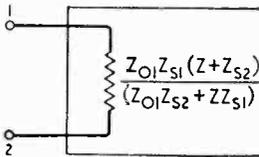
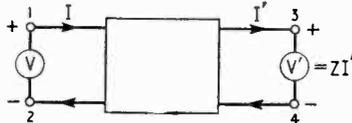
$$= Z_{S1}Z_T^2 / (Z_T^2 - Z_{S1}Z_{S2})$$

As far as the network is concerned, it is conscious only of an open circuit across terminals 3 & 4 and



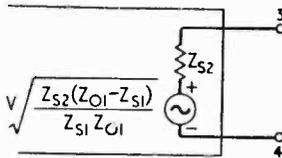
Left: Fig. 6. Four-terminal network terminated in an impedance Z.

Right: Fig. 7. Substitution of a suitable generator for the impedance Z in Fig. 6.



Left: Fig. 8. Equivalent input circuit of a four-terminal network terminated in an impedance Z.

Right: Fig. 9. Equivalent output circuit of a four-terminal network.



hence presents to the generator V the impedance Z_{O1} by definition, so that,

$$V/I = Z_{O1} = Z_{S1}Z_T^2 / (Z_T^2 - Z_{S1}Z_{S2}),$$

Therefore,

$$Z_T^2 = Z_{S2} / (1/Z_{S1} - 1/Z_{O1}) \dots \dots \text{ (vi)}$$

Now, instead of adjusting V' to make I' zero, we will adjust the voltage of the generator connected to terminals 1 & 2 to make the current I zero. To do this we have to make $V = (Z_{S1}/Z_T)V'$, from (iv).

As a result, V'/I' becomes

$$\frac{V}{(Z_{S1}/Z_T)V'/Z_T - (V'/Z_{S2})}, \text{ from (v)}$$

$$= Z_{S2}Z_T^2 / (Z_{S1}Z_{S2} - Z_T^2)$$

By the same reasoning as before, the impedance presented to the generator V' is Z_{O2} , so that, noticing the direction of I' in Fig. 5,

$$-V'/I' = Z_{O2} = Z_{S2}Z_T^2 / (Z_T^2 - Z_{S1}Z_{S2})$$

Therefore,

$$Z_T^2 = Z_{S1} / (1/Z_{S2} - 1/Z_{O2})$$

Comparing this with (vi), we see that

$$Z_{S1}/Z_{O1} = Z_{S2}/Z_{O2} \dots \dots \text{ (vii)}$$

Although we defined *four* impedances Z_{S1} , Z_{S2} , Z_{O1} , and Z_{O2} , we see that they are not independent, but are related in a simple way as shown in equation (vii).

We are now in a position to calculate the behaviour of the four-terminal network when terminated in a general impedance Z, as in Fig. 6.

In this case the voltage V' is produced by the current I' flowing through Z, and is therefore related to I' by the equation $V' = ZI'$. We can substitute this value of V' into equations (iv) and (v) without further ado, but for the benefit of readers who have not fully grasped the idea of generator substitution I repeat that, *as far as the network is concerned*, the impedance Z may be replaced by a generator of zero impedance and voltage $V' = ZI'$, as shown in Fig. 7, without in any way affecting the currents I and I'.

(a) Input Impedance Z_{in} .

This is the ratio V/I which in this case equals

$$\frac{V}{(V/Z_{S1}) - (ZI'/Z_T)} \text{ from (iv)}$$

Z_T is given by (vi), and I' is given by (v) as follows

$$I' = V/Z_T - ZI'/Z_{S2}$$

$$= V/[Z_T(1 + Z/Z_{S2})] \dots \dots \text{ (viii)}$$

Therefore,

$$Z_{in} = \frac{V}{(V/Z_{S1}) - ZV/[Z_T^2(1 + Z/Z_{S2})]}$$

$$= Z_{O1}Z_{S1}(Z + Z_{S2}) / (Z_{O1}Z_{S2} + ZZ_{S1})$$

The input circuit is therefore as in Fig. 8.

Using equation (vii), we could express this impedance in terms of Z and *any three* of the four impedances Z_{O1} , Z_{S1} , Z_{O2} and Z_{S2} .

Notice in passing that $Z_{in} = Z_{S1}$ for $Z = 0$ and $Z_{in} = Z_{O1}$ for $Z = \text{infinity}$, as we would expect.

(b) Output Circuit.

Substituting for Z_T from (vi) into equation (viii), I' becomes

$$\frac{V}{(1 + Z/Z_{S2})\sqrt{Z_{S2}(1/Z_{S1} - 1/Z_{O1})}}$$

$$= V\sqrt{\frac{Z_{S2}(Z_{O1} - Z_{S1})}{Z_{O1}Z_{S1}}} / (Z + Z_{S2})$$

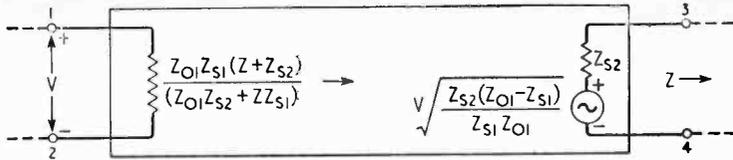
This suggests the output circuit shown in Fig. 9, which is of course none other than that indicated by the well-known "Helmholtz-Thevenin" theorem. Z_{S2} , as we saw, is the impedance measured across terminals 3 and 4 when the source of voltage V is short-circuited.

Once again, the output e.m.f. could have been expressed in terms of V and *any three* of the four characteristic impedances of the network.

(c) Combined Equivalent Circuit.

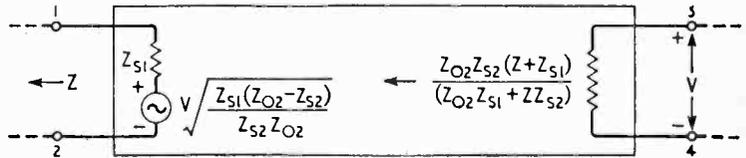
Combining the results (a) and (b) into one circuit, we can express the whole of the left-to-right behaviour of the network as in Fig. 10.

The dotted lines suggest other circuitry. The circuitry connected to terminals 1 and 2 *results in*



Left: Fig. 10. Left-to-right equivalent circuit of a four-terminal network obtained by combining the input and output circuits of Figs. 8 and 9.

Right: Fig. 11. Right-to-left equivalent circuit of a four-terminal network obtained by interchanging suffixes 1 and 2 in the left-to-right circuit of Fig. 10.



a voltage V across these terminals—it is not, of course, necessary to suppose an actual generator of zero impedance and voltage V connected directly to these terminals.

To derive the right-to-left behaviour, we do not need to go through all these calculations again. We only need change all suffixes 2 into 1 and all suffixes 1 into 2. Fig. 11 shows the result.

Application to the T-network.

Fig. 12 shows the circuit of the general T-network. Its open- and short-circuit impedances are:

$$\begin{aligned} Z_{O1} &= Z_1 + Z_3, & Z_{O2} &= Z_2 + Z_3 \\ Z_{S1} &= Z_1 + Z_2 Z_3 / (Z_2 + Z_3), & Z_{S2} &= Z_2 + Z_1 Z_3 / (Z_1 + Z_3) \end{aligned}$$

If a voltage V is applied to terminals 1 and 2, and an impedance Z is connected to terminals 3 and 4, the voltage appearing across Z is

$$V Z Z_3 / (Z Z_1 + Z Z_3 + Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3)$$

And the input impedance across terminals 1 and 2 comes to

$$(Z Z_1 + Z Z_3 + Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3) \div (Z + Z_2 + Z_3)$$

The reader may check for himself that the equivalent circuit of Fig. 10 gives exactly the same results.

If we solve for Z_1 , Z_2 and Z_3 , we get

$$\begin{aligned} Z_1 &= \sqrt{Z_{O1}} (\sqrt{Z_{O1}} - \sqrt{Z_{O2} - Z_{S2}}) \\ Z_2 &= \sqrt{Z_{O2}} (\sqrt{Z_{O2}} - \sqrt{Z_{O1} - Z_{S1}}) \\ Z_3 &= \sqrt{Z_{O1}} (Z_{O2} - Z_{S2}) = \sqrt{Z_{O2}} (Z_{O1} - Z_{S1}) \end{aligned}$$

It follows therefore that a given network having open- and short-circuit impedances Z_{O1} , Z_{O2} , Z_{S1} and Z_{S2} will behave, as far as coupling between input and output is concerned, exactly like a T-network

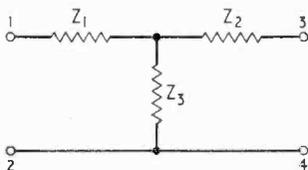


Fig. 12. General T-network.

whose series arms have impedances $\sqrt{Z_{O1}} (\sqrt{Z_{O1}} - \sqrt{Z_{O2} - Z_{S2}})$ and $\sqrt{Z_{O2}} (\sqrt{Z_{O2}} - \sqrt{Z_{O1} - Z_{S1}})$, and whose shunt arm has impedance $\sqrt{Z_{O1}} (Z_{O2} - Z_{S2})$.

The above treatment is quite general for sinusoidal voltages and currents. In so far as Z and the four characteristic impedances Z_{O1} , Z_{O2} , Z_{S1} and Z_{S2} can be expressed as Laplace coefficients $Z(p)$, $Z_{O1}(p)$, $Z_{O2}(p)$, $Z_{S1}(p)$ and $Z_{S2}(p)$, the results obtained

express the transient behaviour of the network just as well as its steady-state behaviour.

Another point to be emphasized is that the treatment supposes nothing about the four-terminal network beyond its linearity, and the results therefore hold for any form of coupling from input to output, e.g., the coupling existing between two aerials.

Imperial College

SELECTED in 1953 as the spearhead of the national attack on the problem of providing more university-trained scientists and engineers, the Imperial College of Science and Technology, London, is in the process of doubling its size to provide for 3,000 students. The college, which has been a school of the University of London since 1908, is itself a federation of three institutions—Royal College of Science, Royal School of Mines and City & Guilds College. Since 1953 the number of students has increased by 1,000 and there are now some 2,600. There have also been established over 40 new posts as professor or reader. Sir Patrick Linstead, C.B.E., F.R.S., is Rector.

The work of Imperial College is divided between the three constituent colleges; the R.C.S. covering pure sciences (chemistry, physics, mathematics, botany, zoology, geology and meteorology), the R.S.M. mining, mineral dressing, metallurgy, mining geology, oil technology and applied geophysics, and the C. & G. the main branches of engineering (aeronautical, chemical, civil, electrical and mechanical).

The normal undergraduate honours degree course is of three years leading to the B.Sc. or B.Sc.(Eng.) of London University and the Associateship of the particular college (A.R.C.S., A.R.S.M. or A.C.G.I.). Advanced study or research leads to the Diploma of Membership of Imperial College (D.I.C.) and/or a higher degree.

The Dean of the Royal College of Science is Professor H. Jones, F.R.S. The head of the physics department is Professor P. M. S. Blackett, F.R.S., with Dr. M. Blackman and Dr. C. C. Butler professors of physics, Dr. J. D. McGee, O.B.E., professor of instrument technology, Dr. A. Salam, F.R.S., professor of theoretical physics and Dr. W. D. Wright professor of technical optics. Dr. R. W. B. Stephens is reader in acoustics and Drs. J. A. Clegg, H. Elliot, O. Klemperer and C. E. Wynn-Williams readers in physics.

The Dean of the City & Guilds College is Professor O. A. Saunders, F.R.S. The teaching staff of over 40 includes Dr. E. C. Cherry (professor of telecommunications), Dr. D. Gabor (professor of applied electron optics), A. Tustin (professor of electrical engineering), Dr. A. R. Boothroyd (reader in electronics) and Drs. B. Adkins, J. Lamb and D. G. O. Morris (readers in electrical engineering).

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Beam Indexing Tubes

2.—CIRCUIT DETAILS OF THE COLOUR TELEVISION DISPLAY UNIT

By IAN MACWHIRTER,* A.M.I.E.E.

(Concluded from page 7 of the January 1961 issue)

HAVING considered the matching of a beam index tube to an N.T.S.C. type colour signal, the next step is to examine the problem of beam position indexing and the synchronizing of the chrominance signal with the phosphor strips. A simple method of determining the position of the beam on the screen, would be to have a photomultiplier cell, optically filtered to receive light from one primary colour, say blue, and to use the repetitive series of blue light pulses to generate rectangular gating pulses for switching on the appropriate colour video signal.¹¹ However, this arrangement suffers from the disadvantage of requiring extremely fast rise-time amplifiers and expensive artificial delay lines. In practice the method is best suited to laboratory development work where the possible errors of signal translators and the loss of saturation occasioned by comparatively wide angle sampling of the chrominance signal by the display screen may be completely obviated. Moreover, small departures from linearity in the line time base will not cause objectionable colour errors, provided that such departures are small, compared with one colour triplet of width, say, 60×10^{-3} in.

A complete circuit diagram for a gated display is shown in Fig. 9(a) and (b).

The indexing pulses generated in the photo pick-up are amplified in a wideband amplifier and limiter. No afterglow correction is provided since the indexing strips are made of P16 phosphor whose afterglow is down some 20 dB in 100 m μ sec, whereas the pitch of the indexing pulses is approximately 240 m μ sec. The pulses are fed from the wideband amplifier to an earthed grid stage (V1) which raises the pulse level to about 5 V. This is sufficient to be differentiated and to trigger the transistor (T1) in the avalanche mode.¹² The triangular output of some 20 V p-p and rise time of 4 m μ sec is applied to the grid of V2 in whose anode circuit is a short-circuited delay line. The line can be a lumped-constant one, but the cut-off frequency should be not less than 50 Mc/s and preferably higher. The line has a delay of 20 m μ sec which provides a rectangular pulse at the anode of V2 of width 40 m μ sec (this width was chosen as being suitable for one application of the circuit). This pulse is injected via a polarity inverter (V3); (a) into the lower valve (V7) of a series pair which constitute part of the gate; (b) into a further delay line which is centre-tapped and whose delay is equivalent to twice the phosphor pitch. Again, the cut-off frequency of the delay line should be at least 50 Mc/s.

In one application the pulse at the input to this line feeds the "red" gate, the centre tap feeds the

"green" gate and the end of the line feeds the "blue" gate; the delay between adjacent colours is 80 m μ sec, so that the total line delay is 160 m μ sec.

Referring now to the gate proper, it consists of V5, V6 and V7 which are therefore triplicated. Video signals of the appropriate colour are fed into the grid of V5, from a preceding stage (V4) where the direct component is re-inserted.

The video signal appears at the anode of V7 and is periodically "lifted up" by the gating pulse so that the black portion (if any) of the "lifted" video signal is greater in amplitude than peak white level of the "unlifted" video signal. The remaining valve of the gate (V8) is biased well beyond cut-off so that only the "lifted up" video signal appears at the anode. This point is connected directly to the anodes of the other two gates (V9 green), (V10 blue). The peak signal here of some 20-25 volts is polarity inverted by (V11). The rectifier restorer in the grid circuit works sufficiently well to prevent V11 from passing grid current when the signal amplitude is large. The signal from V11 is then fed to the output stage V12 in whose grid is a d.c. clamp of conventional design.

It is possible to obtain a signal of just 100 V p-p at the anode of V12. The video pulse rise time at this point is 10 m μ sec, the pulse base width is 40 m μ sec, and the repetition rate is about 4.25 Mc/s in one particular application. The overall linearity is good, and the differential non-linearity between channels is negligible. (See Appendix 3).

Ultra-violet Indexing Strips

A better method for beam position indexing in a domestic receiver still employs light pulse pick-up, preferably from a low visibility ultra violet phosphor which may be conveniently mixed with the visible blue primary phosphor. From this pulse is derived a sinusoidal signal which is used to heterodyne the incoming equi-angle chrominance signal up to the colour switching frequency of the screen, which can then sample directly the chrominance information, as outlined earlier in this article.

If the manufacturing technology of the screen structure allowed indexing pulses to be generated whose rise times are very short i.e. less than 5 m μ sec, and a wideband amplifier followed the photo pick-up, it should be possible to limit the amplitude of the indexing signals at the level corresponding to the 1% minimum beam current. From these limited rectangular pulses there may be derived the sinusoidal indexing signal. Provided that the maximum negative excursion of the approximately sinusoidal chrominance signal does not allow the beam current to drop below 1% of its maximum value (i.e. pulse

* Associated Electrical Industries Ltd.

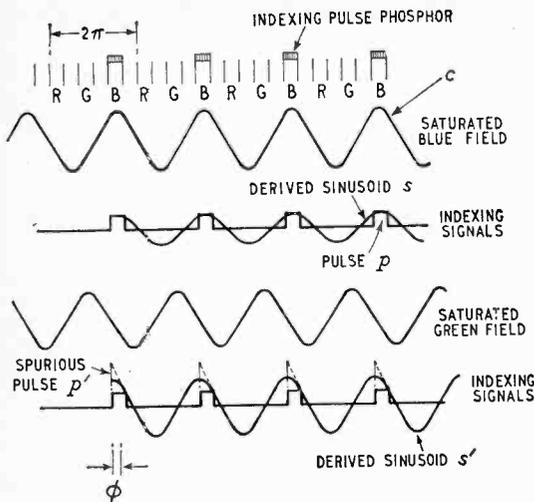


Fig. 10. Illustrating the development of crosstalk when using sinusoidal chrominance information. For diagrammatic clarity a point spot size has been assumed.

saturated green field. Assuming the green drive voltage to be the same as for the blue, we can see that part of the green sinusoid will generate a spurious indicating pulse p' as well as the regular indicating pulse p which is generated by a pre-set minimum beam current. Thus the sinusoidal indicating signal s' formed by both p and p' will be displaced in time as shown by ϕ (See Appendix 1).

Further colour errors may be introduced by unwanted changes in indexing frequency. If the transverse scanning of the phosphor strips should be non-linear, or if the pitch of these strips should vary as a result of manufacturing inaccuracies, then the frequency of the sinusoidal indicating signal will vary. It is essential that the phase of this signal be preserved if colour errors are to be avoided. In general, the phase response of a normal amplifier over a limited pass band is such that the phase angle ϕ varies more or less linearly with frequency, i.e., the envelope delay D is constant since $D = d\phi/d\omega = K$. In amplifying the sinusoidal signal the requirement is that $D = d\phi/d\omega = 0$ and this is satisfied by combining the indicating sinusoid amplifier with a suitable phase corrector (see Fig. 16).

Slow variations in line time-base linearity (e.g., a normal "exponential" sweep) and scan amplitude will be accommodated by this method, colour synchronization remaining good. It is possible, however, that apparent changes in linearity of a transient nature will result in areas of local colour errors. Such transients may be caused by flaws in the evenness of the display tube face plate.

In order that the colour synchronizing circuits shall not become inoperative in areas of picture black it is necessary to run the display tube with a minimum beam current of about 1% of the peak white value.

The chrominance signals illustrated in Fig. 10 have, in fact, been squared by the transfer characteristic of the display tube gun, but similar spurious signals are generated.

For the reasons given, it appears prudent to adopt a screen layout which might minimize the crosstalk and of many possible solutions to the problem of layout, two are here described.

Case I.—(Using regular R, G, B, sequence phosphor strips).

Fig. 11 shows a phosphor strip structure in which there is an indexing strip in every gap between the R, G, B, strips. When scanned, the frequency of the indexing signal will be three times the colour repetition frequency and it can be shown that although the indicating signal may be modulated in amplitude by the luminance and chrominance signals it is not phase modulated (see Appendix 2). This indexing signal, after amplitude limitation and after a frequency division by three, may be used directly to control the colour circuitry of the receiver, provided that the frequency divider starts off in the correct phase at

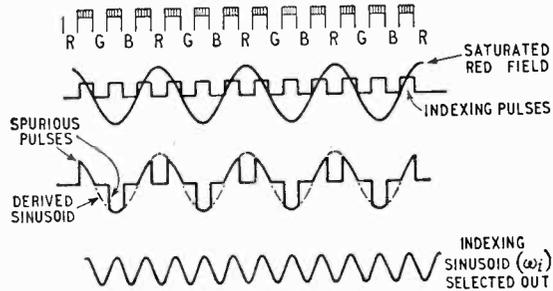


Fig. 11. Use of intermediate ultra-violet indexing strips.

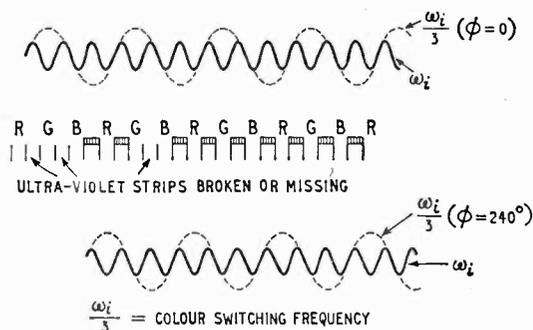


Fig. 12. Effect of broken or missing indexing strips.

the beginning of each line. Referring to Fig. 12 it can be seen that if the first ultra-violet strips at the beginning of the line sweep are unbroken, i.e., missing, this would be true; however, a broken ultra-violet strip would cause a phase error in the frequency division. In order to avoid this triple phase ambiguity of 0° , 120° , 240° , it is necessary to have at the beginning of each line a further set of strips which, on scanning, generate a frequency whose possible phases with reference to the indexing frequency uniquely determine the phase of frequency division. A suitable frequency for the second set of scanned strips would be at triplet repetition frequency, only two possible phases for frequency division would then be possible 0° , and 360° . It should be clear that these "run-in" strips should only exist at the beginning of the line sweep when no chrominance signals are applied to the tube, in this way there will be no cross modulation between the "run-in" signal and the video signal.

Fig. 13(a) shows a suitable layout for a practical

(Continued on page 95)

screen structure, and Fig. 13(b) shows a way in which a control signal may be derived. However, it should be pointed out that it may not be desirable to generate both signals by the same means, i.e., photoelectrically, and it is possible to pick off the "run-in" signals from secondary-electron emitting strips and a suitable collector within the display tube bulb.

The photocell P_1 will generate two signals, one at a frequency f_r i.e. "run-in" frequency, and one at $3f_r$. Component f_r will be present only at the beginning of scan where there is no video modulation. The filter F separates the two components and will have band-pass characteristics to allow for variations in scanning speed, etc. Component $3f_r$ is presented to a normally "closed" gate, this gate will be "opened" by a signal f_r . When the gate opens, the frequency divider provides an output of $\frac{3f_r}{3} = f_r =$ colour switching frequency f_c . The component

$f_r = f_c$ is then applied (a) back to the gate via a suitable equalizing delay, so that the divider will continue to work when the run-in signal has stopped, (b) to the chrominance control circuits of the receiver.

Since the component $3f_r$ is not cross-modulated by the video signal the phase of the output control signal f_c will also be unaltered.

Case II.—(Using an alternating sequence strip structure.¹³)

Fig. 14 shows a different screen structure which will directly generate an indexing signal of correct frequency and free from cross-modulation effects.

It will be seen that red phosphor borders each side of the combined blue and ultra-violet indexing strip. Let the colour shown be a saturated blue, then the indexing pulses will be generated as shown at p ; from these pulses an indexing sinusoid may be formed.

Now let the phase of the sub-carrier be shifted to reproduce a saturated green field. Assuming the green drive voltage to be the same as for the blue, we

Fig. 13(a). Section of practical screen structure and (b) derivation of control signal.

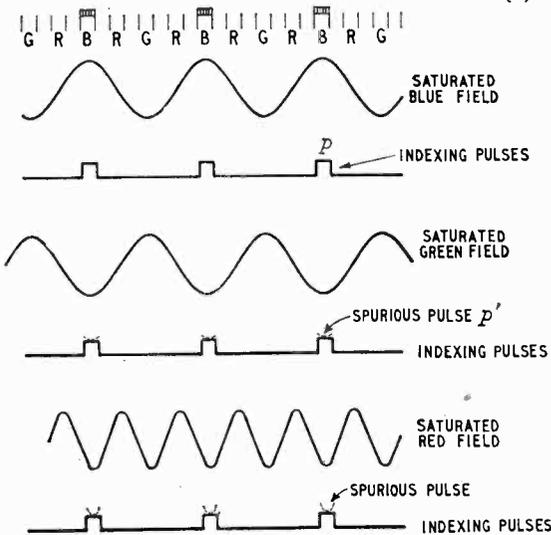
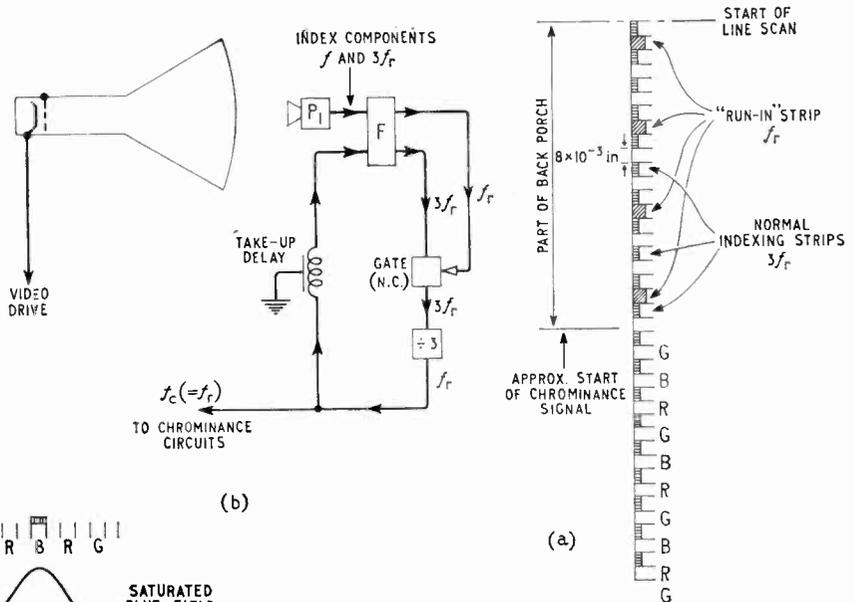


Fig. 14. Alternative screen structure with red-bordered combined blue and ultra-violet strips.

can see that the contribution of the green signal to a spurious indexing signal p' is not only small but symmetrical about the true indexing pulse. When the phase of the sub-carrier is shifted again to show a saturated red field, the spurious indexing pulse is larger in amplitude than before, but is again symmetrically placed about the true indexing pulse. These small, symmetrically placed, spurious signals will not phase-modulate the indexing signal.

A block diagram for a receiver using this screen structure is shown in Fig. 15. Because there are two red phosphor strips per unit group of white forming strips, it is necessary to gate the red signal at twice the indexing signal frequency.

A screen with this structure has the additional advantage of producing more red light than from a simple colour triplet. Therefore, less inert material need be mixed with the green and blue phosphors and the maximum brightness for a given beam current, will increase. However, it would not be easy to use

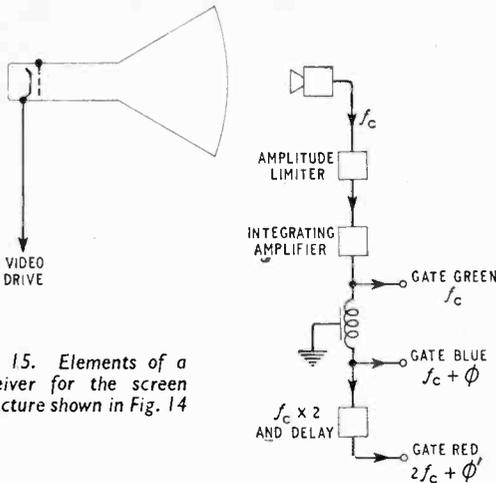


Fig. 15. Elements of a receiver for the screen structure shown in Fig. 14

a tube with this screen structure in a non-gating receiver and it is doubtful whether the extra complexities in the video circuitry would cost less than the extra circuitry used for handling the "run-in" signals.

A complete colour receiver using a beam position indexing cathode ray tube and the N.T.S.C. proportioned signals is shown in block form in Fig. 16.

It has been shown that the formulation of the N.T.S.C. signal is not suited for direct application to the beam indexing tube. The question now arises whether it would be advantageous to modify the transmitted signal to the form suggested earlier in this report. Before making any recommendations on this it must be borne in mind that the formulation of

a compatible band-shared colour television signal should never be designed for the requirements of any particular type of display tube to the exclusion of all others. With the exception of contrast-law correction problems the N.T.S.C. formulated signal uniquely satisfies these general requirements:

(i) *Compatibility.* Compatibility on black and white display tubes is potentially good since the luminance composition of the colour signal is similar to the photopic visibility curve of the eye, i.e., the luminance of colours shown by a black and white display would be the same as if seen direct by the eye and the subjective effect of this is to observe pleasing tones of grey in the picture.

A change to an equi-weighted luminance signal will adversely affect this compatibility. Moreover, the colour receiver would no longer obey the constant luminance principle unless some deficiencies in colour reproduction are tolerable.

(ii) *Constant Luminance Principle.* The composition of the luminance signal is inevitably involved with the relative contributions of the reproducing phosphors to white, if constant luminance operation is considered necessary with a simultaneous display.

The effectiveness of these two concepts is restricted by the present form of contrast-law correction and it is outside the scope of this article to comment further on this. However, it should be recognized that as permanent colour television standards are still unformed in the United Kingdom the possibility of re-scaling the luminance signal to match any new developments in phosphors ought not to be excluded. It is possible to modify the angular positions of the N.T.S.C. chrominance vectors to make them more suitable for use with a beam indexing display, but one attraction with the present formulation is that the two colour differ-

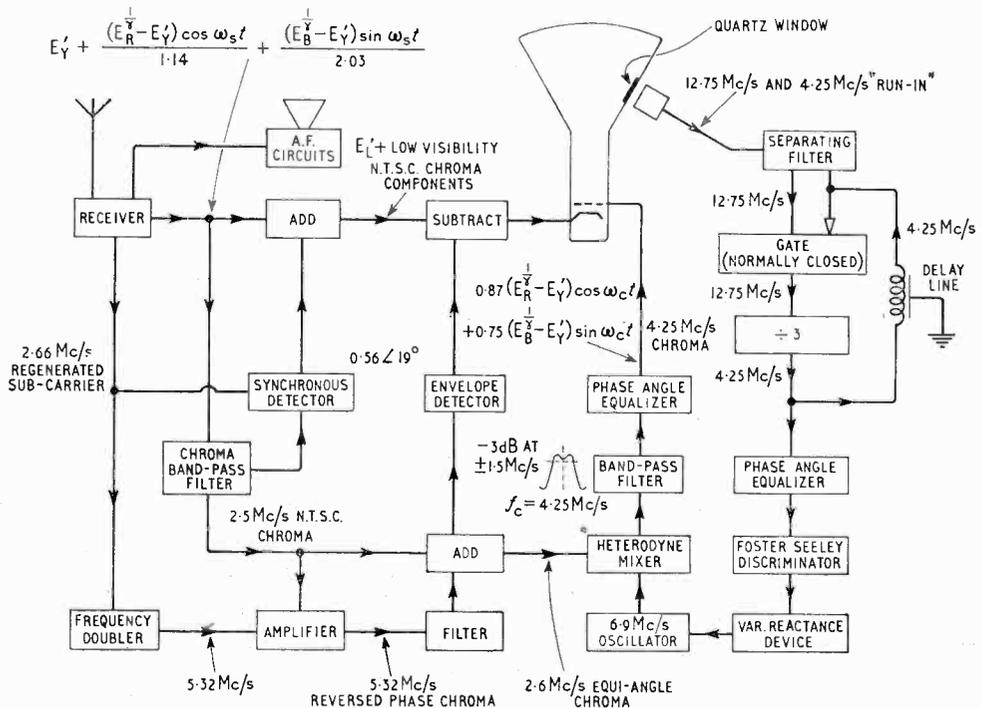


Fig. 16. Block diagram of complete beam index tube receiver working from an N.T.S.C. colour signal.

ence components are in exact quadrature. This fact alone provides such operational advantages that the benefit from the change would have to be proved significant.

Conclusions

The "beam indicating" or "beam index" display tube of the kind described can provide superior pictures, both in colour and black and white, to the shadow mask cathode ray tube. Whilst the former tube is relatively cheap to make, it must appear disappointing that, at the present state of the art, the costing estimate of a receiver with such a tube and all the refinements necessary to produce correct colour reproduction, is not significantly less than the ordinary three-gun shadow mask receiver. Whilst certain economies may be effected in the exactness in operation of the signal translating apparatus already described, it appears necessary to employ line time bases with non-linearities of the order of 1% if objectionable colour errors are to be avoided.

It can be said that if this figure for line time base non-linearity is considered impracticable for cheap, mass produced receivers, and the subsequent colour errors are accepted, the remaining advantage in using the beam indexing display is the superiority in the reproduction of black and white pictures. Therefore, until simple circuitry can be devised which permits the use of line time base non-linearities of some 7% and yet secures satisfactory colour reproduction, the single-gun beam indexing display cannot be considered as a potential successor to the well-established, three-gun shadow mask display.

Acknowledgements

The above review of some of the problems of beam indexing tubes formed part of a programme on colour television displays carried out at the Applications Laboratories of the Radio & Electronic Components Division of Associated Electrical Industries Ltd. and the author wishes to thank the company for permission to publish these results. In particular, the author thanks the Divisional Engineering Manager, Mr. C. L. Hirshman for helpful criticisms of the review's contents and Mr. D. W. Furby for his design of the pulse generator using an avalanche transistor.

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- 12 G. B. B. Chaplin *et alia*, "A Method of Designing Avalanche Transistor Trigger Circuits", *Proc. I.E.E.*, Paper 2944E, Part B Supplement, May, 1959.
- 13 U.S.A. patent No. 2,752,420, Philco Corporation and W. G. Ehrlich.

APPENDIX I

The generation of the spurious indexing signal is not only dependent on cross-modulation caused by the non-linearity of the display tube gun but on the simple scanning of the indexing phosphor structure. An attempt to illustrate this graphically has already been made in the text relevant to Fig. 10; a simple equation is derived below which identifies

the relative magnitudes of the cross-modulation parameters.

If the display tube has a linear transfer characteristic (i.e. contrast = unity) then the light output L from the whole screen can be expressed by

$$L = k [E_y' + E_c' \cos(\omega_c t + \phi)]$$

where E_y' is the luminance signal.

E_c' is a measure of saturation

ϕ is a measure of hue

The generated indexing signal S is of the form

$$L(a_0 + a_1 \cos \omega t + a_2 \cos 2 \omega t + \dots a_n \cos n \omega t)$$

$$\text{Thus } S = Lk [E_y' + E_c' \cos(\omega_c t + \phi)] [a_0 + a_1 \cos \omega_c t + \text{etc.}]$$

$$= Lk [E_y' a_0 + a_0 E_c' \cos(\omega_c t + \phi) + a_1 E_y' \cos \omega_c t + a_1 E_c' \cos \omega_c t \cos(\omega_c t + \phi) + a_2 E_c' \cos \omega_c t \cos(2 \omega_c t + \phi) + \dots a_n E_c' \cos \omega_c t \cos(n \omega_c t + \phi)]$$

Extracting components at the fundamental frequency (ω_c) S becomes $Lk [a_0 E_c' \cos(\omega_c t + \phi) + \frac{a_2 E_c'}{2} \cos(\omega_c t + \phi) + a_1 E_c' \cos \omega_c t]$

which shows that the amplitude and phase of S will be affected by the phase ϕ of the chrominance signal.

APPENDIX II

It has been stated in the text that with the use of an indexing strip between each colour phosphor an indexing sinusoid may be generated which is not affected by the phase of the chrominance signal. The key point in understanding this is that the generated indexing pulses are of equal mark/space ratio and therefore the even harmonic components are zero.

As in Appendix 1,

$$L = k [E_y' + E_c' \cos(\omega_c t + \phi)]$$

The generated indexing signal S is of the form

$$L [a_0 + a_1 \cos 3 \omega t + a_3 \cos 5 \omega t + \dots a_n \cos(n + 2) \omega t]$$

where n is not an even integer.

$$\text{Thus } S = Lk [E_y' + E_c' \cos(\omega_c t + \phi)] [a_0 + a_1 \cos 3 \omega_c t + a_3 \cos 5 \omega_c t + \text{etc.}]$$

$$= Lk [a_0 E_y' + a_0 E_c' \cos(\omega_c t + \phi) + a_1 E_y' \cos 3 \omega_c t + a_1 E_c' \cos 3 \omega_c t \cos(\omega_c t + \phi) + a_3 E_y' \cos 5 \omega_c t + a_3 E_c' \cos 5 \omega_c t \cos(\omega_c t + \phi) + \text{etc.}]$$

extracting the components at a frequency ($3 \omega_c$), S becomes $Lk (a_1 E_y' \cos 3 \omega_c t)$ which shows that the generated indexing sinusoid will be unaffected by the phase (ϕ) of the chrominance signal.

It should be pointed out, though, that any manufacturing inaccuracies of the strip structure, or any sudden change in scanning linearity can cause even-harmonic components to appear; this will be accompanied by a colour error in the reproduced picture.

APPENDIX III

The actual figures for the linearity of the complete gate circuit are not stated because the overall linearity (i.e. picture contrast or "gamma") including the display tube, depends on:—

(a) The shape of the gating pulses entering the gate. Fig. A illustrates the formation of a simple gated step wedge by the gate circuit as shown in Fig. 9

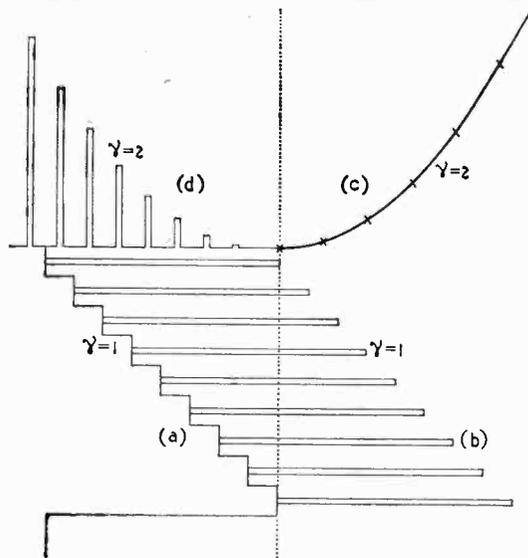


Fig. A

when ideal rectangular gating pulses are available. It will be seen from (b) in Fig. A that the overall contrast of the reproduced picture is that of the display tube (for which adequate correction is usually made in the formulation of the video signals at the transmitter).

Fig. B illustrates the reproduction of the same step wedge when only bandwidth-limited gating pulses are available. In practice trapezoidal pulses are used, although triangular pulses are shown in the figure. Now the phosphor excitation is proportional to the area under the pulses as shown in (d), it can be seen that there will be a considerable reduction in low level excitation. (Notice the reduction in base width.) For the triangular pulses a

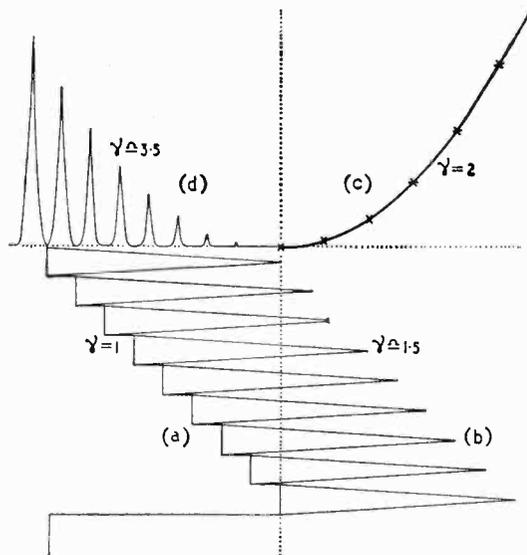


Fig. B

calculation showed that the picture contrast may be increased by 1.5. This clearly establishes the need for maintaining a good pulse shape, at least until the gate proper. Such residual contrast in excess of unity can be corrected by means of judiciously introduced non-linearity in the main amplifier. (b) Subsequent integration of the pulses in amplifier following the gate. In practice, the effect of integration has not been proved detrimental to picture quality, because the bandwidth of the main amplifier is quite adequate to handle the trapezoidal gate pulses. (c) Spot modulation defocusing. No measurements on this possible source of contrast change are available.

BOOKS RECEIVED

Phototubes, Edited by Alexander Schure. A mainly non-mathematical survey of the field of photoelectricity. The history of the photoelectric effect is discussed and the theory behind the operation of modern devices is explained. A chapter is included on the design of phototube-operated amplifiers designed to perform a variety of functions. Pp. 88; Figs. 40. John F. Rider Publisher, Inc., 116, West 14th Street, New York 11, N.Y.

Electronics and Nucleonics Dictionary, by Nelson M. Cooke and John Markus. This second edition contains over 12,000 definitions of terms. Attention has been paid to modern practice in hyphenation and usage. The range has been extended to cover the related field of nuclear energy technology and new developments in electronics. Where American usage is at variance with British, this is noted. Pp. 543; illustrated. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 93s.

Fundamentals of Semiconductors, by M. G. Scroggie. The level of treatment is at an intermediate stage between the simplified layman's guide and the advanced textbook. The whole field is covered, from basic electron theory to short descriptions of electroluminescence, Hall effect, and masers. Pp. 160; Figs. 129. Gernsback Library, Inc., 154, West 14th Street, New York 11, N.Y. Price \$2.95.

A Simple Approach to Electronic Computers, by E. H. W. Hersee. Concerned with principles rather than practice, the book explains to the layman the operation of simple digital and analogue computers. Non-mathematical in treatment, it deals with most of the basic computing-circuit elements and methods in general terms. Pp. 104; Figs. 27. Blackie and Son, Ltd., 16-18, William IV Street, Charing Cross, London, W.C.2. Price 12s 6d.

How to Install and Service Auto Radios, by Jack Darr. A practical book on car radios. Well known to readers of *Wireless World* for his humorous articles on radio servicing, Mr. Darr writes in a readable style, giving helpful advice to servicemen in all phases of their dealings with car radio installations, including transistorized and hybrid types. Pp. 154; Figs. 101. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 26s.

Radar and Collision—A Handbook for Mariners, by L. Oudet. A discussion of the principles and practice of the avoidance of collision between radar-equipped ships. Seeks to impress the concept of intelligent use of radar facilities, rather than reliance on its capabilities as a "magic box." Examples of actual collisions are used to illustrate the arguments. Pp. 89; Figs. 36. Hallis and Carter, 25, Ashley Place, London, S.W.1. Price 15s.

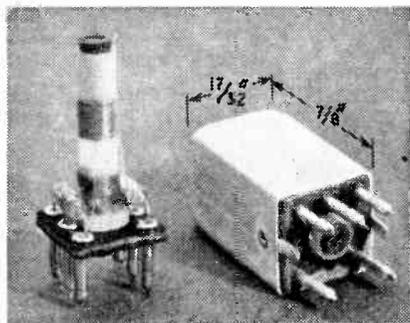
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NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Transistor I.F. Transformers

SHOWN in the illustration is a new miniature 10.7-Mc/s i.f. transformer introduced by Denco for use in transistor v.h.f./f.m. receivers. The transformer (IFT15) consists of two coupled circuits with tapped primary and secondary windings each tuned by polystyrene-foil fixed capacitors. Adjustment is by means of the customary dust-iron core. The unloaded "Q" of each winding is said to be approximately 70 at 10.7Mc/s and the working bandwidth 250kc/s (-6dB points).

There is a companion ratio-detector transformer



Denco 10.7-Mc/s i.f. transformer for transistor v.h.f./f.m. receivers.

(RDT2) having a bifilar secondary winding and an effective bandwidth of 220kc/s.

I.F. and discriminator transformers are provisionally priced at 10s 6d each and the makers are Denco (Clacton), Ltd., 357-359, Old Road, Clacton-on-Sea, Essex.

Transistor Test Set

IN the compact mains-operated Beulah Electronics Model D900, variable input currents (up to 1mA) and collector voltages (up to 25V) are provided for measuring transistor direct-current gains and leakage currents

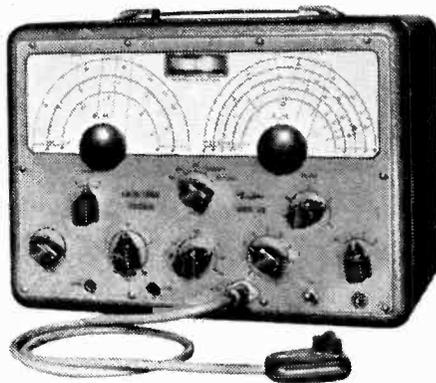


Beulah Electronics Model D900 transistor test set.

with the aid of an external meter. This instrument can also measure the a.c. gain of a transistor *in situ*. To do this the transistor is connected in an oscillatory circuit in the test set and the feedback decreased until oscillations as indicated by a flashing neon just cease. The degree of feedback then gives a measure of the current gain. The oscillations have a high harmonic content which also allows them to be used as an a.f. and r.f. signal tracer source. The model D900 costs £10 and is available from Beulah Electronics of 138 Lewisham Way, New Cross, London, S.E.14.

A.M./F.M. Signal Generator

THE Taylor Model 61A contains both an a.m. and a f.m. (or sweep) generator. C.w., a.m., f.m. or swept signals or, alternatively, a combination of a swept and a c.w. or a.m. signals can be obtained. The a.m. (or c.w.) generator covers from 4 to 120Mc/s on fundamentals; the f.m. (or sweep) generator covers from 4 to 12Mc/s as well as from 70 to 120Mc/s (also on fundamentals). The f.m. deviation is at 400c/s and can be continuously varied up to ± 100 kc/s; the sweep deviation is at 50c/s and can be continuously varied

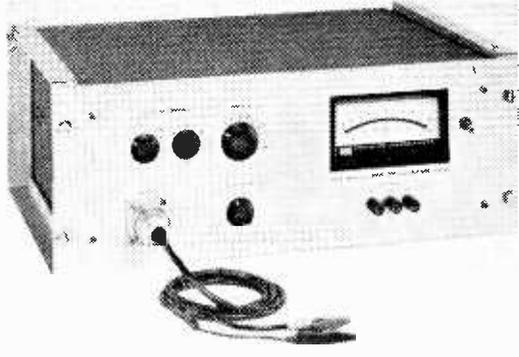


Taylor Model 61A a.m./f.m. signal generator.

up to ± 1 Mc/s. The r.f. output is 100mV, and a 0 to 120dB attenuator is provided. Up to three crystals can be mounted internally for calibration purposes. This generator costs £55 and is manufactured by Taylor Electrical Instruments Ltd., of Montrose Avenue, Slough.

D.C. Milli-microvoltmeter

THE Keithley Model 149 has 13 overlapping ranges with full-scale deflections extending from as low as 0.1 μ V up to 100 mV (d.c.). The stability after an hour's warming up is within 0.01 μ V per hour or 0.03 μ V per 8 hours; the noise with the input short circuited is less than 0.003 μ V peak-to-peak. The response speed is within one second except on the 0.1 μ V f.s.d. range where it is within two seconds. The input resistance is 10¹⁰ M Ω /V on the ranges up to 100 μ V f.s.d. and 10M Ω on all ranges above this. On many of the scales (but not the 0.1 or 0.3 μ V f.s.d. ranges) zero suppression up



Keithley Model 149 d.c. milli-microvoltmeter.

to 100 times full scale is possible. A 10V, 5mA output for feeding a recorder is also provided. This instrument utilizes a 100 c/s mechanical chopper followed by a resonant amplifier and synchronous detector. It costs £352 and is distributed in the U.K. by Livingstone Laboratories, Ltd., of Reicar Street, London, N.19.

New Elapsed-time Indicators

EACH indicator in the new Industrial Instruments "Selachron" range contains a small replaceable electro-chemical cell. As current is passed through the cell the anode is consumed so that its remaining length indicates the elapsed time. Each indicator is 2½in long, has a diameter of 1in and weighs less than 2oz. Different models cover maximum elapsed times from 100 to 10,000 hours and a.c. or d.c. inputs from 6 to 300V. Different input voltages and a.c. are catered for by the use of suitable dropping resistors and semiconductor half-wave rectifiers respectively. The current consumption of these



Electro-chemical elapsed-time indicator by Industrial Instruments.

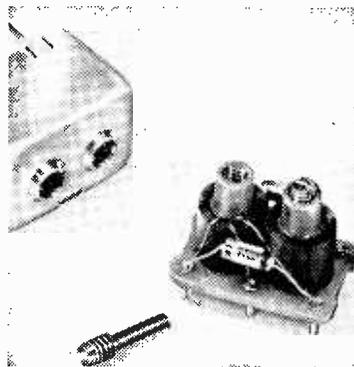
units ranges from a maximum of 4.7mA for a 100-hour indicator down to 0.065mA for a 10,000-hour indicator. These indicators cost £2 5s each and the address of their manufacturer is Industrial Instruments Ltd., of 9 Paved Court, Richmond, Surrey.

Miniature I.F. Transformers

THE Wireless Telephone Company (one of the Plessey group) has introduced a new range of miniature i.f. transformers for portable transistor receivers with intermediate frequencies within the range 450-480kc/s.

Chief feature of the new transformers is the parallel mounting of the coils which gives stable coupling and compact assembly. The ferrite-cup cores are potted in an epoxy resin which ensures good mechanical rigidity and resistance to vibration. Can size has been reduced to 1½ × ¾ × 1½in high.

Double-tuned transformers are used in the first two stages and a single-tuned unit in the third with diode and i.f. by-pass capacitor included in the can. Alignment is carried out by adjustable dust cores mounted



Wireless Telephone Co.'s new miniature i.f. transformers for transistor receivers.

in a novel way. In place of the usual threaded core a plain core is bonded to a polystyrene screw working in a threaded hole in the coil former. This provides a robust screw for adjustment by an ordinary metal-bladed screwdriver, and it also allows the cores to be wax sealed after final trimming.

Of special interest to production engineers is the use of a colour coded indent to identify each transformer type. The indent enables an operator to orient the transformer correctly when assembling a receiver chassis.

Further details can be obtained from the Wireless Telephone Co. Ltd., Hallamgate Works, Crookes Road, Sheffield 10.

Multi-band Short-wave Aerial

THE SWL7 wire-trap aerial, as it is styled, is intended to provide efficient reception on the seven short-wave broadcast bands of 11, 13, 16, 19, 25, 31 and 49 metres. Briefly the principle involved is that if a tuned circuit, or its electrical equivalent, is inserted at each of two points along a random length of wire they behave as insulators at the frequency to which they are tuned and the section of wire between them behaves as an efficient half-wave dipole at that frequency. Like an orthodox dipole its efficiency is well maintained over a limited range of frequencies either side of the resonant frequency.

By inserting a number of traps along the aerial on either side of the centre point and with pairs adjusted to "look like" insulators at one of the above short-wave broadcast bands, a single-wire can be made to function as a number of separate half-wave dipoles with a single low-impedance feeder connected to the electrical centre of the system. And the feeder will be satisfactorily matched to the aerial on all bands. This is the basic design of the SWL7. Practically it covers seven short-wave bands. It costs £7 complete and including 100ft of 75Ω twin-wire feeder.

Aerials functioning on any desired combination of bands can also be supplied and further details are obtainable from Mosley Electronics Ltd., 15 Reepham Road, Norwich, Norfolk.

FEBRUARY MEETINGS

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

LONDON

1st. Brit.I.R.E.—“A fast electronically scanned [radar] receiving system” by Dr. D. E. N. Davies at 5.30 at the London School of Hygiene, Keppel Street, W.C.1.

2nd. I.E.E.—“Silicon power rectifiers” by A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams at 5.30 at Savoy Place, W.C.2.

7th. Brit.I.R.E.—“Tunnel diodes”, joint meeting with Institute of Physics and Physical Society, at 2.15 at 47 Belgrave Square, S.W.1. (Members only.)

7th. I.E.E.—“Magnetic properties of thin films for computing devices” by E. M. Bradley at 5.30 at Savoy Place, W.C.2.

8th. Brit.I.R.E.—“Perseus, a medium-scale data processing system” by G. Emery at 5.30 at the London School of Hygiene, Keppel Street, W.C.1.

8th. Women's Engineering Society.—“Space flight” by a member of the British Interplanetary Society at 7.0 at 45 Great Peter Street, S.W.1.

8th. British Kinematograph Society.—“Past, present and future trends in sound recording techniques” by F. W. Rennie at 7.30 in the Mezzanine Cinema, Shell-Mex House, Strand, W.C.2.

9th. Radar & Electronics Association.—“Digital computers” by A. St. Johnston at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

10th. Television Society.—“Transistorized distribution amplifiers” by B. Marsden at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

13th. I.E.E.—Discussion on “The road to corporate membership: what is the responsible experience required?” opened by A. H. Mumford and D. S. Rolfe at 6.0 at Savoy Place, W.C.2.

14th. Brit.I.R.E.—“Some psycho-acoustic and engineering aspects of hearing aid design” by J. Jessop at 5.30 at the London School of Hygiene, Keppel Street, W.C.1.

14th. I.E.E.—Discussion on “Technical teacher training” opened by Dr. F. T. Chapman at 6.0 at Savoy Place, W.C.2.

16th. I.E.E.—Faraday Lecture “Transistors and all that”, by L. J. Davies at 6.0 at Central Hall, S.W.1.

17th. B.S.R.A.—“Organ pipes and reeds” by H. Willis at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

22nd. Brit.I.R.E.—Discussion on transistorized medical and biological electronic equipment at 5.30 at the London School of Hygiene, Keppel Street, W.C.1.

22nd. British Kinematograph Society.—“Carbon in motion picture engineering and electronics” by A. C. Conford at 7.30 at the Central Office of Information, Hercules Road, Westminster Bridge Road, S.E.1.

23rd. Television Society.—“Programme problems and possibilities associated with Monitor by Huw Wheldon at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

28th. Society of Instrument Technology.—“Three terminal bridge measurements and automation” by Dr.

V. S. Griffiths at 7.0 at 26 Portland Place, W.1.

BIRMINGHAM

22nd. Television Society.—“Television on Royal occasions” by T. H. Bridgewater at 7.0 at the College of Advanced Technology, Gosta Green.

BRISTOL

14th. Television Society.—“Television advertising—the first five years” by D. Ingram at 7.30 in the Colston Room, Hawthorns Hotel, Woodland Road, Clifton.

15th. Brit.I.R.E.—“High speed digital applications of transistors” by M. L. N. Forrest at 7.0 at the College of Science and Technology.

CARDIFF

8th. Brit.I.R.E.—“The principles of analogue to digital computer conversion” by J. L. W. Churchill at 6.30 at the Welsh College of Advanced Technology.

CHELTENHAM

24th. Brit.I.R.E.—“Design aspects and characteristics of long-distance waveguide communication systems” by Dr. A. E. Karbowiak at 7.0 at the North Gloucestershire Technical College.

CHESTER

23rd. Society of Instrument Technology.—“The atomic clock” by J. V. L. Parry at 7.0 in the Lecture Theatre, Administration Building, The Associated Ethyl Co., Oil Sites Road, Ellesmere Port, Wirral.

EDINBURGH

8th. Brit.I.R.E.—“Measuring stability and spurious modulation spectra of high-quality oscillators” by A. L. Whitwell at 7.0 at the Department of Natural Philosophy, The University, Drummond Street.

FAWLEY

3rd. Society of Instrument Technology.—“Instrumentation in radio astronomy” by Dr. H. P. Palmer at 5.30 at the Administration Building, Esso Refinery.

GLASGOW

9th. Brit.I.R.E.—“Measuring stability and spurious modulation spectra of high-quality oscillators” by A. L. Whitwell at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

LIVERPOOL

15th. Brit.I.R.E.—“Inertial navigational systems” by Wing Cdr. E. W. Anderson at 7.0 at the Adelphi Hotel.

MANCHESTER

2nd. Brit.I.R.E.—“The manufacture of television tubes” by P. Funnell at 7.0 at Reynolds Hall, College of Technology.

SOUTHAMPTON

22nd. Brit.I.R.E.—“The application of computers to commercial problems” by N. D. Hill at 7.0 at the Lanchester Building, the University.

WOLVERHAMPTON

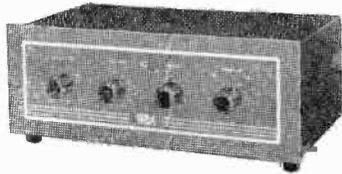
8th. Brit.I.R.E.—“Computers and mathematics” by R. Wooldridge at 6.15 at the College of Technology, Wulfruna Street.

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RANDOM RADIATIONS

By "DIALLIST"

Colour Television

MYSELF, I'm glad that the Postmaster-General hasn't approved the starting of a colour television service by the B.B.C. There's no doubt that the B.B.C. could make a good job of it with satisfactory and completely compatible transmissions; but I don't feel that the time is yet ripe, or that it will be until much cheaper receivers have been developed. And they must be such that their adjustments stay put and don't call for constant, or at any rate frequent, fiddling with delicate controls; otherwise they'd be of little use to the man-in-the-street, and he'd quickly be put off buying by tales of tribulations of his friends who had taken the plunge and gone in for colour receivers. The very fact that a service was in being would in all probability give him the idea that prices of colour sets would quickly come down to his sort of figure and would have a distinctly harmful effect on the sale of black-and-white receivers. Much better—don't you think?—that people shouldn't be led to believe that colour television is just around the corner.

It'll Come

Colour television will undoubtedly come, but I don't think that when it does it will be done by any of the systems so far developed. Something much less complicated and fiddly is needed and I think there's no question that it will come along in time. Till then let's be content with the monochrome system and put money

and brains into improving that. The TV receiver, when you come to think of it, is now vastly better than it was only a few years ago. The number of outside-the-cabinet knobs has been steadily reduced by increasing the number of inside pre-set controls and by introducing refinements such as automatic brightness control. And there are other similar improvements. Anyhow, we mustn't put on colour TV until we're certain that it won't be a flop.

U.S. Television DX

AN American reader tells me that there is a strong body of enthusiasts for long-distance v.h.f./f.m. and television reception in his country and in Canada. They have formed The American Ionospheric Propagation Association which now has members all over the world. Should any DX-minded reader of *Wireless World* wish for particulars, the address of the association is: c/o 68 Amber Street, Buffalo 20, N.Y., U.S.A. I've often seen accounts in American magazines of long-distance reception of television programmes and I know that London has been received in or near New York under freak conditions. My correspondent doesn't appear to have picked up any of our TV stations, but he says he is going "to keep his eyes peeled for London this winter." Here's wishing him success. I don't suppose that a standard American receiver would answer unless it were specially adapted. For one thing, their images are negative, the sync and the in-

tervals being not blacker than black, but whiter than white. I wonder if the real enthusiasts get British sets.

Some Telescope!

THE Americans, I see, are to build a gigantic radio telescope in the Allegheny Mountains of West Virginia. Our own at Jodrell Bank, with its reflector bowl 250 feet in diameter, is a pretty sizeable affair; but the new American 'scope will quite dwarf it, for it is to have a bowl no less than 600 feet in diameter. Carried by 256 railway wagon wheels, this can be revolved on a circular rail track. It is stated that its range will be 38,000 million light years—and a light year is quite some distance, being in round figures six million million miles. Our Jodrell Bank telescope has made some remarkable discoveries about outer space and the bodies existing in it. Still more astonishing results are to be expected from the device in the Allegheny Mountains when it gets to work. It should also be of great value for tracking space vehicles launched by man and for obtaining data transmitted from them to earth. The cost is estimated at £29M!

Television in Eire

A TELEVISION service is due to start in the Dublin area before the end of this year. From this beginning TV will be extended gradually over the whole of Southern Ireland. Since there are already the best part of 100,000 405-line sets in use in the country for the reception of B.B.C. and I.T.A. transmissions in Northern Ireland, a 405-line standard is to be adopted, to begin with at any rate. What standard will finally be used hasn't yet been decided, but presumably it will be governed by the decision taken in this country. It won't be an easy business to provide a service giving national coverage, for there are many mountainous districts and they always mean headaches for planning engineers. The solution may well be similar to what we have developed in Wales, Scotland and other hilly districts, a few high-powered stations and the gradual building up of a network of low-powered relays. I don't suppose that the system will ever be so com-

CONFERENCES AND EXHIBITIONS

We regret the omission of the dates of the British National Radio and Television Show from the list of conferences and exhibitions in our January issue. Since going to press with that issue we have also obtained details of other forthcoming events. The following should therefore be added to the list given in our last issue:—

Mar. 5-14	Leipzig Spring Fair (Leipziger Messeamt, Post Box 329, Leipzig C1)	Leipzig
Mar. 20-25	Radio & Electronic Engineering Convention (Institution of Radio Engineers (Australia), 157 Gloucester Street, Sydney, N.S.W.)	Sydney
Aug. 23- Sept. 2	National Radio and Television Show (Radio Industry Exhibitions Ltd., 59 Russell Square, London, W.C.1)	Earls Court, London
Sept. 1-8	Firato—International Radio Show (Firato Secretariat, Emmalaan 20, Amsterdam)	Amsterdam
Sept. 14-25	French Electronics, Radio & Television Show (Fédération Nationale des Industries Electroniques, 23 rue de Lubeck, Paris XVI)	Paris

plete as our own, for that would cost a great deal of money and Southern Ireland's population is scattered.

Not Dead Yet

FOR some time there have been those who say that the valve is on the way out; but it's still a very long way from being a back number, for there are so many things that it can do and that transistors can't—not yet, at any rate. It's difficult, for instance, to imagine the output stage of a high-powered transmitter being worked by any sort of semiconductor devices. That may come, but it's still a long way off. Meantime, interesting developments continue to be made in the world of valves. For example, the compactrons, tiny multiple valves, each containing several sets of electrodes within its small envelope. I confess that I've never been very keen on multiple valves myself, largely because if the single heater goes west you may lose the equivalent of a pair or a trio of valves at one blow. But that may be an old-fashioned idea, for people today don't seem to fight shy of them.

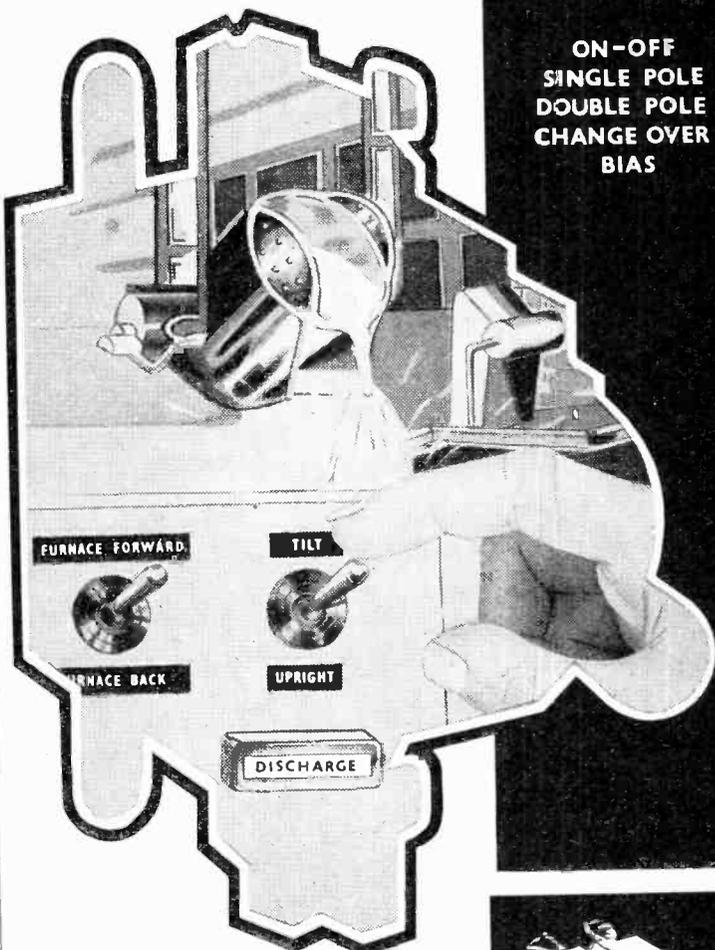
Components on Show

THE 1961 Radio and Electronic Components Show will be held in Olympia and it will be at least three times as big as those of yesteryear which were somehow fitted into one big room at Grosvenor House, with latterly a small overflow into a nearby building. To me the Components Show has always been one of the highlights of the year. It'll go on being a highlight, but it's now to be held every other year. This year's will be of special interest because it is to include components for computers, for the controlling mechanisms of machine tools, for man-made satellites, for guided missiles and for apparatus used in nucleonic engineering.



WIRELESS WORLD, FEBRUARY 1961

CENTRAL OFF POSITION

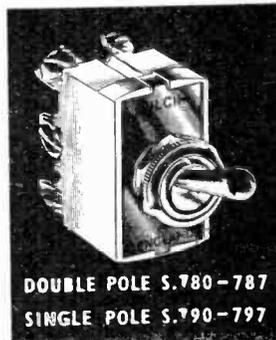


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By "FREE GRID"

Diary Worry

WE have had our *Wireless World* Diaries in use for a few weeks now, and many of us have had occasion to use the information on one or more of the eighty data-packed pages which precede the actual diary.

I received my Diary as a gift from the Editor and I am, therefore, a little worried about a recent decision of the High Court in which it was laid down that for income-tax purposes such a gift should be rated at its second-hand value. To unthinking people such a value in the case of a diary—even a *Wireless World* one—would be a small fraction of the few shillings at which it was priced when new.

But some diaries, unlike a suit of clothes which was actually the test-case gift dealt with by the court, have a habit of increasing in value enormously when second hand. This is obvious when one considers what the original diaries of Pepys, Evelyn or even Nell Gwynne would fetch on the open market today. As was recently pointed out, parts of Pepys diary were so severely critical of certain personalities of his day that they have never been published, and this greatly enhances their potential value.

Naturally my own year-by-year diary contains many references to famous names in the world of wireless, and in some cases critical remarks which could bring me a tempting offer from certain sensational newspapers, as any income-tax inspector would quickly realize. I hope, therefore, that next year the Editor will make it a suit of clothes (vital statistics 40-in x 38-in x 29-in) and I will buy my own diary.

As for the *Wireless World* Diary, I have nothing but praise for the data pages and it is only the actual diary section for which I have any criticism. I can't grumble at being told such an obvious thing as that Christmas Day falls on December

25th, as *Wireless World* has many readers in non-Christian countries who would not necessarily know this.

All the same, I do feel that rather than be told that Lammas falls on August 1st, I should have been informed of when the National Radio Show opens its doors. But maybe the show date was not known when the diary went to press.*

* It was not; but it was when the calendar of conferences and exhibitions in the January issue went to press. We regret the omission. The dates are Aug. 23 to Sept. 2.—Ed.

C.I.D. Censured

WHEN a person as important as the chief of the C.I.D. writes his memoirs I always feel that he ought to take the utmost care to be meticulously accurate, especially when dealing with a technical subject like wireless. The late Sir Basil Thomson who was chief of the C.I.D. in the first world war rather let Scotland Yard down in that respect; at least that is my opinion.

In his book entitled "Queer People," which I recently picked up, he discusses the great German spy scare of 1914 when it only needed the flimsiest reason for reports to reach the C.I.D. that somebody was

sending wireless messages across the North Sea to the enemy.

Such a wireless spy scare was in evidence before the war started and I recalled a striking instance of it when writing on this subject in the issue of *Wireless World* for June 4th, 1937, although a natural modesty made me omit to mention being a witness of it.

It happened that an unfortunate girl was paying a visit to her brother in a certain naval dockyard where there was a powerful radio transmitter. By chance, she was standing within a few feet of the aerial mast when the operator started transmitting. The field strength was so great that the metal ribs of her "stays"—a commonplace appliance in 1914—were forced into electrical oscillation, they apparently resonating to a harmonic of the wave being radiated. The result was that sparks were observed to be leaping from her person to some earthed iron railings against which she was leaning, and she was promptly arrested.

This incident led to patriotic young men following girls in the interests of national security, especially the younger girls whose trailing tresses could so easily have concealed a primitive dipole. In my illustration it can be clearly seen that an alert young man's attention has been attracted by the suspicion-rousing coiffure of a young girl in the grounds of the old White City on which the B.B.C.'s new TV headquarters now stands. This patriotic following of girls led so frequently to the altar—or should be say halter—that the whole idea was later suspected to have been initiated by the wiles of women.

Sir Basil seems to dismiss the feasibility of spies using a radio transmitter in those days because, to quote his own words, "a Marconi transmitter needed a 4 h.p. engine to generate the wave." In actual fact with a standard Marconi 10-in spark coil and a couple of 12-volt car batteries with an aerial suspended down a chimney, I should be very surprised indeed if a spy could not have sent a message from the East Kent coast to the nearest point of the Belgian coastline occupied by the Germans, a distance of 40 to 50 miles; even if the enemy were using the—by modern standards—relatively insensitive magnetic detector.

Such a transmitter as I have described, using a 12-cell 80 AH capacity storage battery, was the basic emergency transmitting equipment of a British ship in those days. The maximum current taken by the coil just before the make-and-break did its stuff was between 7 and 8 amps, which is, of course, not at all beyond the capabilities of a car battery of large capacity. Ships' emergency transmitters were expected to—and did—have a much greater range than 40-odd miles.



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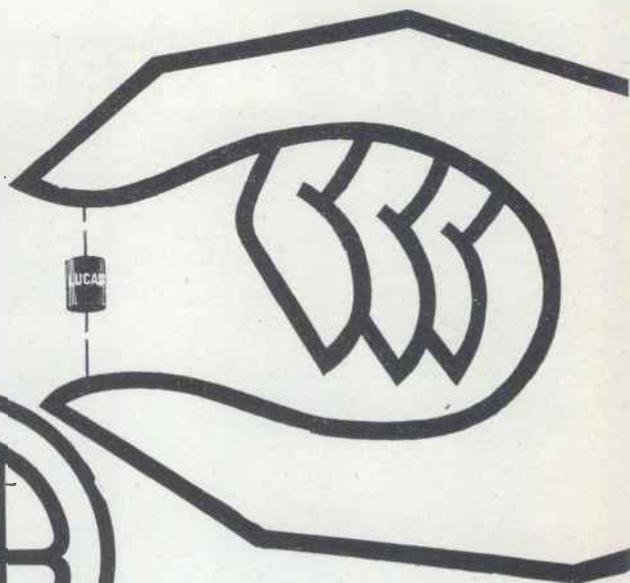


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DM160

VOLTAGE INDICATOR TUBE

OPERATING CHARACTERISTICS

Filament voltage	1.0V
Filament current	30mA
Anode voltage	50V
Grid resistor	100k Ω
Grid voltage for max. light output	0V
Anode current at max. light output	585 μ A
Grid voltage for zero light output	-3V
Anode current at zero light output	<5 μ A



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Particularly suitable for portable equipments, this tube is a space-saver with an extremely small power consumption. Special features are its high sensitivity (3V Grid base), low filament power, and long operational life.

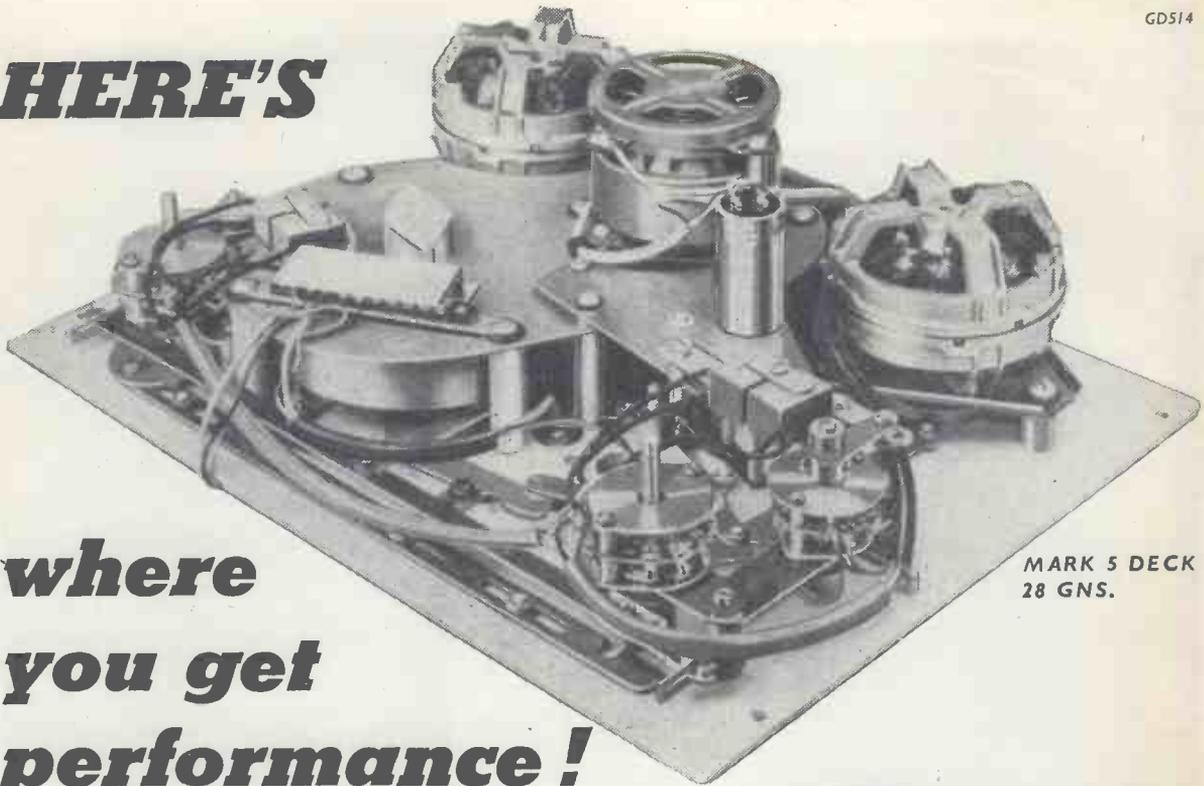
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MARK 5 DECK
28 GNS.

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 HYS-TERESIS 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 25 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 3½ ips	3½ ips:	60/7,000 c/s ± 3db
Below .25%	at 1½ ips	1½ ips:	60/4,000 c/s ± 3db

SELECTIVE FREQUENCY CORRECTION at 15, 7½ and 3½ ips.
ACCEPTS 8½in. REELS, PAUSE CONTROL, DIGITAL REV. COUNTER,
PROVISION FOR EXTRA HEADS.



3 STAR



MK. 5

TAPE RECORDERS:

3 STAR: 58 GNS.
MK.5: 64 GNS.
3 STAR. R/P STEREO: 89 GNS.
MK.5 R/P STEREO: £99.12.0

* ¼ track available with 3 Star models

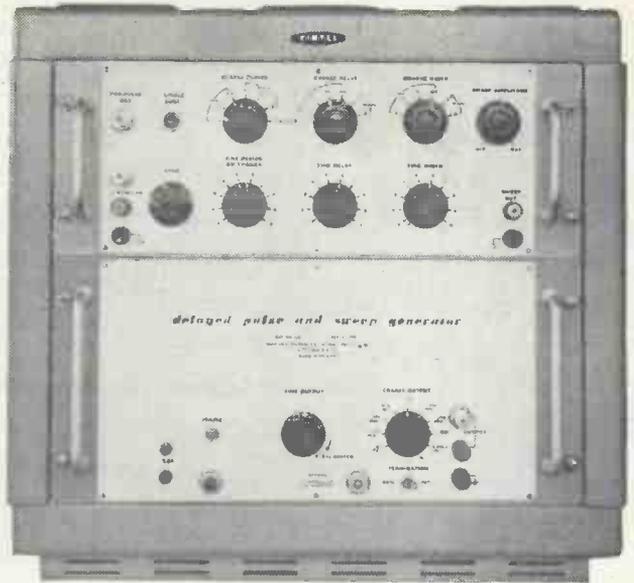
Brenell

Full details and the address of your nearest stockist from the Sole Manufacturers
BRENELL ENGINEERING CO. LTD. • 1a DOUGHTY STREET • LONDON WC1

CHAN 5809 & HOL 7356

DELAYED PULSE AND SWEEP GENERATOR

A versatile pulse generator designed to meet the need for a comprehensive instrument covering a wide range of pulse work. Four main facilities are provided: a pre-pulse, a main pulse delayed on the pre-pulse, a negative going sawtooth and a fast rising pulse formed from a pure line.



BRIEF SPECIFICATION

Period

Continuously variable from $0.9\mu\text{sec}$ to 1.05sec i.e. 0.95c/s to 1.1Mc/s . Accuracy $\pm 5\%$.

Pre-pulse

$40\mu\text{sec}$. 8V peak in 75Ω , positive going.

Main pulse

Width: Variable from $0.09\mu\text{sec}$ to 105msec $\pm 5\%$.

Amplitude: Control gives 4:1 attenuation of each of four maximum outputs as follows:
 5V max in 75Ω rise time $10\mu\text{sec}$
 10V max in 150Ω rise time $< 20\mu\text{sec}$
 25V max in 600Ω rise time $< 40\mu\text{sec}$
 50V max in 1000Ω rise time $50\mu\text{sec}$

Polarity: Positive or negative going.

Accuracy: $\pm 2\%$.

Delay

Conclusion of pre-pulse to advent of main pulse, delay variable from $0.09\mu\text{sec}$ to 105msec . Accuracy $\pm 5\%$.

Sweep

D.C. coupled negative going sawtooth same width and delay as main pulse. 15V peak max.

Cable pulse

Obtained from short circuited pure line. One positive and one negative going pulse coincident with main pulse. $25\mu\text{sec}$ wide 3V max in 75Ω , rise time $< 8\mu\text{sec}$.

Sync, trigger or single shot facilities provided. Full data available on request.



RANK CINTEL LIMITED

WORSLEY BRIDGE ROAD · LONDON · SE 26

HITHER GREEN 4600

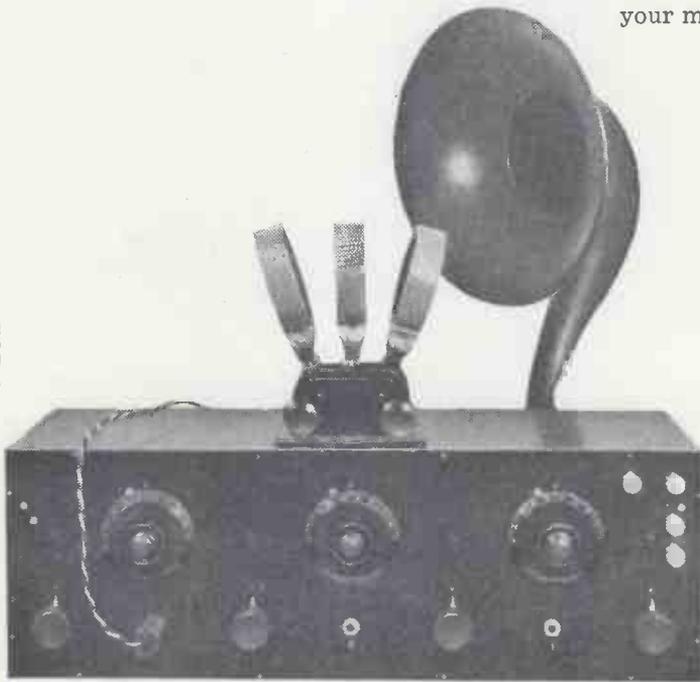
Sales and Servicing Agents: Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow.

McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester 16. Hawnt & Co. Ltd., 112/114 Plitchett Street, Birmingham 6

We've come a long way since the crystal set era.

V.H.F., frequency modulation, stereo, big screen television — constant developments in the air create a constantly growing market. It pays to advertise to this market on television — a fact endorsed by the dealer himself.

In a recent survey commissioned by Associated-Rediffusion, dealers mentioned television as being more successful than any other medium in helping them sell more television sets. In addition, more and more people are buying replacement television sets on styling. There is no better medium than television for actually demonstrating your model or a particular feature of its design.



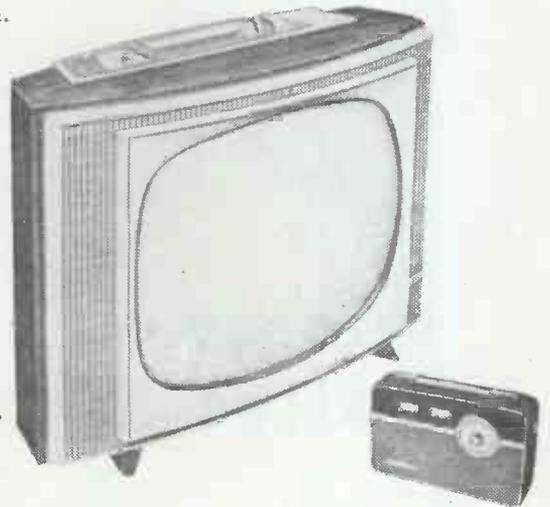
An early valve receiver, 1923.

Look at the size of the replacement market for television sets in the London area covered by Associated-Rediffusion. Nearly half of the homes viewing Independent Television have sets three years old or more. The following table shows the breakdown in detail.

	AGE OF PRESENT SET	TOTAL
Base of %-No. of informants		2088
Percentage who had present television set	Three years	14%
	Four years	12%
	Five years or more	18%

There is no better medium than television for driving home your sales message in the face of increasing competition.

Manufacturers of all electrical goods advertising on Associated-Rediffusion can reach over 8 million people in their homes, in London. This represents a prosperous mass market in an area where there is a huge replacement trade waiting to be developed. Advertise on television in London—on Associated-Rediffusion.



The above figures are quoted from the London Viewership Survey No. 4, commissioned by Associated-Rediffusion. John Talbot (HOLborn 7888) will be pleased to let you have full details.

ASSOCIATED-REDIFFUSION



LONDON



London's Television, Monday to Friday

Television House, Kingsway, London, W.C.2. Tel: HOLborn 7888
 also Norfolk House, Smallbrook, Ringway, Birmingham 5. Tel: Midland 9151/2
 and Peter House, Oxford Street, Manchester 1. Tel: Central 9867/8

Easy-to-build kit-sets of



highest quality at lower cost

"GLOUCESTER" STEREO CABINET KIT. Specially designed to meet the varying needs of different homes. Mk. I houses Record Player, F.M. Tuner, Stereo Amplifier, records, etc. Mk. II will house a Tape Deck in addition. 46 $\frac{1}{2}$ in. long, 30in. high, 21in. deep. "In the white" for finish to personal taste. Mk. I £15.18.6. Mk. II £17.8.6

"COTSWOLD" HI-FI SPEAKER SYSTEM KIT. Acoustically designed enclosure "in the white" 26in. x 23in. x 15 $\frac{1}{2}$ in. housing a 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with pressure unit to cover the full frequency range of 30-20,000 c/s. Complete with speakers, cross-over unit, lever control, etc. £19.18.6

"CHEPSTOW" EQUIPMENT CABINET KIT. Occupies minimum floor space. Will house Record Player F.M. Tuner, Stereo, Amplifier and additional power amplifiers where needed. Dim. 35 x 18 x 33in. high. £10.10.0



HI-FI SINGLE CHANNEL AMPLIFIER KIT. Model MA-12. 12 w. output, wide freq. range, low distortion. £9.19.6

STEREO CONTROL UNIT KIT Model. USC-1. Push button selection, accurately matched ganged controls to ± 1 dB. Accepts inputs from most tape heads and any stereo or mono pick-up. £17.19.6

HI-FI STEREO AMPLIFIER KIT. Model S-88. 16 w. output, 20 mV. basic sensitivity (2 mV. available, 20/- extra). Ganged controls, Stereo/Monaural gram., radio and tape recorder inputs, Push-button selection. Two-tone grey metal cabinet. £25.5.6

6-W. STEREO AMPLIFIER KIT. Model S-33. 3 watts per channel, 0.3% distortion at 2.5 w/channel, 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 SPEAKER SYSTEM KIT. Model SSU-1. Ducted-port bass reflex cabinet "in the white." Twin speakers. With legs £11/12/6 £10.5.6

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

TRANSCRIPTION RECORD PLAYER. Mod. RP-1U. 4-speed A.C. motor. Ronette Stereo/Mono pick-up. Complete on plinth. £12.10.0

TAPE AMPLIFIER UNIT KITS. Models TA-1M and TA-IS. 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 £16.14.0; TA-IS, £22.4.0; TA-1C £6.

TAPE DECKS are now available as "packaged deals" with other equipment.

Details on request.

5in. OSCILLOSCOPE KIT. Model O-12U. Has wide-band amplifiers, essential for TV servicing, F.M. alignment etc. Vertical frequency response 3 c/s to over 5 Mc/s, without extra switching T/B covers 10 c/s to 500 kc/s in 5 ranges £34.15.0

ELECTRONIC SWITCH KIT. Model S-3U. (Oscilloscope Trace Doubler). Enables a single beam oscilloscope to give simultaneous traces of two separate and independent signals. Switching rates approx. 150, 500, 1,500, 5,000 and 15,000 c/s. Sig. freq. response 10-100 kc/s. ± 1 dB. Separate gain controls and sync. output. Sig. input range 0.1-1.8 v. r.m.s. £9.18.6

CAPACITANCE METER KIT. Model CM-1U Direct reading $\frac{4}{10}$ in. scale. Full-scale ranges 0-100 μ F, 0-1,000 μ F, 0-0.0 1 μ F & 0-0.1 μ F £14.10.0

DECADE CAPACITOR KIT. Model DC-1. Capacity values 100 μ F to 0.111 μ F in 100 μ F steps. £5.18.6

VALVE VOLTMETER KIT. Model V-7A. 7 voltage ranges d.c. volts to 1,500 a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1 Ω to 1,000 M Ω with internal battery. D.C. input impedance 11 M Ω . dB measurement has centre-zero scale. Complete with test prods, lead and standardising battery. £13.0.0

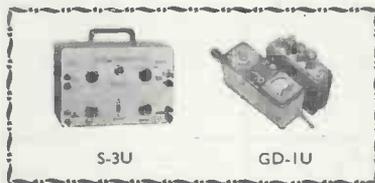
R.F. PROBE KIT. Model 309-CU. Extends the frequency range of our V-7A to 100 Mc/s. and enables useful voltage indication to be obtained up to 300 Mc/s. £1.5.6

R.F. SIGNAL GENERATOR KIT. Model RF-1U. Provides extended frequency coverage on six bands from 100 kc/s.-100 Mc/s. on fundamentals and up to 200 Mc/s. on calibrated harmonics. £11.11.0

GRID-DIP METER KIT. Model GD-1U. Functions as oscillator or absorption wave meter. With plug-in coils for continuous frequency coverage from 2 Mc/s. to 250 Mc/s. £9.19.6
Two Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves, 15/-.

TRANSISTORISED VERSION. Model XGD-1. Similar to GD-1U. Fully transistorised with a frequency range of 1.75 to 45 Mc/s. £9.18.6

AUDIO WATTMETER KIT. Model AW-1U Up to 25 w. continuous. 50 w. intermittent. £13.18.6



MATCHED HI-FI STEREO KIT
We offer as a "packaged deal" the following matched Hi-Fi Stereo Equipment.
4-speed Record Player (RP-1U) £12 10 0
6 w. Amplifier (S-33) £11 8 0
Twin Speaker Systems (SSU-1) £20 11 0

Cost of Units £44 9 0
At an "all-in" price of £42 10 0
Pedestal Speaker legs £2/14/- optional extra.

● Deferred Terms ●

Available on all orders above £10.

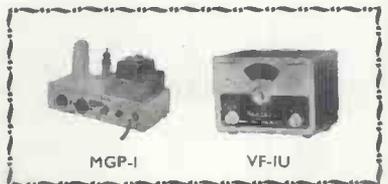
2 $\frac{1}{2}$ in. SERVICE 'SCOPE KIT. Model OS-1 Light, compact portable for service engineers Dim. 5 x 8 x 14 $\frac{1}{2}$ in. long. Wt. 10 $\frac{1}{2}$ lb. £18.19.6

POWER SUPPLY UNIT KIT. Model MGP-1 Input 100/120 v. 200/250 v., 40-60 c/s. Output 6.3 V., 2.5A A.C.; 200, 250, 270 V., 120 mA. max. D.C. £49.0

MULTIMETER KIT. Model MM-1U. Ranges 0-1.5 V. to 1,500 V. A.C. and D.C.; 150 μ A to 15A. d.c.; 0.2 Ω to 20 M Ω . 4 $\frac{1}{2}$ in. 50 μ A meter. £11.8.6

AUDIO VALVE MILLIVOLTMETER KIT Model AV-3U. 1 mv. to 300 v. A.C. 10 c/s. to 400 kc/s. £13.18.6

AUDIO SIGNAL GENERATOR KIT. Model AG-9U. 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



RESISTANCE - CAPACITANCE BRIDGE KIT. Model C-3U. Measures capacity 10 pF to 1,000 μ F., resistance 100 Ω to 5 M Ω and power factor. 5-450 v. test voltages. With safety switch. £7.19.6

DUAL-WAVE TRANSISTOR RADIO KIT. Model UJR-1. This sensitive headphone set is a fine introduction to electronics for any youngster. £2.16.6

4-WAVE TRANSISTORISED PORTABLE KIT. Model RSW-1. 7 Transistors and three diodes. For Short and Medium wave-bands (200-550, 90-200, 18-50, and 11-18 m.). In solid leather case fitted with retractable whip aerial. £20.18.6

TRANSISTOR PORTABLE RADIO KIT. Model UXR-1. Pre-aligned I.F. transformers, printed circuit and a 7 x 4in. high-flux speaker. Real hide case. £14.18.6

HI-FI F.M. TUNER. Tuning range 88-108 Mc/s. For your convenience this is available in two units sold separately as follows: Tuner Unit (FMT-4U) with 10.7 Mc/s. I.F. output £3/2/- inc. P.T. I.F. Amplifier (FMA-4U). Complete with case and valves £10/10/6. Total £13.12.6

AMATEUR TRANSMITTER KIT. Model DX-100U. Covers all amateur bands from 160-10 metres. Self contained including Power Supply. Modulator and V.F.O. £78.10.0

"HAM" TRANSMITTER KIT. Model DX-40U. From 80-10 m. Power input 75 w. C.W., 60 w. peak controlled carrier phone. Output 40 w. to aerial. Provision for V.F.O. £29.10.0

VARIABLE FREQUENCY OSCILLATOR. KIT. Model VF-1U. From 160-10 m. Ideal for our DX-40U and similar transmitters. Price less valves £8/19/6. £10.12.0

BALUN COIL UNIT KIT. Model B-1U. Will match unbalanced co-axial lines to balanced lines of either 75 or 300 Ω impedance £4.4.6

Prices include free delivery in the U.K.

DAYSTROM LTD.
DEPT. W.W.2 GLOUCESTER, ENGLAND

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WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

Please send me FREE CATALOGUE (Yes/No).....

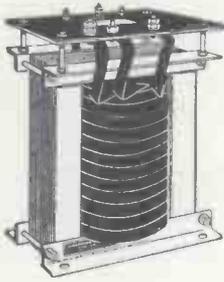
Full details of model(s).....

NAME
(Block Capitals)

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W.W.2

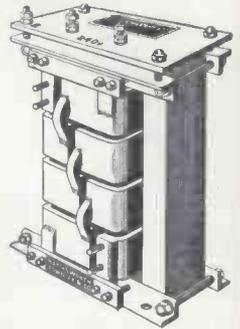
TRANSFORMERS



5 V	80 A	£10
4 V	100 A	£10
12 V	15 A	£4
60 V	7 A	£8
110 V	4 A	£9
18 V	30 A	£9
6 V	100 A	£12
24 V	30 A	£12
30 V	25 A	£12
55 V	15 A	£12
5 V	150 A	£14
110 V	10 A	£15
40 V	25 A	£17
5 V	300 A	£20
6-12 V	50 A	£10
12 V	60 A	£12
12 V	100 A	£16
50 V	60 A	£29
10-15-25 V	100 A	£28
10-20-30 V	100 A	£33
110 V centre tapped	25 A	£29
6-12-18-24-30 V	12 A	£11

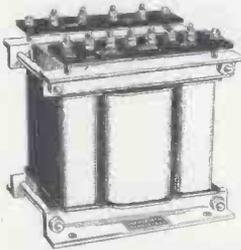
All for 240 V Input. Other Supply Voltages as Required. CONTINUOUS RATING. Short Rating Transformers also available.

5 V	5,000 A	£110
2.5 V	5,000 A	£64
4 V	5,000 A	£94
2 V	10,000 A	£98
3.5 V	20,000 A	£127
2 V	30,000 A	£130
10 V	700 A	£59
10 V	2,000 A	£103
10 V	1,000 A	£66
10 V	900 A	£62
10 V	500 A	£38
10 V	300 A	£28
20 V	800 A	£80
20 V	3,000 A	£150
5 V	1,000 A	£39
22 V	1,000 A	£75
28 V	1,000 A	£90



TRANSDUCTORS

SATURABLE REACTORS



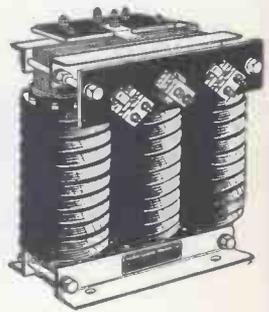
Saturable Reactors for controlling AC loads from .5kVA to 300kVA. Available for all standard AC supply voltages, single-phase and 3-phase. Standard DC control volts: 12, 24, 36, 110 and 240 V.

THREE-PHASE TRANSFORMERS

Input 400/440 V.

40 V	50 A 3-phase	£40
230 V	50 A 3-phase	£78
110 V	100 A 3-phase	£90
4 V	5,000 A 3-phase	£130

These and other Transformers can be supplied for 3-phase, 6-phase and 12-phase Rectifiers.



VOLTMOBILE VOLTAGE SELECTOR AUTO-TRANSFORMERS

Range: From 1.6% to 100% of Supply Volts in 64 steps of 1.6%. ON LOAD SWITCHING.

VOLTMOBILES can be used by themselves or in the primary of another transformer to give very fine changes of output. Overvoltage available as extra.

Single Phase Units	240 V	440 V
15 A	£28	£37
30 A	£39	£50
60 A	£69	£81
100 A	£99	£121

D-C MOBILE RECTIFIER SETS

For 240 V. AC. The larger outputs are available for 3-phase supply. Full load DC Volts and Amps are stated. Prices are without Meters and Regulators.

6 V	15 A	£14	36 V	10 A	£26
6 V	50 A	£47	36 V	20 A	£32
6 V	100 A	£66	36 V	40 A	£42
12 V	10 A	£15	36 V	60 A	£55
12 V	20 A	£22	110 V	5 A	£32
12 V	30 A	£28	110 V	10 A	£42
12 V	60 A	£45	110 V	15 A	£53
12 V	105 A	£62	110 V	20 A	£67
12 V	210 A	£83	110 V	25 A	£84
12 V	1,000 A	£185	220 V	130 mA	£15
24 V	12 A	£23	250 V	6 A	£49
24 V	20 A	£27	250 V	10 A	£70
24 V	30 A	£33	250 V	15 A	£89
24 V	60 A	£41	250 V	20 A	£110
24 V	105 A	£70	1,200 V	225 mA	£30
24 V	200 A	£86			
24 V	750 A	£262			



Built in to order—Ammeters—Voltmeters—Rheostats—Stabilising Circuits—Smoothing Circuits—Variacs.

CARRIAGE EXTRA on all units. SPECIFIC ENQUIRIES are invited for Transformers and Rectifiers. We specialize in HEAVY CURRENT EQUIPMENT.

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Accumulators



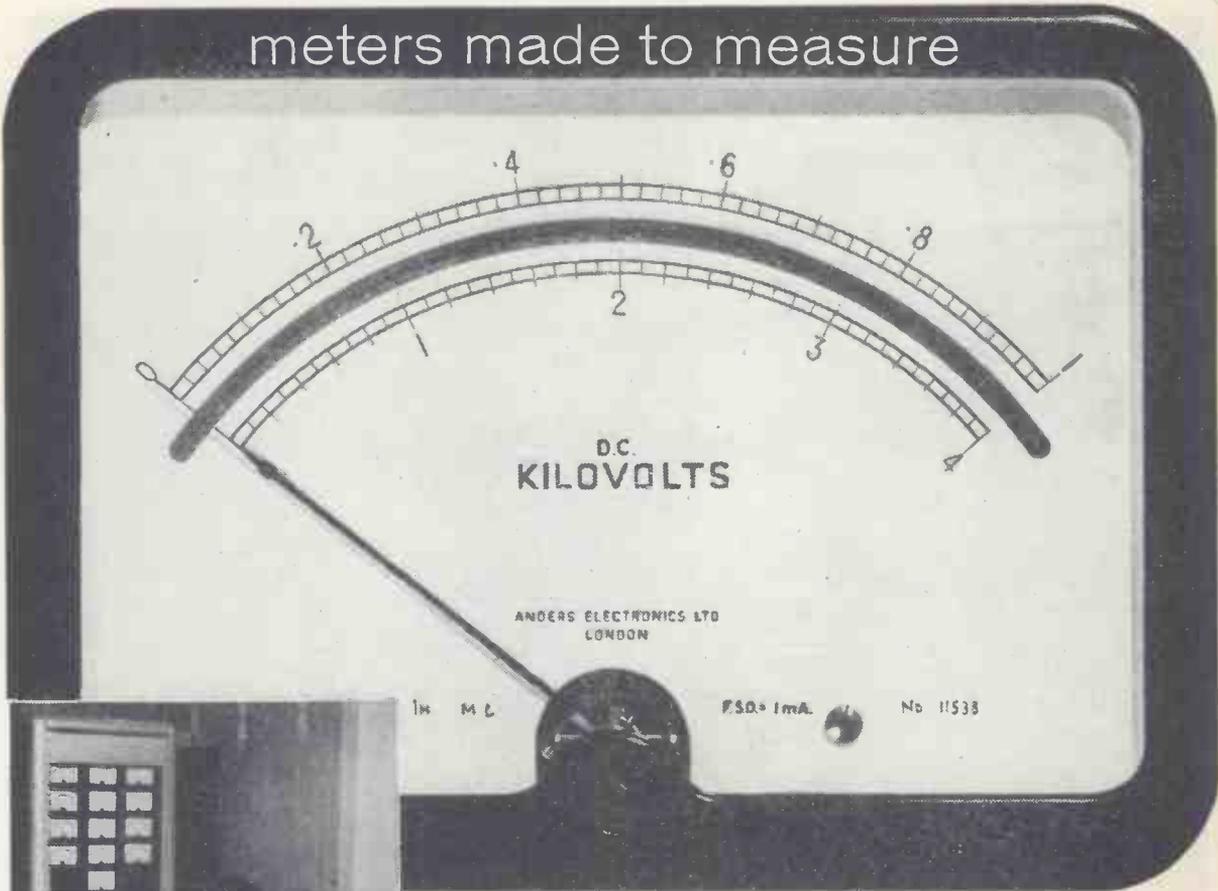
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*The lightest and
smallest rechargeable
accumulator in the world*

meters made to measure



special EHT meter rushed through for MO Valve Company

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.

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 1½" 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.

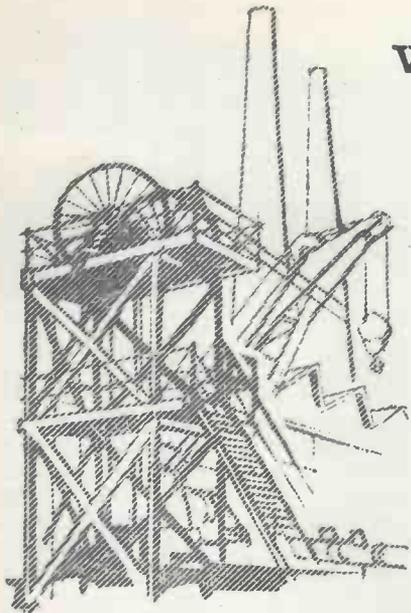
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Contractors to GPO and Government Departments.
Ministry of Aviation approved.

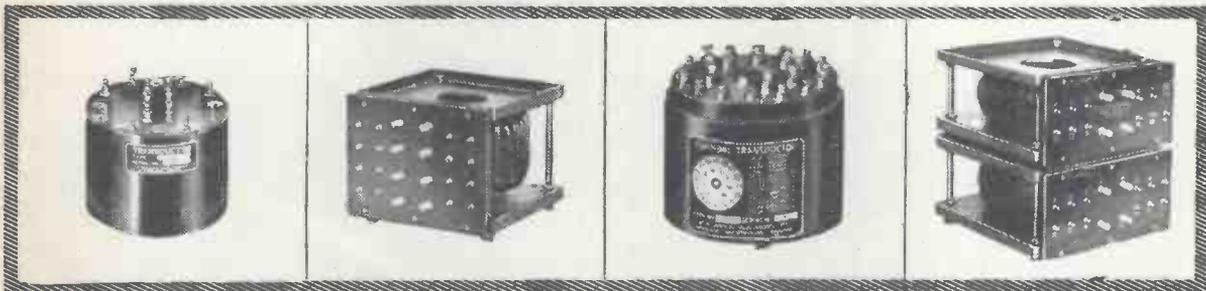
METERS, ELECTRONIC AND TEST EQUIPMENT TO INDIVIDUAL SPECIFICATIONS



wherever
speed, frequency or
voltage is controlled
you'll find



TRANSDUCTOR AND MAGNETIC AMPLIFIER SYSTEMS



Type 1000

Encapsulated transducers meeting Climatic Classification 40/70 H1. They have passed the tests for Inter-Service Type Approval as specified in RCS (Frov) 217, and are used extensively in Service equipment.

Supply Freq.	D.C. Output
50 c/s	From 0.005W to 11W
400 c/s	From 1W to 145W

Type 2000

Open-type transducers suitable for use in industrial applications requiring Climatic Classification 40/70 H2. Many of these transducers are in use in steel works, coal mines and similar situations where robustness and reliability are of prime importance.

Supply Freq.	D.C. Output
50 c/s	From 50W to 600W
400 c/s	From 500W to 4000W

Type 3000

Transducers use toroidal cores, the whole assembly being encapsulated in an epoxy-resin to make a component satisfying the requirements of Climatic Classification 40/70 H1. This range is Admiralty Approved and is used extensively in Service equipment.

Supply Freq.	D.C. Output
50 c/s	From 50W to 250W
400 c/s	From 500W to 2000W

Type 4000

In the 4000 range the transducers are of the same high quality and finish as the 2000 range, but the construction is such that they can be supplied as either 1-, 2-, or 3-element assemblies. Climatic Classification 40/70 H2.

Supply Freq.	D.C. Output
50 c/s	From 50W to 1000W
400 c/s	From 500W to 8000W

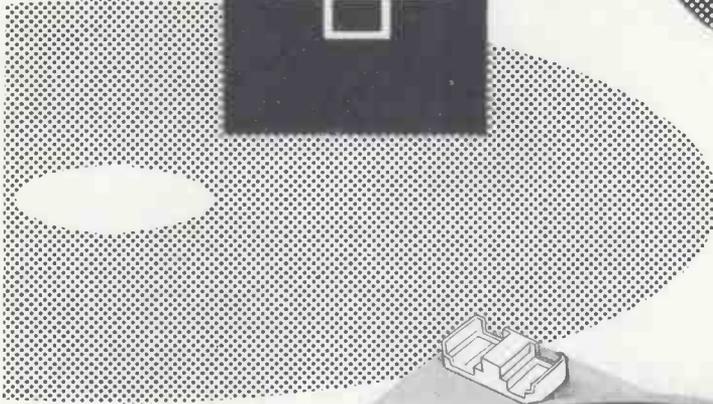
The Sanders range of high performance transducers is ideally suitable for use in automatic control systems and applications where size, weight and quality are important. A comprehensive selection of transducers exists for operation from both 50 c/s and 400 c/s supplies. The advantage of being able to obtain a standard type of transducer with known characteristics enables them to be offered at competitive cost and with a short delivery period. In addition to this standard range, a large selection of transducers is produced using the same high quality construction, but having different windings to suit individual requirements.

*This is one of a series of new
instruments and components by*



W. H. SANDERS (ELECTRONICS) LTD

GUNNELS WOOD ROAD STEVENAGE · HERTS
Telephone: Stevenage 382. Telex 82159, Sanders Stev.



Speeds	16. ² / ₃ , 33. ¹ / ₃ , 45, 76 r. p. m.
Turntable Diameter	13 inch
Wow and Flutter, peak to peak	max. 0,1 %
Dimensions	15. ¹ / ₈ x 19. ³ / ₄ inch
Depth	6. ¹ / ₄ inch
Weight	22 lbs
Power requirements	220 volts, 50 cps, a. c.
on request	117 volts, 60 cps, a. c.
Power consumption	approx. 20 watts



EMT 940

BRAND NEW, FOUR-SPEED TRANSCRIPTION TURNTABLE

Younger brother of the excellent model EMT 930 well-known to most broadcast stations of the world. The new EMT 940 has also two turntables in one, a heavy flywheel as main turntable and a light plexiglass cover for instantaneous starting and stopping by means of a mechanical brake.

For additional delivery:

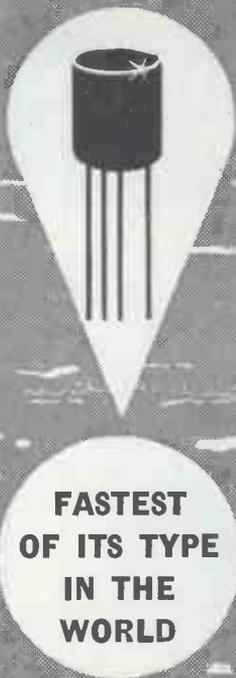
EMT 940T Ortofon Stereo Tone Arm Kit with mono or stereo pickup heads.

EMT 940E Remote Controlled Magnetic Brake Kit, with key, pilot lamp and rectifier.

Please write for full details.

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NEW MULLARD AVALANCHE TRANSISTOR

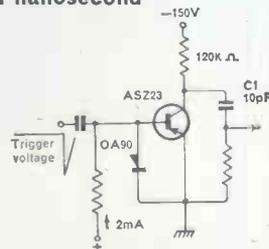
Today you can specify a truly *dependable* avalanche junction transistor, for use in very high speed circuits. It is the Mullard ASZ23—a new *purpose-made* transistor that is manufactured by the Mullard alloy diffusion technique to give complete reliability of the avalanche mode. Mullard experience in the development of alloy diffused transistors has made possible the production of this high avalanche performance p - n - p junction transistor at a realistic price.

Here is a transistor to give the designer tremendous scope. The ASZ23 opens up a new field of nanosecond pulse techniques. A typical application is in the sampling oscilloscope circuit shown alongside.

Supplies of the ASZ23 are immediately available.

ASZ 23

60mA pulse with rise time of 1 nanosecond



A typical method of obtaining a predetermined sampling by means of the ASZ23

ASZ23 ALLOY DIFFUSION p - n - p JUNCTION TRANSISTOR

Absolute Maximum Ratings	
Collector current i_c (pk) max	100mA
Reverse emitter-base voltage V_{eb} max	-2.0V
Temperature Ratings	
Storage temperature limits	-55 to +75°C
Maximum junction temperature	75°C
Junction temperature rise above ambient	0.6°C/mW
Junction temperature rise above case	0.5°C/mW

Typical Characteristics	
at $T_{junction} = 25^\circ C$	
V_{eb} turnover at $I_{co} = 1mA, I_e = 0$	-24V
Rise time of output pulse in circuit shown	1ns

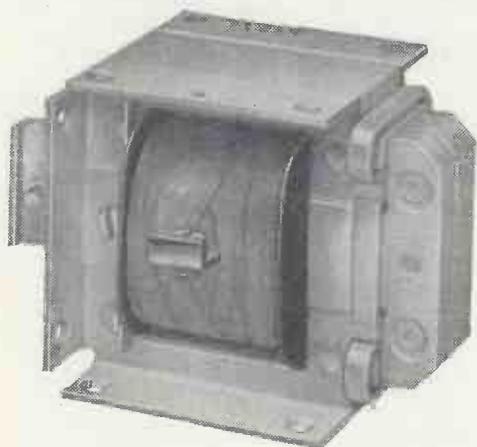
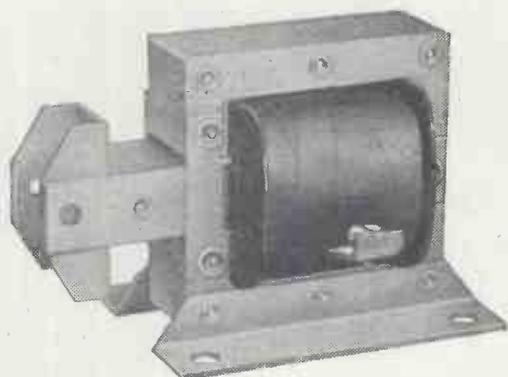
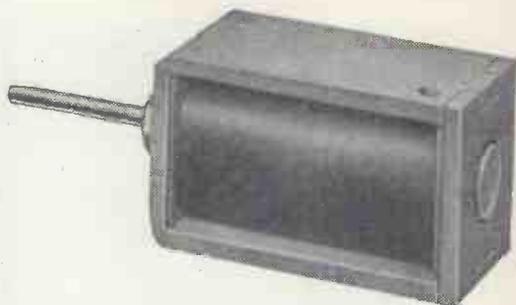
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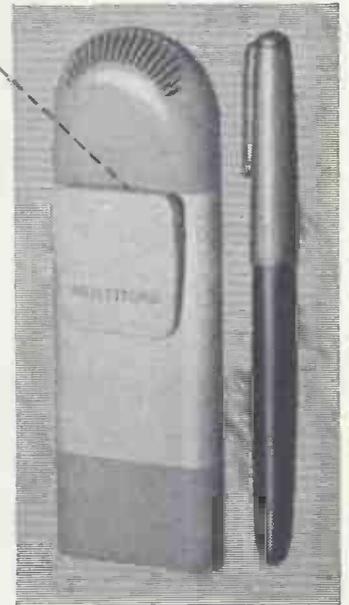
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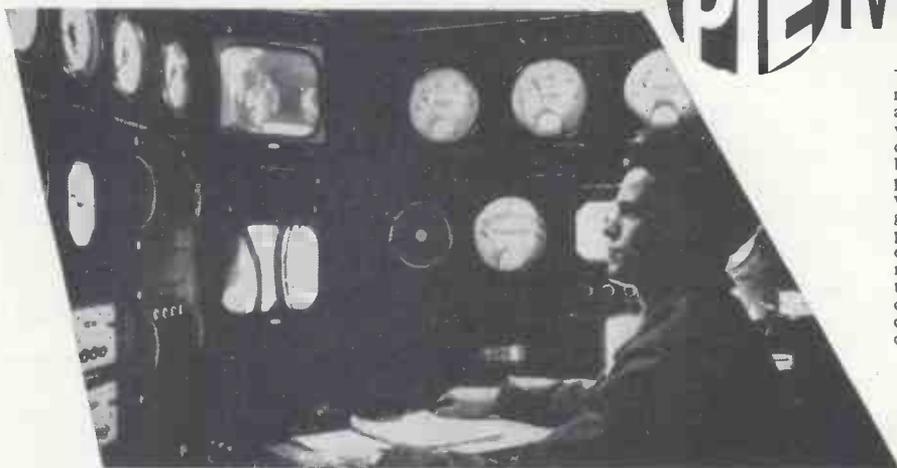
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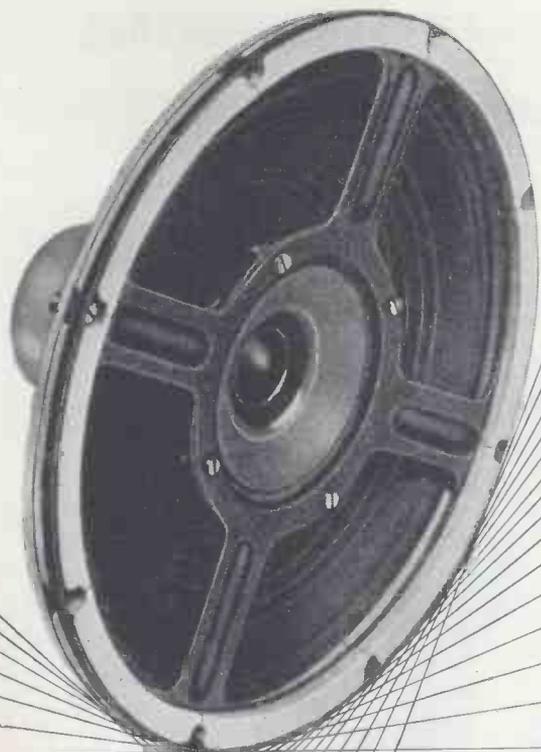
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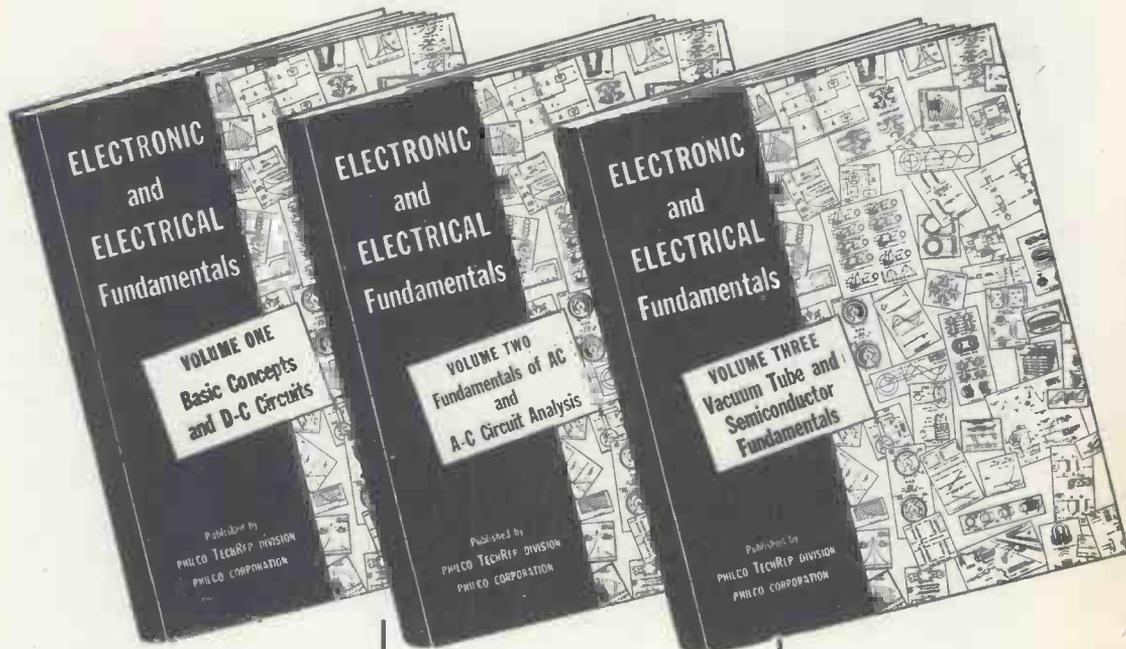
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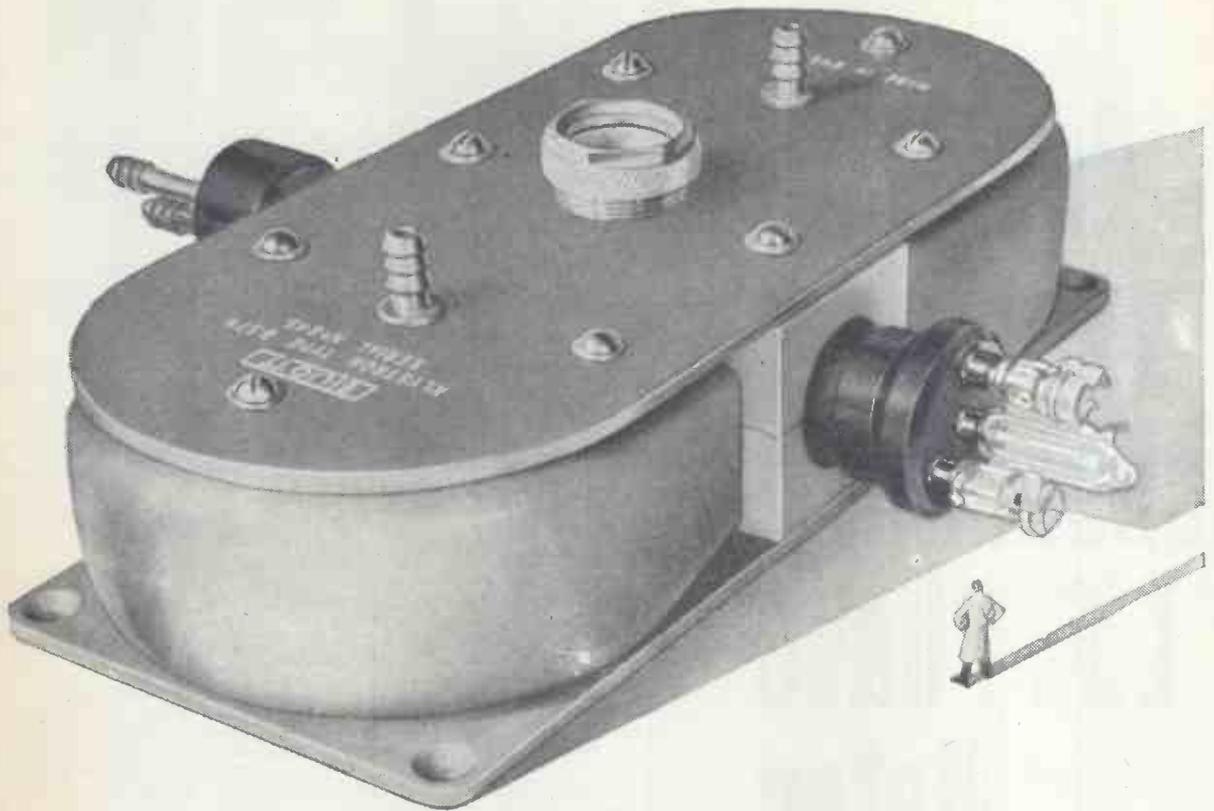
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INPUT LEVEL. Is the input level range wide enough?

In present day circuitry, wide differences in signal level are likely to be encountered. The Airmec L.F. Phase Meter Type 206 will accept input signals between 1 millivolt and 1 volt, the maximum level difference between the two measured points being 60 dB.

LEVEL COMPARISON. Can a direct comparison of signal level difference be obtained?

Even though phase measurement is the primary object, it is advantageous to be able to read instantaneously the value of any level difference between the points of measurement. Signal level differences are indicated on the Airmec L.F. Phase Meter Type 206 by reference to the settings of two attenuators, one in each channel.

INPUT IMPEDANCE. Is the input impedance high enough?

The addition of a measuring device to the circuit under test should obviously not change the operating conditions. The input impedance of the Airmec L.F. Phase Meter Type 206 is 12 Megohms at 1 kc/s.

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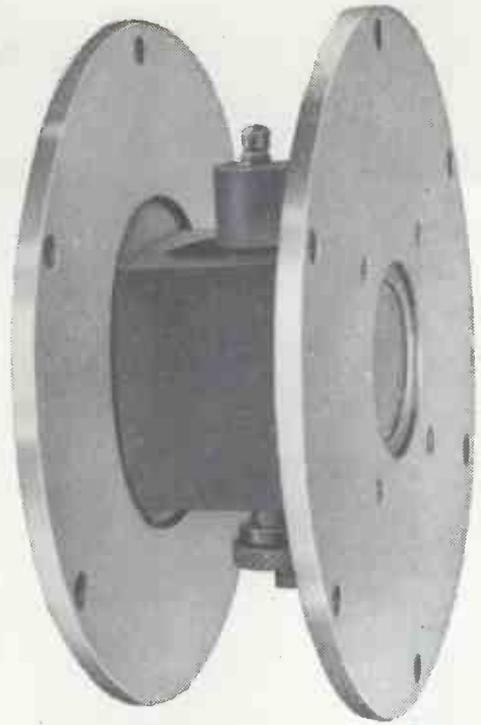
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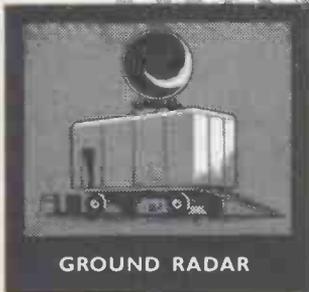
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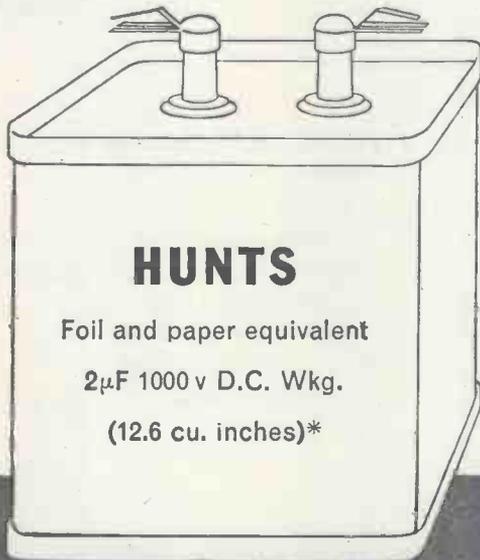
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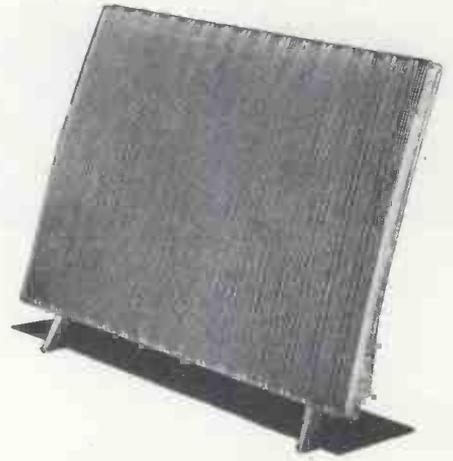
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	C1108	4-125A*	CV2130	120	125
	C1112	4-250A*	CV2131	75	250
	C1134	6252 *	CV2799	150	10+10
MAINTENANCE	813	813	CV26	30	100
	829B	829B	CV2666	200	20+20
	832A	832A	CV788	200	7.5+7.5

* Near equivalent

AGENTS THROUGHOUT THE WORLD

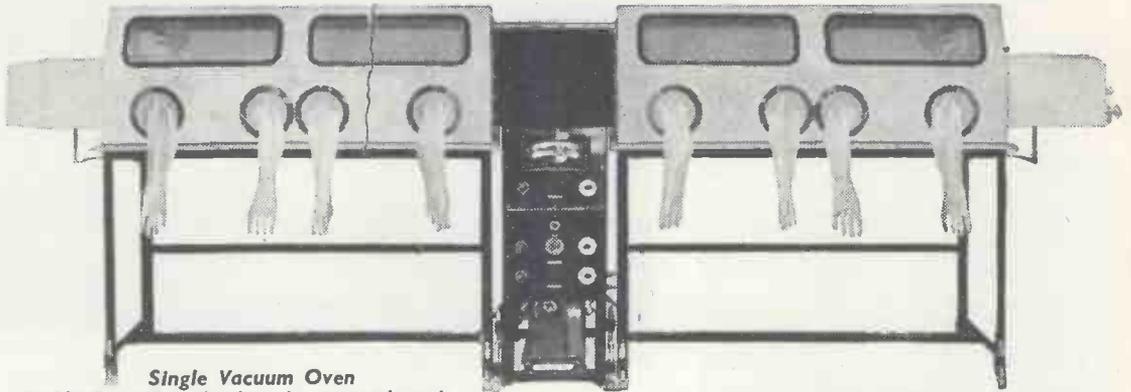
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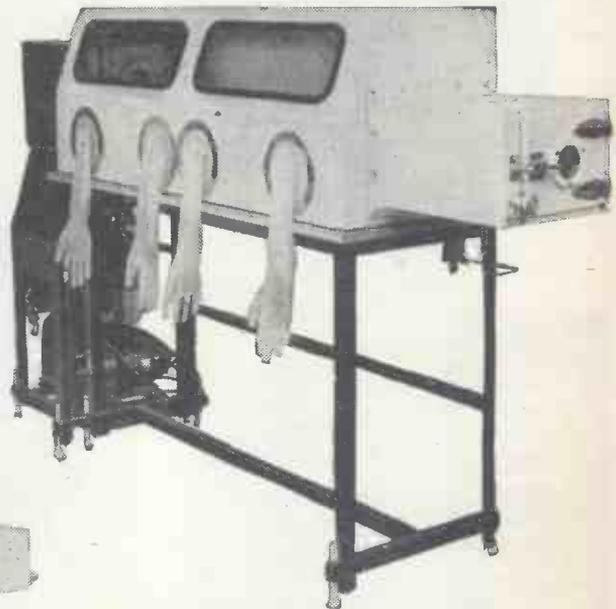
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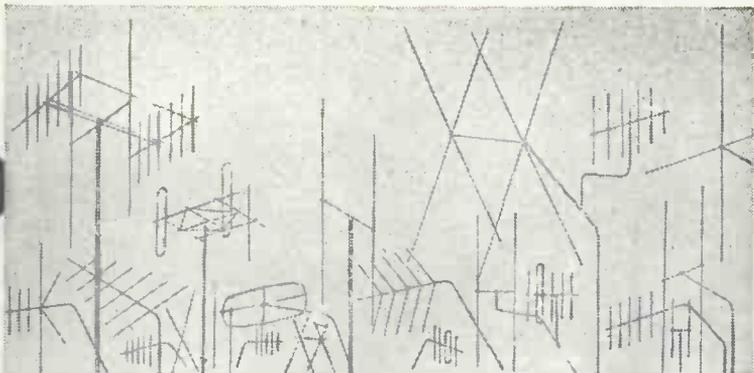


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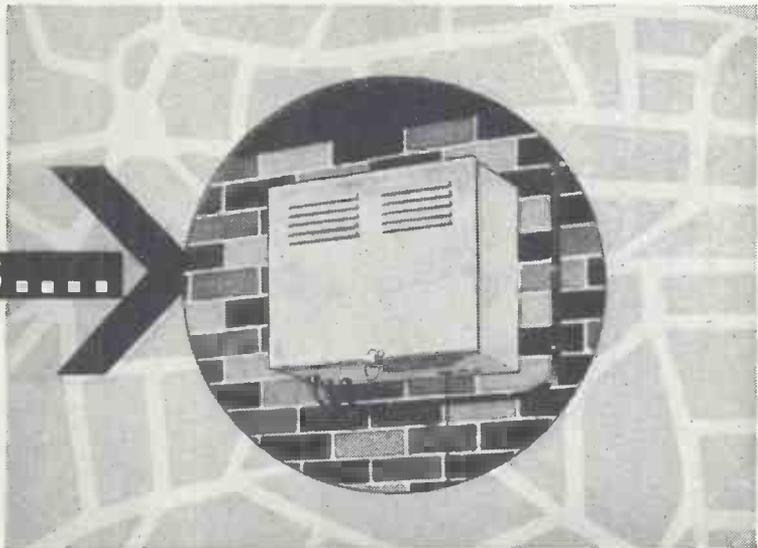
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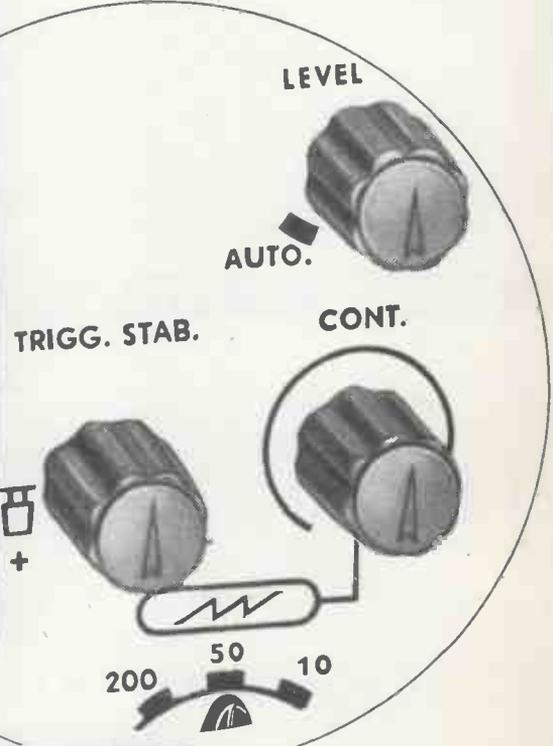
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Some other data

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Bandwidth: 0—5 Mc/s (—3 dB), risetime 70 μ sec

Sensitivity: 50 mV/cm—20 V/cm in 9 calibrated steps (accuracy \pm 4%)

Continuous control: 1: 2.5

Time base

Sweep speeds: 0.5 μ sec/cm—30 msec/cm in 7 steps and continuously adjustable

Trigger-possibilities

Internal or from an external source both with pulse repetition frequencies from 10 c/s to 1 Mc/s, as well as from the mains frequency. Stability control and manual or automatic level control.

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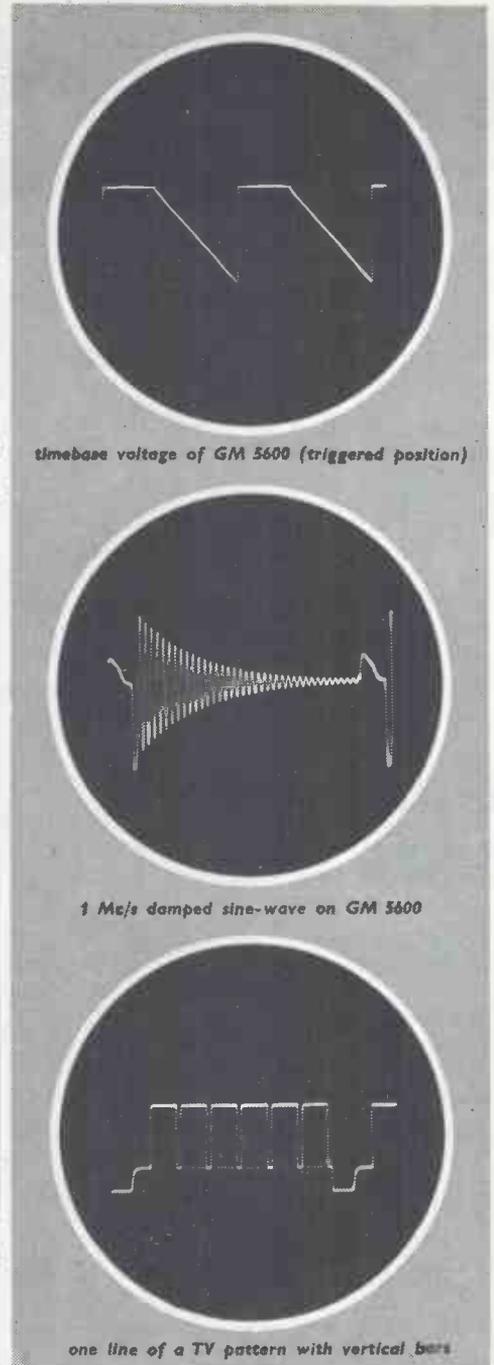
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E55L

E810F

The introduction of the E810F and E55L wideband pentodes makes possible cascaded amplifiers with bandwidths hitherto only achievable by distributed amplifier techniques. They will be of particular interest to designers of wideband amplifiers for oscilloscopes, microwave radio links and telephone repeaters.

In the E810F the frame grid technique has been used for both the control grid and screen grid. This results in a particularly good ratio of anode to screen grid current. Moreover, special attention has been paid to the provision of an adequate grid base—making the valve ideally suitable for large signal applications.

The E55L has twice the anode dissipation of the E810F whilst still achieving a figure of merit of nearly 200Mc/s—a performance far in advance of conventional power pentodes. Like the E810F this large valve has the grid base required for large signal applications.

ABRIDGED DATA

Characteristics	E810F	E55L
V_a	120V	125V
V_{g_2}	150V	125V
V_{g_3}	0V	0V
V_{g_1}	-1.9V	-2.0V
I_a	35mA	50mA
I_{g_2}	5mA	10mA
g_m	50mA/V	45mA/V
$\mu_{g_1-g_2}$	58	38
r_a	70k Ω	20k Ω
r_{g_1}	500 Ω	1000 Ω
	(f=100 Mc/s)	(f=50 Mc/s)

Gain bandwidth product 238 Mc/s 194 Mc/s

Capacitances (unshielded)

C_{a-g_1}	40mpF	110mpF
C_{in}	16pF	18pF
C_{in} (working)	25pF	28pF
	($I_k=40mA$)	($I_k=60mA$)
C_{out}	3.5pF	4pF

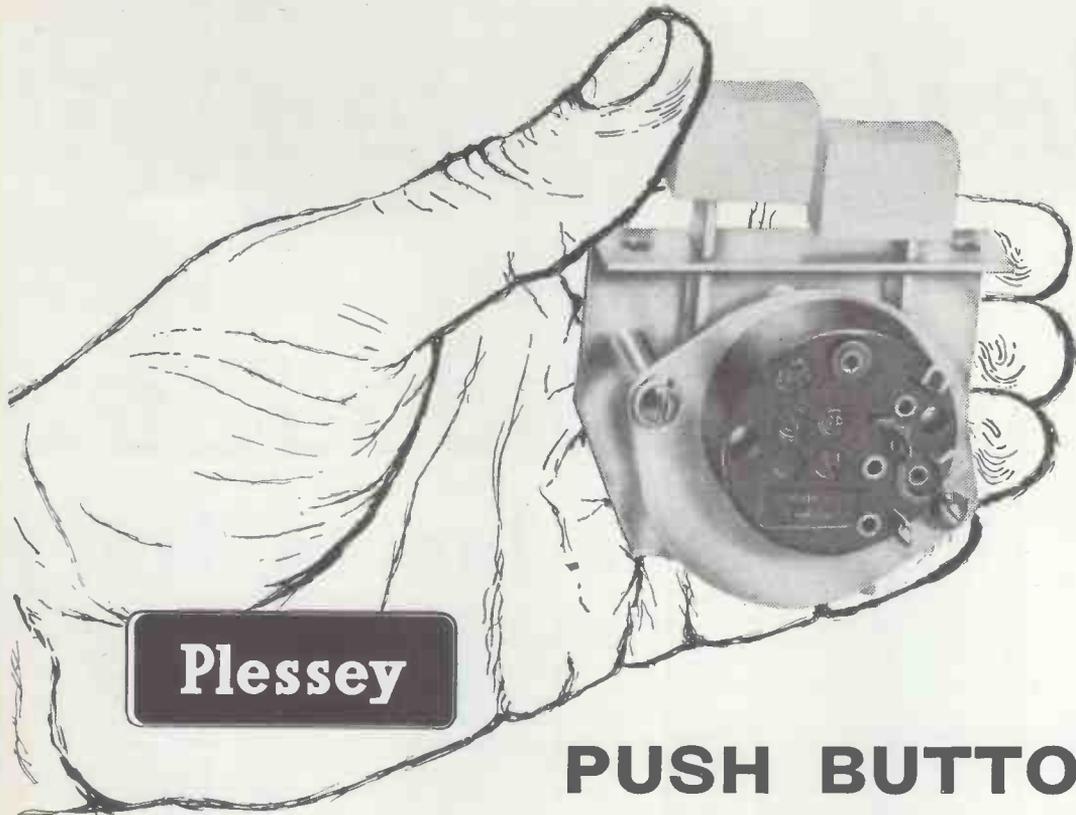
Valve Base **B9A** **B9D**

* For more detailed information please write to the address below or telephone LANgham 6633.



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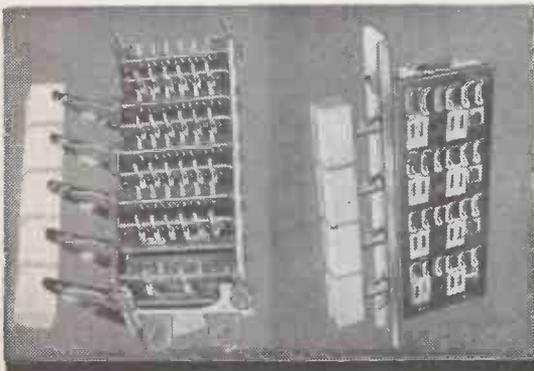
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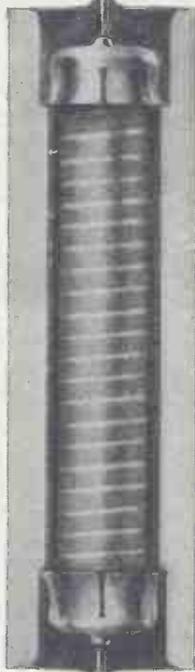
Resistors

The Inside Story

There is, of course, a lot of "know-how" in the manufacture of a high stability resistor element to the exacting characteristics demanded of a high stability resistor, but, having made the element, two problems remain. How to protect the smoke thin resistance film from damage in transit, in handling, and in assembly, and how to isolate the element from contact with paints, lacquers, and other finishes, all of which have a tendency to pull the film under extremes of temperature and humidity.

In the Erie high stability resistor these two problems have been solved very simply and with complete effectiveness by the encapsulation of the element in the ceramic insulating tube, cement sealed at the ends, proven on billions of Erie solid carbon resistors and ceramic dielectric capacitors in use throughout the world. This tube obviously affords complete protection from all manner of physical damage, and, as can be seen from the illustration, the counter bore at either end and the close affinity between the counter bore and the caps of the element ensures that the element is supported by the caps clear of the inner bore of the tube, and there is thus no contact whatsoever with any material that might prove harmful.

Only Erie high stability resistors are protected in this way, and that is why they are found in all equipment where robustness and reliability under all conditions must be allied to first-class performance.



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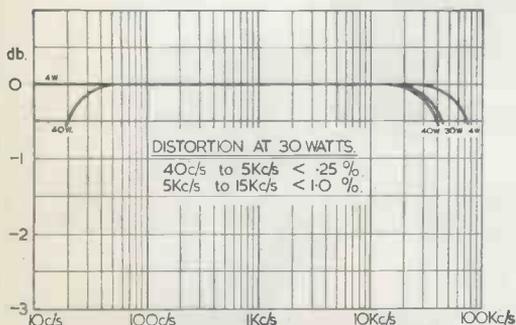


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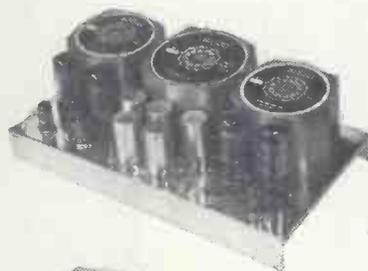
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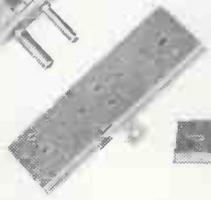
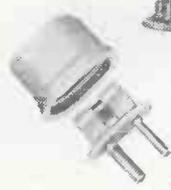
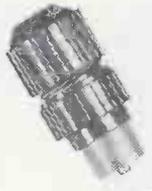
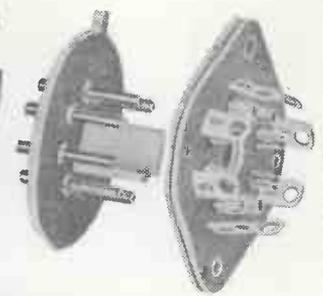
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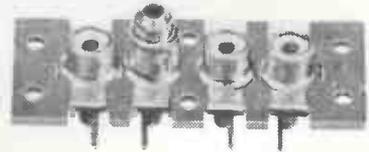
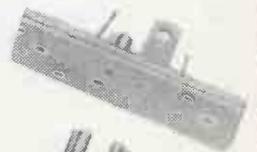
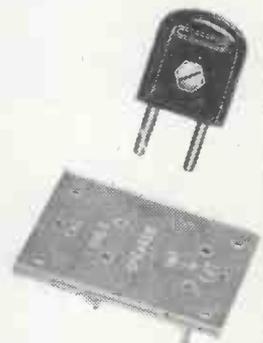


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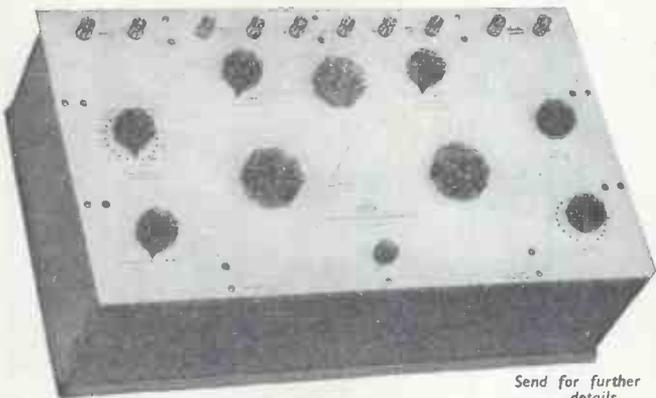


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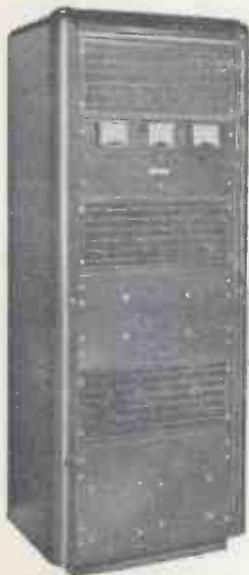
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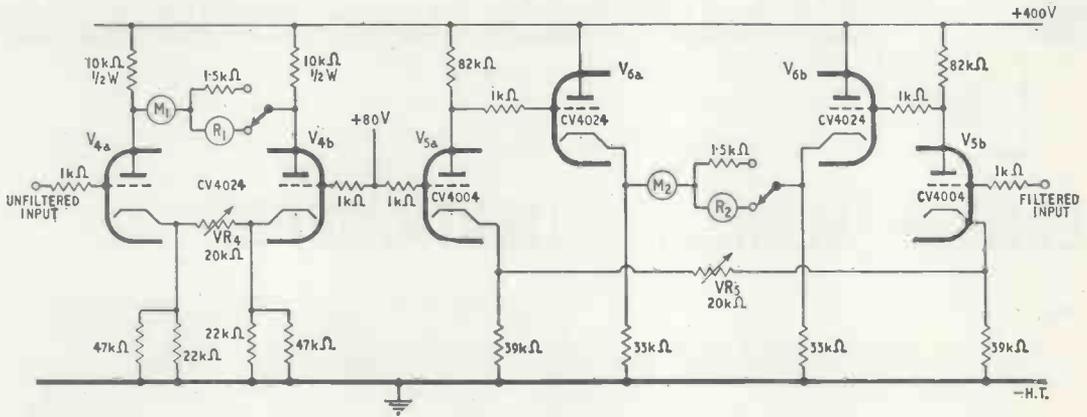
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Water-level Surge Recorder

The current January issue of **ELECTRONIC TECHNOLOGY** includes an article which describes an instrument developed for measuring the amplitude and frequency of standing oscillations in an experimental water wave channel. The author gives details of the unusual problems arising and provides information on the transducer and various sections of the instrument, including a low-pass filter, driver amplifier and recorder. Drift and noise figures for the instrument and calibration and operation procedures are also given.

ARTICLES IN THE FEBRUARY ISSUE INCLUDE:

SPEED CONTROL OF D.C. MOTORS

In this article, the authors describe electronic methods of controlling the speed of small d.c. motors, such as those used in tape recorders. It is shown that by using transistor circuits it is possible to design speed-control systems for d.c. motors which are economic in cost, physical size and current consumption, giving speed performances which are superior and more reliable than those obtained from electro-mechanically-governed motors. Details and circuit diagrams are given for two systems.

EXPERIMENTAL TRAVELLING-WAVE TUBES

Small-size t.w.t.s are described in this article with 150-W and 300-W c.w. output and gains greater than 20 dB over the band 7.5 to 11.5 kMc/s. The author describes various experimental tubes, gives details of their construction and performances and shows that by using high-pressure water cooling of helices, the advantage of high coupling impedance over a very broad band is retained and the thermal dissipation proves to be sufficient up to power limits set by other factors.

ELECTRONIC TECHNOLOGY retains all the familiar features of *ELECTRONIC & RADIO ENGINEER* including the well-known *Abstracts and References* section. Regular readership will keep you in constant touch with progress in the entire field.

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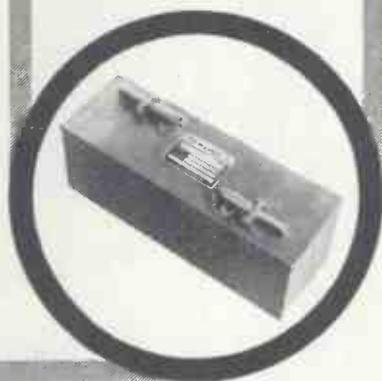
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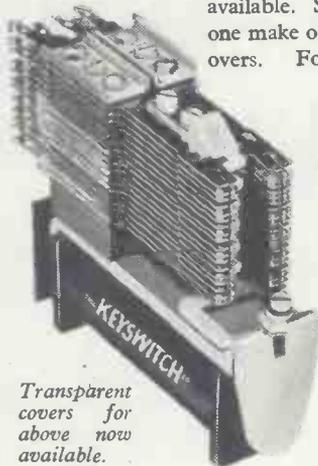
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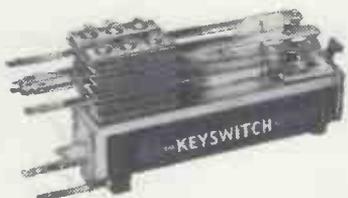
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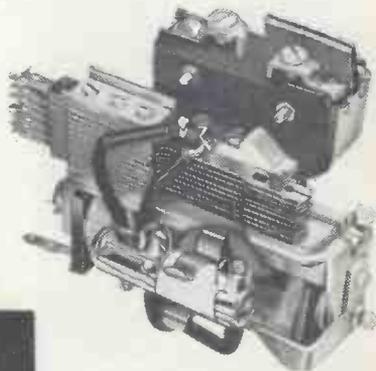


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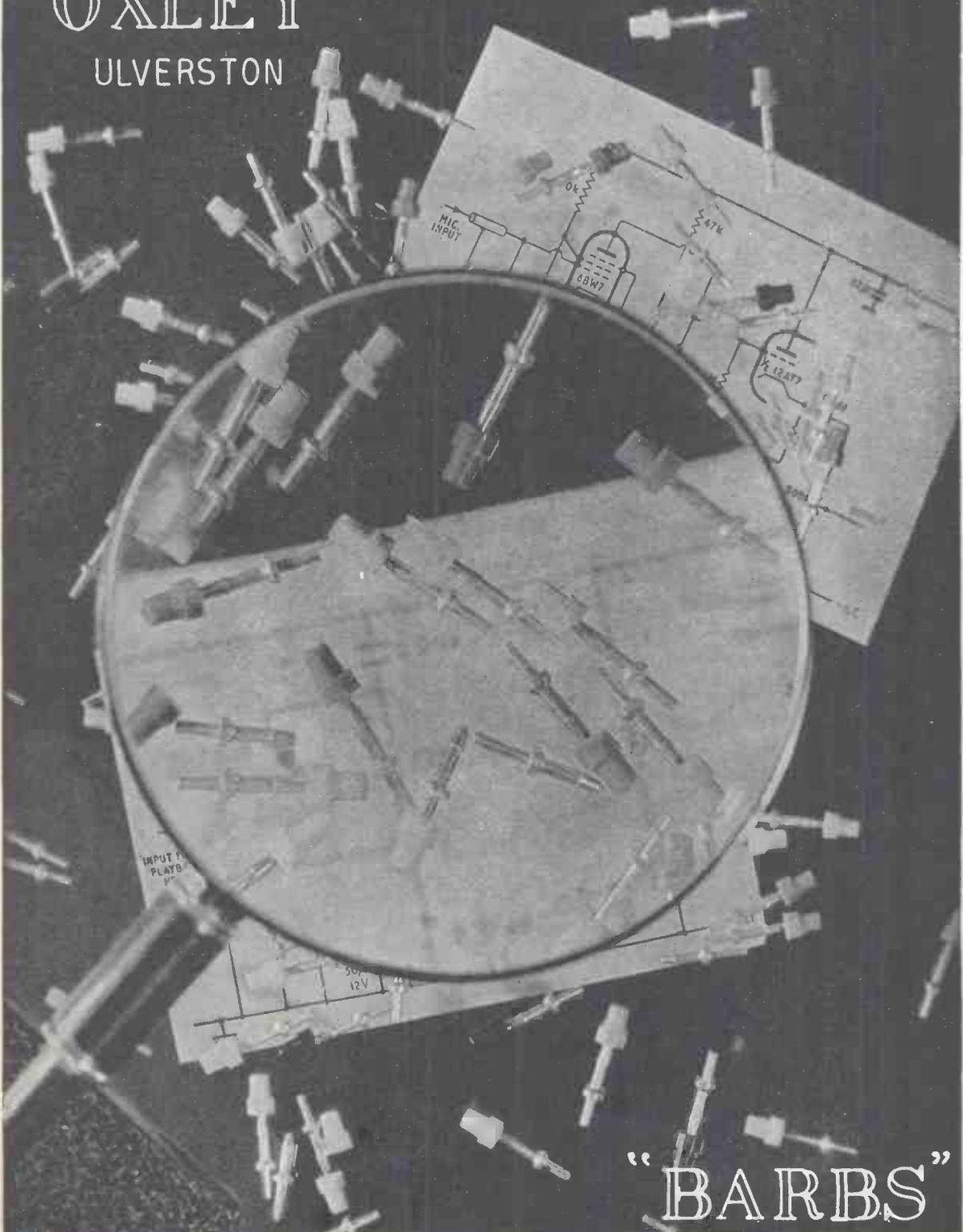
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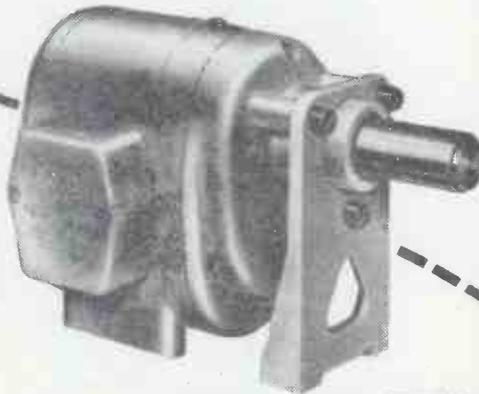
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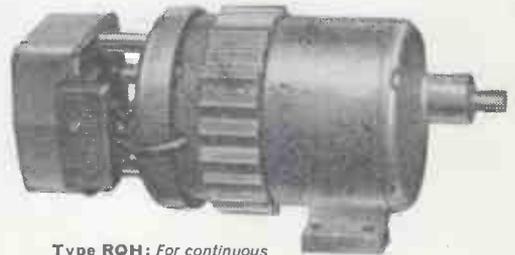
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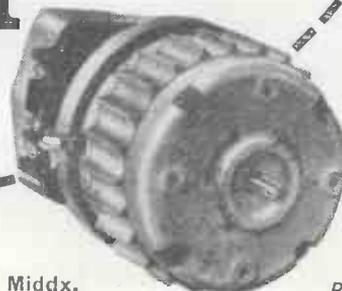
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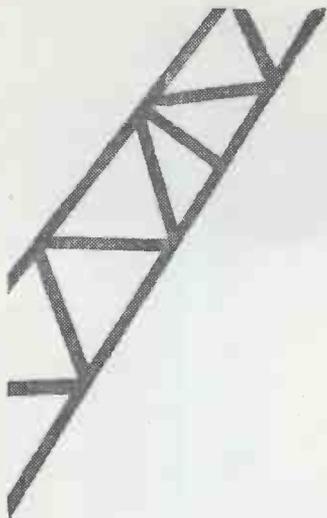
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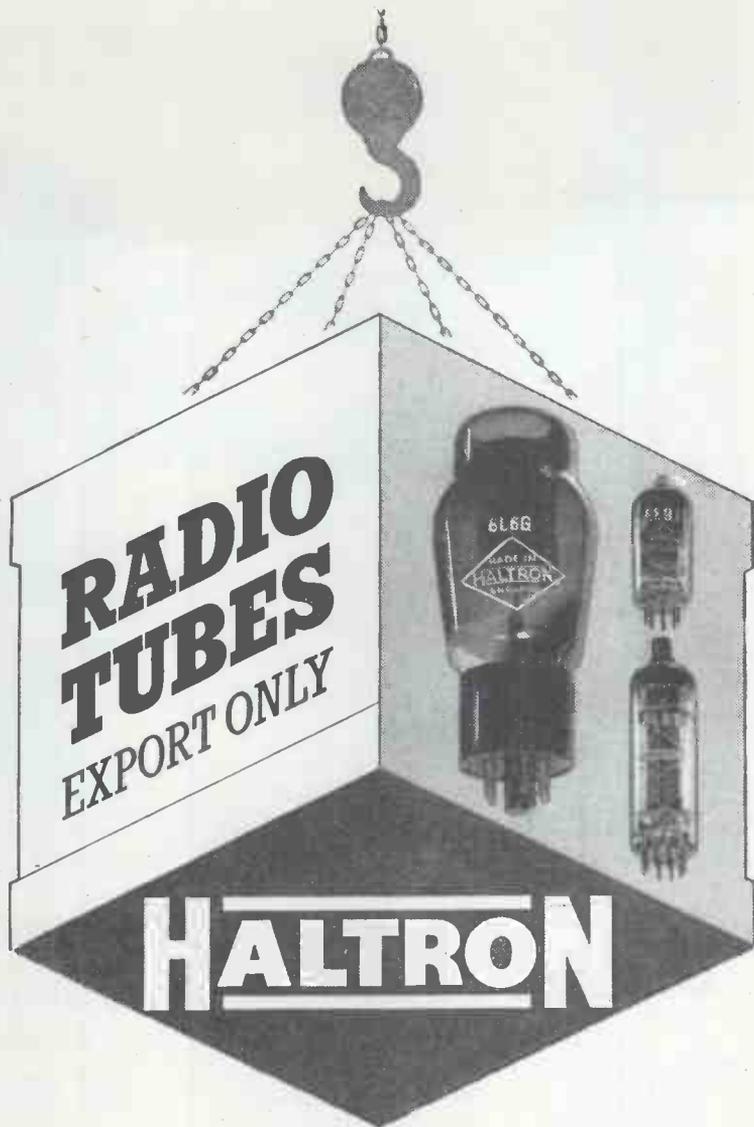
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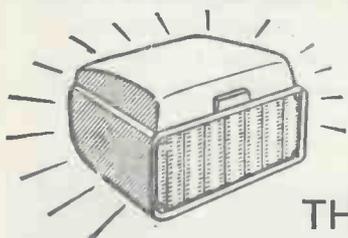
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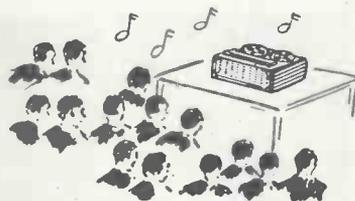
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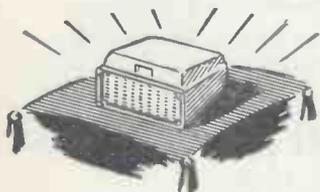
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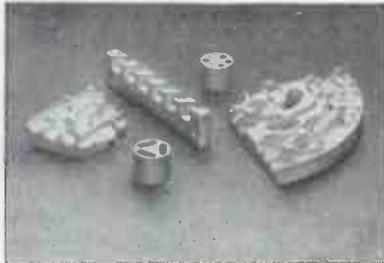
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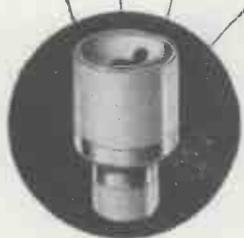
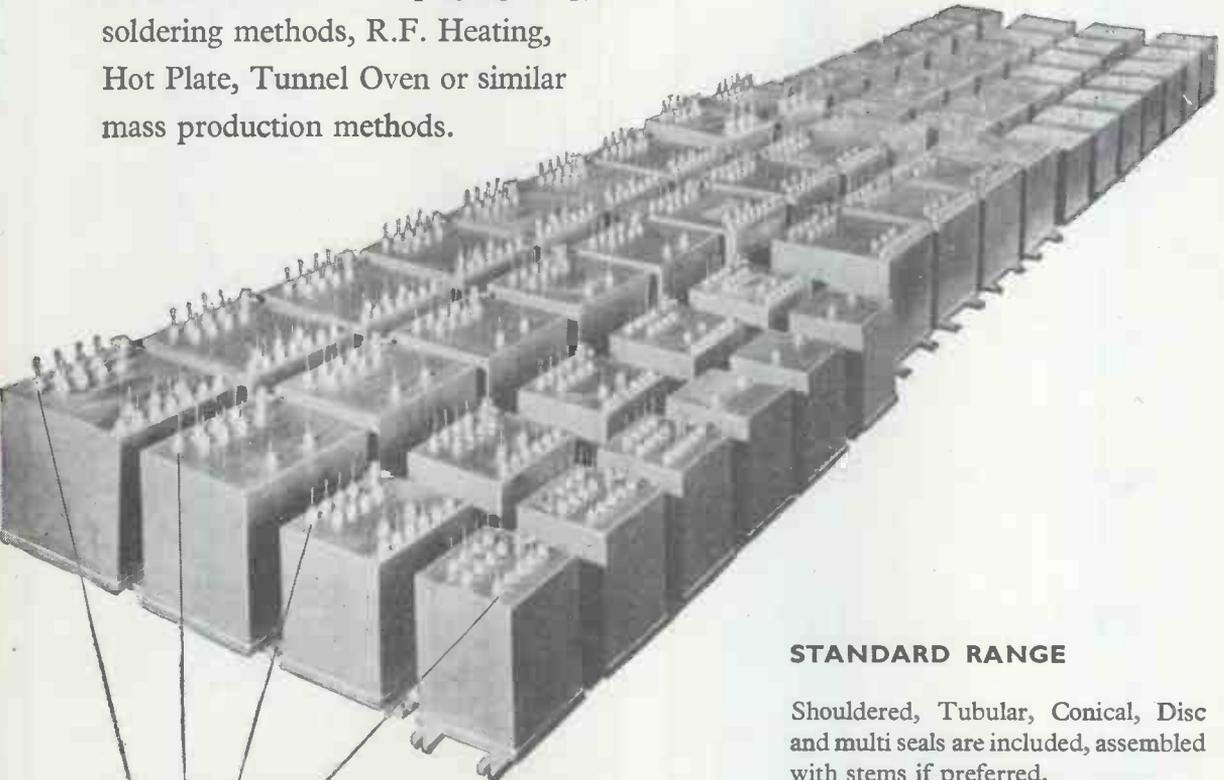
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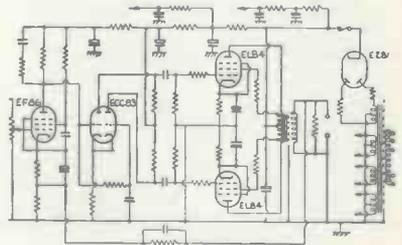
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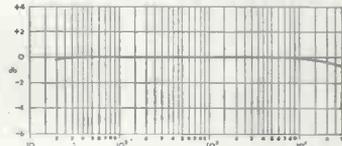
designed for



Type AS.7012*, Solent series Audio Output Transformer, has been designed especially for the Mullard 5 Valve 10 Watt High Quality Amplifier, and is capable of the highest quality reproduction. The static frequency response (without feedback) is within 0.5 db. from 20~ to 25,000~, and there is appreciable response at 50 kc/s. and above. Primary tapplings for feedback are provided at 43% and 20% of the windings, and the secondary windings are suitable for 3.75Ω and 15Ω with identical characteristics on both outputs. A response curve, panel layout and loudspeaker connection chart are included with each transformer. Priced at 49/3, it can be obtained through your local radio dealer, or direct from us, post free.

*This is one of twenty-two Audio Transformers in the Solent and Miniford series described in Gardners new leaflet "S/M" especially prepared for retailers and private users, which includes over a hundred standard Mains Transformers and Chokes. We shall be pleased to post you a copy upon request.

Below is reproduced the response curve of the AS 7012 which is typical of the whole of the Solent Series.



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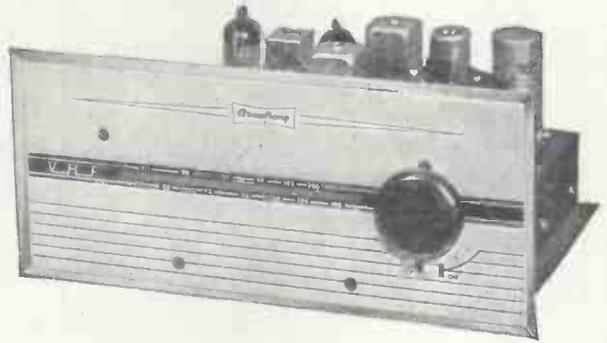
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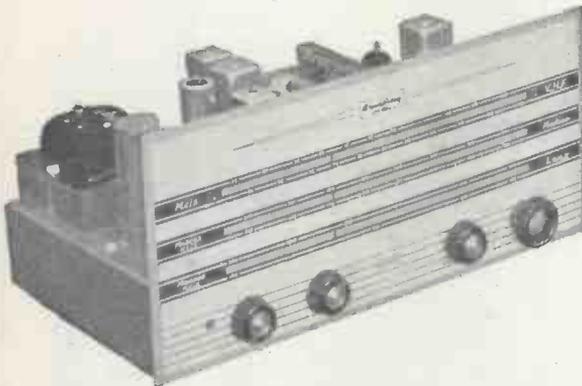
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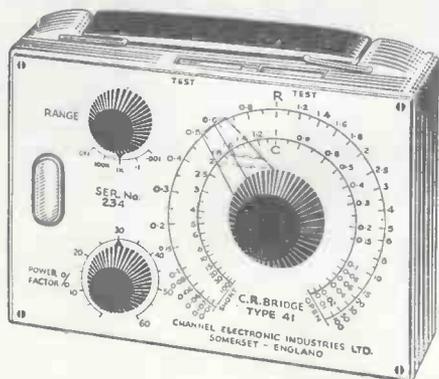
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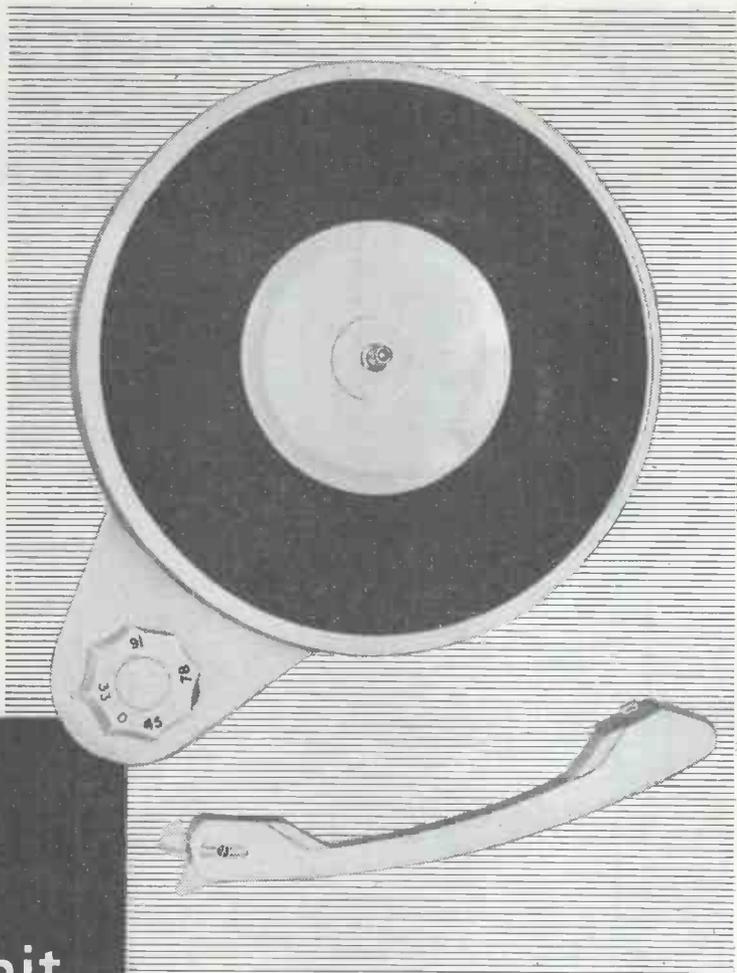
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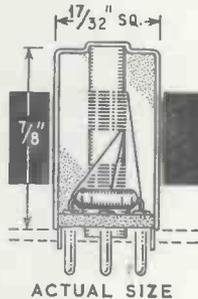
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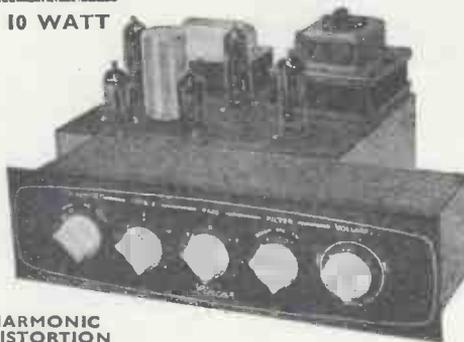
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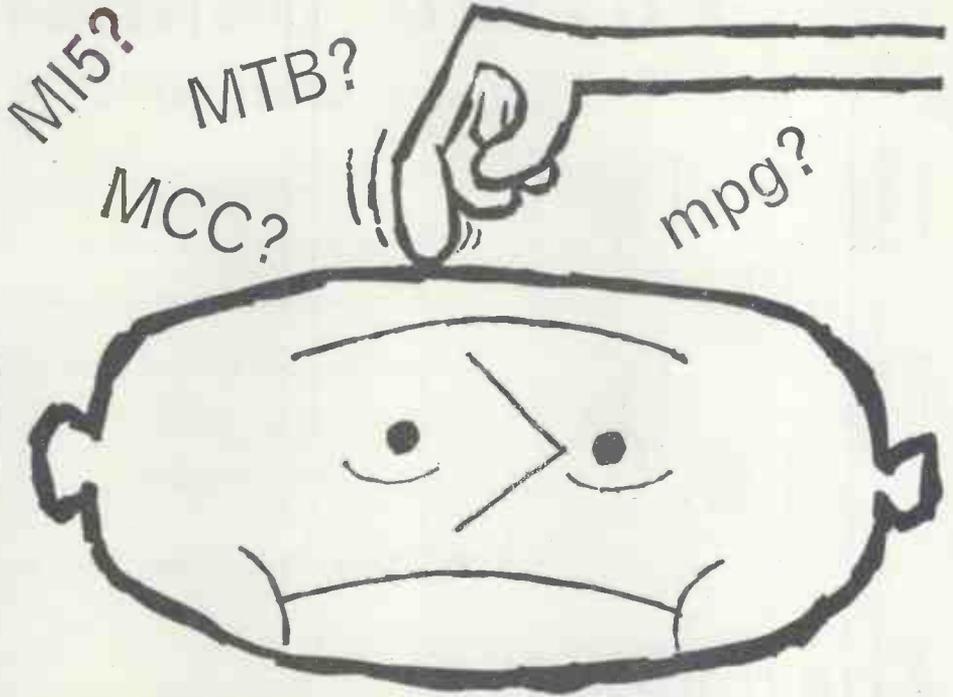
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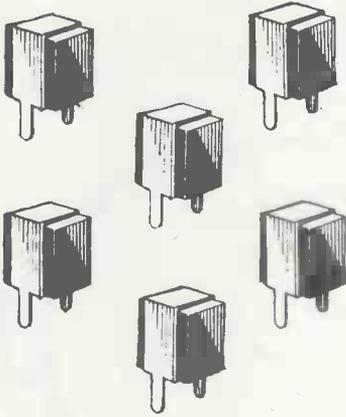
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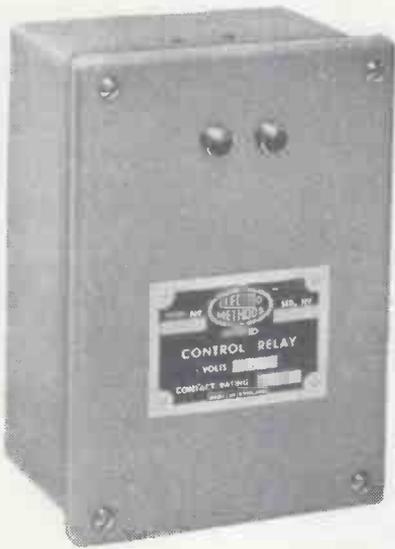
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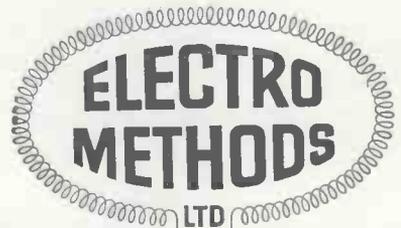


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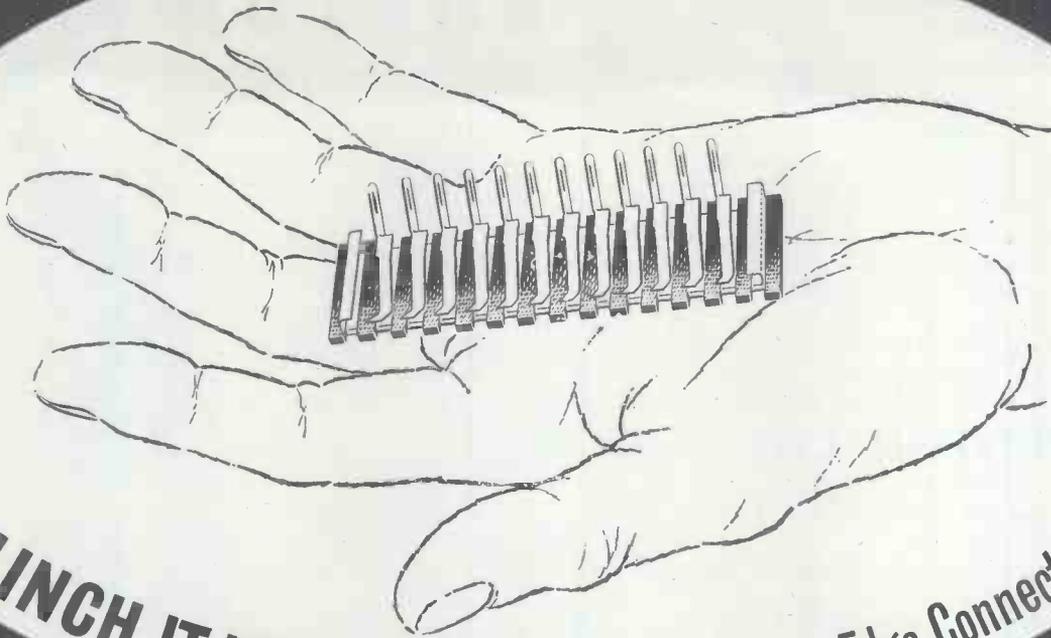


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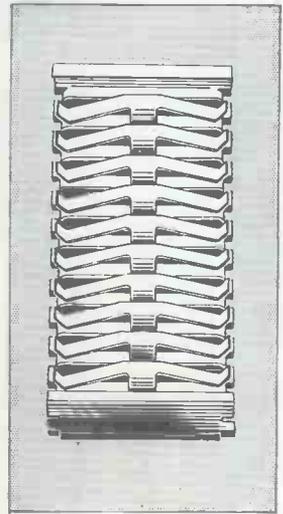


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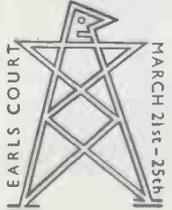
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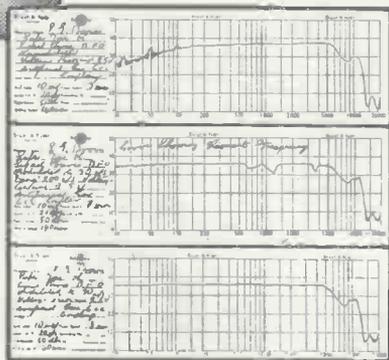
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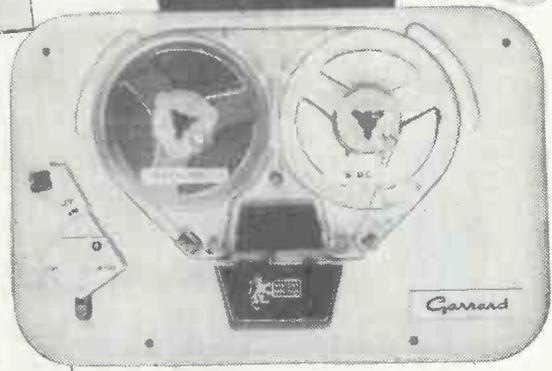


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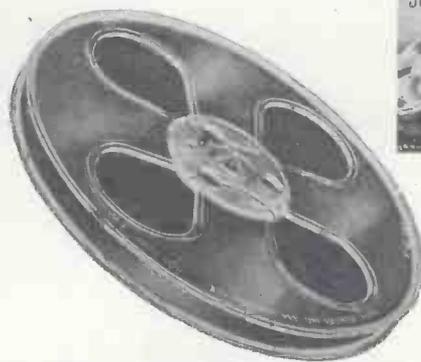
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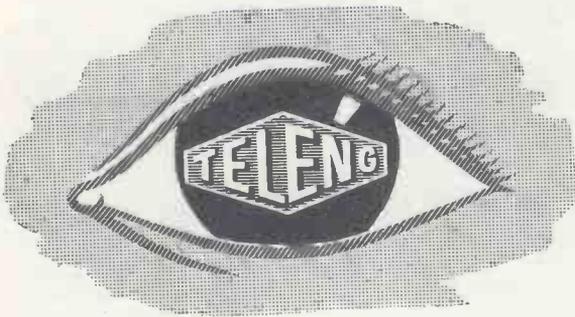
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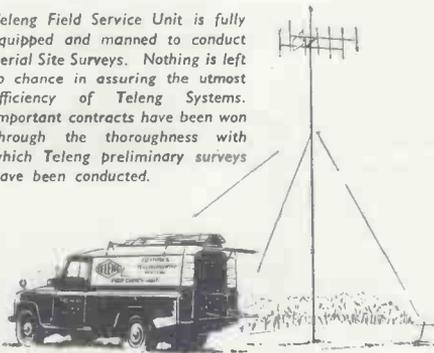


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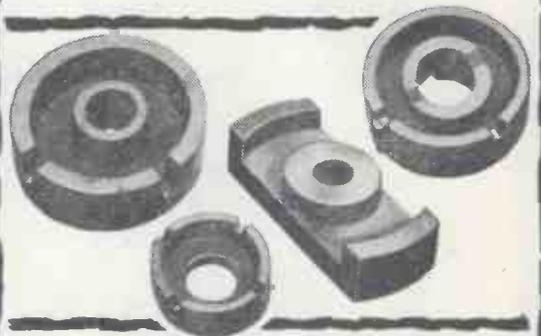


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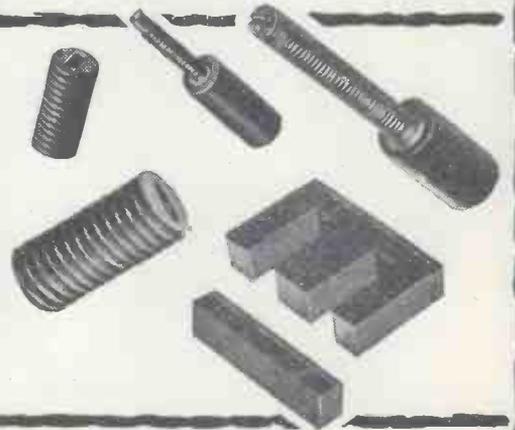
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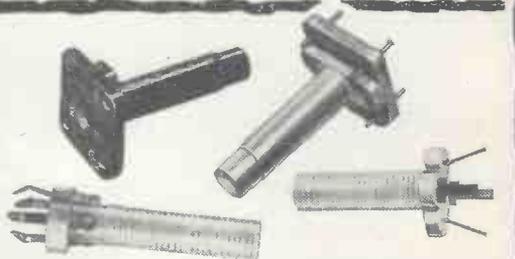
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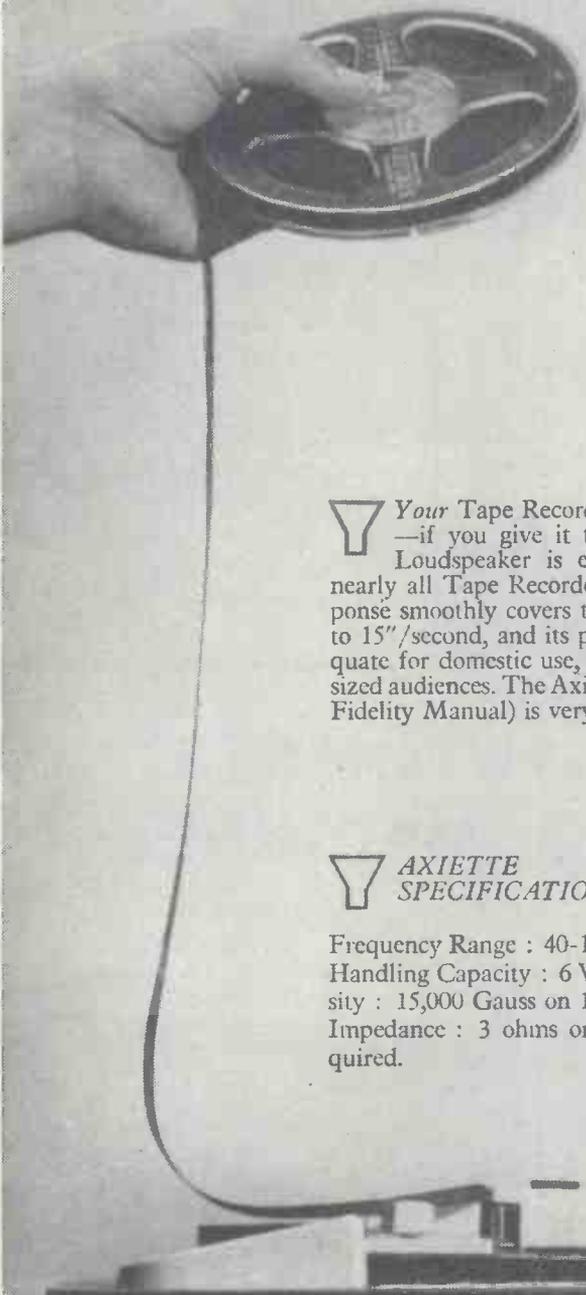
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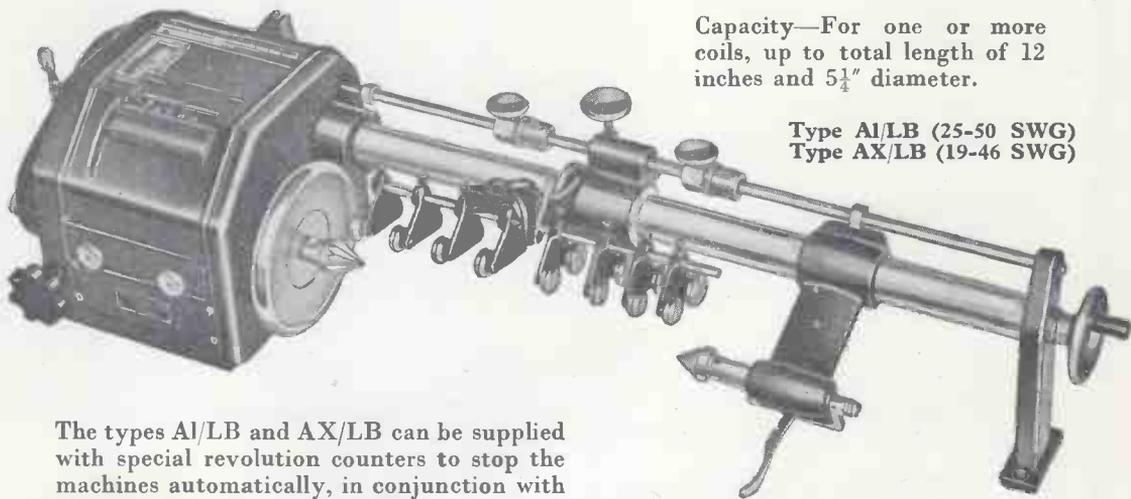
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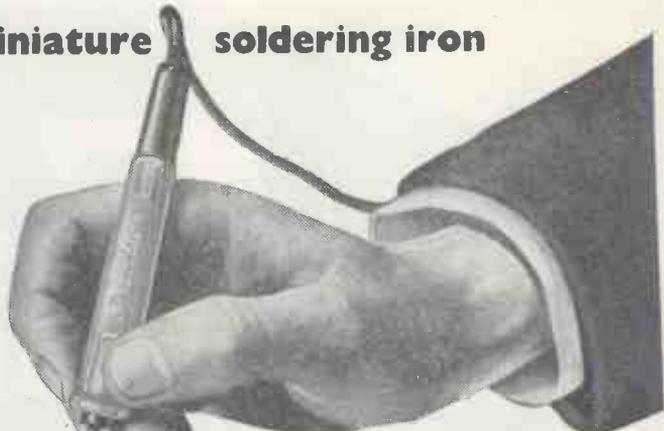
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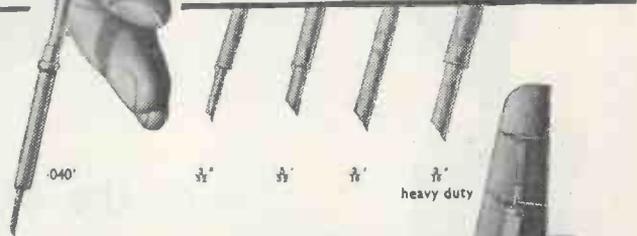
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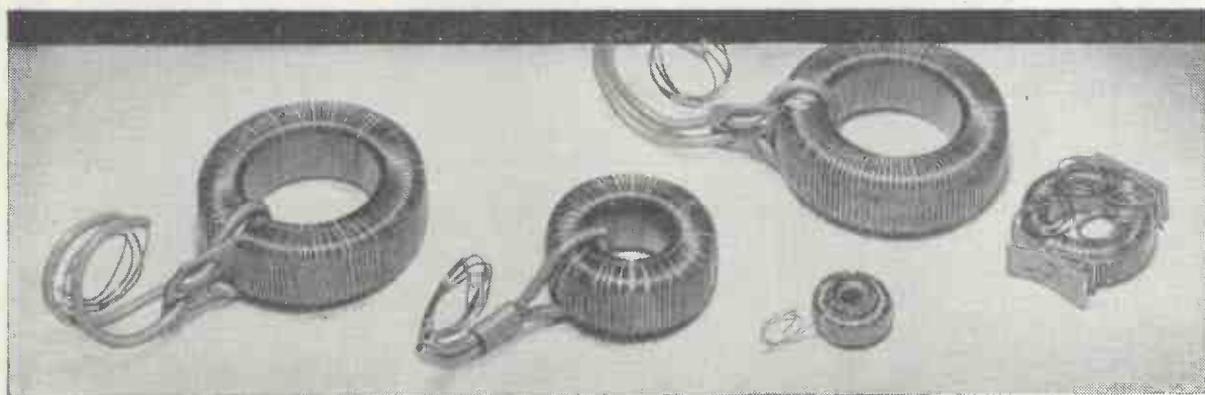
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	Outer Diam. cm	Inner Diam. cm	Length cm	Weight gm	
B1	1.3	0.7	0.52	3.5	from 250 μ H ($\frac{1}{4}$ amp) to 750 μ H (0.1 amp)
C2	2.3	1.2	0.8	14.5	" 100 ,, (1 $\frac{1}{2}$,,) to 1000 ,, ($\frac{1}{2}$ amp)
C3	2.95	1.4	1.3	50	" 100 ,, (2 $\frac{1}{2}$,,) to 1000 ,, ($\frac{1}{4}$ amp)
C4	4.1	2.4	1.3	85	" 100 ,, (4 ,,) to 2000 ,, (1 $\frac{1}{2}$ amp)
C5	4.8	2.7	1.4	130	" 100 ,, (5 ,,) to 2000 ,, (2 amp)

ELECTRICAL CHARACTERISTICS OF SELECTED TYPES

CODE	Inductance at Cont. rated current (μ H)	Current Rating		Volt Drop at Cont. Rated Current (V)	Self Resonating Frequency (Mc/s)	D.C. Resis. (Ω)
		Cont. (A)	Peak (A)			
C1A9 300	300 \pm 10%	0.5	0.7	0.25	5.0	0.5
C2B8 500	500 ,, ,,	1.0	1.2	0.30	3.2	0.3
C3B1000	1000 ,, ,,	1.5	2.2	0.45	1.2	0.3
C4C1000	1000 ,, ,,	2.0	3.5	0.44	0.9	0.22
C5D1000	1000 ,, ,,	3.0	4.4	0.54	0.8	0.18

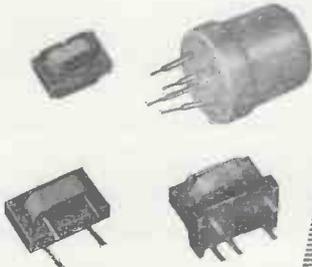
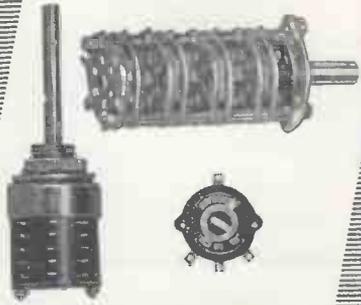
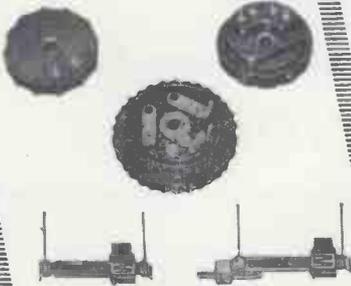
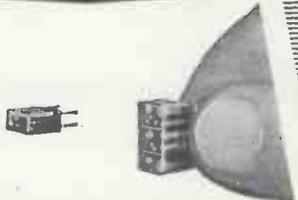
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	Z2A39F	3.9
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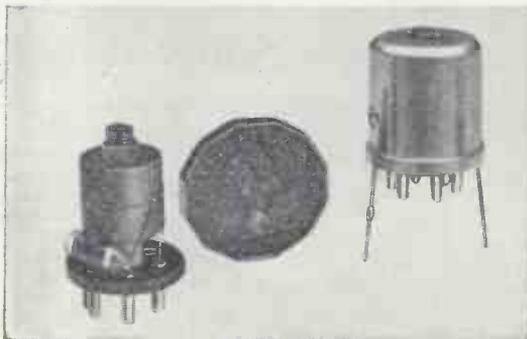
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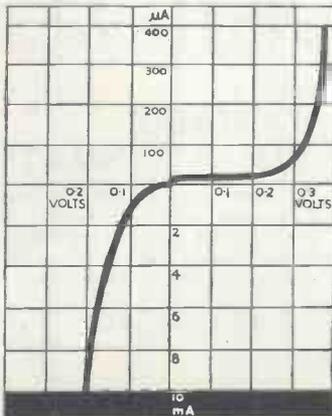
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	JK 9A	JK 10A	JK 11A	JK 19A	JK 20A	JK 21A	Unit
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Current Ratio typ	4	4	4	6	6	6	
Junction Capacitance typ	25	50	125	10	40	80	pF.
Resistive cut-off Frequency typ	540	810	810	1200	880	1100	Mc/s

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Current in low resistance direction. ($V_F=200mV$)	10 mA
Slope resistance. ($V_F=400mV$)	1.1 Ω
Shunt capacitance. ($V_R=200mV$)	90 pF

BACKWARD DIODE (Typical Characteristic)



Full details of these devices may be obtained on request from

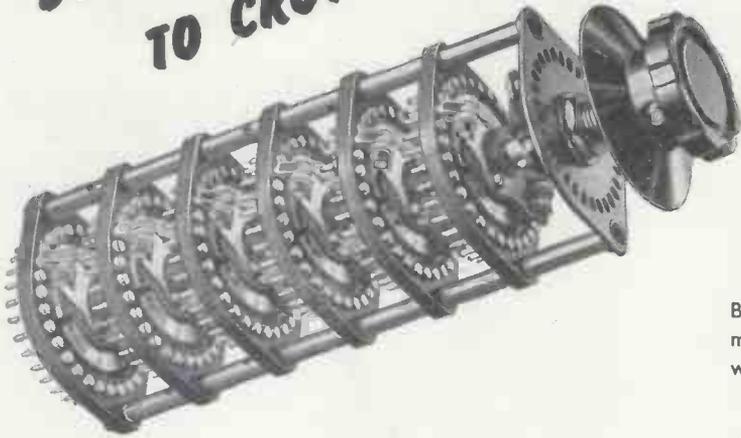
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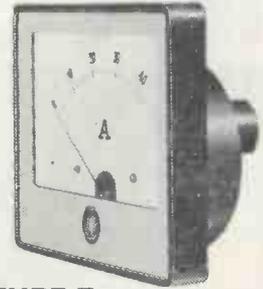
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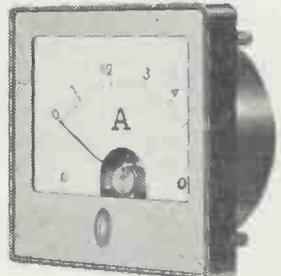
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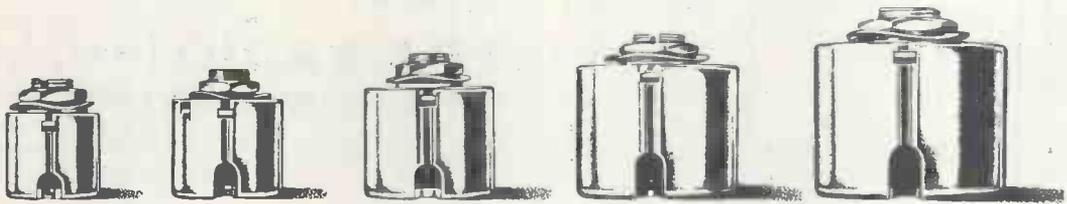
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Build your own Hi-Fi Tape Equipment using our tape pre-amp and the new Collaro deck. **INC. PRICE 41 gns.** Carr. extra. Complete with instructions. The M2A is complete with external power-pack and is also suitable for use with Wearite and Brenell decks. C.C.I.R. Characteristic. **PRICE 27 Gns.** Plus P. & P. 4/-. Leaflet on request.

PNEUMATIC LID STAY with pressure adjuster. Heavy duty, 10/- complete. P. & P. 1/6.

SPECIAL OFFERS!

1. "ROLA" 7 x 4in. elliptical speaker. 3-5 ohms. **ONLY 13/6.** P. & P. 1/6.
2. Mains Transformer. Drop through. Primary 0-200-10-20-30-50. Secondary 300-0-300 v. at 70 mA., 6.3 v. 2.4 A. **15/6.** P. & P. 2/3.
3. Choke 10H 250 mA. Potted "C" Core, 25/-.
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"EVEREST" PORTABLE RADIO. Super model, 7 transistors with 3 gang tuning and RF stage, efficient speaker and attractive case. Kit **£15/18/9.** P. & P. 3/6.
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OSCILLOSCOPE QG.10. Push-pull scan on X and Y plates with an X bandwidth of 10 c.p.s. to 1.5. Mc/s. \pm 1dB. Kit **£22/10/-.** P. & P. 3/6.
ATTENUATOR A.A.10. Calibrated in dB giving any reading between 1dB and 110dB. Uses 1% resistors. Kit **£7/15/-.** P. & P. 3/6.
CRYSTAL CALIBRATOR CC.10. Complete with crystal oscillator and audio output, so that signal generators in the range of 100 kc/s.-200 Mc/s. may be accurately checked. Kit **£19/19/-.** P. & P. 3/6.
VALVE VOLTMETER EM.10. A four-valve bridge circuit. May be used as a general purpose meter since there are 23 ranges including D.C. current ranges. Kit **£18/10/-.** P. & P. 3/6.
W.11 WOBBLATOR KIT. Produces a frequency modulated signal for alignment of F.M./A.M. including 465 kc/s. I.F. and T.V. Sound and Picture channels, **£14/19/-.** P. & P. 3/6.

Immediate dispatch of goods available from stock. Carriage charged extra at cost. Phone: PAD 4455/6

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5 x 5 x 8in. Sloping Front	14 11
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10 x 7 x 7in. Alum. Panel	£1 4 9
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14 x 7 x 7in. with Alum. Panel	£1 15 9
14 x 9 x 8in. with Alum. Panel	£2 5 8
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ALSO FULL RANGE OF CHASSIS
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 A.B. Metal and N.S.F. Made to order. Price list free on request.

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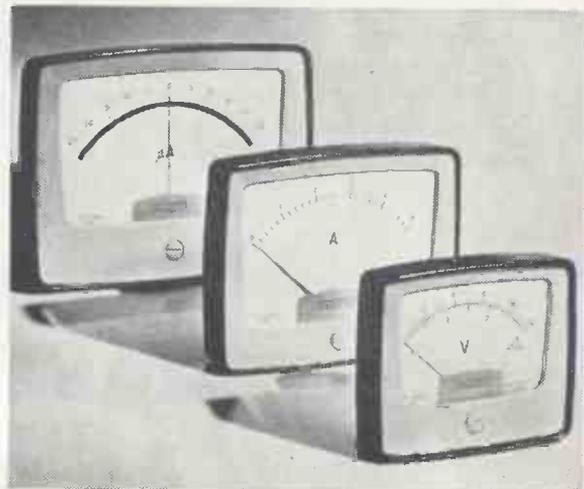
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For Quality Instrumentation
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Some of the Marconi test equipment installed in the Radio & Parts Factory of Matsushita Electric, manufacturers of FM broadcasting installations, sound systems, television receivers, radios and many other products in the electronics field.

**STANDARD
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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%. For full details write for Leaflet G 189.

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AM & FM SIGNAL GENERATORS • AUDIO & VIDEO OSCILLATORS • FREQUENCY METERS • VOLTMETERS • POWER METERS • DISTORTION METERS
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EVERYTHING FOR RADIO, RECORD & TAPE

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- HOME AND EXPORT ENQUIRIES WELCOME AT ALL TIMES
- 110 VOLT ITEMS AVAILABLE

★ RECORDERS

Vortexion W.V.A.	£93 13 0	\$267
Vortexion W.V.B.	£110 3 0	\$315
Brenell Mk. V	64 gns.	\$192
Brenell 3 Star Stereo	89 gns.	\$267
Clarion Transistor	25 gns.	\$75
Cosser 1601 4 Tr.	37 gns.	\$111
Cosser 1602 4 Tr. 3 spd.	59 gns.	\$127
Simon Minstrelle	39 gns.	\$117
Ferrogaph 4AN	81 gns.	\$243
Ferrogaph 4AH	86 gns.	\$258
Ferrogaph 808 Stereo	105 gns.	\$315
Grundig TK60 Stereo	128 gns.	\$384
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	59 gns.	\$117
Philips 4 Track Stereo	92 gns.	\$276
Philips 4 Track	34 gns.	\$102
Reflectograph 'A' 4 Tr.	95 gns.	\$285
Reflectograph 'B' 4 Tr.	105 gns.	\$315
Stuzzi Magnette	69 gns.	\$207
Stuzzi Tri-corder	75 gns.	\$225

★ DECKS

Wearite 4A	£36 10 0	\$105
Wearite 4B	£41 10 0	\$119
Brenell Mk. V	28 gns.	\$84
Brenell Stereo Deck	£33 16 0	\$101
Brenell Pre-Amp. and Amp.	£24 0 0	\$69

Microphones by Lustraphone, Reslo, Acos, Simon, etc.

PLEASE NOTE—Prices subject to alteration in accordance with any which may be made by manufacturers at time of receipt of order.

● TAPES BY ALL LEADING MAKERS

★ SPEAKER SYSTEMS

Quad Electrostatic	£52 0 0	\$149
Wharfedale SFB/3	£39 10 0	\$113
Wharfedale Coaxial 12	£25 0 0	\$156
Wharfedale Golden 10	£8 14 11	\$18
Tannoy 12in. Monitor	£30 15 0	
Tannoy 15in. Monitor	£37 10 0	
WB. 1016	£7 12 3	\$16
Goodmans AL.120	£29 10 0	\$84
Goodmans AL.100	£23 10 0	\$67
Goodmans Triaxiom	£25 0 0	\$72
Goodmans 300	£11 5 9	\$32
Goodmans 400	£16 17 0	\$46
Kelly Ribbon Mk. II	£10 10 0	\$30
B. J. Tweeter complete	£5 5 0	\$11

★ MOTORS AND PICK-UPS

Decca Stereo P.U.	£21 0 0	\$45
Lenco GL60 Trans. Unit	£28 19 2	\$62
Lenco GL58/R, Stereo P.U.	£29 3 10	\$62
Garrard 301	£29 7 3	\$54
Garrard 4HF/Stereo P.U.	£19 17 7	\$41
Garrard TA/Mk. II	£9 15 8	\$22
Connoisseur Motor Type 'B'	£27 16 1	\$33
Connoisseur, 2 sp. Motor	£16 3 1	\$36
Goldring 700	£9 14 9	\$21
Ronette DC284	£4 3 5	\$9

★ AMPLIFIERS & TUNERS

Quad 22-Control Unit	£25 0 0	\$73
Quad II Amplifier	£22 10 0	\$65
Leak Stereo 20 Amp.	£30 9 0	\$87
Leak Point One Pre-Amp.	£21 0 0	\$60

Rogers Junior-Stereo	£28 10 0	\$81
Rogers Master Stereo Unit	£35 0 0	\$100
Quad FM Tuner	£28 17 6	\$60
Chapman AM/FM	£29 8 0	\$60

Enquiries for all items by firms mentioned in this advertisement invited.

BINSON "ECHOREC"

Distributed exclusively by Modern Electrics Ltd. (see W.W. Feb. page 92). For super-imposing controlled echo on to any audio signal. Compact, fully portable instrument, with three working channels, echo interval is variable, swell and other effects are obtainable.

ABRIDGED DESCRIPTION

- Three inputs and outputs.
- Push-button channel selection for 1, 2 or 3 channels.
- Controls for echo intervals, volume of echo, swell effect, volume level on input channels, etc.
- Complete with fitted carrying case, leads, plugs. A.C. mains.

Professional Discounts
140 gns. \$420 Leadset on request. Trade enquiries invited.

BINSON "BABY ECHOREC"

Similar to above but for single channel working 80 gns. \$240

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 Schreiben Sie uns bitte auf Deutsch.
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 (3 shops from Tottenham Court Road Station Underground)
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EDDYSTONE COMMUNICATION RECEIVERS



Model 840A illustrated

HIRE PURCHASE TERMS

Model No.	Cash Price	Deposit	12 Monthly Payments	24 Monthly Payments
870	£33	£6/12/-	£2/6/8	£1/5/4
840	£55	£11	£3/18/10	£2/2/2
888A	£110	£22	£7/17/8	£4/4/4
680X	£140	£28	£10/0/8	£5/7/4

The fabulous Model 880. Probably the world's most powerful production model receiver, 21 valves, complete coverage, 500 Kcs. to 30.5 Mcs. 30 ranges. Price on application. These sets are the choice of the discerning professional and amateur users. Descriptive literature gladly forwarded.



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 Telephone: AINTREE 1445 ESTAB. 1935

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(Established 1935)

We offer only first-class material at the most attractive prices and with prompt delivery. Satisfaction assured. Prices net.

SMALL GEARED MOTORS. In addition to our well-known range we can now offer smaller open type S.P. units, 200/250 v. A.C. final speed either 6 or 12 r.p.m. (torque approx. 6 lbs/inch.). Size: 5in. long by 2 1/2in. by 1 1/2in. with 1in. shaft prof. Suitable for display work and many industrial purposes. Either speed, only 69/6 (despatch 2/-).

MINIATURE COOLING FANS (200/250 v. A.C.) with open type induction motor, 3in. by 2 1/2in. by 1 1/2in. and 4in. 4-bladed metal impeller. Ideal for projector lamp cooling and convactor heaters, etc., 28/6 (despatch 2/-).

AIR THERMOSTATS (Pullin). Adjustable range 30/90 deg. F. Switching capacity 15 amps. A.C. Close differential only 2 deg. F. In smart Ivorine housing 4 1/2 x 2 x 2 1/2 ins. Easily installed, instructions with each. Perfect for greenhouses, rooms, labs., etc., 45/6 (despatch 1/6).

SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS. 200/250 v. 50 c/s. Fitted with spindles for hours, minutes and seconds hands. Self-starting, central hole fixing. Dia. 2 1/2in., depth behind dial only 1 1/2in. Very latest model 'With dust cover, 29/6 (despatch 1/6). Sets of three hands to fit, in good style for 5/7in. dial, 2/6 set, or 3/10in. dial, 3/6 set.

SYNCHRONOUS TIMER MOTORS (Sangamo). 200/250 v. 50 c/s. Self-starting, 2in. dia. by 1 1/2in. deep, 1 r.p.m., 1 r.p.h., and 12 r.p.h., any one 37/6 (des. 1/-). Also high torque model (G.E.C.) 6 r.p.m., 57/6 (des. 1/-). These are suitable for display turntables.

SUPPLY METERS (Kilowatt-hour). 200/250 v. 50c/s. Usual 5-index dial reading from 1/100th Unit. Loading 5 amps. L.E. (quite suitable for 10 amps). These are brand new, at zero, simple to instal, 39/6 (despatch 3/6).

SYNCHRONOUS TIME SWITCHES. (Sangamo) for accurate pre-set switching operations on 200/250 v. 50 c/s. Providing up to 3 on-off operations per 24 hours at any chosen times, with 'Any-omitting device (use optional). Capacity 20 amps. Compactly housed 4in. dia., 2 1/2in. deep. With full instructions. 25/8/6 (despatch 2/6). Also Smith's Rejyon Twin-circuit model, 20-amp. switching, 27/8/- (des. 2/6).

EXTRACTOR FANS. A very popular line. Well-made units at much lower than normal prices. 200/250 v. A.C. induction motor, silent running, no interference. With mounting frame and back grille, ready for easy installation. With 8in. impeller (10in. overall dia.), 200 C.F.M., 25/5/-, 10in. impeller (12in. overall), 240 C.F.M., 25/12/6. Also minor model, 6in. overall dia., 75 C.F.M., 24/12/6 (despatch any one 3/-).

COMPLETE SEWING MACHINE MOTOR OUTFITS. No better job obtainable any price. 200/250 v. A.C./D.C. Fitted latest radio/T.V. suppressors. Comprising motor with fixing bracket, foot control and switch, needle light, with switch, belt, etc., and instructions for easy fixing to ANY machine. The complete outfit still! 26/15/- (despatch 3/-).

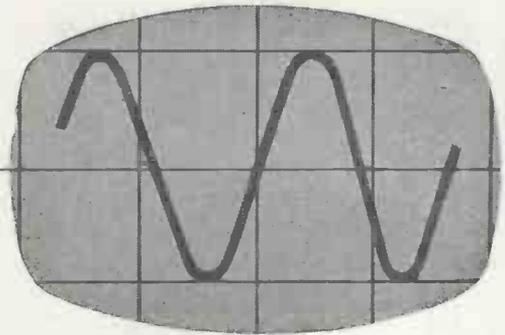
SYNCHRONOUS TIMERS (by well-known British maker—brand new). Good news for those who applied too late for first supply—a limited new delivery now available. 200/250 v. 50c/s. Providing any "on" period between 5 mins. and 8 hours, switching "off" at the end of the set period. Made for electric cookers and suitable for many other purposes—tape recorders, immersion heaters, etc. Capacity 25 amps, fitted neon indicator. Housing 6in. sq. by 3 1/2in., 24/12/6 (despatch 3/6).

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 (Telephone: MUSEum 2958)

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SINUSOIDAL

VOLTAGE



by *Advance*

THE CVH RANGE

Advance constant voltage transformers are available in the CVH range with low harmonic distortion in the output waveform, ideal for use with precision equipment sensitive to power frequency harmonics, and also with all equipment requiring a constant voltage sinusoidal input.

In most applications the harmonic distortion present in the output waveform will not exceed 3%. Under the most unfavourable conditions this figure will not rise substantially above 5%. When used with a rectifier to provide a d.c. supply, the characteristics of the system are identical to the normal mains source and particularly close regulation of the output is obtained.

VOLSTAT

- CONTINUOUS AND AUTOMATIC STABILIZATION
- RAPID RESPONSE TIME
- CURRENT LIMITING CHARACTERISTIC
- COMPACT DESIGN
- NO MOVING PARTS
- NO ROUTINE MAINTENANCE

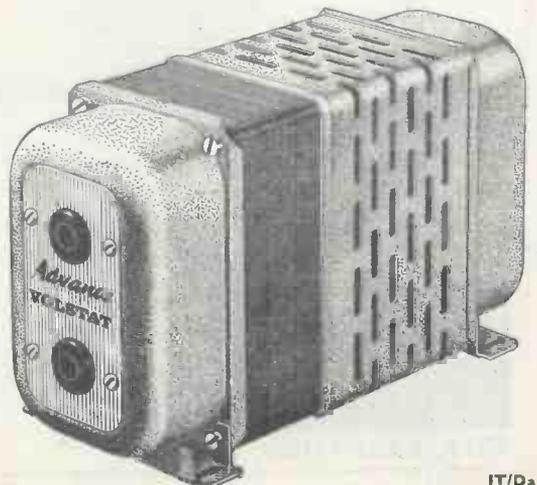
Type	I/P V Range	O/PV r.m.s.	Watts	p.f.	Net Price in U.K.
CVH60A	190-260 50 ~	240	60	1.00	£10 10
CVH125A	190-260 50 ~	240	125	1.00	£17 0
CVH420A	190-260 50 ~	240	420	1.00	£37 0
CVH750A	190-260 50 ~	240	750	1.00	£68 0
CVH1500A	190-260 50 ~	240	1,500	1.00	£99 0
CVH3000A	190-260 50 ~	240	3,000	1.00	£185 0
CVH6000A	190-260 50 ~	240	6,000	1.00	£355 0

Full details in Folder M1 available on request

Advance COMPONENTS LIMITED

MAINS STABILIZATION DIVISION

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A to Z in AUDIO



THE NEW BOOK

by

G.A. Briggs

WITH R. E. COOKE, B.Sc. (Eng.) as Technical Editor.
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 224 Pages, 160 Illustrations (of which 110 are original).
 Fine art paper. Cloth bound. Price 15/6 (16/6 post free).

FIRST REACTIONS TO THIS PUBLICATION

B. J. WEBB, Leicester. (Hon. Technical Officer, N.F.G.S.)

"I think this book is excellent and fills a real need. I am fairly used to these things but I could not put it down, for nearly every page brought its smile as well as information"

J. H. R., Billericay, Essex.

"Reading A to Z in Audio I got as far as letter E going home in the train last night, and it was so entertaining and enlightening that Mrs R. had to drag me away at 10-45 p.m., when I had progressed as far as letter O."

F.L.D., London.

"Having obtained a copy of A to Z in Audio, I am looking forward to reading it systematically from page 1: - the first time I ever did this with a dictionary."

D. W. Aldous—"Gramophone Record Review."

"G.A.B. has done it again. He has written and produced, with the technical collaboration of Raymond Cooke, yet another popular text on aspects of audio which without doubt will find a ready and eager public. Although the author disclaims that the new book is intended to be a hi-fi dictionary, I look upon it as a kind of dictionary—if you are willing to regard a dictionary as gran' mixed readin'."

Other Books by G. A. Briggs still available:

- LOUDSPEAKERS, 5th Edition 19/6 (20/9 post paid).
- SOUND REPRODUCTION 17/6 (18/6 post paid).
- PIANOS, PIANISTS & SONICS 10/6 (11/6 post paid).
- STEREO HANDBOOK 10/6 (11/6 post paid).

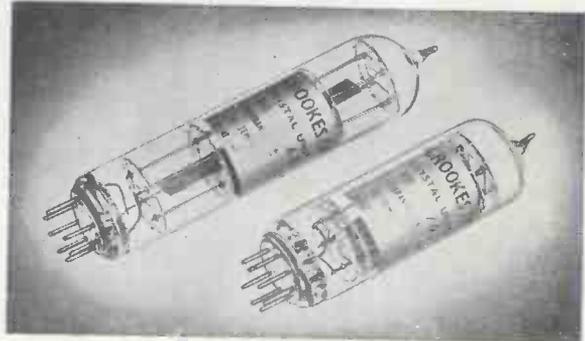
From many radio dealers and booksellers: but in case of difficulty direct from:

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 WIRELESS WORKS LTD

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mean DEPENDABLE frequency control

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ALL Brookes Crystals are made to exacting standards and close tolerances. They are available with a variety of bases and in a wide range of frequencies. There is a Brookes Crystal to suit your purpose—let us have your enquiry now.

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Superspeed Cored Solder, incorporating Enthoven's unique 6-channel stellate core, is unchallenged as the most efficient cored solder wire for general assembly work on radio, television, electronic and telecommunication equipment. It speeds production, reduces costs and makes a vital contribution to the dependability of your products.

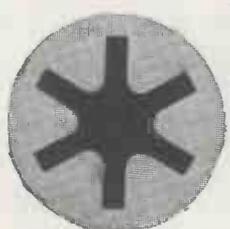
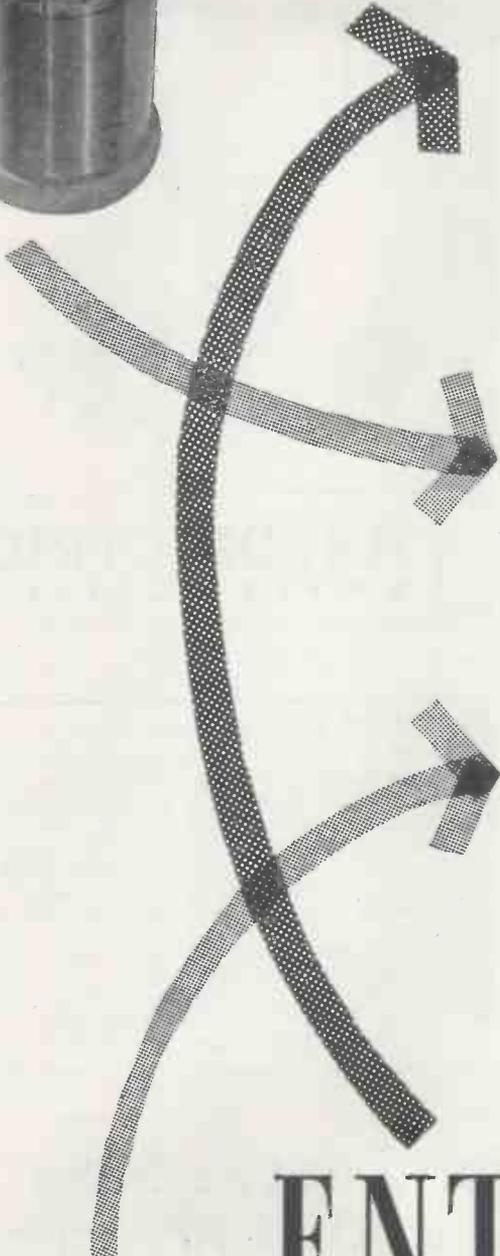
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for normal electrical assembly work

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specially developed to solder tarnished, plated, and/or oxidised surfaces easily

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Arcoelectric

SWITCHES & SIGNAL LAMPS

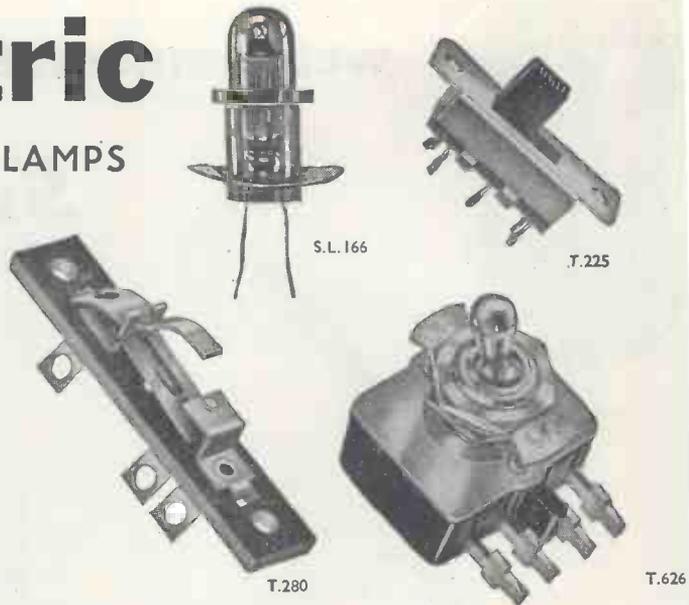
T.225: Miniature Slide Switch

D.P. change-over switch

S.L.166: Very small low cost
mains neon indicator

T.280: Sensitive Snap Action Switch
Popular switch for tape recorders

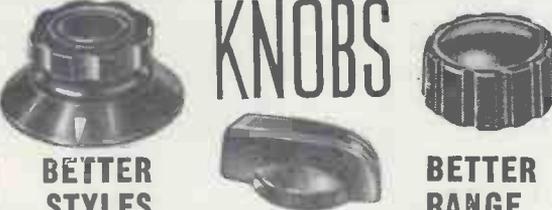
T.626: Double pole 3-AMP switch
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Write for Catalogue No. 132

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AUTOMATIC VOLTAGE REGULATORS**

Any stabilized output voltage in the range 200-250 v. can be selected by plug-board tapplings. The selected output voltage is automatically maintained constant within $\pm\frac{1}{2}\%$, at all loads 0 to 30/37½ amps., when the supply voltage is varying over the range +8% to -12%.

- Frequency compensated 45-55 and 54-66 c/s.
- Excellent output wave-form.
- Can also be used as a variable transformer.
- Unused. Complete with spares and instruction book.

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Spring-Loaded Clips

PRESS TRIGGER
TO OPEN

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For Safety's Sake use AVO Prodclips

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Safety first every time with these patented spring-loaded AVO Prodclips.

Cleverly designed for use as insulated prods, they are invaluable for reaching and holding test points which are difficult of access.

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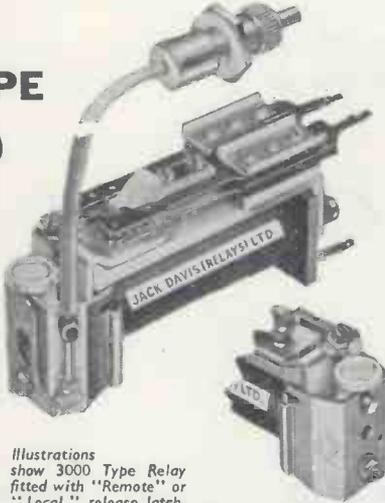
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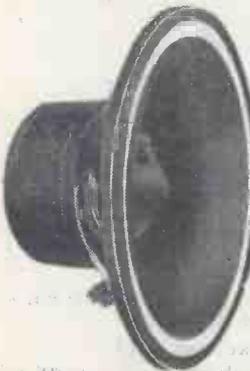
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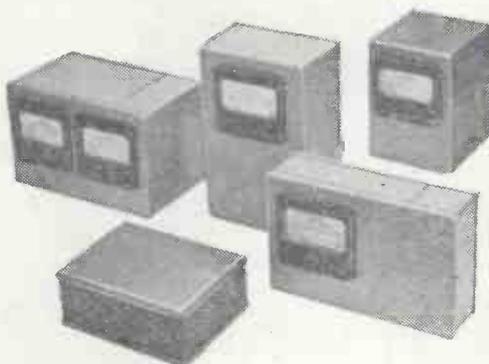
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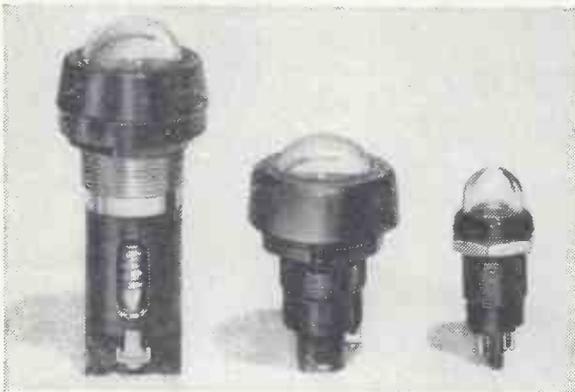


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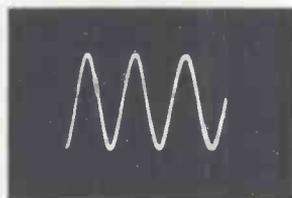
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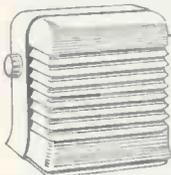
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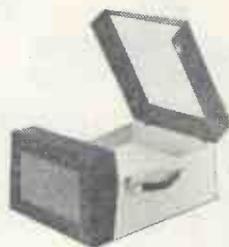
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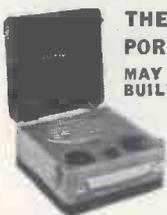
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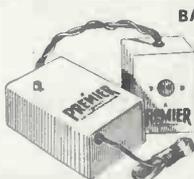


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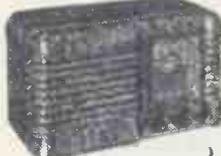
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THE MODEL VT41 VALVE FILAMENT TESTER

Will instantly check the filaments of all Radio and T.V. Valves, Fuses and Dial Bulbs. Will also give an accurate circuit continuity test and also has built-in 7 and 9 valve straighteners. Size 5½ x 3½ x 1½ in. **PRICE 30/-** with Battery, post paid.

THE VERDIK QUALITY TEN AMPLIFIER & PRE-AMPLIFIER

A truly High-Fidelity Ultra-linear Amplifier with a push-pull output of 10 watts and incorporating negative feedback. Provision for Tuner, also bass and treble control and 6-position selector switch for Microphone, Radio Tape and L.P. and Standard Recordings. Finished in an attractive grey/green stove enamel. **FOR A LIMITED PERIOD ONLY. £14/19/6** Original cost 23 gns. P. & P. 7/6.



THE 'MID-FI'

A NEW DESIGN 4 WATT AMPLIFIER KIT **MAY BE BUILT FOR 95/-** Plus 3/- P. & P.

A new circuit for the home constructor requiring a good quality medium-powered Amplifier for reproduction of Records or F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up EF86, EL34, EZ80. Voltage adjustment for A.C. mains from 200/250 volt, 3 or 15 ohms impedance. Negative feedback. Size 7 x 5 x 2½ in., overall height 6 in. Silver-hammered finished Chassis.



GABY MODEL B20 MULTI-METER

DC/V 0-0.5 v. 0-2.5 v. (2K Ω/V).
DC/V 10-50-250-500-1000 v. (4K Ω/V).
AC/V 10-50-250-1000 v. (4K Ω/V).
DC/ma 0-100 microamps (500mV).
DC/ma 0-2.5-25-250 mA (250mV).
OHMS, 2K-20 meg.
COMPLETE WITH TEST LEADS—PRICE £6/10/0 plus 2/- P. & P.

GABY MULTI-METER A-10

DC/V 10-50-250-500 1k Ω (2k Ω/V).
AC/V 10-50-250-500-1k Ω (2k Ω/V).
Ranges: DC/ma 0.5-25-250 (250mV).
OHM 0-10 k Ω 1M Ω.
COMPLETE WITH TEST LEADS—PRICE £4/17/6 P. & P. 2/6.

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The 'Magnaphon'

A truly top quality and versatile Tape Recorder at a price well below the original cost. Incorporating the latest Collaro 3-speed Studio Tape Deck.

- ★Volume and Tone Control for recordings.
- ★Volume and separate Bass and Treble Controls for replay.
- ★Facilities for monitoring.
- ★Output 4 watts.
- ★Separate Output Sockets for Amplifier and Extension Speaker.
- ★Mixing Facilities.
- ★Housed in attractive red and beige two-tone Cabinet with detachable lid.

★Fully guaranteed and supplied complete with the following accessories—
Price £32.0.0 Good quality Crystal Microphone with Lead and Jack Plug fitted, 5 1/2" Reel of Standard Tape and Spare Reel, spare Lead fitted with Jack Plug and Wander Plugs for recording from Radio.

TAPE DECKS

- LATEST BSR MONARDECK. Single speed 3 1/2 l.p.s. Will take 5 1/2 in. spools. £8/19/6. P. & P. 5/-.
- COLLARO STUDIO TAPE TRANSCRIPTOR. 3 speeds 1 1/2, 3 1/2, 7 1/2 l.p.s. 3 motors. Push-button controls. Will take 7 in. spools. £12/19/6. P. & P. 7/6.
- COLLARO MK. 4 TAPE TRANSCRIPTOR. Twin track operation, 3 speeds: 3 1/2, 7 1/2, 15 l.p.s. Will take 7 in. spools. £17/19/6. P. & P. 7/6.
- TAPE RECORDER & AMPLIFIER specially designed to match the Collaro Studio Tape Deck. £10/19/6. P. & P. 4/-. Size 11 1/2 x 5 x 3 in., uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. i.s. jack, superimposing switch, with matching knobs.

RECORDING TAPE

- By well-known manufacturers, brand new, boxed and fully guaranteed.
- 1,800 ft. on 7 in. spool 22/6
 - 1,200 ft. on 5 1/2 in. spool 22/6
- P. & P. 1/- per spool.

AMERICAN G.B.S. RECORDING TAPE

- Brand new, fully guaranteed and with Leader Tape—
- 600ft. on 5 in. Spool. 17/6
 - 1,200ft. on 5 1/2 in. Spool 25/-
 - 1,800ft. on 5 1/2 in. Spool D.P. 47/-
 - 1,200ft. on 7 in. Spool 25/-
 - 1,800ft. on 7 in. Spool L.P. 35/-
- Plus 1/- per Spool P. & P.

First Again!! "THE PREMIER TR/2"

Once again, Premier is first, with another magnificent offer. Introducing the "TR/2" the latest and cheapest addition to our range of popular Recorders.

- Star features:
- ★Latest BSR Tape Deck, with interlocking device to prevent accidental erasure.
 - ★Single speed 3 1/2 in. per sec.
 - ★Playing time 5 1/2 in. std. tape—1 1/2 hours. L.P. tape—2 hrs. 8 mins.
 - ★Volume on/off and tone control.
 - ★Power output 3 watts.
 - ★Input sockets for Microphone, Radio/Gram.
 - ★Extension speaker socket.
- Size: 13 1/2 x 9 1/2 x 6 in., weight 17 lb.



PRICE including Microphone, Tape and Spare Spool **19 Gns.** Plus 15/- P. & P.

SINGLE PLAYERS

- Collaro Junior 4-speed Player complete with Pick-up £3 15 0
 - Garrard 4SP 4-speed Player, complete with Pick-up and automatic stop .. £6 19 6
 - Garrard TA Mk. 2, 4-speed Player, wired for stereo, with plug-in Head. £8 10 0
 - Philips AQ2009, 4-speed Player, with diecast turntable and Microlift, wired for stereo £10 10 0
- P. & P. 3/6 on above units.

RECORD CHANGERS

- BSR UA8, 4-speed £6 19 6
 - BSR UA8, 4-speed with stereo cartridge £7 19 6
 - BSR UA12, 4-speed, wired for stereo and complete with Stereo cartridge. . £8 19 6
 - Collaro Conquest, 4-speed Changer £7 19 6
 - Collaro RC457, latest type 4-speed changer £8 10 0
 - Garrard RC111 3-speed Changer £7 19 6
 - Garrard RC130 Mk. 2, 4-speed £8 19 6
 - Garrard RC121/AD, 4-speed £9 19 6
 - Garrard RC121 Mk. 2, 4-speed, wired for stereo and with plug-in Head. £10 19 6
- P. & P. 5/- on above units.

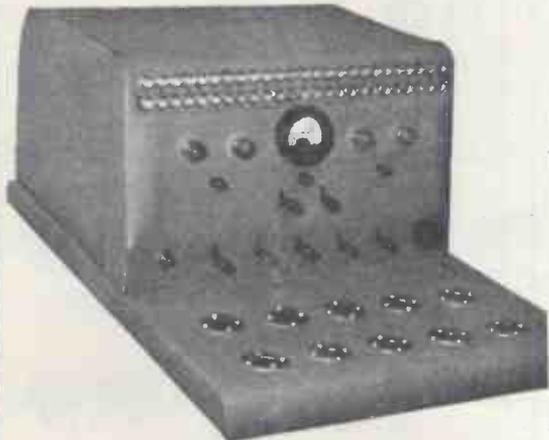
TRANSCRIPTION UNITS

- Garrard 301 £22 7 3
 - Garrard 301 (Strobe turntable) £28 18 4
 - Garrard 4HF (Stereo) £19 4 8
 - Garrard 4HF (GC8) £18 9 9
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Example of testing speed 25 pt cable tested:—

625 insulation tests, 25 leakage to screen, 25 continuity tests—all in 25 seconds.

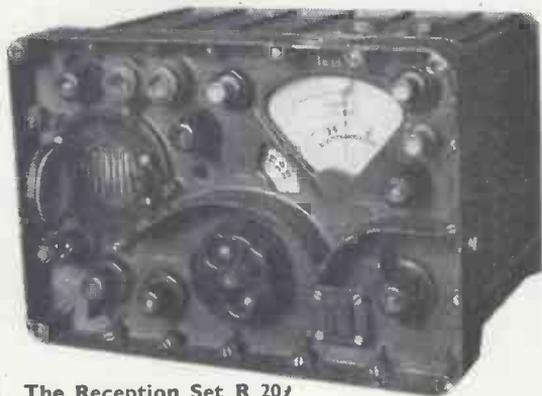
Insulation faults are shown and faulty circuits indicated by lamps. Cross connected circuit leakages to screen are discovered, also involved circuits indicated.

Continuity tests are carried out with low voltage, insulation tests 500 v. A.C.I.T. stops automatically after discovering any fault or when the test is finished.

Brass type Plessey Mk. IV sockets and plugs are used, also an aluminium version Mk. IV is available if required. A.C.I.T. is built for 25, 50 or to order for more circuits. Fully descriptive leaflet on request.

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The Reception Set R 20/

A 10 valve High-Grade Super Heterodyne Receiver with facilities for Receiving R/T (A.M. or F.M.) and C.W.

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 loudspeaker or phone output.

Overall measurements:—Length 12in., width 8in., depth 9in. Weight 23 lbs.

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This grommet provides a thoroughly efficient seal. Around the panel hole the first seal is effected, while a good, tight second seal around the top periphery is set up by tension. In the grommets designed for cable entry the internal seal is applied within the conical section. All grommets can be fitted to various panel thicknesses—thus reducing the range.



Large grommet in use, sealing a thin control rod



Small grommet sealing thick cable at angle

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MODEL DPA 10 MONO PRE-AMPLIFIER

The perfect component for the DPA-10 Amplifier. It possesses all features normally associated with equipment of this very high calibre and incorporates every facility for the reproduction of high quality sound from radio, record, tape and microphone. Power Supply: Through multi-lead cable terminating in octal plug. L.T. 6.3 v. A.C. 0.8 amp. H.T. 250 v. D.C. 2.5 mA. Dimensions: 11½ in. x 3 in. x 5½ in. Weight: 2 lb. 7 oz. Price: 8 gns.

MODEL DPA 10 MONO AMPLIFIER

A superb high-fidelity laboratory-designed amplifier for domestic use or in assembly halls holding up to 500 people. The DPA-10 incorporates every facility needed for enjoyment of high quality sound from radio, record, tape or microphone with a range of features and versatility rarely combined in any equipment. A pre-amp and control unit is required. Mains Supply: 200-250 v. A.C. Output: 10-15 watts. Impedance: 3 ohms, 7½ ohms, 15 ohms. Dimensions: 12½ in. x 6 in. x 5½ in. Weight: 12 lb. 8 oz. Price: 14 gns.



Model DPA 10 Mono Amplifier

ALSO AVAILABLE

Model FMT/2 High Fidelity FM(VHF) Tuner.

Model Stereo 2 Twin Channel Pre-amp.

Model Stereo 8 Twin Channel Pre-amp.

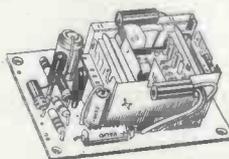
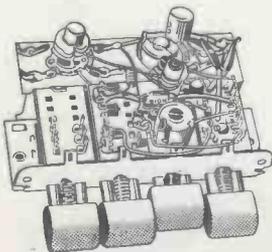
Model H4T/2 High Fidelity AM/FM Tuner.

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using the very latest transistors

3 WAVEBAND CONVERTER TA-12401
With OC170 transistor in emitter injected autodyne converter circuit. S.W. 5.9-13 Mc/s; M.W., 510-1,620 kc/s; L.W., 150-275 kc/s. Wavechange and on-off by four push-buttons. Overall size 3.4 x 2.1 x 1.8 in. 67/6 plus 22/9 purchase tax. Set of aerial coils 9/-; 8 x ¾ in. ferrite rod 5/-.

THE SMALLEST YET
Sub-miniature M/Coil Loudspeaker, LP45F. Overall dia. 1¼ x ¾ in. deep. 9,500 gauss ferrite magnet, precision engineered gap. Max. loading 0.3 watts; min., 1 mW. 25/- (inc. purchase tax).

460 kc/s I.F. AMPLIFIER 322-0001
2 x OC169 transistors are used as very high gain common emitter amplifiers. High cut-off frequency makes neutralisation unnecessary; high gain provides for greatly increased degree of A.G.C. High "Q" double-tuned I.F. transformers give 5 kc/s square wave response. A signal separated from 460 kc/s by 9 kc/s will be 57 dB down. Size 3.5 x 1.5 x 1 in. 92/6.

Using the very latest transistors to provide new standards of sensitivity and low noise level, these units open up exciting new vistas in sub-miniature equipment design. All components are to precision standards and are mounted on printed circuits. All Units are pre-aligned, factory checked and guaranteed. Obtainable from all stockists of good equipment.

Inquiries invited from trade and manufacturing houses for quantity deliveries.

1 WATT A.F. AMPLIFIER GS-12005
2 x OC71's direct coupled cascade drive to 2 precision matched OC74's in Class B push-pull provide up to 1 W. undistorted output from 5 mV. in at 1.5 K-ohm. Frequency response, 60-16,000 c/s ± 3 dB. Overall size 3 x 2.2 x 1.2 in. 92/6.

Power requirements for this and other 2 units—6 volt battery.

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● ALSO AVAILABLE
Transistorised FM Front Ends: 10.7 Mc/s I.F. transformers, OC169 transistors; Constructors' Manual No. 167. 2/6. Leaflets on request.

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite), 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 new Collaro "STUDIO" TWIN TRACK 3-speed Deck **£39.10.0**
H.P. Terms: Deposit £7/18/- and 12 months of £2/17/11.
- MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIPTOR" Deck, which has both upper and lower tape tracks **£47.10.0**
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- MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck **£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 FERROXUBE POT CORE PUSH-PULL OSCILLATOR and 3-speed treble equalisation by FERROXUBE POT CORE INDUCTOR. FOR WEARITE—COLLARO—TRUVOX—BRENNELL or MOTEK TAPE DECKS. 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 TAPE AMPLIFIER

(Mullard Type "A" Design) A very high quality Amplifier incorporating 3-speed treble equalisation, using the latest FERROXUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENNELL WEARITE or MOTEK Tape Decks, has GILSEN Output Transformer. Includes separate Power Supply Unit.



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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**
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- (f) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**
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EACH OF ABOVE CAN BE SUPPLIED IN PORTABLE CASE FOR £5/10/- extra, THUS FORMING A COMPLETE PORTABLE PRE-AMPLIFIER SEND FOR DETAILS.

A LARGE PURCHASE OF BRAND NEW and FULLY GUARANTEED TRUVOX and GARRARD TAPE EQUIPMENT ENABLES THESE OUTSTANDING PRICE REDUCTIONS



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FOR **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 3 1/2 in/sec. providing up to 1 hour 10 mins. 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/- extra. 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 TR3/Mk. IV" PORTABLE TAPE RECORDER (Original Price £49.10.0)

FOR **£36.10.0** PRICE INCLUDES A 7in. SPOOL OF EMI TAPE. (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 3 1/2 and 7 1/2 in./sec. Incorporates SAFETY BUTTON (prevents accidental erasure). 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 £1/2/8. COMBINED ORDER FOR BOTH DECK AND AMPLIFIER, £30. H.P. Deposit £6. 12 months £2/4/-.



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STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

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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 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 £1/8/- extra.

MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EP86 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 tapes.
- 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.

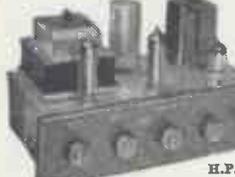
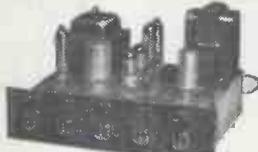
Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE Ultra Linear Output Transformers.

Price: COMPLETE KIT, Parmeko Transformer..... **£11.10.0**

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Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/8/- 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 6/8 carriage and insurance). Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 5/6 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.

STEREO "3-3" MAIN AMPLIFIER

Comprises two MULLARD 3-3 Main Amplifiers on one chassis. Operates with MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner.

Price: COMPLETE KIT OF PARTS..... **£10.0.0** or ASSEMBLED..... **£11.15.0**

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.

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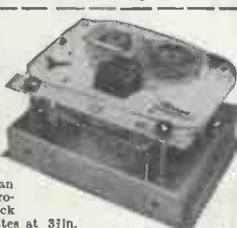
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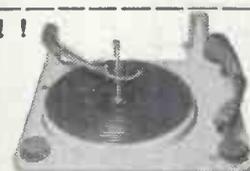
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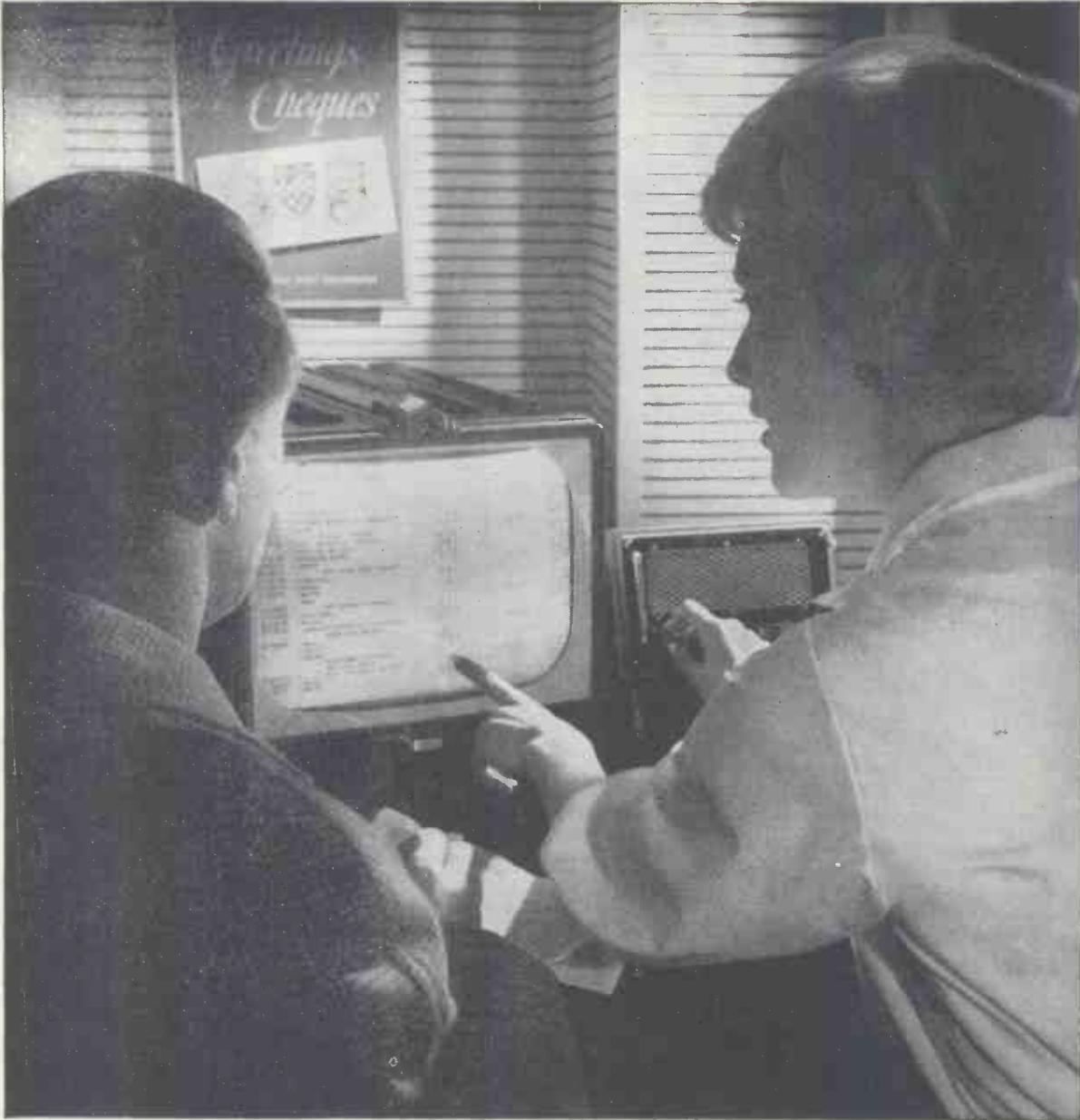
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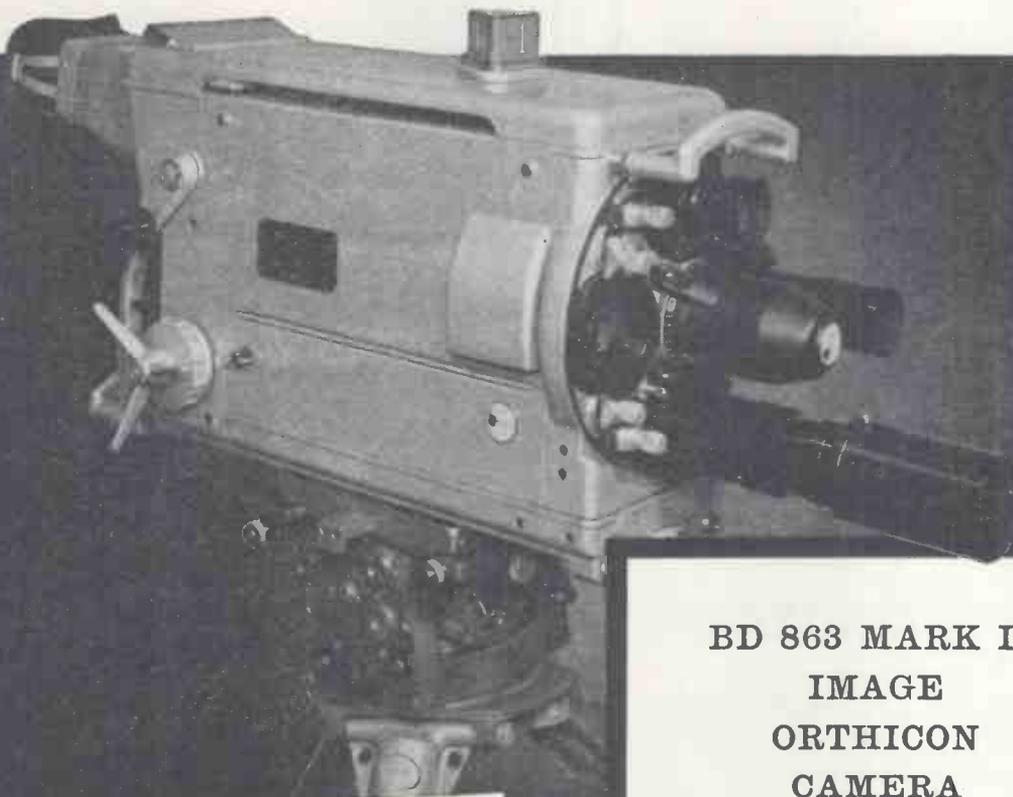
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"BELLING-LEE" NOTES*No. 25 of a Series***Voltage Rating**

The voltage rating of an electrical component is one of several parameters defining its conditions of use. It is usually determined by the electrical strength of the materials and parts of which the item is constructed, the limiting factor being the value of the lowest rated ingredient. However, other considerations sometimes govern the rating, such as the safety of the users, or the nature of the application for which the component is intended.

Thus we find in the case of a certain class of fuseholder that two alternative lids are available to permit their use on 250 volt or 440 volt supplies, although from the point of view of electrical breakdown there is nothing to choose between them. The only difference lies in their physical size, the one for use at the higher voltage being much larger than the other in order to provide adequate protection to the fingers of the user so that they cannot possibly come into too close proximity to live metal parts. However, as unnecessary size can be inconvenient, the smaller lid is provided for use in circumstances where the danger is less. On the other hand, it is common practice to rate terminals entirely on considerations of electrical breakdown, leaving it to the equipment designer to take whatever precautions he thinks necessary in the interests of safety. The same sort of thing applies to plugs and sockets, and it must not be assumed from the voltage rating alone that a particular connector is suitable for mains use unless B.S.S.415 is referred to; this defines the general requirements of safety for mains connectors in terms of shielding, creepage distances, etc.

Some components, which are themselves only part of a unit, may be rated in terms of the lowest rated member of the overall device; thus a fuseholder may be rated in relation to the fuse-links which are immediately available for use in it, rather than by electrical considerations of the fuseholder alone. It may be argued that this is logical, but who knows whether fuse-links of higher voltage rating may one day become available? It has happened already in the case of the size "O" (1½ in. × ½ in.) with the introduction of the heavy duty type for 440 volt circuits, whereas the standard light duty variety is restricted to 250 volts.* The real rating of the fuseholder may be determined largely by its sheer physical dimensions, and it may be suitable for the higher voltage without in any way being over-designed.

Other components may be rated according to their applications, and

this applies in the case of the familiar 3-pole, flat pin connectors rated at 80 volts; from purely electrical considerations obviously they will withstand considerably higher pressures. However, they were designed essentially for use in audio signal circuits where voltages are not likely to exceed this figure, and it is a feature of the design that they cannot be interchanged with standard mains connectors, making it impossible to insert the plugs into mains outlets by mistake with the obvious danger which would ensue to the user and the appliance.

Ratings may be given in terms of D.C., A.C., or peak voltages, and if the condition is not specified, it is advisable to enquire which applies. The stresses imposed on an insulator by an alternating supply are quite different from those under steady conditions, and we are not thinking simply of the peak value of the alternating supply so much as the repetitive reversal of loading, and the dielectric current. In other words, even with an unpolarised component it is not necessarily safe to divide a D.C. rating by $\sqrt{2}$ and assume that the result is the permissible A.C. loading.

It must also be remembered that the voltage rating of a component is related to specific environmental conditions, for humidity, temperature and pressure all exert a considerable influence, and so also can the frequency of the supply, and, of course, high frequency radiation starting with frequencies in the visible spectrum (photo-electrical effects). It can be seen, therefore, that voltage ratings must be interpreted very carefully, with full knowledge of the context, and all the practical conditions of application.

*The voltage rating of a fuse-link is governed by the rupturing conditions which it can withstand, that is to say the intensity of the arc which it can handle on blowing (see "Notes on Fusing," section 4).

FREE. The series of notes on "Fusing" is now complete and, in response to many requests, will shortly be reprinted for issue as a booklet. Please write if you would like a copy, if you have not already done so.

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	P out† (W)	Distortion† (%)	V supply (V)	DIMENSIONS	
				Seated height (mm)	Max diameter (mm)
KT 55	25	1.5	*	128	53
KT 66	50	3	525	120	53
KT 77	70	1	600	98	33
KT 88	100	1.5	500	110	53

† Class AB₁, ultra-linear connection
* 190–260 V. AC or DC mains

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Aspects of design

This is No. 31 of a series of articles dealing with advanced problems in circuit design published by The Ediswan Mazda Applications Laboratory. No. 32 will appear next month. We will 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.

British television receivers have used 17 and 21 inch C.R. tubes with 110° deflection for some considerable time. They were originally introduced for the purpose of decreasing cabinet depth, thereby enabling better overall styling to be achieved. Their introduction, however, created a number of problems, particularly in respect of the design of the bulb. The more an evacuated bulb departs from a spherical form the more difficult it becomes to make it strong enough to withstand the external pressure of the atmosphere. To provide a bulb of the necessary strength which could be manufactured by the usual CRT bulb production techniques and also to simplify scanning problems, the faceplates of the 110° tubes were given a smaller radius of curvature than those of corresponding tubes of 90° deflection angle. In addition, the back of the bulb was given considerable curvature and the sides and corners of the faceplate were also rounded. This gave a picture which departed considerably from a true rectangular shape.

The new Ediswan Mazda CME1901 and CME2301 (19 and 23 inch) tubes have been developed with the main object of improving the picture presentation. The face has been made more nearly rectangular and its radius of curvature has been increased making it flatter. Although the picture height and width have only increased slightly, compared with 17 and 21 inch tubes, the straighter sides and lesser curvature at the corners of the face have resulted in a greater picture diagonal and added picture information previously lost in the corners. See Fig. 1.

Techniques and materials for producing scanning coils for 110° tubes are readily available, so new tubes should be designed to use coils which do not depart, radically, from existing coils. The CME2301 is designed to give a diagonal deflection angle of 110° with the external contours of the glass in the scanning coil region identical with previous types.

In the CME1901, which is the tube most likely to be used in transportable receivers, where space is at a premium, the diagonal deflection angle has been increased to 114° . This results in a bulb length, from the reference line to the front of the face, which is only slightly greater than that of previous 17 inch tubes. Due to the fact that the face of the new CME1901 is more nearly rectangular than that of previous 17 inch tubes, the increase of diagonal scanning angle from 110° to 114° is not accompanied by a corresponding increase in the horizontal and vertical scanning angles; in fact, it will be found that the scanning power requirements for the new tube are practically identical with its 17 inch predecessor. Slightly less scanning power is required in the CME2301 than in its 21 inch predecessor.

To avoid substantial changes from the scanning coil winding shapes previously used with 110° tubes, the external mechanical contours of the glass in the scanning coil region on the CME1901 have been made identical with its predecessor. See Fig. 2. The increased deflection angle of 114° has been accommodated by removing glass from the inside of the neck at the point of closest approach of the electron beam.

Thus, the inside of the neck-to-bulb flare has a fluted form with longitudinal grooves corresponding to the corners of the picture. The 114° deflection angle and the flatter face of the CME1901 tube, mean that with the scanning coils designed for the 17 inch predecessor the CME1901 will give some pincushion distortion. This also applies, in somewhat less degree, to the CME2301. It is possible, however, to design common scanning coil assemblies for both types of tube, the differences between the 114° and 110° deflection angles being taken up by changing the picture-shape correction magnets. Both new designs of tubes will employ magnetic cores of the original form and dimensions.

31 19 AND 23 INCH TELEVISION CR TUBES

When using a tube with a faceplate radius of curvature much greater than the distance from screen to deflection centre, it is necessary to arrange for the rate of change of current in the scanning coils to be lower at the beginning and end of a deflection stroke than in the middle. This corrects the tendency for the linear velocity of the scanning spot to be greater at the sides of the picture than in the centre. This technique has been employed since the introduction of 90° tubes. The greater radii of curvature of the CME1901 and 2301 tubes call for slightly more linearity correction than the previous 17 and 21 inch types.

Both CME1901 and 2301 are fitted with unipotential electron guns designed to give good uniformity of focus over the whole of the tube face, despite the increased radius of curvature. Optimum performance is obtained with a first-anode voltage of approximately 450 V.

Under these conditions the normal production variations in voltage required by the third anode for best focus can be accommodated within the range of voltages normally available in a television receiver. These tubes are not critical to small changes in focus voltage and sufficient adjustment to take up production variations can usually be provided by four fixed tapping points between the chassis and the boosted HT line.

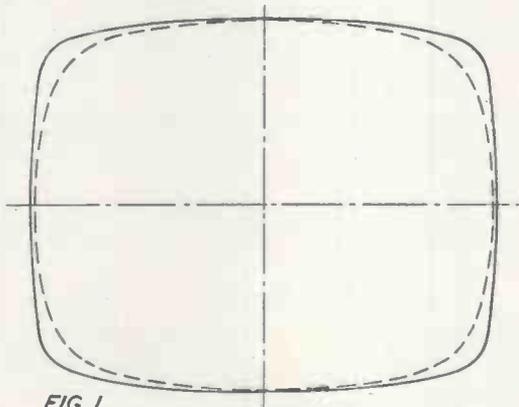


FIG. 1

Comparison of outlines of faceplates of CME2301 and CME2101 (dotted)

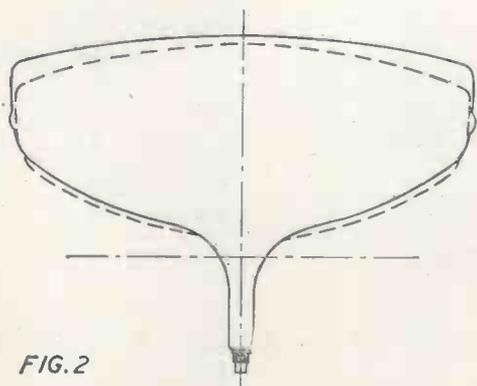
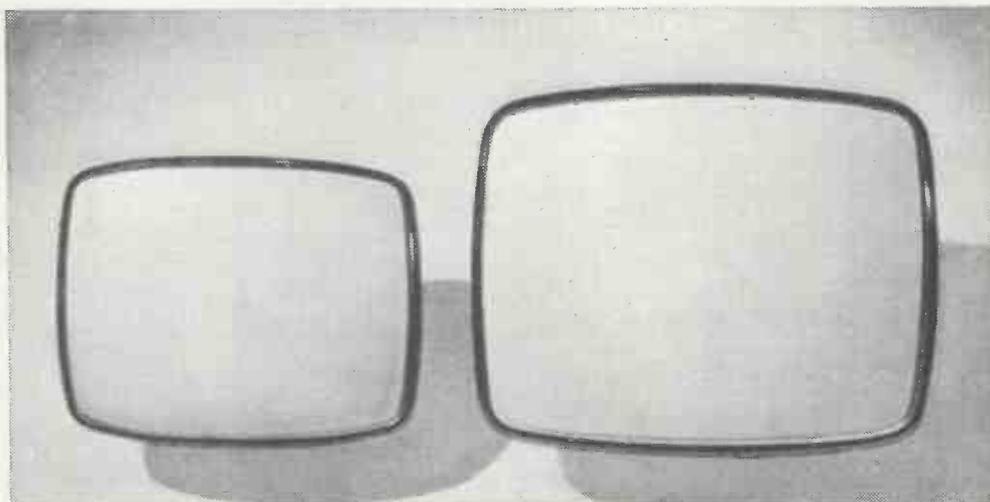


FIG. 2

Comparison of outlines of bulb shapes of CME2301 and CME2101 (dotted)

NEW 19" AND 23" TELEVISION CATHODE RAY TUBES



EDISWAN MAZDA TYPES CME1901 AND CME2301

The CME1901 and CME2301 are, respectively, 19in. and 23in. cathode ray tubes using magnetic deflection and electrostatic focus. The diagonal deflection angle of CME1901 is 114° and that of CME2301 is 110°. The shape of these tubes differs from the shape of conventional 110° tubes in that the face plates are more nearly rectangular. In addition the radii of curvature of the faces of the 19in. and 23in. tubes are greater than those of the 17in. and 21in. tubes. These changes result in a more pleasing presentation of the picture.

The external shape of the glass in the deflection region of these tubes is identical to that of conventional 110° tubes, enabling coils with conventional 110° internal mechanical contours to be used.

With equal values of final anode voltage, beam deflection in the CME1901 and CME2301 can be carried out with no more power consumption than in the CME1703 and CME2101.

GENERAL DETAILS

Rectangular face	Aluminised screen
Electrostatic focus	Silver activated phosphor
Magnetic deflection	Grey glass
Straight gun — non ion trap	External conductive coating
Heater for use in series chain	

Heater Current (amps)	I_h	0.3
Heater Voltage (volts)	V_h	12.6

TENTATIVE RATINGS AND DATA

Design Centre Ratings	CME1901	CME2301	
Maximum Second and Fourth Anode Voltage (kV)	$V_{a2, a4}(\max)$	17	17
Minimum Second and Fourth Anode Voltage (kV)	$V_{a2, a4}(\min)$	14	15
Maximum Third Anode Voltage (volts)	$V_{a3}(\max)$	±700	±700
Maximum First Anode Voltage (volts)	$V_{a1}(\max)$	500	500
Maximum Heater to Cathode Voltage—Heater Negative d.c. (volts)	$V_{h-k}(\max)$	180	180

Inter-electrode Capacitances (pF)	CME1901	CME2301	
Cathode to All*	C_{k-all}	5	5
Grid to All*	C_{g-all}	8	8
Final Anode to External Conductive Coating (approx.)	$C_{a3, a4-M}$	1500	2000

*Inter-electrode capacitances including AEI "Clix" B8H holder VH68/81 (8 pin).

TYPICAL OPERATION

	CME1901	CME2301	
Second and Fourth Anode Voltage (kV)	$V_{a2, a4}$	16	16-17
First Anode Voltage (volts)	V_{a1}	450	450
Third Anode Voltage for Focus-Mean (volts)	$V_{a3(av)}$	180	180
Grid Bias for cut-off of Raster (volts)		38 to 72	38 to 72
Average Peak to Peak Modulating Voltage for Modulation up to 350μA (volts)		34.5	34.5

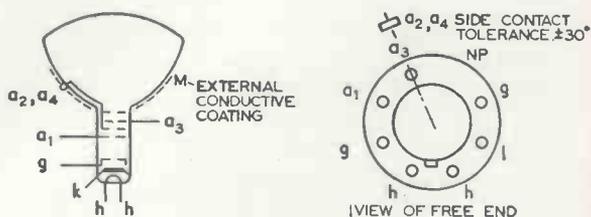
Note: All voltages given with respect to the cathode.

Maximum Dimensions (mm)	CME1901	CME2301
Overall Length	322	386
Face Diagonal	476†	598†
Face Width	420†	524†
Face Height	342†	422†
Neck Diameter	29.4	29.4

†The maximum dimension at the face seal may be 3.5 mm larger than this dimension but at any point around the seal the bulge will not protrude more than 2 mm.

Tube Weight (lb.)	CME1901	CME2301
Nett (approx.)	13.5	27

Side Contact: CT8 (Cavity) Base: B8H



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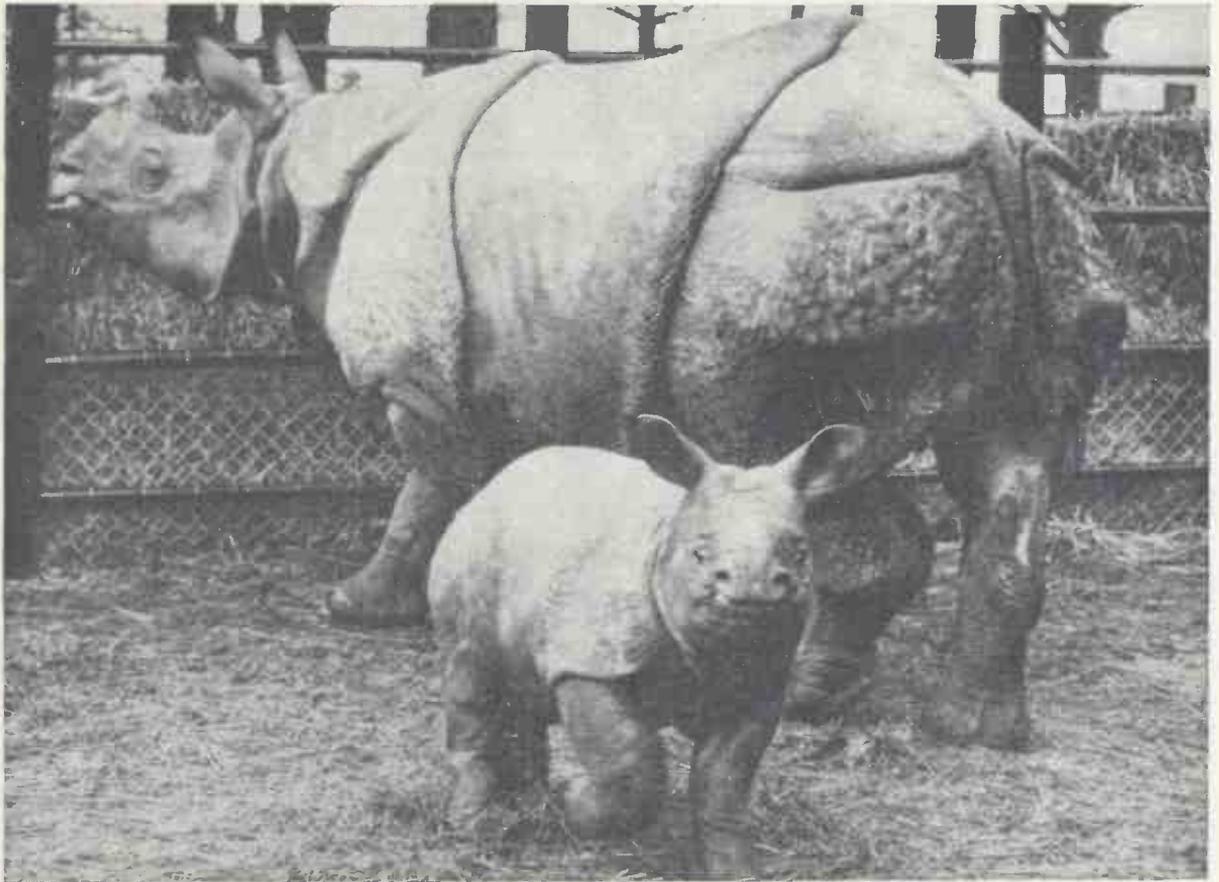
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G.E.C. Variable Capacitance Diodes now available

The SVC11-17 series of silicon variable capacitance diodes is designed for use in parametric amplifiers at frequencies up to S-band. These devices are the first of their kind to be produced in this country. The diodes are suitable for use in radar and other communications systems and are designed for high power dissipation so that no elaborate precautions against surges are necessary. The device can be used as a frequency multiplier — an important step towards the realisation of a microwave receiver based entirely on solid state devices — and because of its very low forward impedance and very high reverse impedance it can also be used as a microwave switch. The diode is mounted in a coaxial structure for direct insertion into coaxial and waveguide circuits and it has the low series inductance of 0.5 m μ H. The range consists of diodes of minimum cut-off frequencies from 25 to 85 kMc/s in 10 kMc/s steps. Reverse polarity versions of SVC11 and 12 are SVC21 and 22 for use in balanced circuits.

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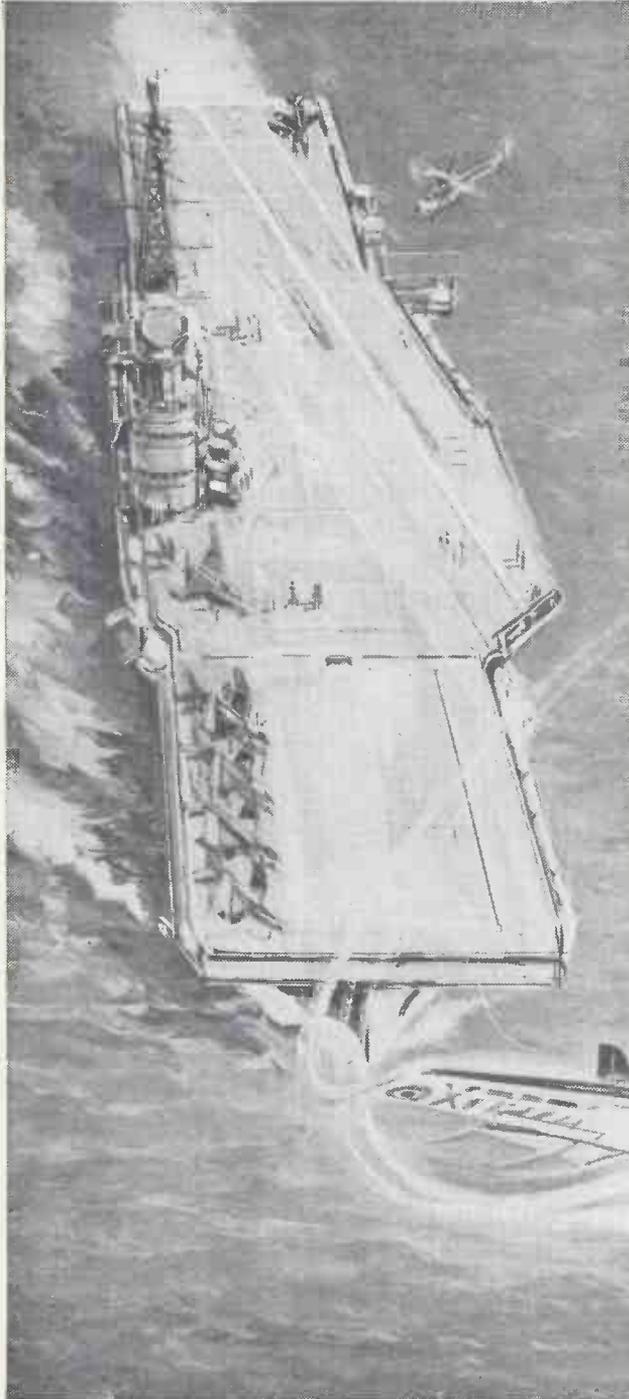
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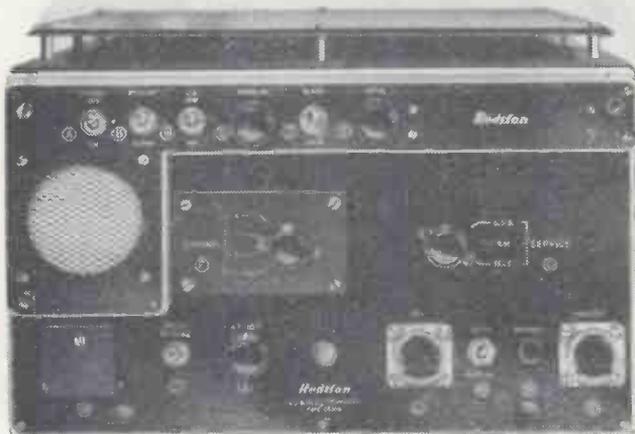
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The W.V.A. recorder has provision for a plug in stereo head and can be supplied with this and stereo playback pre-amplifiers with equalisation each having an output of 1 volt from a cathode follower. This is type W.V.A/S.

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.

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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.

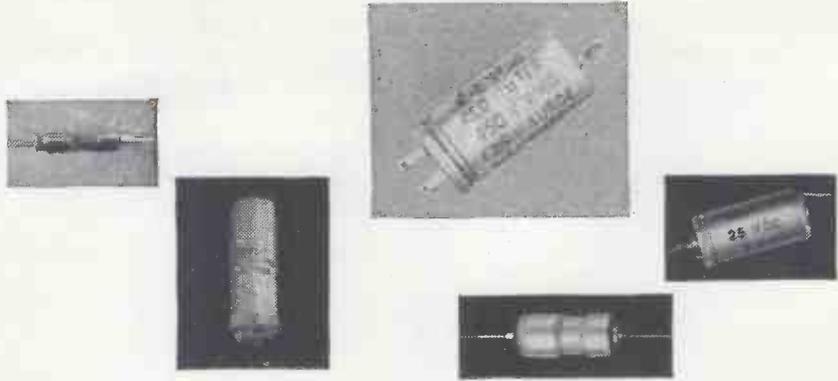
Adjustment to the bias level while listening to the result is useful in this connection especially where the brand of tape and the bias setting for it are not exactly known.

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.

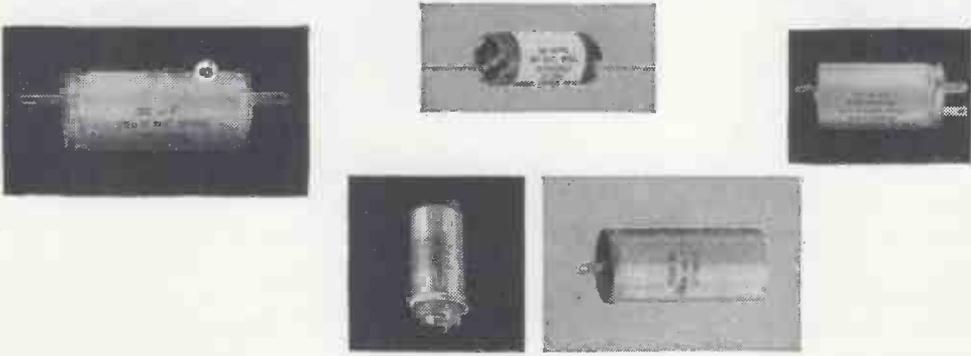
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A telephone interview with the winning driver was recorded over land lines from Monte Carlo to the A.B.C. Studios, while photographs were wired to Fleet Street and rushed by motor-cycle to Teddington.

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 Helnitz' review of this "Remarkable new control unit for stereo" reprinted from "Records and Recording."

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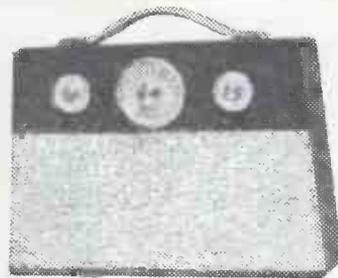
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"I am writing to express my satisfaction at the standard of your kit for your Pocket 4 Transistor set and also to state that it has come up to my expectations in regard to performance."

Mr. K. Edwards, Boreham Wood, Herts.
"I have completed the assembly of your Pocket 3 and am very pleased with the results."

Mr. N. Elliott, Pontypool.
"I have completed the assembly of your Pocket 4 radio and am pleased to say that it works from the first switching on."

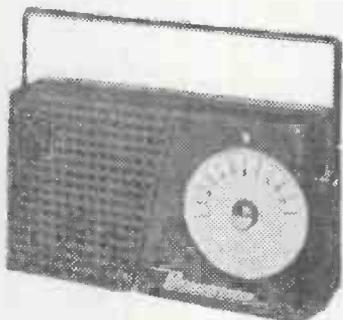
Mr. F. Jackson, Ickenham, Middx.
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"I find this set even better than you claim it to be and most certainly up to your usual standard of quality. I feel that nobody could fail to build it and get results. Even the first-time-ever novice, as your circuit diagrams and instructions are so clear and precise."

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Now available with first grade transistors.

Circuit comprises 2 HF transistors reflexed to equal 4 stages. Permanent germanium diode and high gain AF output stage, fitted with miniature speaker, proper tuning condenser, volume control and in case with handle as illustrated (less monogram), completely portable. No aerial or earth required. Pocket 4 uses 3 transistors and 1 diode, price 52/6, plus 2/6 post and insurance. Pocket 5 uses 4 transistors and 1 diode and has feedback control, price 67/6, plus 2/6 post and insurance.

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Mr. E. Balcombe, Manchester.
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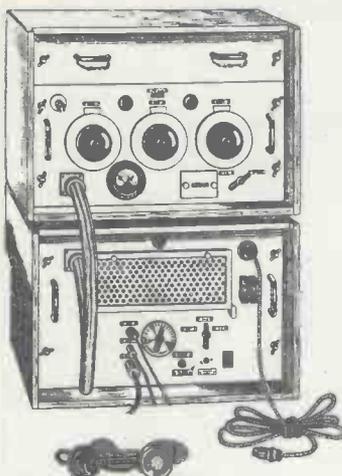
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HALLICRAFTER VIBRAPACK. Input 6 v. output 300 v. at 170 mA. Designed for SX28 or S27. Size 6 1/2 x 7 in. BRAND NEW, BOXED. 29/6. Carr. 3/6.

TRIPLETT METER MOVEMENT
 This article consists of a basic 400 microamp meter movement mounted on a Bakelite panel 5 1/2 x 2 1/2. The dial is scaled as a 15 range Testmeter. A circuit and parts list of the original instrument is supplied.
 BRAND NEW. Boxed. 35/-, post paid.



QQVO6-40 37/6
 PVI-35 32/6, 2D21 7/6, OC3 6/-, PT15 12/6, CV51(Y65) 5/-, 6F33 5/-, 2050 W. 7/6, 5J26 £10, 5670 5/-, FW4/500 7/6. BRAND NEW in individual cartons. Bulk enquiries invited.

CANADIAN RECEIVER No. 52
 1.75-16 Mc/s (19-170 m.) in three wavebands R.F., Mixer, Sep. Osc., 2 I.F.'s, Det./A.V.C., 1st Audio, Output, BFO (10 valves), plus a 3-valve dual Crystal Calibrator. Controls: R.F. Gain, L.F. Gain, Crash Limiter, C.W. Filter, Variable Selectivity, Slow and Fast Tuning and Osc. Vernier Tuning, Man. or A.V.C. BFO pitch control. Internal 3in. speaker and valve check meter. Power supply required 160 v. H.T., 12 v. L.T. Data and Circuit supplied. A really excellent receiver, £8/19/6, carr. 15/6. Power supply Unit, 59/6, carr. 5/6.

SEARCH RECEIVER
 Type AN/APR4. Covers 38 to 1000 Mc/s. with 3 Plug-in R.F. Heads. TN 16 (38-95 Mc/s.), TN 17 (74-320 Mc/s.) and TN 18 (300-1000 Mc/s.). Self-contained power supply for 115v. 50-2,600 c.p.s. Thoroughly reconditioned as new. In 100 per cent. mechanical and operational order. £100.

MARCONI CR100
 Still one of the finest surplus communications receivers. Ready for immediate use on A.C. mains. Of new appearance, completely overhauled and in perfect working order. Later model with Noise Limiter, £25. Carr. England and Wales 30/- Send S.E.A. for full details.

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 are 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.

RCA AR-88 SPEAKERS
 A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10 1/2 x 11 1/2 x 6 in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker. CR 100. etc. In original cartons. BRAND NEW. 45/- Post 3/6.

MINIATURE 373 IF STR.PS. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1 of EB91. A fresh release enables us to offer these once again. BRAND NEW. Complete reprint of conversion instructions and circuit supplied free. 35/- OR less valves 12/6. Post, either, 2/6.

LOUD-HAILER EQUIPMENT
 IDEAL FOR GROWD 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 8 VOLTS A.C. WITH SLIGHTLY REDUCED OUTPUT CONSUMING ONLY 2 AMPS. OUTPUT POWER 8 WATTS: ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. £4/19/6. CARRIAGE 25/6.

T.C.C. VISONCON CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V Size 3 x 1 1/2 x 5 in. 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, 670Ω, 2 H/D makes, M1099..... 15/-
 G.E.C., sealed, wire ends, 5,000Ω 2 c/o., plat., M1052 17/6
 Siemens High Speed, IK+1KΩ, 1 c/over..... 10/6

GIANT COMPONENT PARCEL
 Contains 100 1/2 and 1 watt resistors, 50 HI Stab resistors, wire wound resistors, carbon and W/W pots, 100 capacitors (mica, paper, Sprague, bin, variable, etc.), valveholders, tag strips, metal rectifiers, sleeving etc. All components are unused. GUARANTEED VALUE, 25/- plus 2/6 post.

CHARLES BRITAIN (Radio) LTD.
 11 UPPER SAINT MARTIN'S LANE
 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.



CRYSTAL CALIBRATOR No. 10
 A crystal controlled heterodyne wave-meter 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 7 1/2 x 4 in. Good condition, complete with valves, crystal, instruction manual and circuit. ONLY 59/6. Post 3/6.

CANADIAN CRYSTAL CALIBRATOR. Uses double crystal and multi- vibrator circuit to give "pips" at 1 Mc/s., 100 Kc/s. and 10 Kc/s. Incorporates Modulator With book. 79/6, post 2/6.

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-Rentgens per hour. Supplied complete with carrying haversack. BRAND NEW £17/10/0. 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.

HEAVY DUTY SLIDER RESISTORS. 1.25Ω 20 A., 12/6, post 3/6 1Ω 12 A., 8/6. PRECISION RESISTORS. 1 Megohm. 1/8 I watt wire wound, Ex-U.S.A. BRAND NEW. 10/6 per dozen.

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. 2 1/2 in. 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. 2 1/2 in. 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. 2 1/2 in. 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 5 1/2 x 3 1/2 x 2 1/2 in. Fully guaranteed with test leads, prods and internal battery, 59/6.

FERRANTI VOLT METERS N.5.
 0-300 volts, 25-100 c/s. Moving iron, 6in. scale. Fl. mtg. Hermetically sealed, grade IN. Made 1955. BRAND NEW. Boxed. 79/6. Post 3/6.



G.W. SMITH & CO

(RADIO) LIMITED

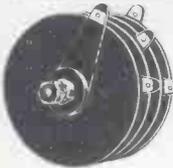
Phone: GERRARD 8204/9155

Cables: SMITHEX LESQUARE

3-34 LISLE STREET, LONDON, W.C.2

SELENIUM L.T. METAL RECTIFIERS

Full wave, bridge connected. All new and guaranteed.



12/18 v. 1 amp. 4/3	12/18 v. 10 amp. 22/6
12/18 v. 2½ amp. 6/9	24/36 v. 1 amp. 9/6
12/18 v. 4 amp. 9/9	24/36 v. 2 amp. 13/6
12/18 v. 5 amp. 12/6	24/36 v. 6 amp. 22/6
12/18 v. 6 amp. 13/6	24/36 v. 10 amp. 45/-
	24/36 v. 15 amp. 47/6

Please add postage.

L.T. TRANSFORMERS. For charging or models. All 200/250 volt primaries. 3.5, 9 or 17 volt 1 amp., 9/9; 3.5, 9 or 17 volt 2 amp., 14/3; 3.5, 9 or 17 volt 4 amp., 16/6; 9 or 17 volt 6 amp., 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 2 amps, 18/6; Ditto but 4 amp., 30/-. Please add postage.

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. ½ BSP inlet/outlet union. Only 15/6 each. P/P 2/6.

CARPENTER RELAYS

570 ohm coils. Side stable single changeover contacts. Brand new boxed, 12/6 each. P/P 1/3.



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.



SPARES KITS FOR CR.100 RECEIVERS
Contains 15 valves; 2—DH63; 2—X66; 2—KT63; 2—U50; 7—KTW61. Condenser and resistor packs, pots, toggle switch, output transformer, etc. All brand new, 59/6. P/P 3/6.

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/-.



PAINTON MINIATURE JINES 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.
Please add postage.

MULTI-RANGE TESTMETER BARGAIN



Imported, brand new and guaranteed. 1,000 ohm/volt A.C./D.C. Volts D.C.: 10, 50, 250, 500, 1,000 v. Volts A.C.: 10, 50, 250, 500, 1,000 v. Current D.C. 1 mA., 100 mA., 500 mA. Resistance: 2,000 ohms and 200,000 ohms. Supplied complete with all instructions and test leads. Price 59/6 each. P/P 2/6.

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.
MARCONI TF-329 "Q" METERS. Range 0 to 500 Q. Frequency 50 kc/s to 50 Mc/s. Reconditioned to maker's specification. £65 each.

ARB AMERICAN RECEIVERS



Frequency coverage on 4 bands 195 kc/s to 9.05 Mc/s continuous. Operation ideal from 24-volt D.C. for boat or car. Precision vernier drive. Valve line-up: 12SA7, 4—12SF7, 12A6 and 991. Supplied fully tested and checked, £10/19/6 each. P/P 7/6.

BRAND NEW MEDRESCO HEARING AIDS



Supplied fully tested and complete with ear-piece, leads and battery pouch. Incorporates 3 sub-miniature valves and sensitive crystal microphone. Only 32/6 each. P/P 1/-.

VALVE VOLTMETERS No. 2. A laboratory instrument at a fraction of cost. Five ranges A.C. and D.C. 1.5 v., 5 v., 15 v., 50 v. and 150 volts. Operation 200/250 volts A.C. Supplied as new, fully tested and complete with internally mounted H.F. probe. £17/10/- each. P/P 10/-.



BRAND NEW BOXED 100 MICROAMP METERS. Standard 2½in. flush panel mounting. Scale calibrated 0-100 microamps. 42/6 each. P/P 1/3. Also available 3½in. panel mounting 62/6 each.

COLLARO STUDIO TAPE TRANSCRIPTORS



Latest 1961 model. 3 speeds 1½, 3½ or 7½. Fitted with 3 separate motors, digital counter, press button switching, provision for fitting extra stereo head. Supplied brand new and guaranteed complete with spare 7in. spool. £12 each. P/P 3/6.

COAXIAL PLUGS AND SOCKETS

All new and unused. Large stocks available. Type 1. Films and Equipment, 2/6 per pair. Type 2. Miniature Pye, 2/6 per pair.



BC. 221 HETERODYNE FREQUENCY METERS

125 kc/s to 20 Mc/s As new condition. Supplied complete with valves and crystal but no calibration charts.

Only £14/10/0 each P/P 7/6.



PARMEKO TABLE TOP TRANSFORMERS

Input 230 volt 50 cycles. Output 620/550/375/10/375/550/620 volts 250 mA., 5 volt 3 amp., 5 volt 3 amp. Size 6½in. x 6½in. x 5½in. Brand new and boxed, 45/- each. P/P 3/6.



7.5 K.V.A. AUTO TRANSFORMERS

115/230 volts. Brand new and boxed, ex-U.S.A. £15 each. P/P 10/-.



MINIATURE EARPIECES



Available high (Crystal) or low (5 ohm) impedance. Ideal for transistor receivers, etc. Supplied brand new complete with lead and jack and plug. Only 7/6 each complete. P/P 9d.

HOURS OF BUSINESS:

9 a.m.-6 p.m.

Thursday 1 p.m. Open all day Saturday.

Please print name and address clearly.

LOOK! THOUSANDS OF BARGAINS AVAILABLE WHICH WE ARE UNABLE TO ADVERTISE. IT IS WORTH YOUR WHILE TO PAY US A VISIT

HIGH FIDELITY RECORDING TAPES

Bargain prices. All new and guaranteed.

3in. long play 225ft.	6/-
5in. std. play 600ft.	12/-
5in. long play, 900ft.	16/-
5½in. long play, 1,200ft.	19/6
7in. std. play, 1,200ft.	19/-
7in. long play, 1,800ft.	29/-
7in. double play 2,400ft.	49/6

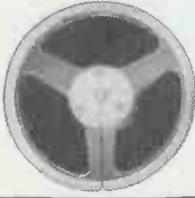
PLASTIC SPARE SPOOLS.

All new.

5in. 2/- ea., 5½in. 2/3 ea., 7in. 2/9 ea.

BRAND NEW PLASTIC SPOOL CONTAINERS

5in. 1/6 ea., 5½in. 2/- ea., 7in. 2/3 ea. Please add postage.



NATIONAL H.R.O RECEIVERS



Senior model, table mounting. Supplied complete with full set of 9 coils covering 50 kc/s. to 30 mc/s. All receivers are fully tested and aligned. Price 21 gns. Carriage 10/- extra. Power units are also available at an extra cost of 59/6 each.

AVO SIGNAL GENERATORS

Frequency coverage 95 kc/s to 40 mc/s. Ideal for all general radio work. 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 each extra.

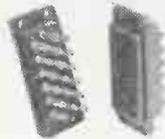


PHOTO VOLTAGE AMPLIFIERS

These special units contain a 1 microamp Tinsley galvanometer and a double selenium photo electric cell. Brand new £9/19/6 each. P/P 7/6.

AMPHENAL CHASSIS UNITERS

All new and unused. Available with 15 or 18 pins. Both types 3/6 per pair.



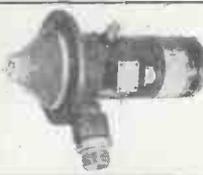
HALLICRAFTER 6 VOLT VIBRATOR POWER SUPPLIES.

Housed in grey metal case and supplied with all necessary connectors etc. Made for SX28, S27, S36 receivers. Output 300 volts 170 ma., fully smoothed. Supplied new and boxed, 29/6 each. P/P 3/6.

SOUND POWERED TELEPHONE HANDSETS



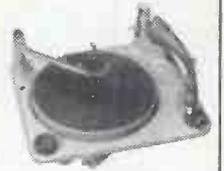
Make simple intercom system. No batteries required. Just connect together with twin flex. Brand new only 15/- per handset. P/P 1/6. Suitable twin flex 2½d. per yd.



24 VOLT D.C. FUEL PUMPS.

Perfect condition, 15/6 ea. P/P. 2/6.

RECORD CHANGERS AND PLAYERS



B.S.R. Monarch UA8 4 speed record changers, £6/12/6 each.
B.S.R. Monarch UA8 Stereo 4 speed record changers, £6/12/6.
B.S.R. UA14 Stereo 4 speed record changers, £7/10/- each.
Garrard RC.120 Mk. II 4 speed record changers £8/15/- each.
Collaro Junior 4 spd. single players, £3/15/- ea. POST EXTRA.

1,000 WATT MAINS ISOLATION TRANSFORMERS. 230 volt primary, 230 volt secondary. Ex-Admiralty heavy duty type. New boxed, £5 each. Carriage 10/-.

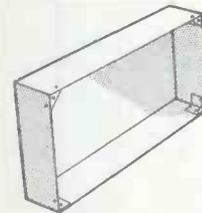
AR.88 WAVECHANGE SWITCHES. 8 banks, 6 positions, complete with all screens. New, boxed, 17/6 each. P/P 2/6.



R.C.A. LOUD-SPEAKERS

High quality 8in. 3 ohm. speaker housed in black crackle metal case to match AR-88 or H.R.O. receivers. Supplied brand new and boxed, 45/- each. P/P 3/6.

R.C.A. PLATE TRANSFORMERS. Primary 200/250 volts 50 cycles. Secondary 2,000/1,500/0/1,500/2,000 volts 500 milliamps. Supplied brand new and boxed, £6/10/- each.



ALUMINIUM CHASSIS

18 swg, four sided and with reinforced corners. 6 x 4 x 2½in. 3/6; 10 x 7½ x 2½in. 5/3; 7½ x 5½ x 2½in. 4/6; 11½ x 7½ x 2½in. 6/-; 13½ x 9 x 2½in. 6/9. Post extra.

24 AMP. VARIAC TRANSFORMERS. Primary 230 volts. Adjustable secondary from 185 to 250 volts at 24 amps. Can also be used in reverse, £12/10/- each. P/P 10/-.



MUIRHEAD CELL TESTERS

Brand new. Incorporates a 6in. scale 3 amp. D.C. meter and variable rheostat for controlling current. Only 32/6 each. P/P 3/6.

POWER UNIT TYPE 234A. Input 200/250 volt. Output 250 volt 150 ma., fully smoothed and 6.3 volt. 5 amp., 19 inch rack mounting chassis, 59/6 each, carriage 7/6.

METER BARGAINS

20 microamp D.C. M/C flush rd.	2½in.	69/6
25 microamp D.C. M/C proj. rd.	2½in.	59/6
50 microamp D.C. M/C proj. rd.	2½in.	49/6
100 microamp D.C. M/C flush rd.	2½in.	42/6
100 microamp D.C. M/C flush rd.	3½in.	62/6
200 microamp D.C. M/C proj. rd.	2½in.	29/6
300 microamp D.C. M/C flush rd.	2½in.	29/6
1 milliamp D.C. M/C flush rd.	2½in.	25/-
1 milliamp D.C. M/C flush sq.	4in.	69/6
30/0/30 milliamp D.C. M/C flush	2½in. rd.	9/6
15 amp. D.C. M/C proj. rd.	2in.	8/6
120 volt D.C. M/C flush rd.	3½in.	32/6
300 volt A.C. M/C rectifier flush rd.	2½in.	25/-
300 volt A.C. M/I flush rd.	2½in.	25/-
500 volt A.C. M/I flush rd.	2½in.	25/-
1,500 volts electrostatic proj. rd.	2½in.	25/-

Postage extra.

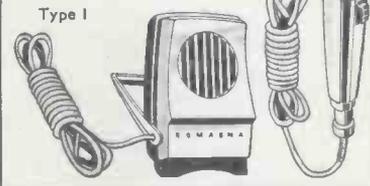
CRYSTAL MICROPHONES

Brand new and guaranteed.

Type 1. Hand or desk type with screened lead. ONLY 15/6 each. P/P. 1/-.

Type 2. High fidelity stick type, metal cased and fitted with switch.

Supplied with screened lead and screened 2-pin connector. ONLY 35/- each. P/P 1/-.



Type 1

Type 2

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL
FAMOUS MAKES HI-FI EQUIPMENT
AT TERRIFIC REDUCTIONS!

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. x 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. for 20/-.
 Two 6 x 4in., 25/-.

Suitable cabinets available to callers.

MICROPHONE BARGAINS

The "Diana," High impedance moving coil mike with unique magnetised table base. Response 30-15,000 c.p.s. Ideal for tape recorders. List 4 Gns. Lasky's Price **55/-** Post free.



ACOS CRYSTAL STICK MIKE Type M.C.39/1, complete with cable. Listed at £5/5/-.
 Lasky's Price **39/6** Post free.

MINIATURE moving coil dynamic microphone, incorporating switch and complete with pocket clip. As used for the "Fi-Cord," **35/-** Post 1/6.

HI-FI SPEAKER SYSTEM

SPECIAL OFFER. Limited quantity only. ELAC Hi-Fi Speaker system comprising 10in. bass unit (woofer), 8 x 6in. enclosed middle range unit, and 4in. tweeter. **LASKY'S PRICE, complete 49/6** Post 3/6.

TWO MATCHED SETS FOR STEREO £5 post paid.

Units available separately:

10in. Bass Unit 27/6. Post 2/6.	8 x 6 Middle Unit 15/6. Post 1/6.	4in. Tweeter 12/6. Post 1/6.
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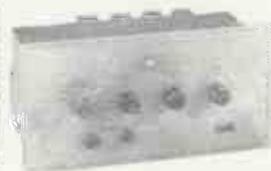
ALL TYPES OF CHASSIS

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.

SAVILLE

STEREO & MONAURAL

For 200-250 v. A.C. mains. New and fully guaranteed. Few only.



SAVILLE STEREO

Pre-Amplifier and Control Unit. Uses two EF80 and two ECC81 valves. Separate controls, bass and treble, balance and switched selector for various inputs. List £15. Lasky's Price **8 Gns.** Post 3/6.



SAVILLE TWENTY

Main Amplifier and Power Unit. 20 watts nominal, 30 watts, peak from "C" core distributed load stage. Freq. range: 34 c/s to 30,000 c/s ± 1 dB at 20 watts < 0.1%. Mains transformer will sustain 100% overload continuously. Power supplies for Tuner: 300 v. 50 mA. 6.3 v. 2.5 amp. 4 valves: 2 EL34 push-pull, ECC81, GZ34. List £27. Lasky's Price **£14.19.6** Carr. 9/6

SPECIAL COMBINED OFFERS

One Saville Twenty Amplifier and one Saville Pre-Amplifier and Control Unit, if purchased together, **20 Gns.**

STEREO

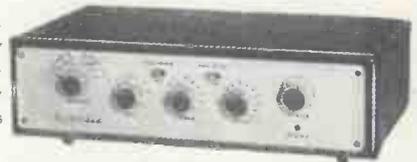
Two Amplifiers and one Pre-Amplifier.

32 Gns.

Carr. & Ins. 12/6.

AVANTIC STEREOPHONIC

For 200-250 v. A.C. mains. New and fully guaranteed. Few only. Secure yours now!



SPA11 Stereo Amplifier and Pre-Amplifier, twin

10 watts output, 3-dimensional monaural reproduction by combining both channels. 3 inputs for each channel. Size: 14 1/2 in. wide, 4 in. high, 8 1/2 in. deep. LIST £29/9/-. Lasky's Price **19 Gns.** Carr. & Ins. 7/6.

SP21/2 Stereo Pre-Amplifier Control Unit. twin channel. Freq. response 40 c/s-15 Kc/s. LIST £28/10/-.

Lasky's Price **£16.19.6** Carr. & Ins. 7/6.

PL6/21. 20-watt Monaural Amplifier and combined Control Unit. Freq. response 40 c/s-15 Kc/s ± 1dB. LIST £29/8/-.

Lasky's Price **19 Gns.** Carr. & Ins. 7/6.

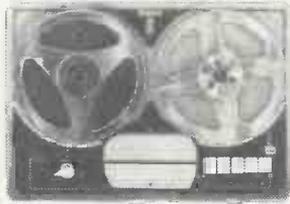
GREAT TAPE DECK OFFER!

LIMITED NUMBER ONLY

The well-known MOTEK K10 Deck with push-button controls, 3 motors, 3-speed (1 1/2, 3 1/2, 7 1/2 i.p.s.), rev. counter. Freq. response better than 40-12,000 c/s. at 7 1/2 i.p.s. 2-tone grey finish. Listed at £22.

Lasky's Price **£9.19.6** Carr. and Ins. 7/6

SUITABLE CASE AVAILABLE, TO CALLERS 39/6.



COLLARO TAPE TRANSCRIPTOR

Mk. IV, fitted digital counter. List £25. Lasky's Price **£16/19/6.** Carr. & Ins. 12/6. Tape extra.

TAPE RECORDER AMPLIFIER

for use with Collaro Studio Transcrip-tor. Size 11 1/2 x 5 x 3in. Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. l.s. jack, superimposing switch. Complete with matching knobs (Gold/Black). Lasky's Price **12 Gns.** Post 3/6.



COLLARO STUDIO TAPE TRANSCRIP-TOR.

3 motors, 3 speed 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push-button controls. Lasky's Price complete with Tape and Spool **£12/19/6.** Carr. & Ins. 12/6.

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 7 1/2 i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7 1/2 i.p.s. ERASE, low impedance. LIST 44 FAIR. LASKY'S PRICE, per pair **29/6** Post free.

PLASTIC TAPE SPOOLS

3in. 2/9	5in. 2/9	5 1/2in. 2/9	7in. 2/9	8 1/2in. 5/8
7in. Metal Spools, 1/9 each. Post extra.				

SPECIAL OFFER OF TAPE

Famous make. P.V.C. base on latest type plastic spools. Brand new, boxed and guaranteed, 1,200ft. on 7in. spool: **20/-**

1,800ft. on 7in. spool **32/6**
 1,200ft. on 5 1/2in. spool **21/-**
 850ft. on 5 1/2in. 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 5 1/2in. spool **29/6**
 850ft. on 5in. spool **25/6**
 220ft. on 3in. spool **7/11**
 Post: 1 spool 1/6.
 Orders over 60/- post free.



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100 large pages, 11 1/2 x 8 1/2 in., copiously illustrated. A COMPARATOR-CATALOGUE to enable you to choose from all the latest hi-fi equipment. Price 3/6, post 6d. (Refunded on making your first hi-fi purchase.)

ALL MAKES OF TAPE. Long Play, Double Play and American "MYLAR."

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

STEREO ADAPTOR

CONVERTS ANY RADIOGRAM TO GIVE STEREOPHONIC REPRODUCTION

2-valve Amplifier using EF80X and EL84 metal rectifier (full-wave bridge). Mains voltage 195-250, 50/60 c.p.s. Ganged volume control and ganged tone control.

CAN ALSO BE USED AS A SINGLE-END AMPLIFIER.

LASKY'S PRICE complete with printed circuit, circuit diagram, full service data and 2 new valves. Post & Pkg. 3/6. **59/6**

AMPLIFIER BARGAIN

6-watt, employing 4 valves: EX80 rect., ECC83, feeding two E184 in push-pull. Separate control unit with bass, treble and volume controls. Size of chassis: 4½ x 4½ x 12in. Complete with 4 new Mullard valves.

LASKY'S PRICE **85/-** Post 4/6.

GRAM AMPLIFIER

Uses two valves, ECL82 and EZ80 and separate mains transformer to minimise hum. Incorporates Elac 8 x 5in. loudspeaker with output transformer mounted. Size of printed circuit 4 x 3 x 2½in.

Lasky's Price **59/6** Post 3/6.

MINIATURE POCKET TRANSISTOR RADIOS

Large selection of various well-known makes at money-saving prices. Call and select or write for latest Bargain List.

TRANSISTOR RECORD PLAYER



6 v. operation. For all L.P. and standard records. All components available separately.

AMPLIFIER
300 milliwatts push-pull output, using two OC71 and two OC72 transistors. Fully assembled, 79/6. Knobs 3/6 extra.

LOUDSPEAKER
30 ohms, 7 x 4in. elliptical, matched to Amplifier, 25/-.

3-SPEED TURNTABLE
6 v., with rubber mat and speed adjustment, complete with t.o. crystal cartridge and two sapphire styl. 79/6.

CARRYING CASE
As illustrated, handsome two-tone, finish. 17in. deep, 14in. wide, 5½in. high. Well made and finished. 49/6. Batteries extra.

LASKY'S F.M. TUNER
PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION
CAN BE BUILT FOR **7 Gns.** (including valves)
Post free. Details on request.

DRASTIC STOCKTAKING REDUCTION TO CLEAR!



Few only. "LIGHT" TAPE RECORDER for A.C. mains 200/250 v. Brand new and unused in maker's cartons. 2-speed, 3½ and 7½ i.p.s., twin track, 60 min. playing time at 3½, 30 min. at 7½. Inputs for mike and tuner. 5in. speaker, smart duo-tone blue/grey carrying case, 12½ x 9½ x 7½in. Weight approx. 6½lb.

SPECIAL CLEARANCE PRICE

£15.19.6

Carr. & Ins. 15/-.

NOTE: Complete with 5in. spool of tape, empty spool, crystal hand mike and radio jack, absolutely ready for use. WORTH DOUBLE. LIMITED QUANTITY ONLY.

ANOTHER WONDERFUL TAPE RECORDER OFFER!

Complete Tape Recorder using Collaro Studio 3-speed deck, 1½, 3½, 7½ i.p.s. Twin track with pause control, rev. counter, latest type electronic recording indicator. Superimposing switch, volume and tone controls, 7 x 4 loudspeaker. 4 watts output. Takes 7in. spools.

In contemporary design carrying case, 9½ x 16 x 16in. Brand new, fully assembled, ready for use.

LASKY'S PRICE **29 Gns.** COMPLETE WITH MIKE TAPE AND SPOOL Carr. & Ins. 25/-.



LIMITED QUANTITY ONLY NEW AND UNUSED 17" TV CHASSIS



200-250 v. A.C./D.C. Complete with 13 new Brimar valves, latest Fireball turret tuner covering all channels bands I and III (i.f. 33-38 Mc/s.). Ferroxcube line output transformer and wide angle 90° scanning coils, ion trap, latest electrostatic focus. All first quality components. Overall dimensions 8 x 15½in.

Valve lineup: 3 PCF80, 1 PCC84, 3 B6W7, 1 PCL84, PCL82, PY82, PL81, PY88, EY51.

LASKY'S PRICE **£18.19.6** Carr. & Ins. 7/6.

BRAND NEW BRIMAR 17in. C.R. TUBE, C17SM. 3-amp. heater, electrostatic focus. 12 months' guarantee. LIST 10 gns. Lasky's Price **£6/19/6**. Carr. & Ins. 12/6.

SPECIAL COMBINED OFFER. CHASSIS & NEW BRIMAR C.R.T. **£23.19.6** Carr. & Ins. 19/6.

A few cabinets available to callers.

"LINEAR" AMPLIFIERS

- "DIATONIC" 10-14 watts 12 Gns.
 - "CONCHORD" 30 watt 15 Gns.
 - L45 4.5 watt Amplifier 25/19/6
 - 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.
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- GARRARD 4HF, stereo or monaural, complete with plug-in head **£18.9.0**
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 - GARRARD 301 £22 7 3
 - GARRARD 301 (Strobe) £23 18 4
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New and Unused in Maker's Cartons



- B.S.R. type UA8 £6 19 6
 - B.S.R. UA8, stereo £7 19 6
 - B.S.R. UA12, stereo £8 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

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- 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

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Auto start and stop. Complete with pick-up and crystal cartridge.

- GARRARD 4SP £6 19 6
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- Post on all above 5/-.

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 - B.S.R. TU9, non-auto Turntable and separate pick-up... 79/6
- Post free.

PICK-UP CARTRIDGES

ACOS HGP.59 or HGP.37 turnover, 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.

P.M. SPEAKERS

- 3½in. 4in. 5in. 6½in. 8in. 10in.
 - 17/6 19/6 14/6 16/- 16/6 25/-
 - 12in. 27/6. ELLIPTICAL: 7 x 4 9 x 6 10 x 2½ 10 x 6 10 x 7 14/6 22/6 25/- 25/- 25/-
- Post extra.

THE 'VANCOUVER'

3-TRANSISTOR POCKET RADIO

Employs 3 transistors plus germanium diode, on printed circuit size 3½ x 4 x ½in. Tunable over medium and long waves. Built-in Ferrite rod aerial.

CAN BE BUILT FOR **39/6** (including valves)
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Circuit diagram and step-by-step instructions, 1/6 (free with parcel).

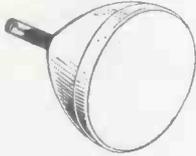


LASKY'S RADIO

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN MANY BARGAINS IN MULTI-TEST METERS

All new and guaranteed unused.

C.R. TUBE BARGAINS NEW AND UNUSED



FERRANTI, 12in. types T12/44 or 9in. type T9/3 4 v. heater.

LASKY'S PRICE **49/6**
Carr. & Insur. 12/6.

FERRANTI 17in. type TR17/10, 6.3 v. .3 amp. heater. Brand new and unused.

LASKY'S PRICE **£6.19.6**
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16in. METAL CONE, famous make, type T901/A, 6.3 v., 0.3 amp. heater. **£6.9.6**
Carr. & Insur. 21/-.

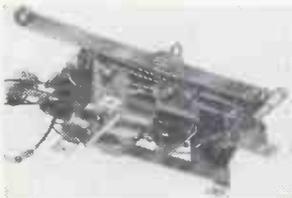
17in. 90 degrees C.R. TUBES

Seconds but in perfect working order and guaranteed.
Carr. and insur. 12/6. **79/6**

RE-GUNNED C.R. TUBES

Type	From	Carr.	& Ins.
12in. round	£5 10 0	12/6	12/6
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17in. rect.	£5 19 6	12/6	12/6
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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, 7 1/4 x 5 x 1 1/4 in. enables it to be used in the smallest of car radios.

LASKY'S PRICE **49/6**

With circuit diagram and full data. Post 2/6

LASKY'S MIDGET T.R.F. CAN BE BUILT FOR **99/6**

Post & Pkg. 5/-.

For A.C. mains, 200-250 v. Med. and Long wave. Uses 2 double-purpose valves EBF89 and ECL80 contact-cooled rectifier. 5in. P.M. Speaker. Plastic cabinet, 8 1/2 x 5 x 4 1/4 in. deep. Circuit diagram, shopping list, 1/6.

RESISTORS. The largest stocks of all types, high stability, wire wound, carbon, vitreous enamel, miniature and submin Millions in stock.



The KAPURA Mdl. U1. MULTI-RANGE TEST METER, incorporating 3in. rectangular meter. 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. x 3in. x 2 1/2 in. Weight: 22 ozs.

Fully guaranteed. LASKY'S PRICE **69/6**
Complete with test leads. Post & Pkg. 3/6.

AN/20. Famous make pocket size 18-range multi-test meter for amateur or service engineer. 5,000 ohms. per volt A.C. and D.C. with accurate linear scales for the lower A.C. ranges. In black leatherette-covered case, 3 1/2 x 3 1/2 x 1 1/4 in. deep. LIST 9 gns.

LASKY'S PRICE **99/6**
Post 3/6. Leads 3/6 extra.



AN/27. Accurate, highly sensitive 27-range Test Meter by famous maker. 5,000 ohms per volt A.C. and D.C. In

black-leatherette-covered wood case, 7 1/2 x 9 1/2 x 3 1/2 in. deep, with carrying handle and ample room for small tools as well as leads. An ideal multi-range meter for all general purposes. LIST 15 gns.

LASKY'S PRICE **£8/19/6**
Post 5/-.

Leads, 7/6 extra.

VERY LIMITED QUANTITY

LABGEAR A.F. POWER METER KIT. Two ranges: 25 milliwatts to 1 watt; 1 watt to 10 watts. Accuracy 5% and matched for 3, 15 and 600 ohms. Dimensions: 4 1/2 x 6 1/2 x 3 1/2 in. COMPLETE KIT with clear step-by-step instructions, circuit, data, **59/6** Post 1/6.



LASKY'S
CAR RADIO
CAN BE BUILT
ABSOLUTELY COMPLETE
FOR **£11/19/6**
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- ★ Small size. Will fit any car.
- ★ 12 volt operation.
- ★ New Hybrid circuit.
- ★ Transistor 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. x 4in. elliptical speaker.
- Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 (returned if you order).

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OVER 100 ILLUSTRATED PAGES, SIZE 8 x 5 1/2 in.

Price 2/- Post 6d.
Latest 12-page BARGAIN BULLETIN included free.

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Dept. W 237 Edgware Road, London, W.2.

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., 37/6, 6-9 mc/s., 59/6, 9-14 mc/s., 59/6, 14-25 mc/s., 59/6.

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 T81. Suitable for all audio applications. Post 6d. **3/6**
One dozen 35/- post free.

Special prices quoted for large quantities. Enquiries invited.

OC44 15/-; OC45 15/-; OC70 8/6; OC71 8/6; OC78 15/- (Matched Pair 30/-); OC73 14/-; OC18 54/-.

EDISWAN MAZDA TRANSISTORS. The very latest types. XB/102 10/-; XB/103 10/-; XC/101 12/6; XA/101 15/-; XA/102 17/6.

SPECIAL OFFER. Set of 7 Ediswans 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/-.

MINIATURE EARPHONES FOR POCKET TRANSISTOR RADIOS

High quality and remarkably sensitive, giving clear reproduction of music as well as speech. Lightweight and comfortable to wear. Supplied complete with transparent ear-insert 3ft. cord, sub-miniature jack and socket. Fully guaranteed.

Mdl. CR-5. Crystal Earpiece, high imp. **12/6**
Mdl. MR-4. Magnetic Earpiece, low imp. **10/-**
Post free.

SUB-MIN. COMPONENTS FOR TRANSISTOR RADIOS

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.

OPEN ALL DAY
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Early Closing
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SAMSON'S SURPLUS STORES LTD.

LONDON'S GREATEST DEALERS IN RADIO AND ELECTRONIC EQUIPMENT

HEAVY DUTY L.T. TRANSFORMERS
LONDON'S LARGEST SELECTION



All ratings tropical and in perfect condition.

No. 1. Pri. 240 v. Sec. 6.12 v. 10 amps. 45/- Carr. 4/-.

No. 2. Pri. 100-240 v. Sec. two separate windings. Tapped 15, 17 v. 4 amps. 37/6 Carr. 4/-.

No. 3. Pri. 200-240 v. Sec. 6.3 v. 15 amps. 25/- P.P. 3/6.

No. 4. Pri. 220-240 v. Sec. four separate windings 3 x 5 v. C.T. 4 amps., 4 v. 4 amps. Potted type, 32/6. P.P. 3/6.

No. 5. Pri. 220-240 v. Sec. three separate windings, 6.3 v. 4 amps. C.T., 6.3 v. 4 amps. C.T., 6.3 v. 4 amps. 29/6. P.P. 3/6.

No. 6. Pri. 230 v. Sec. 6.3 v. 5 amps., 6.3 v. 1 amp. and tapped H.T. winding, 65 v., 130 v., 195 v., 85 mA., 15/- P.P. 2/6.

No. 7. Pri. 220-240 v. Sec. tapped 9 v. 15 v. 4 amps. 22/6. P.P. 3/6.

No. 8. Pri. 220-240 v. Sec. tapped, 12, 20, 24 v. 2 amps., 22/6. P.P. 3/6.

No. 9. Pri. 200-240 v. Sec. tapped 48, 56, 60 v. 1 amp., 27/6. P.P. 3/6.

No. 10. Pri. 200-240 v. Sec. tapped 3, 5, 12, 20, 30 v. 2 amps., 25/- P.P. 3/6.

No. 11. Pri. 230 v. Sec. 10 v. C.T. 10 amps. and 4 v. 7 amps., 32/6. P.P. 3/6.

No. 12. Pri. 200-240 v. Sec. tapped 30, 32, 34, 36 v. 5 amps., 57/6. Carr. 4/-.

No. 13. Pri. 200-240 v. Sec. tapped 10, 17, 18 v. 10 amps., 57/6. Carr. 4/-.

No. 14. Pri. 230 v. 50 v. 2 a., 6.3 v. 5 a., 6.3 v. 2 a., 6.3 v. 1 a., 6.3 v. 0.6 a., 5 v. 3 a., 5 v. 5.6 Potted type, 39/6. Carr. 5/-.

No. 15. Pri. 240 v. Sec. tapped 6 v.-12 v., 20 amps., 69/6. Carr. 4/-.

No. 16. Pri. 240 v. Sec. tapped 12 v.-18 v., 10 amps., 52/6.

No. 17. Pri. 230 v. Sec. 4.2 v. + 4.2 v. 10 amps., 25/- P.P. 3/6.

No. 18. Pri. 230 v. Sec. 24 v. 30 amps., £8/10/- Carr. 5/-.

No. 19. Pri. 230 v. Sec. 20 v. 20 amps., £4/5/- Carr. 5/-.

No. 20. Pri. 230 v. Sec. 20 v. 30 amps., £6/15/- Carr. 5/-.

SPECIAL OFFER: PARMEKO L.T. TRANSFORMERS. Pri. 230 v. Sec. 24 v. 2 amps. Tropically rated, completely enclosed in metal cases with fitted fuses and neon indicator. Brand new in maker's cartons. Fraction of cost. 25/- P.P. 3/6.

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.

JUST ARRIVED. EXCLUSIVE PURCHASE OF A.M. HEAVY DUTY TRANSFORMERS
(A) Pri. 400-440 v. S.P. Sec. 220 v. or 110 v. 600 watts. £6/10/- Carr. 7/6.
(B) Pri. 230 v. Sec. 55 v. 10 amps. £5/19/6 Carr. 7/6.
(C) Pri. 230 v. Sec. 230 v. or 110 v. 600 watts. £5/19/6 Carr. 7/6.

GUNFIRE ELECTRIC TIME SWITCHES A.C. 200-250 v. 20 amp. switch contacts. Make and break once every 24 hours. Complete with mounting bracket, earth strip and instructions. Supplied brand new at a fraction of maker's price. 69/6. P.P. 2/6.

A.M. CAPACITORS TROPICALLY RATED AND GUARANTEED



BRITISH TYPES. 30 mfd., 400 v. wkg., 10/6. 16 mfd., 500 v. wkg., 20 mfd. 500 v. wkg., 15/- each. 8 mfd., 1,500 v. wkg., 12/6. 10 mfd., 450 v. wkg., 8/6. 8 mfd. 500 v. wkg. sub chassis mounting, 8/6. 8 mfd., 250 v. wkg., 5/6. 4 mfd. 1,000 v. wkg., 5/- 4 mfd., 800 v. wkg., 4/6. 2 mfd., 1,000 v. wkg., 3/9. 0-5 mfd., 2,000 v. wkg. 4/6. 15 mfd. 250 v. wkg. A.C., 15/- P.P. 2/- 8 mfd. 1,000 v. wkg. at 71 deg. C., 10/6. P.P. 2/- 4 mfd. 1,500 v. wkg. at 140 deg. F. 10/6. P.P. 2/-.

AMERICAN TYPES. 45 mfd., 200 v. wkg., 10/6. 16 mfd., 400 v. wkg., 8/6. 10 mfd., 1,500 v. wkg., 15/6. 10 mfd., 600 v. wkg., 10/6. 8 mfd., 1,500 v. wkg., 12/6. 6 mfd., 330 v. wkg., A.C., 7/6. Please add 2/- postage on all capacitors.

AMERICAN HIGH VOLTAGE CAPACITORS. 2 mfd., 10,000 volts wkg., £8/10/- 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.

A.M. 4 1/2" A.C. VOLT METERS 90-180V.



Manufactured by Crompton Parkinson MI 50 cycles, supplied new and guaranteed, 32/6. P.P. 3/6.

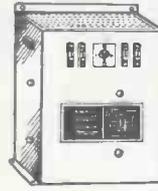
STURTEVANT A.C. 220-240 v. BLOWERS. Cap. start. 0.012 h.p. Complete with fan housing and capacitor. Brand New. £4/17/6. Carr. 7/6.

SANGAMO SYNCHRONOUS MOTORS A.C. 200-250 v. 1 1/2 in. dia., 7/6. P.P. 1/6.

RECTANGULAR 500 MICROAMMETERS. 5 x 4 in. Panel mounting. Scaled 0-250, 59/6. P.P. 2/6.

CROMPTON PARKINSON 4 1/2 in. A.C. MI AMMETERS. 0-30 amps. flush mounting, 27/6. P.P. 3/6.

WESTINGHOUSE HEAVY DUTY L.T. SUPPLY UNITS TYPE 115. A.C. input 200-250 volts. D.C. Output 26 amps. into a 24 volt (nominal) battery. Rating continuous. Max. ambient temp. 35 deg. C. Completely smoothed and stabilised. Built in metal case approx. size 17 x 21 x 19 inches. With fitted fuses. On/Off switch. Reconditioned as new. £32/10/- ex warehouse. Original maker's price over £100.



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 15 1/2 in. x 12 in. x 6 1/2 in. £7/10/- Carr. 15/-.

AMAZING OFFER!! POWERFUL 6-12 v. D.C. MINIATURE MOTORS.



OFFERED AT A FRACTION OF MAKERS PRICE

Weight 2.1 oz. Motor dimensions 1 1/2 in. long, 1 1/2 in. dia. Spindle 0.4 in. long, 0.77 in. dia. Consumption 0.72 watts off load, 7.68 watts on load. Speed 7,000 r.p.m. Switch. Centre off reverse by switching either side. General specification. These motors have a tremendous power-weight ratio, are extremely efficient. Can be used on 6 volts without great loss in power. Precision built in polythene housing. Self lubricating. With sintered bronze bearings. Easily mounted. Supplied brand new and guaranteed, 15/6. P.P. 1/6. Special price for quantities over 50.

BRAND NEW AIR MINISTRY POCKET VOLT METERS



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/-.

HEAVY DUTY AUTO TRANSFORMERS. Tropically rated at 5 kVA. Tapped 250, 240, 230, 220, 120, 115, 110, 105 volts. Completely enclosed in metal case. Size 23 x 14 x 1 1/2 in. Weight approx. 2 cwt. Brand new, £15. Ex-warehouse.

We have London's largest selection of Auto Transformers from 60 watts to 15 kVA. Available from stock. Let us know your requirements.

AMERICAN HEAVY DUTY AUTO TRANSFORMERS. 7 1/2 kVA, 115-230 v. "C" core winding. Completely enclosed, £12/10/-, ex-warehouse.

BRAND NEW ARON 50 AMP. CHECK METERS. 200-250 volts A.C. single phase, 37/6.

A.C. ELECTRIC CHECK METERS. 200-250 v. 20 amp., 22/6. 10 amp. 19/6, carr. 3/6. Reconditioned and guaranteed.

HEAVY DUTY FOOT SWITCHES. Press to break, size of pedal 4 1/2 x 3 1/2 inches. 17/6. P.P. 3/6.

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 75 v. D.C. output 18 amps. £7/10/- Carr. 5/-.

No. 3. Max. A.C. input 80 v. D.C. output 3 amps. £3/5/- Carr. 5/-.

No. 4. Max. A.C. input 45 v. D.C. output 8 amps. funnel cooled. 59/6. Carr. 4/-.

No. 5. Max. A.C. input 18 v. D.C. output 15 amps. 45/- Carr. 3/6.

24 v. AIRCRAFT PUMPS AND AIR BLOWERS AVAILABLE FROM STOCK. PUMPS FROM 35/- BLOWERS FROM 17/6.

RECTANGULAR 500 MICROAMMETERS. 5 x 4 in. Panel mounting. Scaled 0-250, 59/6. P.P. 2/6.

A.M. HEAVY DUTY CUT-OUTS. Type 7. Completely enclosed in Bakelite case. 8/6. P.P. 2/-.

SPECIAL OFFER HIGH GRADE PVC SLEEVING. 6 mm. 100 yd. coils, 10/6. P.P. 2/- 2 mm. 1 gross yd. coils 6/- P.P. 2/- 1 mm. 250 yd. coils, 6/- P.P. 2/-.

R.C.A. 1616 VALVES. Brand new and boxed. 3/6 each. P.P. 1/6. Six for 17/6. P.P. 3/6.

AMERICAN PRESSURE ACTUATED SWITCHES. Proof P.S.1.75., 10/6. P.P. 2/-.

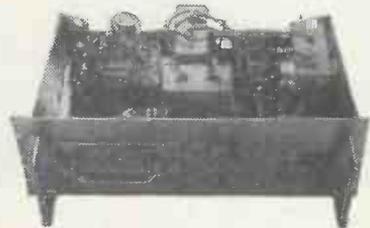
RCA AR88D RECEIVERS

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 Cracked Case size 19 1/2 in. W. x 11 in. H. x 19 1/2 in. D. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. Covers 500 kc/s-32 Mc/s, price (add carriage 30/- and 50/- deposit on returnable transit case). **£45** S.A.E. brings illustrated descriptive leaflet.

R1155 RECEIVERS

The famous Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges: 18.5-7.5 Mc/s. 7.5-3.0 Mc/s, 1,500-600 kc/s., 500-200 kc/s., 200-75 kc/s. and is easily and simply adapted for normal mains use, full details being supplied. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Fitted with latest type Super Slow Motion tuning assembly. Have had some use, but are in excellent condition. **ONLY £9/19/6**. 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 19 in. x 7 in. **ONLY 59/8** (carriage, etc. 7/6). Or fitted with 2 1/2 in. A.C. volts output meter, 79/8 (plus carr. as above).

CARRYING CASES, solid leather. SLIGHTLY USED. Internal dimensions 8 1/2 in. H. x 8 1/2 in. W. x 4 1/2 in. D. Fitted lock and key, and shoulder strap. Ideal for Test Instrument, Camera and accessories, etc. **ONLY 25/-** (postage 2/-).

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/-).

ERO 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 cracked case **ONLY 59/6**.

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, 6 1/2in. 17/6, 8in. 21/-, 12in. 29/6.

SPRAGUE CONDENSERS. Metal cased wire ends. New. .01 mfd. 1,000 v. and .1 mfd., 500 v. 7/8 per dozen. Special quotes for quantities.

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 5 1/2 in. x 3 1/2 in. x 2 1/2 in. Beautifully made, and fully guaranteed. Complete with leads, prods and internal battery. **ONLY 59/6**



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

W 1191A WAVEMETER

Crystal controlled heterodyne frequency meter covering 100 kc/s to 20 Mc/s. in 8 switched bands and is virtually the British BC221. Power requirements 2 v. LT, and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Valves and full set of spares. **BRAND NEW IN ORIGINAL TRANSIT CASES. ONLY £9/19/6** (carriage 15/-).

METERS

F.S.D.	SIZE AND TYPE	PRICE
25 microamps	D.C. 2 1/2 in. Proj. circular	59/6
50 microamps	D.C. 2 1/2 in. Flush circular	59/6
50 microamps	D.C. 2 1/2 in. Flush circular	30/-
100 microamps	D.C. 2 1/2 in. Flush circular	39/6
1 milliamp	D.C. 2 1/2 in. Flush square	22/6
1 milliamp	D.C. 2 1/2 in. Flush circular	30/-
1 milliamp	D.C. 2 1/2 in. Flush circular	25/-
1 milliamp	D.C. 3 1/2 in. Flush circular	50/-
200 milliamp	D.C. 2 1/2 in. Flush circular	12/6
20 amps	D.C. 2 1/2 in. Proj. circular	7/8
40 amps	D.C. 2 1/2 in. Proj. circular	7/8
5 amps	D.C. 2 1/2 in. Flush square	12/6
300 volts	A.C. 2 1/2 in. Flush circular	25/-
500 volts	A.C. 2 1/2 in. 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 1,500-2,400 cycles. In substantial Oak case w. removable lid, overall size 8 1/2 in. x 8 1/2 in. x 5 1/2 in. Recently made for the Air Ministry, by Everett Edgecombe, 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.



POWER UNIT TYPE 3. Primary 200/250 volts A.C. 50 cycles. Outputs of 250 volts 100 mA., and 6.3 volts 4 amps. Fitted double smoothing and 2 meters to read H.T. current and voltage. For normal rack mounting (or bench use) having grey front panel. Size 19 in. x 7 in. **BRAND NEW. ONLY 79/8** (carriage 7/6).

INTERCOM. TELEPHONE SET. Two pairs of Brand New Headphones connected to Breast Microphones, with leads, etc. in fitted carrying cases. Supplied with 4-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 Cayb model is a handy pocket sized tester 5 1/2 x 3 1/2 x 2 1/2 in. 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 mega. D.C. current to 250 milliamps and also Decibels. Complete with Test Leads, Batteries and Instruction Book. **ONLY £8/10/-**.

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 milli. Size 5 1/2 x 3 1/2 in. diameter. Ideal for running Radio and Electric Shaver etc. from car battery. **ONLY 32/6**.

MARCONI SIGNAL GENERATOR TF 1440/7. Coverage 85 kc/s-2.5 Mc/s and 8 Mc/s-70 Mc/s. Complete, and in **AS NEW CONDITION. ONLY £95**.

AMPLIFIER N24



Utilises 4 valves, 1 each 5Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Pack Smoothing Condensers. A.C. Mains Pack for nominal 110 x 230 volts. Provision for 600 ohms or High Impedance Input. Output to 600 ohm line. For normal use only requires changing Output Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19 in. x 7 in. All connections to rear panel, front having "On/Off" Switch Gain Control, Indicator Light, Fuses and Valve Inspection Panel. **BRAND NEW IN MAKER'S PACKING. ONLY £4/9/6** (carriage 10/6).

Cash with order please, and print name and address clearly
PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

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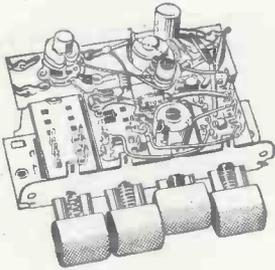
We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

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LONG AND
SHORT WAVE**

**SEVEN TRANSISTOR
SUPERHET**

★ **PRE-BUILT UNITS** ★

—THE NEW EASY WAY TO BUILD A RADIO—



- Press Button Short, Medium and Long Wave Coil Pack (illustrated), OC170 OSC/Mixer staged. Printed Circuit. Pre-aligned and tested. 90/3. P.P. 1/6.
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- 8in. Ferrite aerial with coils, 12/6. 176pF-176pF Tuner for above, 9/6. 7 x 4in. 3 ohm Speaker, 20/-.

**FULLY ILLUSTRATED BOOKLET SHOWING
INTERCONNECTION OF ABOVE..... 2/6**

6-TRANSISTOR RADIO

Size 3 x 2½ x ¾ in.

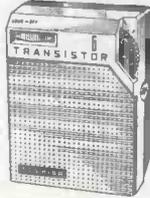
**THE WORLD'S
SMALLEST RADIO**

**FITS INTO VEST
POCKET OR PURSE**

Complete with Batteries, Leather Case, Earphone, in Presentation Box.

- All your favourite stations, including Luxembourg.
- Superhet Circuit with Push-Pull output on 2in. speaker.
- 540 to 1600 kc/s coverage.

BUILT AND READY TO USE



CASH OR C.O.D.
12 gns Reg. Post Free.

9.72 Mc/s IF STRIP

- 2-EF92 Valves
- 3-EF91 Valves
- 1-EB91 Valve

32/6 P.P. 1/6



BRAND NEW WITH DIAGRAM

● **SPECIAL OFFER** ●

**6 EDISWAN TRANSISTORS
AND TWO DIODES**

- 1-XA102
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 - 2-XC101
 - and
 - 2 Diodes
- ONLY 57/6**
PER SET

● **SPECIAL OFFER** ●

**6 MULLARD TRANSISTORS
AND DIODE**

- 1-OC44
 - 2-OC45
 - 1-OC71
 - 2-OC72
 - and
 - 1-OA81
- ONLY 60/-**
PER SET

● **SPECIAL OFFER** ●

**6 MULLARD TRANSISTORS
AND DIODE**

- 1-OC44
 - 2-OC45
 - 1-OC81D
 - 2-OC81
 - and
 - 1-OA81
- ONLY 62/6**
PER SET

● **SPECIAL OFFER** ●

**1 WATT MULLARD
AMPLIFIER**

- 1-OC71
 - 1-OC81D
 - 2-OC81
- ONLY 49/6** PER SET

MATCHED SETS FOR HIGH SENSITIVITY

★ **A SMALL SELECTION FROM OUR RANGE OF EASY TO BUILD TRANSISTOR UNITS** ★

— **DIAGRAMS 6d. EACH POST FREE** —

**HEARING AID
THREE TRANSISTOR,
TRANSFORMER**

Coupled high gain circuit. Size 3 x 2 x ¼ in., including mic. and battery.

All parts with earphone. 70/6. P.P. 1/-.

RF, IF and AUDIO TRACER

Handy test unit. Ideal for servicing all types of radios, etc. Includes min. earphone, two transistors. Size 3 x 2 x ¼ in. All parts. 45/- P.P. 1/-.

2-WATT OUTPUT AMPLIFIER

Single transformer coupled power transistor. Ideal for added output when using your portable in the car. Works from 12 to 14 volt supply. All parts. 49/6. P.P. 2/-.

RADIO CONTROL RECEIVER

Four transistor transformer, coupled single channel. Size 3 x 2 x ¼ in. Weight 2 oz. Operates actuator, etc., direct. Range approx. ½ mile. All parts (less battery). 59/6. P.P. 1/6.

250mW OUTPUT AMPLIFIER

Two transistor push-pull output stage. For use with Ranger-3 or similar. Includes Elao 3in. speaker. All parts with battery. 59/6. P.P. 1/6.

3-12 MC/S CRYSTAL MARKER.

Uses Crystal controlled oscillator. fundamental crystals of FT243, 10X, R76, etc. All parts (less crystal). 20/- P.P. 1/- Crystals from 5/- See separate list. Ideal for frequency check or BFO.

NEW LIGHT OPERATED SWITCH

With two transistors and light sensitive cell. Operates from 12 to 18 volts. Includes relay. Size 3 x 2 x ¼ in. All parts. 29/6. P.P. 1/-.

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For alignment of all receivers. Output 450 to 485 kc/s. Steps up to 4 Mc/s. Size 3 x 2 x ¼ in. All parts 22/6. P.P. 1/-.

AUDIO TEST GENERATOR

New design giving pure sine wave. Approx. 1 kc/s. Ideal for bridges, modulator or amplifier checker. All parts. 24/- P.P. 1/-.

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Ideal for the busy office. No more "holding on" and waiting time. Four transistor push-pull circuit; 5in. speaker. Attractive cabinet. All parts with battery and telephone coil. 92/6. P.P. 2/-.

BUILT AND TESTED £5/10/-

P.P. 2/-.

LOW IMPEDANCE PRE-AMP

For coupling a low impedance mic. or P.U. to a valve amplifier. Works from 150 to 250 volts D.C. taken from amplifier. HIGH GAIN, NO HUM. All parts 12/6. P.P. 1/-.

ALL PARTS IN STOCK FOR "WEYBARD"

6-TRANSISTOR SUPERHET
● FREE LIST ON REQUEST.

**"STEREO
3-D"**

**STEREO RECORD PLAYER
AMPLIFIER**

New high-gain circuit with full tone, balance and volume controls. Can be used with all types of records as well as stereo.

- ★ 2 WATTS PEAK PER CHANNEL
- ★ ECC83; 2-ECL82 VALVES
- ★ MAINS 110/250V A.C.

Complete with speaker sockets, calibrated dials, etc. **£5.7.6**
P.P. 2/-

BUILT AND TESTED

- ★ ★ **COLLARO 4-SPEED STEREO AUTO-CHANGER**, ideal for use with above amplifier, £7/10/-, P.P. 3/6.
- ★ ★ 9 x 6in. large magnet Elac speaker, for use with STEREO 3-D, 37/- pair. P.P. 1/6.

**PRACTICAL
TRANSISTOR CIRCUITS**

No 2. GADGETS RECEIVERS
AMPLIFIERS TEST UNITS
TRANSMITTERS All transistor

Now contains 40 Easy to Build Transistor Circuits for the home constructor with diagrams and prices. **3/6** POST FREE

**931A (27M1)
(CV 2696)**

PHOTO MULTIPLIER

Brand new, original cartons.

60/- P.P. 1/-
Base 2/-.

Also: Special purpose 931A-CV337
80/- each. Base 2/-.

DECCA AMPLIFIER

As supplied in the well-known Deccamatic III. Uses ECL82 valves, full range tone and volume controls. Size 8½ x 3½ x 3in. P.P. 2/6.

● **IDEAL FOR PORTABLE RECORD
PLAYER** ●

8 x 6in. CELESTION SPEAKER for use with above. 25/- P.P. 1/-.

**QUARTZ
CRYSTALS**

FOR TRANSMITTING
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FREE ON REQUEST.**

The "CONTESSA" NEW 6-TRANSISTOR COMBINED PORTABLE/CAR RADIO

SPECIFICATION

- 425mW Push-Pull Output
 - 6 "Top Grade" Ediswan Transistors
 - New Type Printed Circuit with all Components Marked
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 - High "Q" Internal Ferrite Aerial
 - Car Radio Adaptation and AVC
 - Slow Motion Fingertip Tuning
 - "Hi-Fi" Quality Speaker
 - Size 10 x 7½ x 3½ in. Weight 4½ lb.
- All components available separately



"First Class in every way"

EQUALLY SENSITIVE ON MEDIUM AND LONG WAVE BANDS
 ★ STEP BY STEP FULLY ILLUSTRATED INSTRUCTIONS
 ★ ALL COMPONENTS GUARANTEED
 ★ AFTER SALES SERVICE

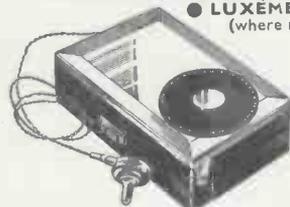
Total Cost of all Components
£11.10.0 P.P. 3/6
 including Cabinet, Battery, Transistors, Car Radio, AVC and all necessary items.
 ★ NO TECHNICAL KNOWLEDGE REQUIRED
 ★ STEP BY STEP WHEN BUILT
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DESCRIPTIVE LEAFLET FREE ON REQUEST

ALL THE CONTINENTAL AND LOCAL STATIONS AT YOUR FINGERTIPS
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★ RANGER-3 ★ PERSONAL POCKET RADIO

FULL TUNING OF MEDIUM WAVEBAND AND AMATEUR TOP BAND (120 metres to 500 metres)

● LUXEMBOURG GUARANTEED (where normally receivable)



- ★ Full Station Separation Calibrated Dial
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- ★ Size 4½ x 3 x 1½ in.

TOTAL COST with Personal Earphone, Battery Transistors, etc.

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 All parts sold separately and guaranteed.

- NO EXTERNAL AERIAL OR EARTH
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Full Instructions and Prices FREE On Request. Continental as well as local stations—GUARANTEED!

THE "PW" 6-TRANSISTOR POCKET SUPERHET

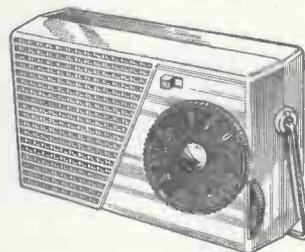
Full Medium and Long Wave Tuning

- ★ Printed circuit with all components marked
- ★ 6 MATCHED MULLARD TRANSISTORS

- ★ Built-in Ferrite Aerial
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All Parts Sold Separately

- Easy Construction
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TOTAL COST OF ALL NECESSARY ITEMS
£9.19.6
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 ● ACKNOWLEDGED THE SPECIALISTS ●

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36 WINCANTON RD., HAROLD HILL, ROMFORD



MICROPHONE Carbon hand type (as illus.) with pressel switch and lead Brand New 6/- ea.

Tannoy Power Type with switch and lead. Brand New 7/6 each.

HEADPHONES, LOW RESISTANCE Sound power type DLR5, complete with low level dynamic throat microphone. Suitable for crystal sets etc. Brand new and cartoned. 8/6 pair.

BLOWER MOTOR. Made by Hoover. 80 volt D.C. Will operate on 240 volt A.C. with 8 mfd. cond. in series. New and cartoned 17/6 ea.

HYSTERESIS MOTORS. By Smith's Aircraft Instruments. Type: HM2/1/D. Drag Cup. 2 volt 400 cycles. 40/- each. New. Type HM/14/1. 115 volt 400 cycles. 50/- each. New. Type: HM/12/10. 115 volt 400 cycles. 50/- each. New.

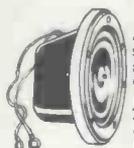
8 FOOT WHIP AERIALS. Supplied in 2 sections. No. 1 and 2. ZA/26800 and 26286. Each section collapsible down to 1ft., with retaining wire through each section. Ideal also for Radio Control, fishing rod or pennant mast. 7/6 complete. New.

ROTARY TRANSFORMERS TYPE HT.31.



Input: 11.5 volt. Output: 250 volt at 120 mA. Type HT.32. Input: 11.5 volt. Output: 490 volt at 65 mA. HT.31. Ex-Units but tested, 35/- ea. HT.32. New, in cartons, 20/- ea.

12-VOLT VIBRATORS: 4-pin non-synchronous. Manufactured by Mallory. New in original Cartons of 20. Sorry no smaller quantity supplied. 21/- per 20.

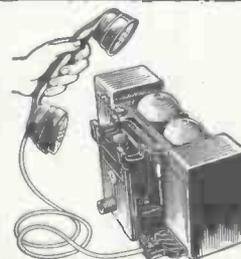


MINIATURE DYNAMIC SPEAKERS

A must for all build-it-yourself hams. As supplied with all current transistor kits. Can also be adapted for home phones or inter. com. 2in. diameter, resistance 70 ohms. **ONLY 5/- each.** New and unused.

TELEPHONE SETS

Ex-Army. TYPE "F." Ideal Phone system between 2 points. Efficient up to 5 miles. For use in Factory, Building Sites, Timber Yards and Offices. Housed in portable carrying case, and complete with Ringer and 100ft. twin twisted telephone wire. As new. Tested and guaranteed.



OUR PRICE ONLY
£5.19.6 per pair.

PLESSEY E.H.T. CONCENTRIC CONNECTORS

Types available. Plugs: CZ 64662/64658/64646. Sockets: CZ 64659/64661. New and unused. For Radar Stations, TV Link-ups and Atomic research applications. **8/6 pair or 5/- each**



HEADPHONE AND MICROPHONE ASSEMBLY. No. 1 Moving coil. As used on W.S. No. 19. New and packed. 21/- complete assembly.

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: 2½ in. long x 1 in. wide. Spindle: ½ in. x ⅛ in. **Only 9/6 each**



BENDIX DYNAMOTORS. New and packed. Input 28 volts D.C. 16 amps. Output 230 volts. 100 mA. Type D.A.I.A. 12/6 each.

TERMS: C.W.O. or 7 days approved accounts. All our goods are guaranteed new or in working order. Money refunded in full if not absolutely satisfied. Orders despatched same day. No postal or packing charges.
 (C.O.D. 1/9 extra. Carriage extra Ireland and countries outside U.K.)

CLYNE RADIO LTD.



18 TOTTENHAM COURT RD., LONDON, W.1

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 All post orders and correspondence to 162 HOLLOWAY RD., LONDON, N.7

Open: Tottenham Court Rd., and Cheapside: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m. Holloway Road: 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!!

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, key-boards, chokes, etc., are available ready made. Full constructional details are available in book form at 15/- plus 1/6 p. and 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.

CLYNE CATHODE RAY OSCILLOSCOPE for Home Construction (37)

A recent addition to our comprehensive stocks of quality equipment for the constructor. This is an exceptionally sound and robust instrument of the most versatile type, that will be a boon to the seriously minded amateur, serviceman or constructor. Specifications: 8-Range Time Base, switched from 20 c/s to 160 Kc/s. Y-Plate Amplifier has a sensitivity of 50 mV, and frequency response of 20 c/s to 600 Kc/s with a gain of 150. A calibrating voltage of 6.3 v. 50 c/s. is provided. Employs ECR30 2 1/2 in. Cathode Ray Tube and 4 valves: 2/ECF80, 1/EF91, 1/6X5.



Controls: X-shift, Y-shift, Focus, Width, Brilliance. ON/OFF. Time Base Frequency (Fine), Time Base Frequency (Coarse), Sync Selector, Sync. Amplitude, Y-input Selector, X-input Selector, Amplifier Gain. Operates from 200/250 v. A.C. Mains. All required components for the construction of this wonderful instrument, including comprehensive assembly instructions, available at a SPECIAL INCLUSIVE PRICE OF ONLY £12/19/6, plus 5/- c. and p. Attractive engraved Ivorine Front panel, optional extra at only 10/6. Just arrived! Portable carrying case at 45/- extra.

THE NEW LOOK RAMBLER PORTABLE



This wonderful little Medium and Long wave battery superhet incorporates IR5, IT4, IS5, 3V4 miniature valves, 5in. speaker and frame aerial. Housed in smart two-tone Red/Grey cabinet. All required components at 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.

(2) MAINS UNIT FOR ABOVE. Fits into battery compartment. A.C. 200/250 v. All required components at ONLY 47/6 plus 1/6 p. & p. or assembled and tested at £3/5/- plus p. & p. (Also suitable for many other portables.)

NEW LOOK ECONOMY FOUR



(3 & 4)

Our very popular three-valve plus rectifier mains T.R.F. receiver is now available with a new De Luxe cabinet with polished Walnut finish and Cream trimming (as illustrated). Brief Spec.: Valve line-up 6K7, 6I7, 6V6 and contact cooled rectifier. Ready drilled chassis, good quality 5in. loudspeaker, Special Denco Coils Covers Medium and Long Wavebands. Overall dimensions: 12in. x 6in. x 5in. high 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 £5/10/-, plus 5/- p. & p. Instruction book available separately 1/6, post free. Also available with plastic cabinet in IVORY or BROWN if preferred at ONLY £5/5/-, plus p. & p.

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 £5/10/-, plus 5/- p. & p. Instruction book available separately 1/6, post free. Also available with plastic cabinet in IVORY or BROWN if preferred at ONLY £5/5/-, plus p. & p.

RADIO JACK

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.

RECORD PLAYERS

Full range at usual competitive prices. Interesting H.P. facilities E.M.I. 4-SPEED STEREO/MON- AURAL SINGLE RECORD UNIT. Complete with Stereo Head and Sapphire Styli. Brand New and Fully Guaranteed. ONLY £6/19/6 plus 3/6 P. & P.

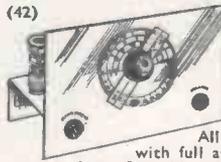
LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10in. and 12in. records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price 10½ gns. plus 3/6 P. & P.

LATEST B.S.R. UA14. 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. £7/19/6, plus 3/6 P. & P.

B.S.R. UA8 STEREO/MON- AURAL. Few only at £7/19/6, plus 3/6 P. & P. Brand new Guaranteed. B.S.R. UA8. Monaural only. £6/19/6, plus 3/6 P. & P.



The CRY (19) BABY ALARM
 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 7 1/2 in. x 3 1/2 in. x 6 1/2 in. 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.



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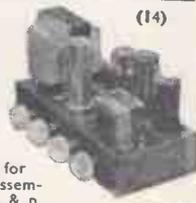
SUPER I-VALVE SHORT-WAVE RADIO

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.

THE R.C. 3/4 WATT AMPLIFIER

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 feedback. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1 1/2 in. 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.



(14)

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 "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

400 MILLIWATTS OUTPUT

To build yourself Medium and Long waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6½in. 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.

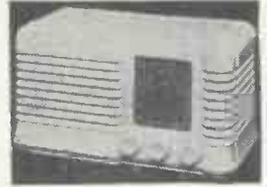
Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3). Oscillator Coil, Trimmer Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. **SPECIAL INCLUSIVE PRICE** for all required components, full assembly instructions—nothing 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 service separately, 2/6, post free.



(43)

THE CLYNE RADIO "DE LUXE" PRINTED CIRCUIT SUPERHET (22)

A new two-wave band (L and M) Superhet using the latest miniature valves: EC88, EF85 and ECL80, plus contact cooled



Rectifier. Incorporates Ferrite Rod Aerial and is of unit construction. Exceptional sensitivity and selectivity. Outstanding performance and quality T.C.C. condensers throughout. Easily constructed in one evening. Brown or ivory Bakelite or wooden Walnut finish cabinet. A.C. mains 200/250 v. All necessary components at special inclusive price of £7/19/6 plus 3/6 P. & P. Instruction Book with itemised price list available separately at 1/6 post free. Also available in De Luxe Cabinet (as "Economy Four" at 5/- extra).

TO BUILD YOURSELF

ALL PARTS AVAILABLE SEPARATELY

"PRACTICAL WIRELESS" POCKET SUPERHET

All required Components for the complete Osom version as described in November issue of "Practical Wireless" now available at special inclusive price of £9/19/6 complete, including Printed Circuit and Osom booklet. All items available separately, send stamp for list.

	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.
(3) "ECONOMY FOUR" T.R.F. Mains Receiver	£5 5 0	2/6	1/6
(4) "ECONOMY FOUR" with New Look Cabinet	£5 10 0	2/6	1/6
(5) "FAMILY FOUR" (our new T.R.F. Receiver)	£3 19 6	2/6	1/6
(6) "SUPERIOR FOUR" (four valve mains receiver)	£5 15 0	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.
(17) R.C. Super Transistor/Crystal Rec. (ditto)	£1 7 6	1/3	3d.
(18) R.E.P. 1-valve Battery Receiver	£2 2 0	2/6	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 WII Wobblulator	£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, Printed Circuit, 5-valve S'het. NEW LOW PRICE	£11 19 6	3/6	2/6
(40) JASON Audio Generator AG10	£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	2/6	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/-

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

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 fiddly 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 dead-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.



(45)

SUPER PERSONAL PORTABLE. A wonderful little set you can take anywhere. Ideal for camping, etc. Detachable aerial rod supplied. Covers Medium wave-band 200-500 metres. Can be built in approx. 1 hour. All necessary components available at the following SPECIAL INCLUSIVE PRICES: 1-valve version **ONLY 35/-** plus 2/- P. & P. Super 2-valve version **ONLY 41/-**. Plus 2/- P. & P. Send for point-to-point wiring diagram and parts price list 2/- post free. Extra for use with the above DLR5 balanced armature headphones, 7/6 pair.



(32) & (33)

"FAMILY FOUR" (5)

Our supersensitive T.R.F. Receiver for home construction. Covers Long and Medium Wavebands, is housed in very smart plastic table cabinet in Brown or Black. For A.C. mains 200/250 v. Comprehensive assembly instructions provided, including practical and theoretical diagrams, which are easy to follow and will enable you to complete this receiver which will be the envy of your friends. **ALL NECESSARY COMPONENTS ONLY 79/6**, plus 2/6 P. & P. Instruction book available separately if you wish to study before purchase at 1/6 post free.



PRINTED CIRCUIT CAR RADIO

(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 out-put 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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TURN OVER FOR MORE CLYNE BARGAINS

CLYNE RADIO LTD.

THE COMPONENT SPECIALISTS

18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
99 Cheapside, London, E.C.2.

★ MORE CLYNE RADIO BARGAINS ★

CATHODE RAY TUBES. Un-repeatable offer! 17in. MWV 43/69 by leading British Manufacturer. Brand new in original cartons. Not regunned. Full 12-month guarantee. Limited quantity at £7/10/- each only, plus 10/- P. & P. Send stamp for comprehensive Valve and Tube List.

METERS. Large selection of panel mounting meters at competitive price. Send stamp for new list now ready.

ANOTHER PORTABLE CABINET! Ex leading manufacturer's battery portable attaché type case. Attractive two-tone grey rexine finish. Size closed 13½ in. x 9½ in. x 3½ in. 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.

AUDIO GENERATOR AG10. Covers from 10 c/s to 100 Kc/s in four ranges. Max. output 10 volts. Min. output 100 microvolts. Square wave output with excellent rise time makes this generator very



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useful for checking all Audio equipment. Housed in attractive metal shelf mounting case measuring 11½ in. x 6½ in. x 5½ in. high. All necessary components available, including valves, at a Special Price of £14/5/-, plus 3/6 P. & P. Fully descriptive booklet with comprehensive assembly instructions available at 2/- post free.

CABY UNIVERSAL TEST METERS

These pocket-size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts, D.C. Volts, resistance and current). Supplied complete with test prods, instruction book and batteries. Model A.10 (2,000 ohms per volt) £4/17/6

Model B.20 (10,000 ohms per volt) £6/10/-, Plus P.&P. 3/6 on ea. Fully detailed and illustrated leaflet available on request

"PIFCO" INSTRUMENT BIT SOLDERING IRON with integral Stand and built-in Spot-light for illuminating work 200/250 v. ONLY 22/6. P. & P. 1/6.

VIBRATOR PACKS. Limited quantity of both 6 volt and 12 volt types available. Output 300 volt. 100 m/a. Fully smoothed. Brand new ex-Gov. surplus. Price 35/- ea., plus 2/6 P. & P. Please specify input voltage required.

12 VOLT VIBRATOR PACK. (Mallory). Output 150 v. @ 40 mA. Complete with synchronous vibrator. Brand new. ONLY 12/6, plus 2/- P. & P.

12in. BAKERS SELHURST LOUDSPEAKER. 15 ohms, 15 watt 30-14,000 cps. Brand new, £4/10/-, P. & P. 3/6.

12in. RICHARD ALLAN P.M. LOUDSPEAKER. 3 ohm speech coil. Brand new. Only 32/6 plus 2/6 P. & P.

DEAF AID TYPE EARPIECES. Ardent Standard magnetic type complete with lead and plug. Only 12/6. P. & P. 1/-.

MINIATURE CRYSTAL DEAF-AID TYPE EARPIECE. Supplied with ear insert, 3ft. lead, sub-miniature jack plug and socket at 8/- only, plus 1/- P. & P. Sub-miniature two-way Jack Plug and Socket only 3/6, plus 6d. P. & P.



LIMITED IMPORT QUOTA ONLY! OUTSTANDING BUY!

MODEL U.1 MULTI-RANGE TEST-METER. Ideal for amateurs and service engineers. Incorporates 3 inch rectangular meter. Ranges: A.C. and D.C. voltage. 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.). Sensitivity 1,000 ohms per volt A.C. and D.C. Size: 5in. x 3in. x 2½in. Weight 22 ozs. only. Fully guaranteed. Supplied complete, and ready to use with test leads, at the **79/6** P. & P. very low price of only **3/6**. (Bona fide trade enquiries invited).

★ 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 TRANSCRIBER. 3 motors. 3 speeds, 1½, 3½, 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 5½in. spools—3½ i.p.s. At only £8/19/6 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 4½in. 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 72/6 plus 3/6 P. & P.

MIC 45-1 Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE 29/6 plus 1/- P. & P. **ACOS MIC 39-1.** Crystal stick microphone. List price 5 gns. Our price 39/6 plus 1/6 P. & P.

MIC 40. General purpose crystal microphone with desk stand. Our price 25/- only plus 1/6 P. & P. **M.C.24.** Imported, crystal, attractive streamlined polished metal case, incorporates muting switch. List price 64/-, OUR PRICE 42/- only. 1/- P. & P. **ANOTHER HAND MIKE BARGAIN!** Lightweight crystal with built-in desk stand at only 19/6. P. & P. 1/-.

SUPER MAGNETIC RECORDING TAPE SPECIAL!!!

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, 5½in. 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.

EXTRA SPECIAL OFFER!!

A small three-valve **PORTABLE RECORD PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6½in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, £5/12/6. P. & P. 3/6.

NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13½ x 8½in. Fitted with carrying handle, £3/9/6 plus 5/- P. & P.

NOTE. If both items purchased together they will be supplied at a special inclusive price £8/7/6 plus 6/6 P. & P.



TRANSISTORS!!!

SURPLUS P.N.P. RED SPOT (Audio/Experimental Application) 3/6 ea.

WHITE SPOT, R.F. up to 2.5 M/cs, 5/- ea.

OC169 VHF PNP 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).

FRUSTRATED EXPORT. Not repeatable! L., M. and S.W. SUPER-HET 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 21½in. x 10½in. 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 plus P. & P. 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

ACOS GP73-2A: Turnover cartridge for Stereo and Monaural Standard and L.P. Few only at 29/6, also GP67-3 Mono at 18/-. Both plus 9d. P. & P.

LOUDSPEAKERS. EX. CHASSIS. As new guaranteed perfect, by leading manufacturers. 5in. high flux. 9/6; 6½in. 10/6; 8in. 13/6; also 10in. with O/P transformer (5,000 ohms), 17/6. All 3 ohm speech coil, also 8in. available, in attractive cloth covered cabinet, ideal for extension speaker, 22/6. Each item plus 1/6 P. & P. Complete list of new speakers on request.

No. 38 AFV WALKIE-TALKIE. A wonderful offer. This famous transceiver unit, with relay operated SEND/RECEIVE switch covering 7.4-9 Mc/s band, range approx. 5 miles. Good condition. ONLY 22/6 plus 2/6 P. & P. per unit (less accessories). Quantity export enquiries welcomed.

AERIAL TUNING UNIT ZA0841. This well made ex-V.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 wavelange 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/- P. & P.

WIRING WIRE. 5 coils 10 yds., each coil, in different colours, contained in cellophane bag, 5/-, plus 9d. postage.

SOLDER. New boxed 1 lb reels, 16 S.W.G. 50/50 at 8/6 only, plus 1/- P. & P.

TRANSFORMER SPECIAL. Superior quality half-shrouded drop thro' mains transformer. Input 200/250 v. Output 350-0-350 v. 80 mA.; 6.3 v. 3 amps. 5 v. 2 amps. Ex-equipment but guaranteed O.K. ONLY 9/6, plus 1/- P. & P.

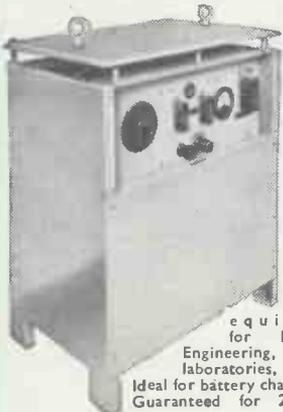
CLYNE RADIO LTD.

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162 Holloway Road, London, N.7.
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THE COMPONENT SPECIALISTS
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Bulk Buying means LOWEST PRICES DELIVERY EX-STOCK

HEAVY DUTY 20 AMP. L.T. SUPPLY UNIT



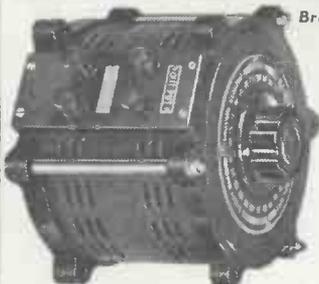
by **S.T.G.**
Normal cost over £100

Output: D.C. Variable up to 20 amps. and 24 v. or trickle charge 125/350/700 ampere hours.
Input: A.C. 100/260 volts 45/65 cycles. Size: 16 x 24 x 32in. high.

£22-10-0

In attractive Grey Cabinet. ex Warehouse (Circ. diag. and instr. loaned for 10/- deposit.)

VARIABLE TRANSFORMERS



Brand New

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—APPROXIMATELY 6" CUBE.

WEIGHT—APPROXIMATELY 13 LB.

PRICE—RIDICULOUS ONLY—**£9.0.0** SUPPLIED NEW AND BOXED

ALSO **£18.5.0** AND **£32.10.0**
10 amps. 20 amps.

CONSTANT VOLTAGE TRANSFORMERS

FERRANTI 71-EVA MOVING COIL
Stabilized output voltage in the range 200-250 v. Plug-board tappings. The selected output voltage is constant with $\pm 1\%$ at all loads 0 to 30/371 amps. when the supply voltage is varying over the range $+8\%$ to -12% .
★ Frequency compensated 45-55 and 54-66 c/s.
★ Excellent output wave-form.
★ Can be used as a variable transformer.
★ Unused. Complete with spares and instruction book at a fraction of the normal cost.
★ A.C. MAINS STABILIZER. ONLY **£65**

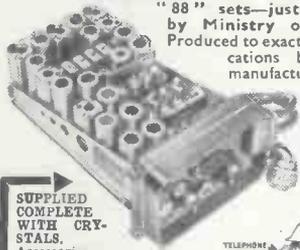


LATEST miniature EXPORT ONLY

WALKIE TALKIE

"88" sets—just released by Ministry of Supply. Produced to exacting specifications by leading manufacturers E. K. Cole & Co.

Only **£10** each



SUPPLIED COMPLETE WITH CRYSTALS. Accessories can be supplied to order at extra cost.



This Transmitter/Receiver weighs only 5½lb. (approx.) and measures 3½in. x 5½in. x 9½in. It is a 4 frequency channel set, crystal controlled, 38-40/40-42Mc/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. 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 2½in. 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. Carr. 15/6.

£8.10.0 only

U.S.A. Type 45ft. TELECOM AERIAL MAST. (7 sections, 6ft. 8in. x 2½in., 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 lin. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag, £5/15/-. Carr. 7/6.

Limited Quantity 36ft. TELESCOPE MASTS

Finest quality brass. Non-rusting. Base diameter 2½in. Complete with hand-winding winch for easy, rapid extension; and cable-wire bracing stays. One of the best masts ever produced. **£35** each Carr. £1/10
Winds down to 9ft.

750,000 YARDS !! SCREENED WIRE FLEX FOR ONLY 2d. per yd.



For immediate Delivery—far below cost. Specification: Close braided 14/00408in. Covered .024 p.v.c. Tinned Copper. Screened. Assorted colours. Applications: Microphone leads, pick-up heads, etc. ON MAKER'S REELS, 220 yd. REELS (min. quantity) **36/8**. P. & P. TEN REELS £17. Carr. Paid. 6/-

UNIQUE OFFER! World Famous TELEPHONES "F" TYPE in Attractive Case

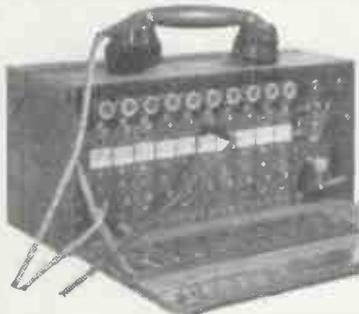


£7-10-0 carr. per pair 9/-

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.

TELEPHONE SWITCHBOARDS



10 Lines U.C. magneto Switchboard. Complete with Telephone handset, cord, plugs, lamps. Supplied complete and fully tested. £27/10/0. Complete Intercom Telephone System for £65. Comprising (1) Switchboard; (10) Tele. "F" extensions (as above) and 1 mile drum of Don 3 telephone cable. Carriage extra. Quantity and export enquiries are invited for all above items, also other telephone component parts.

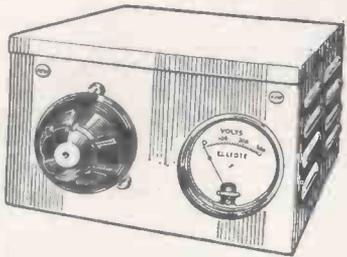
ENGLAND'S LARGEST STOCKS OF TELEPHONE EQUIPMENT

SAVE £100
A COMPLETE Ex. Govt. **PUBLIC ADDRESS SYSTEM 15 GNS**
FOR OFFICES, FACTORIES, WAREHOUSES & CARS CARR 30/-

Set by TRUVOX, etc. Comprises: Amplifier, four Loudspeakers, Heavy duty mic., Leads, etc. 6 or 12 v. D.C.

Irongate (M.O.) COMPANY

Dept. (ww15), 2, IRONGATE WHARF ROAD, PRAED STREET, LONDON W.2
PADDINGTON 223112/3



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/-, Type 2. 5 amp. Price £12, 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/-.

W. W. RHEOSTAT. New. 3.5K or 5K. 25 watts. Price 7/6. P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

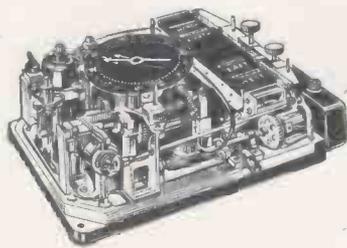
EX P.O. MAGNETIC COUNTER. 500 ohms type for 24 volt also 3 ohm type for 6 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

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 LT. 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/-.

CONSTANT SPEED, HIGHLY PRECISION MADE, BATTERY DRIVEN D.C. GOVERNED MOTORS (Elliott Bros.). Commutator/Brush incorporating Loading Ballast Resistor 2,470 r.p.m. \pm 2% at 12 volt. Loss on 8.5 volt only 4%. Size 1 1/2 in. dia. x 2 3/4 in. long. Spindle .77 in. long x .15575 in. dia. Weight 4 oz. New. Price 25/-, plus 1/- P. & P.

EX R.A.F. AIR POSITION INDICATOR, containing 3 ball and plate infinitely variable resolving gears, miniature spur bevel and worm gear drives, also toggle, push button and rotary switches, repeater motor, 4 mechanical counters, miniature lamp holders and lamps etc. As new. Illustration below. Price 22/6. P. & P. 3/6.



ROTARY SWITCH REGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6 in. Price 15/-, P. & P. 2/6.



TWELVE PLATE F.W. BRIDGE CONNECTED

RECTIFIER mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.

MINIATURE INSTRUMENT RECTIFIERS. Bridge Type 1 millamp. Guaranteed perfect 7/6 each.

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.

BRAND NEW FREQUENCY METERS manufactured by Nalder & Thompson Ltd. Calibrated 45 cycles to 55 cycles per second. 6 in. dial. Panel mounting type. In original manufacturer's boxes. PRICE £10/15/- ea. Postage 3/6.



20-WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 1 1/2 x 3 1/2 x 1/4 in. 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.

LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES. As illustrated. Brand new, low impedance. Price: 10/6 plus P. & P. 1/6.



8-day clockwork Time Switch. Contacts 2 1/2 amp., 230 volt, 24 hour phase, 1/2 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/-.



PYE LEVER OPERATING MICRO SWITCHES. Single pole change over. Brand new. 4/- each or 42/- dozen, p. paid.

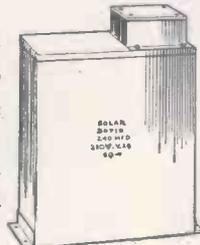
TANNOY P.A. LOUDSPEAKER. For outdoor use, metal exponential horn with 20 in. square flare. Overall length 30 in. Speech coil 15 ohms. Guaranteed in working order and good condition. Price £7/10/-, Carriage 10/-.

PACKARD BELL BRAND NEW RELAYS. 2 pole c.o. 6 volt 80 ohms. 7/6 each. P. & P. 6d.



DIAL THERMOMETER. Made by Short & Mason. Calibrated 0-160 degrees Fahrenheit. 4 1/2 in. dial, 6 in. rim for flush mounting with 6 in. long rod protruding at the back. Brand new. Manufacturer's packing. Price 22/6. P. & P. 3/-.

SOLAR OIL-FILLED CONDENSER. 240 mfd. for 230 V.A.C. or 600 volt D.C. Overall size 1 1/2 in. x 9 in. x 5 1/2 in. 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. Carriage paid.

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 5 1/2 x 4 1/2 in. over terminals. Price 19/-, plus P. & P. 2/9.

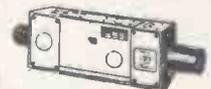


245 AMP. 2 VOLT ACCUMULATOR Admiralty type in wooden casing. Size 15 x 7 1/2 x 7 1/2 in. Weight 60 lb. Unfilled, uncharged. New. Price £4. Carriage 10/-.



MINIATURE P.M. MOTOR. 12/24 volt, reversible. 1 1/2 in. dia. New. Price 10/6 each. P. & P. 1/-.

AIRCRAFT CINE CAMERA G45B Mk. III. Fully modified, fitted with 1/3.5 triple anastigmat lens, takes 25 ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.



SLIDER RESISTANCES. 2 amp. 500ohms, size 1 1/4in. x 6in., plus handle 6in., 27/6. P. & P. 3/6.



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 microamp. and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2 1/2 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 1 1/2 x 3/8 x 3/16 in. 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/-.

G.E.C. SEALED RELAY. Type M.1092. 670 ohms coil. 12/24 volt. 4 C/O. Ex new equipment. Unused. 10/-. P. & P. 1/-.

G.P.O. 600 TYPE RELAY. 400 ohms coil. 24 volt. 2 C/O plus 2 M. New 7/6. 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.

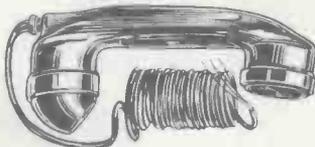
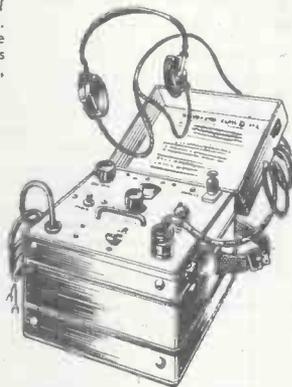


MINIATURE UNISELECTOR SWITCH.

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.



CLASS D WAVE METER. Latest release of these famous Hetrodyne 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.



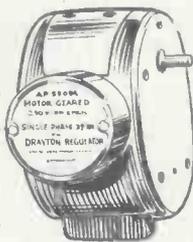
SOUND POWER TELEPHONE HANDSETS. Each couple connected by ordinary 2 core lighting flex will secure instant and reliable intercommunication. No batteries required. Price per set of 2 33/-. plus P.&P. 3/-.

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 P. & P.

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.

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 1 1/2 in. x 1 1/2 in. 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 5 1/2 in. Weight 4 1/2 lb. Ex brand new equipment. Unused. Price £317/6. P. & P. 3/-.

MAINS POWER SUPPLY UNITS

Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6 1/2 x 7 1/2 in., 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. 6/6.

METERS GUARANTEED PERFECT

Charging Types

2 1/2 amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2 1/2 in. fl. rnd.	11/6
7 1/2 amp. D.C. M.I. 3 1/2 in. proj. rnd.	12/6
2 amp. D.C. Hot Wire W.R. 2 1/2 in. 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. 4 1/2 in. 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
40 v. M.C. 2in. fl. sq.	10/6
300 v. A.C. M.C. 2 1/2 in. fl. rnd.	27/6
300 v. A.C. M.I., 2 1/2 in. fl. rnd.	22/-
400 v. A.C. M.I. 4 1/2 in. rnd.	35/-
90-180 v. A.C. M.I. 4 1/2 in. fl. iron	25/-

Milliammeters

1 mA. M.C. 2 1/2 in. fl. rnd.	25/-
200 mA. M.C. 2 1/2 in. fl. rnd.	12/6
500 mA. M.C. 2 1/2 in. fl. rnd.	12/6

Microamp

50 microamp., scaled 0-100, M.C.	
2 1/2 in. fl. rnd.	42/6
500 microamp., M.C. 2in. 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, 1 1/2 in. diameter, flush fitting complete with fixing clip. Price 17/6. P. & P. 1/-.



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. The complete outfit is brand new—repeat NEW. Price £4/19/6. Carra 3/-.



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R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder
in the £70 class for only
Can be assembled in 1 hour.

25 1/2 GNS.
Carr. 17/6.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIBER
THE LINEAR L746X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX
7 x 4in. LOUDSPEAKER, Reel of Best Quality TAPE, Spare Tape Spool, a Portable
Cabinet, size approx. 16 x 13 x 9in., finished in durable and attractive
duo-tone Polycrome, and connection diagram for wiring amplifier to transcriber.

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.

CONSTRUCTIONAL ENVELOPES

Repanco 3 Dee Transistor Radio 1/3. Repanco Mini 3
Pocket Portable Transistor Radio 1/6. Repanco Mini 7
Transistor Pocket Portable (total building cost 9 gns)
1/6. R.S.C. All 12-watt High Fidelity amplifier 1/9.
R.S.C. STEREO/TEN High Quality Stereo Amplifier 1/9.

RE-ENTRANT LOUDSPEAKERS

For factory or outdoor use.
Tannoy 7.5 ohms 8 watts
25/9.

Parameko horn type, highly
efficient. Handles up to
10 watts, 15 ohm 200 ohm
and 600 ohm matching 59/8.
R.C.A. 20 watt rating, 3
ohm, 15 ohm, 200 ohm, and
600 ohm matching 6 gns.

ACOS HI-FI CRYSTAL 'MIKES'

Mic 30 hand or
Desk type
27/9 (Listed)
45/-
39-1 Stick type
39/6 (Listed)
5 Gns.
Limited number.

OR DEPOSIT 25/7/6 and 12
monthly payments of 49/-.
Cash price if settled in 3 months.



HI-FI 10 WATT AMPLIFIERS

BRAND NEW CARTONED
MANUFACTURERS DISCONTINUED **£6.19.9**
MODEL. Carr. 7/6.

A REMARKABLE OPPORTUNITY

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 (especially 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. distor-
tion is avoided. The W. Ch. Sw. incorporates Gram-
position. Controls are Tuning, W. Ch. and Vol. Output
will load most Amplifiers requiring 50 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 24/15/-. Point-to-Point wiring diagrams
and instructions 2/6.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator, Size 6 1/2 x 4 1/2 x 2in. approx. Com-
pletely 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 dia-
gram 39/9 or ready for use 46/9.

Type BM2. Size 8 x 5 1/2 x 2 1/2 in. Supplies 120 v. 90 v. and 80 v., 40 mA. and
2 v. 0.4 a. to 1 amp., fully smoothed. THEREBY COMPLETELY REPLACING
BOTH B.T. BATTERIES AND L.T. 2 v. ACCUMULATORS when connected
to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY
RECEIVERS normally using 2 v. accumulator

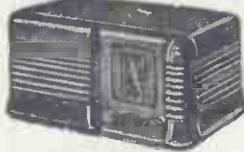
Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

TAPE RECORDERS AT WHOLESALE PRICES. Leading makes, 28 gm. model 18 gns, 29 gm. model 20 gns, 40 gm
model 27 gns, 42 gm. model 29 gns, 63 gm. model 45 gns, 64 gm. model 44 gns. All brand new with manufacturer's
guarantee. Make and model No. on request. No H.P.



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 sen-
sitive rectifier. For
inclusion in cabinet
illustrated or wal-
nut veneered type.
It employs valves
6X7, 8F61, 6F9
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 24/19/6
including cabinet. Avail-
able in brown or cream
bakelite or veneered
walnut.

EXTENSION SPEAKERS. Handsome walnut veneered
cabinets. All standard 2-3 ohms. 6 1/2in. 29/8; 8in. 35/9.

R.S.C. A12 STEREO AMPLIFIER KIT

4 GNS.

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 3-3 ohm speakers.
For 200-250 v. A.C. mains.
Astounding value.

Carr. and packing 7/6.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

8 GNS.

Valves E281, ECC83, ECC83, EL94, EL84. Separate Bass
and treble controls, giving "cut" and "boost". Sen-
sitivity 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. Carr. 7/9.

Illustration full constructional details and priced parts list
1/9.

SELENIUM RECTIFIERS

We can quote special prices for quantities of 12 to 10,000
of most types. Special types available to order.

L.T. Types	H.T. Types H.W.
2/8 v. 1 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. 80 mA. 4/11
6/12 v. 1 a. 3/11	250 v. 80 mA. 6/11
6/12 v. 2 a. 9/11	250 v. 250 mA. 12/9
6/12 v. 3 a. 9/9	Contact Coated
6/12 v. 4 a. 12/3	250 v. 80 mA. 6/11
6/12 v. 5 a. 14/6	250 v. 350 mA F.W.
6/12 v. 6 a. 15/6	(Bridge) 8/11
6/12 v. 10 a. 25/9	250 v. 75 mA F.W.
6/12 v. 15 a. 35/9	(Bridge) 10/11

JUNCTION TRANSISTORS. B.F. Type 9/6. Audio type.
5/9. Power type Goltop V15/10F 2 watts, 17/8. OC71
10/-, OC72 16/8. XB104 10/-, XB104 10/-, XA101,
XA101, OC44 16/8, XA102, XA103, XA104 12/9 and
many other types.

RECORDING HEADS. Baird Record Playback and Erase
(housed in one container) 9/6 pair.

Battery Chargers and Kits for 200-250 v. 50 c/s. A.C. Mains

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6 v. 2 a.	29/9
6/12 v. 1 a.	29/9
6/12 v. 2 a.	38/9

Above ready for use with
mains and output leads.
Cases well ventilated and
finished in stoved blue
hammer. Carr. & Pkg.
3/6.

CHARGER TRANSFORMERS

200-230-250 v. 60 c/s.	
0-9-15 v. 1 1/2 a.	12/9
0-9-15 v. 2 1/2 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.	42/9
(inclusive of ammeter) ...	
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 at-
tractive hammer
blue. Ready for
use with mains
and output leads.
Double Fused.
Only Carr. 3/9. **49/9**

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 69/9
mains and
output leads. 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 more soiled and
is being offered at well below usual price.

SPECIAL OFFER. Of R.C.A.
replacement stylus for Col-
laro Studio "O" and "F"
Rondelet and other pick-up
heads. Sapphire type stan-
dard of L.P. 3/11 each.
Diamond type normally
83/5. Only 29/11.

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, multi-
position switch with
knob, fuses, fuse-
holders, panels, plugs,
and circuit. Only 59/6.
Post 4/6.

POWER PACK KITS. Only 18/11. Fully smoothed H.T.
output of 230 v. 90 ma. and L.T. supply of 6.3 v. 1.5 amp.
Consisting of Double Wound Mains Transformer 230/250v.
50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing
Choke, Double Electrolytic Condenser, Aluminium Chassis
and Circuit.

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. 24/10/9.
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 x 12 x 10ins. Strongly made. Handsome
appearance. Ensure superb reproduction for only 23/19/6.

D.O. 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.

**REPANCO TWINETTE TRANSISTOR PORTABLE RADIO
DESIGN.** Constructional Envelope and parts list 1/3.
Built-in Ferrite Aerial, 7in. x 4in. speaker, Long and
Medium waves. Size approx. 7 x 4 x 3in. Total cost of all
parts 5 gns.

LINEAR TAPE PRE-AMPLIFIER Type TF/L. Switched
negative feedback equalisation. Positions for Record
1 1/2in, 3 1/2in, 7 1/2in and Playback. EM34. Recording level
indicator. Designed primarily as the link between Col-
laro Tape Transcriber and high fidelity amplifier but suitable
almost any Tape Deck.

9 Gns.

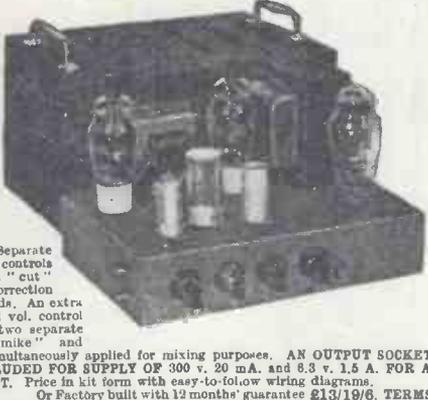
LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER.
Suitable for use with any record playing unit and most
microphones. Negative feedback 12 D.B. Bass and Treble
controls. For A.C. mains input of 200-250 v. 50 c.p.s. Out-
put for 2 1/2 ohm speaker. Three miniature Mullard valves.
Size only 6 x 5 x 6 1/2in. high. Chassis fully isolated from
mains. Guaranteed 12 months. Only **£5.19.6** Or
Deposit 22/- and 5 monthly payments.

P.M. SPEAKERS. 2-3 ohms 2 1/2in. Perdio 21/9. 5in. Good-
mans 17/9. 7 x 4in. R.A. Elliptical 19/9. 6 1/2in. Rola 19/9.
8in. Rola 19/9. 8in. Goodmans 25/9. 8 x 6in. Elac. with
high flux magnet 25/9. 10in. R.A. 23/9. 10 x 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 25/8.

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF88, EF89, ECC83, 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 OR 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 PROVIDED FOR SUPPLY OF 300 v. 20 mA. and 8.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. **ONLY 11 gns.** Or Factory built with 12 months' guarantee **£13/19/6.** TERMS ON ASSEMBLED UNITS. DEPOSIT 31/9 and 9 monthly payments of 31/9.



Carr. 10/-. Cover as illustrated Type 807 output valves are used with High Quality Sectionally 11/2 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/s. ± 12 D.B. to -6 D.B. at 12,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 1/2 x 9 x 5 in. 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. **GRAM MINIATURE 3 WATT GRAM AMPLIFIERS** For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11 1/2 x 2 1/2 in. 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 millivolt 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 equalization. Hum-level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. E.T. of 300 v. 20 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 **£5/-** extra, plus 3/6 carriage. Or Deposit **£2/-** and five monthly payments of **£2/-** for assembled unit.

R.S.C. TRANSFORMERS. Fully Guaranteed. Interleaved & Impregnated. **WE CAN QUOTE FOR SPECIAL OR STANDARD TYPES IN ANY QUANTITY. OUR FACTORY HAS SUPPLIED LEADING EQUIPMENT MANUFACTURERS AND GOVT. DEPTS. FOR 15 YEARS.**

MAINS TRANSFORMERS. Primaries 200-250-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING.	
250-0-250 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a., 2 1/2-3-3 1/2 in.	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., ct. 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	
250-0-250 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., ct. 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
ELIMINATOR TRANSFORMERS	
120 v. 40 A., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11
FILAMENT TRANSFORMERS	
6.3 v. 1.5 a.	7/9
6.3 v. 2 a.	8/11
4-0-4.5 v. 2 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 661 for 354, etc.	3/9
Small Pentode 5,000 Ω to 3 Ω	3/9
Standard Pentode 5,000 Ω to 3 Ω	5/9
Standard Pentode 8,000 Ω to 3 Ω	5/9
Push-pull 8 watts 6V8 to 3 ohms	8/9
Push-pull 8 watts EL84 to 15 ohms	8/9
Push-pull 10-12 watts 6V6 to 3 Ω or 15 Ω	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 610	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 3 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

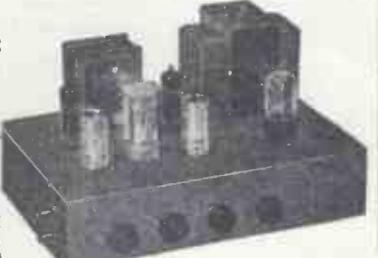
250 mA., 5 H., 100 Ω 11/9	80 mA., 10 H., 350 Ω 5/6
100 mA. 7-10 H., 250 Ω 11/9	60 mA., 10 H., 400 Ω 4/11
100 mA., 10 H., 200 Ω 8/9	1 amp. 0.5 Ω L.T. type 6/6

PARMCO MAINS TRANSFORMERS. Fully shrouded.

500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	31/9
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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 A10 High sensitivity. Includes 5 valves: ECC83, ECC83, EL84, EL84, 5Y3. 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/s. Six negative feedback loops. Hum level 60 D.B. down. **ONLY 23 millivolt 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. 12.9-7 in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring. **8 Gns.** Carr. diagrams supplied. (Or factory built 45/- extra.) **ONLY 8 Gns.** 10/- If required louvered metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 24/3 and 9 monthly payments of 24/3.** 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 8 in. Speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (size approx. 14 x 14 x 7 in.). 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.

Junior model. Size approx. 18 x 18 x 5 in. 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.

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 19 in. P.M. for Bass notes and 1 7/8 in. elliptical for Treble. Cabinet is well made and finished as for Junior model.

COLIARO CONTINENTAL 4 SPEED DE LUXE MIXER AUTO-CHANGERS with TX98 Transcription Cartridge for standard and L.P. records. For normal 200-250 v. A.C. mains. Few only at unrepeatable price of **£10/19/6.** Carr. 4/6.

COLIARO 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.B.R. MONARCH AUTO-CHANGERS.** Type UAS. 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. **COLIARO JUNIOR.** 4-speed Single Players with H-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 x 18 x 5 in. **£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 Coliario. Only 19/9. B.B.R. Ful-Fi 19/9. Garrard GC2 19/9. Acos Stereo/monaural 49/9.

ACOS HIGH FIDELITY PICK-UPS. GP4 with HGP59/52 Cartridge. Turnover sapphire stylus cream finish. Limited number at approx. half price. Only 35/9.

R.C.A. TRANSCRIPTION PICK-UPS. Variable Reluctance type for standard and L.P. Records. Normal price approx. **£14.** Limited number brand new perfect at **£39/9/6.**



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 **£6/19/6.** Or Deposit, **13/9** and 9 monthly payments of **13/9.**

R.S.C. (MANCHESTER) LTD. R.S.C. MANCHESTER, LEEDS & BRADFORD

Open to callers at the following branches—
5-7 County (Mecca) Arcade, Leeds, 1.
54-56 Morley Street (above Alhambra), Bradford;
8-10 Brown Street (Market St.), Manchester, 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.**

HEAVY DUTY EX GOVT. SELENIUM RECTIFIERS

With large square aluminium cooling fins. 12 v. 15 amp. F.W. (Bridge). Limited number. 19/6.

EX. GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 c/s. Input.
Fr. 0-110-200-230-250 v. 275-0-275 v. 100 mA., 6.3 v. 7 a. 5 v. 3 a. 22/9
250 v. 60 mA. 6.3 v. 2 a. 10/11
6.3 v. 5.2 a., 6.3 v. 1.5 a., 6.3 v. 0.5 a., 5 v. 3 a., 5 v. 3 a., 5 v. 2 a., High insulation, Potted. 27/9
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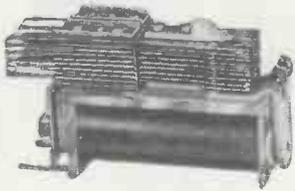
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XC101 10/6		15/-
Germanium Diodes OA70 2/9; OA81 3/6; GEX34 4/-.		

NEW VALVES ALL BOXED GUARANTEED

IT4 6/-	EABC80 8/6	EZ81 7/6
1R5, 1R57/6	ECC84 9/6	MU14 9/6
344, 3V4 7/6	ECP80 9/6	PC84 9/6
3Z4 9/-	ECL82 10/6	PCF80 9/6
6K7 5/-	ECL80 10/6	PCL83 12/6
6K8 7/6	EF90 8/-	PL81 12/6
6Q7 7/6	EF96 12/6	PL82 9/6
6V6 6/6	EF91 5/-	PL83 10/6
D4F96 9/-	EL41 9/6	PY80 7/6
DP98 9/-	EL84 8/6	PY81 9/6
DK98 9/-	EY81 9/6	PY82 7/6
DL98 8/-	EY86 10/-	U35 12/6

SPECIAL PRICE PER SET
 1R5, IT4, 1R5 & 384 or 3V4, 25/-
 DEK6, DP98, D4F96, DL98, 35/-
 6K8, 6K7, 6Q7, 6V6, 6Z4 or 6X6, 32/6.

JASON FM TUNER UNITS (87-105 Mcs)

Design-approved kits of parts for these quality and highly popular tuners available as follows:—

STANDARD MODEL (FMT)—as previously extensively advertised. COMPLETE KIT, 5 ins. P. & P. 3/6. Set of 4 spec. valves, 20/-.

LATEST MODEL (FMT2)—attractively presented shelf mounting unit in enclosed Metal Cabinet with Built-in Power Supply. COMPLETE KIT, 27, P. & P. 3/6. Set of 5 spec. valves, 37/6.

MODEL JTV3. Self-powered Switch Tuned B1-B2-B3 AM/FM Unit. 5 preset stations, AFC and AGC circuits. Complete Kit Incl. ready-built, and valved Turret Tuner, £18/19/6, P. & P. 2/6. 4 spec. valves, 32/6 extra.

MERCURY 2 similar to JTV3 less power pack. Complete Kit Inc. ready-built turret unit 10 ins. P. & P. 2/6. 4 spec. valves 25/-.

NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48hr. Alignment Service, 7/6, P. & P. 3/6.

MAINS TRANS. AND QUALITY OUTPUT TRANS. MID. IN OUR OWN WORKSHOPS TO TOP GRADE SPEC. FULLY INTERLEAVED AND IMPREGATED. ENQUIRIES WELCOME FOR SMALL PRODUCTION RUNS, PROTOTYPES OR INDIVIDUAL JOBS.

TRANSISTOR PORTABLE

Famous manufacturer's 6x1 design based on Mullard and G.E.O. developments. Printed circuit, 6BVA 1st grade transistors, XA102, XA101 (2), OA70, XB103, XC101 (2) or equivalents. Quality components only supplied to ensure best results at attractive price.

Set of 6 BVA Transistors and Diode. P. & P. 64.- 70/-
 Printed Circuit, L.F.'s (3), Osc. coil, Driver Trans. and Ferrite rod aerial. P. & P. 1/6 51/6
 Resistors, Condensers, Twin Gang and Volume control. P. & P. 1/6 37/6
 7in. x 4in. Quality 35 ohm matching Speaker. P. & P. 1/6 25/-

Complete Kit at special offer ONLY (post free) £8/19/6
 Handbook and Circuit details, post free 2/-

KNOBES. Modern Continental types, walnut and Ivory. 1 1/4in. dia. with GOLD RING 1/- ea. Ditto with GOLD CENTRE 1/3 ea. 1 1/4in. dia. with GOLD RINGS 9d. ea. Ditto with GOLD CENTRE 10d. ea. LARGE STOCKS—SEND YOUR ENQUIRIES.

CRT HTR ISOLATION TRANSFORMERS
 New improved types, low capacity, small size and tag terminated, A.C. 200/250 v. Secondary ratios: 1:1.25, 1:1.5, 1:2, 1:2.5, 1:3, 1:4, 1:5, 1:6, 1:8, 1:10, 1:12, 1:15, 1:20, 1:25, 1:30, 1:40, 1:50, 1:60, 1:75, 1:100, 1:150, 1:200, 1:250, 1:300, 1:400, 1:500, 1:600, 1:750, 1:1000, 1:1500, 1:2000, 1:2500, 1:3000, 1:4000, 1:5000, 1:6000, 1:7500, 1:10000, 1:15000, 1:20000, 1:25000, 1:30000, 1:40000, 1:50000, 1:60000, 1:75000, 1:100000, 1:150000, 1:200000, 1:250000, 1:300000, 1:400000, 1:500000, 1:600000, 1:750000, 1:1000000, 1:1500000, 1:2000000, 1:2500000, 1:3000000, 1:4000000, 1:5000000, 1:6000000, 1:7500000, 1:10000000, 1:15000000, 1:20000000, 1:25000000, 1:30000000, 1:40000000, 1:50000000, 1:60000000, 1:75000000, 1:100000000, 1:150000000, 1:200000000, 1:250000000, 1:300000000, 1:400000000, 1:500000000, 1:600000000, 1:750000000, 1:1000000000, 1:1500000000, 1:2000000000, 1:2500000000, 1:3000000000, 1:4000000000, 1:5000000000, 1:6000000000, 1:7500000000, 1:10000000000, 1:15000000000, 1:20000000000, 1:25000000000, 1:30000000000, 1:40000000000, 1:50000000000, 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1:30000000000000000000000000000000000000, 1:40000000000000000000000000000000000000, 1:50000000000000000000000000000000000000, 1:60000000000000000000000000000000000000, 1:75000000000000000000000000000000000000, 1:100000000000000000000000000000000000000, 1:15000

EXCITING NEW PRODUCT EXCLUSIVE TO RELDA TELEPHONE PICK-UP COILS



MODEL FC-8 Induction Pick-up coil enabling conversations to be picked up without tapping of wires or special telephone circuits. Simply place telephone on the pick-up platform and connect lead to the input of any medium gain amplifier or direct to any tape, disc, or wire recorder. Brand new complete with 5ft. shielded cable

ONLY 16/- P. & P. 1/6.

Relda Pick-up Coils require no Electrical connections—offer virtually unlimited use.



OSCILLOSCOPE MODEL 74

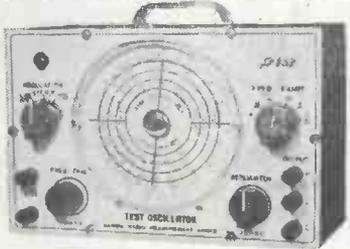
This basic scope represents one of the finest buys we have ever made. Contains Brilliance, Focus, Gain and 2-speed time base controls. Separate X plate terminals. Signal generator modulated at 2 freqs. over 150-255 Mc/s. Complete with 12 valves.

VCR 139A tube, internal A.C. power pack and complete circuit and technical details. ONLY 97/6. Carr. 12/6.

PRECISION SIGNAL GENERATOR MODEL SWO-300. 150 Kc/s-300 Mc/s.

An outstanding instrument specially designed to cover the wide frequency range from 150 kc/s-300 Mc/s, which covers all the requirements of equipment in general use.

Specification:—FREQUENCY RANGE: 150 kc/s-150 Mc/s. on fundamentals (6 bands). 150 Mc/s-300 Mc/s on harmonics. CALIBRATION ACCURACY: within ± 1 per cent. MODULATION: Internal and external. ATTENUATION: To -40 db. OUTPUT: Facilities for high and low. POWER SUPPLY: Internal 230 v. A.C. ACCESSORIES: Test leads and instruction manual. Size 7in. x 10in. x 5in. Only £14/19/6. P. & P. 5/6. FULLY GUARANTEED.



AMERICAN LIGHTWEIGHT HEAD SET

They're High and Low Impedance!



These H.S.30 phones are the smallest used by U.S. Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω.

ONLY 15/- P. & P. 2/6



COMMAND TRANSMITTERS

Complete with all Valves, Crystal etc.

3-4 Mc/s. 45/-
4-5.3 Mc/s. 45/-
5-3.7 Mc/s. 45/-

COMMAND RECEIVERS

6-9.1 Mc/s. 60/-
Post & Packing 3/6 each

PERSONAL EARPHONE

A really sensitive dynamic earphone of exceptionally fine quality. Provides clear reproduction of music as well as speech. Fully Guaranteed and complete with ear insert, 3 feet cord, sub-miniature plug and socket.



Model CR.5 Crystal Earpiece, high imp., Model MR-4 Magnetic Earpiece, low imp.

8/- each
POST 1/-

PORTABLE TRANS/RECEIVER SETS

ONLY 60/- EACH

P. & P. 4/-
2 for £8 post free.

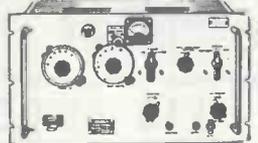


Designed for reliable voice inter-communication operating up to 10 miles depending upon obstructions and elevation. Covers the whole frequency range between 7.4-9 Mc/s. and is fully tunable on both Transmitter and Receiver. Operates from standard dry batteries 3v. L.T. and 120 v. H.T. Incorporates 5 valves: R.F. Amplifier, I.F. Amplifier, Second Detector, Output and Power Amplifier. Supplied complete with all accessories comprising dynamic sound powered headphones, electro magnetic super-sensitive microphone, 4ft. aerial, junction box, battery connection details and full circuit diagram.

V.H.F. COMMUNICATION RECEIVER

1392 15 VALVE SUPERHET. Frequency Range 95-150 mc/s. (2 to 3 metres).

Gives reception of Police, Aircraft and Amateur transmissions. Valve line up: 1st and 2nd R.F. Amp: VR.136 (EF.54), 1st Local Oscillator: VR.65 (SP.61), 2 Oscillator Multipliers: VR.136 (EF.54), 3 I.F. Amp: VR.53 (EF.39); A.G.C. 6Q7; Outputs: 6J5; Muting: VR.92 (EA.50); Noise Limiter VR.92 (EA.50); B.F.O. 6J7; Mixer VR.136 (EF.54); Det. Mod. 6Q7. Slow motion tuning, normally crystal controlled, or tunable over 95-150 Mc/s. Power supply required: 240-250 volts at 80 mA., 6.3 volts at 4 amps. Size 19in. x 10in. Standard Rack Mounting. ONLY £6.5.0 CARRIAGE 15/-



NEW! TRANSISTOR RADIOS With

Miniature Speaker



Gives reception over the entire broadcast band. Each kit is supplied with all latest miniature parts including ★ two transistors ★ ferrite rod ★ speaker ★ coloured plastic case ★ step by step illustrated instructions. 4 x 3 x 2in.

ONLY 27/6 P. & P. 1/6. Battery 1/- ex.

R.C.A. AR-88 RECEIVERS

SPECIFICATION:

Range: 73-550 kc/s and 1.48-30.5 mc/s.
Power Supply: 110/260 v. A.C.
Power Output: 2.5 W. into 2.5 or 600 ohm line or H.I. Headphones.
Sensitivity: From 15 to 2.5 μ v per 500 mW. Image Ratio: From 1,000,000 at 60 kc/s to 200 at 28 Mc/s.
Circuit: Two R.F. stages (6S7); Oscillator (6J5); Frequency Changer (6SA7); Three I.F. stages (6J7); A.V.C./Detector (6H6); Noise Limiter (6-6); Audio Amplifier (6J7); Power Output (6K6); B.F.O. (6-5); Voltage Regulator (VR-150); Rectifier (5Y3); I.F.—455 kc/s. Size: 19 1/2 x 11 x 19 1/2 in. FULLY GUARANTEED. Model AR-88 LF, £37/10/- Carr. 50/-.



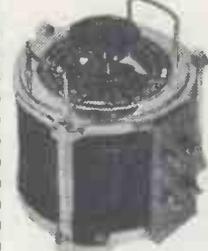
CRYSTAL MIKE INSERTS

1" dia. 70-6000 c/s response. Brand New Only 6/6 P. & P. 6d.

ACCUMULATORS. 2 volts 16 A.H. (unspillable). Ideal for 8 and 12 volts supply, etc. Brand new. Original cartons. Size 4in. x 7in. x 2in. 5/8 each. P. & P. 1/8. 3 for 15/- P. & P. 3/6. 6 for 27/6. P. & P. 5/-.



VARIABLE TRANSFORMERS



● Input Voltage 230 v. continuously variable output from 0-260 v. ● GOOD REGULATION. Output voltage is substantially independent of load. ● SMOOTH CONTROL. Can be set closely to any output voltage within its range. ● HIGH EFFICIENCY. Very low losses under all load conditions. ● LONG LIFE. The same as that of any standard fixed-ratio power transformer when operated at rated loads. ● SMALL SIZE. Smaller than any other type of control of equal power rating. ● LINEAR OUTPUT VOLTAGE. Continuously adjustable from zero to 30% above line voltage by a 320-degree rotation of the knob. The dial is calibrated to read directly in output voltage at rated line voltage. ● DIRECT-READING DIALS. All models are supplied with reversible direct-reading dials. Large white figures, easy to read at a distance. ● MODERATE TEMPERATURE RISE. Less than 50 degrees C. for continuous use. ● ADVANCED MECHANICAL DESIGN. Rugged construction—no delicate parts—protected with a strong iron cover. ALL FULLY GUARANTEED. DELIVERY EX-STOCK.

MODEL B.10

Current rating 10 amps.
£18.5.0

MODEL B.20

Current rating 20 amps.
£32.10.0

Mail Orders:

(DEPT. W.) 32a COPTIC STREET,
LONDON W.C.1.



Callers:

87 TOTTENHAM COURT ROAD,
LONDON, W.1: MUS. 9606

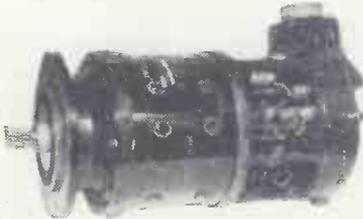
Shop at RELDA for EVERYTHING IN ELECTRONICS

PROOPS Walk-around Store

and MAIL ORDER SERVICE

52 Tottenham Court Rd., London, W.1 • Open 9-6, including Sats., Thurs. 9-1 • LANgham 0141

200 Amp WELDING GENERATORS



Relatively small, but really heavy-duty aircraft quality six-pole shunt-wound self-excited generator with six interpoles delivering 30 volts at up to 200 amps. Requires 8/10 h.p. between 600 and 3,300 r.p.m., clockwise or anti-clockwise rotation according to position of changeover links. Are very successfully driven from tractor take-off pulley or the like. 13in. long, 7in. dia. Weight 57 lb.

ONLY £6.15.0 Carriage paid (U.K. only)

100 Amp WELDING GENERATORS

Similar to 200 amp. generators described above, but of lesser capacity and approximately two-thirds the size. £4.15.0 Carriage paid. (U.K. only)

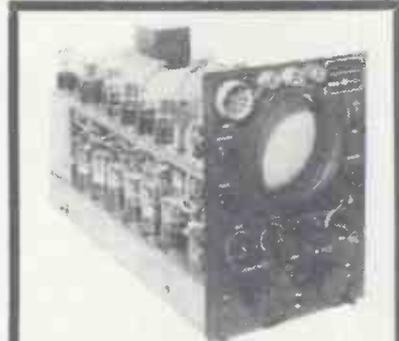
30 KVA 115 Volt 400 c/s ALTERNATOR £32.10.0

Carriage paid.

250 Volt MOTOR-ALTERNATOR SET

Standard 200/240 volt single phase 50 cycle mains input giving 7 KVA of regulated 115 volt 400 cycles output. Input, output and excitation metered.

Full details on request £65.0.0



TELEVISION OSCILLOSCOPE

Release of a small quantity of the latest version of the well known APN-4 Indicator Unit from the American Loran Airborne radio navigation system. This provides a golden opportunity to make a serious television servicing and development tool as described in the *Wireless World*.

This is a nice looking piece of equipment with a really businesslike inside. Steel, double-decked chassis with fully screened 5CP1 tube in the centre, all high-grade capacitors and resistors, separate tag boards and layout diagrams for individual sections, etc. Modern circuit technique centred around one type of valve (14 of 6SN7 double-triodes and 8 of 6H6, plus three 6S7 and one 6SJ7), and RCA. 100 kcs Crystal.

Brand New, with W.W. Circuit for conversion £6/10



NOMOTRON DECADE COUNTER TUBES

STC Type G10/241 latest type cold cathode, gas-filled, single pulse, uni-directional decade counter which illuminates numerals on tube face. Operating range—20 kc/s. Cathode output 40 volts, 3.7 mA. HT supply 310 v. plus. Applications include: tachometers, counting and batching, frequency and time measurement, direct operation of electro-magnetic relays, sequential monitoring of up to 10 different waveforms, etc. Brand New, complete with special base and instructions.

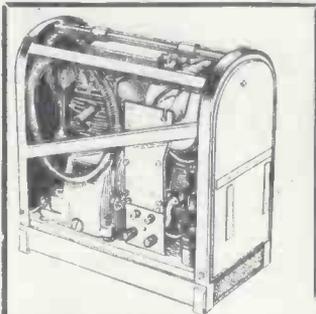
32/6 post paid.

£10 GEIGER COUNTER

Circuit embodies U.K.A.E.A. patent. Specially moulded case. Currently being supplied throughout the world. Three ranges—highly sensitive, light—portable—visual and audible response—plus output socket. Ideal for introduction to radiation measurement and nucleonic circuitry. Specially written 40-page instruction manual supplied. Batteries £2/15/3 extra.

KIT OF PARTS £4/17/6

Identical parts. Guaranteed performance. Manual and printed circuit plates for battery pack supplied (assembled pack £2/15/3 extra). Fully illustrated assembly instructions. Spares and service permanently available.



PORTABLE A.C./D.C. GENERATING SET

Self-contained 80 watt unit on compact chassis delivering 12 to 18 volts D.C. Size only 14 x 15 x 8in. Weight 46lb. Spring mounted air cooled petrol engine with fuel tank in base driving integral generator that has heavy duty bridge rectifier feeding D.C. terminal board. Miniature sparking plug. Filtered air intake.

Guaranteed serviceable. £9 plus 10/- carriage.

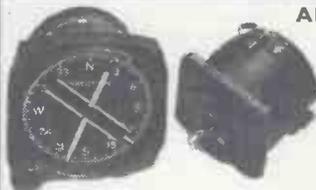
CARPENTER POLARISED RELAYS

Type 519. Two 68 ohm coils 15/- each
Type 5C9. Two 1685 ohm coils 19/6 each

G.E.C. SEALED RELAYS

5,000 ohm double-pole changeover 12/6
670 ohm four-pole changeover 10/-

ANTENNA INDICATOR



Remote indication to within 1° on precision instrument type flush fitting black crackle indicator with 3in. dial calibrated in 2° steps plus the four cardinals. Simple D.C. wiring (6-30 volt) from specially wound potentiometer in sealed die-cast housing with 1in. drilled spindle transmits accurate signal of horizontal or vertical bearing.

Brand New, Post Free, 35/-

MEGISTORS, 125, 1,000 or 10,000 MEGohms

Glass encapsulated 10% tolerance high value resistors for minute grid current applications. Ideal for extending the range of sensitive meters or using in probes to provide a really high impedance input for VTVM's or 'Scopes. One of each value plus any chosen two, the 5 for 10/- post free by return.

3-INCH CIRCULAR SCALE MILLIAMMETER

American panel mounting "Radio Altitude" meter with modern (coil round magnet) movement giving beautifully steady deflection to reading on large dial boldly marked 1 to 4 with sub-divisions in tenths. Supplied with suppressed zero which requires 6.5 mA. for full scale deflection (0 = 1.5 mA.) but pointer is easily re-set to zero by moving conventional hair spring adjuster behind dial, when 5 mA. gives f.s.d. Rear housing incorporates on/off switch (operated by rotating small knob on front face) and 5-pin plug, two pins direct to meter and two to switch. Not new. 17/6, post free.

ROTARY RELAY. Superb, fast acting, brand new precision unit made by Price for RCA. Nominally 12 volt, but mighty lively on 6-volt supply. Two heavy duty single pole changeover contacts and one low current for external circuits, plus one break set that extends coil winding to reduce initial energising current to 50 mA. (at 6 v.) for holding. Solid milled armature, laminated steel frame, 2½ × 2½ in. ⅜ in. thick, moulded inset dielectric block. A highly recommended spare box buy at 7/6 each, post free.

VENNER TIME SWITCHES

Type T.S.2, first grade precision time switches as supplied to G.P.O. Comprises absolutely silent, self starting, 250 volt 50 c/s synchronous clock mechanism totally enclosed in heavy gauge brass case. Central drive takes detachable dial that revolves to operate sensitive on and off trips for external mains operated circuit. Self contained clock is easily detachable from rear mounting panel (self starting down to 80 v. and keeps running down to 15 v.).

Brand new, in original packings, and with dial and adjustable stops, **37/6** post paid.



HIGH QUALITY POWER PACK

Admiralty Rectifier Unit Design 95, totally enclosed in heavy gauge attractive light grey case size 11½ in. high × 6 in. wide × 14 in. deep. Admiralty ratings: transformer 400-0-400 at 50mA, 6.3 v. at 1 Amp, 5 v. at 3 Amp for 5U4G. Insulation tested to 3 kV. Two 350 ohm 20 henry 80 mA chokes; Two 4 µF at 600 v. ceramic terminal square canned paper smoothing capacitors. Double pole mains switch, two 2A fuses and two spares all in screw-in holders on front panel. 3-pin 250 v. 50 c/s mains input, and 3-pin output with matching plug on short screened cable providing 650 v. D.C. and 6.3 v. A.C. with common earth. An unusually neat, attractive, high quality unit. Brand New, still boxed

for only **50/-** carriage paid.



KIT OF BEAM-ECHO AVANTIC PARTS

Due to the exclusive purchase of a large stock of parts originally intended for the Beam-Echo Avantic combined stereo control unit and power amplifier SPA.11 we are able to offer a kit of all the parts necessary to build this superb piece of equipment—complete to the last nut and bolt, with specially prepared assembly instructions, full circuitry and wiring diagrams, plus a full copy of the handbook—at the BARGAIN PRICE of **£11 plus 7/6 carriage.**

Abridged Specification. Two 7 watt channels switchable for either stereo or 14 watt monaural. Wide-range bass and treble controls, channel and phase reversal. Main and pick-up balance controls. Separate output on each channel for tape. 100-245v mains. Mains outlet socket and tuner power supply provided. Two p.u. and two tape and tuner inputs. 4, 8, and 16 ohms output. Six valves and bridge circuit metal rectifiers. 2xECC83 and 4xECL 82. Less than 1% total distortion at 7 watts. Hum and noise 70 dB.

RF EHT POWER UNIT 846

A small, very neat, lightweight unit of most modern construction providing 1000 volt DC from rectification of self-generated AC. Unit employs a 6C4 oscillator and an EY51 EHT rectifier and incorporates its own HT and EHT smoothing. Requires only 12 or 24v DC for filaments and 250 volts of raw AC to provide the EHT for an oscilloscope etc. Unit also contains a 6J6 arranged as an independent multi-vibrator with its inputs and outputs connected to a Breeze multi-socket on front panel. Size: 4½ × 5½ × 5½ in.

Brand New, complete with valves and circuit... **25/-** post paid.



INVERTERS

28 Volt DC To 115v 1 phase AC

Self-contained motor generator unit with complementary carbon pile voltage regulator, contactor and associated rectifier in separate compartment on same base. Continuously rated for 25/28 volts D.C. input with 360 VA output at 115 volts single phase A.C. at 1,600 cycles with a power factor of 1.0. Fan cooled with end plate for blast or internal cooling as required. Type 200. Ref. SUB/5083. In first class condition. **£4.10.0** carriage 7/6

24 Volt DC To 115v 3 phase AC

Output 260 Watts. In first class condition. **£12.10.0** carriage paid

200/220 Volt DC To 200/250v 1 phase AC

Output 260 Watts. New, in soundproof cabinet. **£9.10.0** carriage paid

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Output 6 VA. Size 2½ in. dia. x 4 in. long on 1½ in. high pedestal base. Instrument quality. As new. **£1.10.0** carriage paid

BC.929 SCOPE UNIT

Neat, modern indicator unit especially suitable for quick conversion to attractive general servicing scope. (Suitable circuit diagram and all component values supplied.) Contains fully mu-metal screened 3BP1 tube, intensity and focus controls, 3-position rotary switch and 8 pre-set, potentiometers, plus 2×6SH7, 2×6H6, 6G6, 6X5 and 2X2 valves. Designed for 24 v. D.C. or 400 c/s A.C. input. Size 14 × 8½ in. square. Well known and deservedly popular buy. Offered new, less (unwanted) motor driven aerial switching unit, for post paid. **50/-**

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Latest version of U.S.A. Servomechanisms 400 c/s chopper. High quality 6 v. vibrator oscillating between twin contacts for chopping external circuit. Hermetically sealed in octal based can.

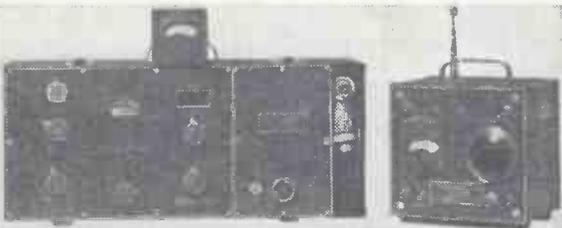
Brand New **£2** post paid.

CHROMEL/ALUMEL THERMOCOUPLE LEADS

7, 10 and 21 foot lengths of flat twin lead—90% nickel, 10% chrome and 95% nickel, 5% aluminium. Total resistance 0.875 ohms. For use with millivoltmeter to read 0 to 1,000°C. Sheathed in heat resisting silicon rubber that will stand 200°C. Price, post paid, 7/6, 10/6 and 21/- respectively.

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Modern, portable, battery operated, 5 valve Signal Generator with alternative crystal or master oscillator, either optionally modulated by 1,000 c/s Hartley oscillator. Large directly calibrated dial with precision slow motion drive. Five step and variable attenuator. Supplied with matching black crackle carrying case for 6 and 135 volt batteries with 10ft. supply cable, and metal cased 1 mA. test meter for checking crystal resonance, etc. Brand new. **£2/17/6 plus 7/6 packing and carriage.**

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Self-contained, tunable-input, valve-voltmeter with telescopic aerial and battery-fed diode rectifier and pentode amplifier for measuring field strength, presence of modulation, and approximate frequency of transmitter. Compensating circuit for state of 1½ and 45 volt batteries. In attractive black crackle case. Brand new. **£2/5/- plus 5/- packing and carriage.**



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Double pole knife changeover switch on porcelain base. 2 for 5/-
 Siemens high-speed relays. 1,000-0-1,000 ohm coils..... 8/6
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 G.P.O. mechanical counters. 0-9999..... 7/6
 Bulgin Type M microswitches, new..... 4 for 11/6

RECEIVER TYPE 88 (R1475)

Highly stable, specially accurately calibrated, Marconi design, RAF communications receiver covering 2-20 Mc/s in 4 bands with built-in 600 kcs Xtal reference oscillator for checking dial which can be reset by special panel trimmer control. 11 Valves: 3x6K7, 6K8, 6J5, 3x6Q7, 6H6, Y63 tuning indicator and VR150-30 voltage regulator. Two stage IF with 8 tuned circuits, Xtal controlled B.F.O. Four position selectivity with audio filters for narrow band-width C.W. Fast and slow AVC, high and low noise suppression. A plug-in unit with additional mixer provides a "listening through" guard channel of either 2-4 or 4-7½ Mc/s. Receiver 16½ x 9 x 11in. Power pack 8 x 9 x 11in. Complete with 200-250 volt AC (or 12v. DC) power pack type 360, and operating and alignment instructions. Used, but in very good condition. Guaranteed serviceable. A sound buy indeed at **£13.10.0** carriage paid.

ETCH-YOUR-OWN PRINTED CIRCUIT KITS 21/- Post Free

outs ready for etching. High-quality materials—completely safe to handle—carefully prepared to ensure fine definition and uniform results without laboratory control.



Each contains over 60 sq. in. of laminated board and sufficient chemicals to make dozens of printed circuits, plus comprehensive instruction book giving advice and examples on translating theoretical circuits into lay-

VARIABLE SPEED HYDRAULIC GEARBOX

This specially made oil-filled casing houses an hydraulic torque conversion unit originally precision made by Westinghouse from high quality materials for the U.S. Government at an acquisition cost exceeding £150 each. Highly suitable for lathe head drive, workshop variable speed power take-off, etc.

Basically the unit is a back-to-back mounted, oil submerged, variable displacement hydraulic pump (input shaft) feeding a reversible hydraulic motor (output shaft) so that variation of the pump displacement by manual control gives very fine selection of output speed from zero up to 6% below input speed while a changeover valve in the supply lines to the motor provides instantaneous reverse at any speed. Recommended input speed 500-1,000 r.p.m., maximum power 1½ h.p. Both shafts ½in. dia. with Woodruff key. Tested and fully guaranteed, supplied complete with technical data and performance curves for the remarkable price of £16 only, carriage paid.

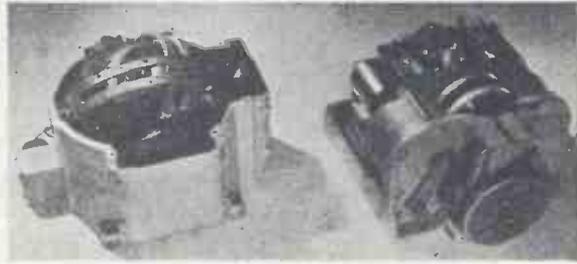
POST PAID VALVE BARGAINS

- 7Z4, EY91, 6AM5, 6AM6, 6C4, 6AL5, CV71 (neon stabiliser)..... any 4 for 10/-
- 6SN7 ... 4 for 12/6; TT15 ... 32/6; QVO.4/7 9/6
- Brand New CV.139A CRT. Boxed £1
- STC Miniature Silicon Diodes, 50 volt Peak Inverse. Output 15v. 0.5A, DC 3/6

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- OC.170 27/6; OC.16 37/6; Goldtop V30/IODP... 21/-
- Also leading make of 3v transistors 4 for 10/-
- Mullard 0A81 Diodes 10 for 10/6

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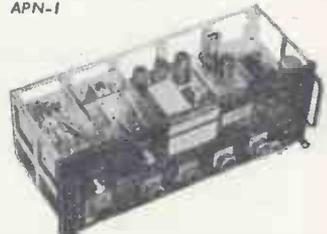


D.C. GYRO & SERVO MOTOR—CI AUTO PILOT

Beautifully engineered Minneapolis-Honeywell precision gyro, totally enclosed in sealed light-alloy housing about 8½in. cube. Automatic erection and precession correction. Large diameter Dessyn type transmitting potentiometers provide signals corresponding to the magnitude of the deviation of gimbal arms. Powerful D.C. motor coupled through a differential reduction gear to a 4in. spur driving gear integral with a 3in. dia. spiral groove cable driving drum. Two powerful solenoid clutches and corresponding brakes hold drum rigidly in position or set free for "neutral." Nominally for 26-volt operation, but operates at 12 volts. Size 10 x 6 x 8in. £10 each unit or £17/10/- pair, carriage paid.

This is the attractive lightweight American Radio Altimeter that superseded the British version. A complete 14-valve radar set covering 420-460 Mc/s it is ideal for conversion to radio control of models or 70 cm. work. It embodies three self-contained sub-units in separate detachable aluminium cases, as follows:

TRANSMITTER/RECEIVER APN-1



TRANSMITTER

A push-pull feed-back oscillator tuneable either side of 445 Mc/s., frequency modulated at 100 c/s by a particularly robust moving coil transducer. Two 955 high frequency acorn valves. Case size only 3½ x 6½ x 2in. plus 2 x 2½in. dia. for transducer.

RECEIVER

Tuneable to transmitter frequency. Size 3½ x 6½ x 2in. Two 9004 acorn valves.

AUDIO AMPLIFIER

Self-contained RC coupled 12SH7, 12SH7 and 12SJ7. Size 3 x 5 x 1½in. Amplifies the received signal which is passed to detector circuit giving a D.C. voltage proportional to the difference between the transmitted and received (reflected) signal to operate internal relays which pass appropriate correction signals to autopilot and supply external indicator (5 mA meter).

MAIN CHASSIS

The main chassis carries the 3 sub-units and has a further three 12SH7 one 12SJ7, two 12H6 and one VR150 regulator, three 1% wire-wound resistors, one 4-pole changeover relay, two SPCO relays, three twin-ganged pre-set potentiometers, trimmers fuses, etc. Power supply is derived from a 27-volt dynamotor (charging rate for 24 v. supply) delivering 285 volts at 75 mA.

BRAND NEW, a very useful buy indeed at only **£2** plus 7/6 carriage.

SCR 522 TRANSMITTER RECEIVER

Well known American airborne equipment covering 100 to 156 Mc/s. BC625 transmitter has a 6G6 Crystal oscillator with the 2nd harmonic fed to a 12A6 and an 832 tripler stage and finally to an 832 power amplifier giving 8 watts. The BC624 superhet receiver has a 9003 RF and Mixer, three 12SG7 12 Mc/s IF's, 12C8 Detector, 12J5 Audio, and 12AH7 oscillator using 8 to 8.72 Mc/s crystals. AVC, Noise Limiter, and Squelch provided. Output transformer provides 50, 300 and 4,000 ohms. Successful conversion to 2 metres was fully described in CQ. Circuit diagram (unmodified) supplied. In good used condition.

Receiver, chassis only, 10/- post paid. Transmitter, chassis only but including modulation transformer, 15/- post paid.

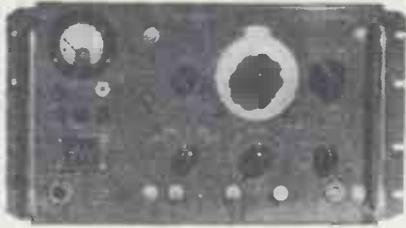
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- Precision decade ladder and silver slide wire attenuator calibrated in voltage and 0-90db.
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- Selected spare oscillator, pre-aged spare monitor, 100µA meter.
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Output 10 watts. Made by B.S.R. 12 v. D.C. Supply. Used but in good working order. £3. 15. 0. Carr. 10/-
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British 1/2-inch Spacing.

- 3.5 Mc/s—3.8 Mc/s. inc. } 9/6 ea. Post Paid.
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American 1/2-inch Spacing. F.T.241A.

Available from 20.1 Mc/s.—27.9 Mc/s. in 100 Kc/s. Steps. Fundamental Frequencies 1/54th of the above. 9/6 ea. Post Paid.

Any Crystal Between 2.2 Mc/s.—9.0 Mc/s. Excluding those listed above..... 7/- ea. Post Paid.

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Attractive, lightweight, black crackle box 11 x 7 x 13 1/2 in. deep with 4 x 2 1/2 in. and 3 1/2 x 3 in. square windows on front panel for twin 5FP7 tubes. Neat arrangement of appropriate (independent) controls and variable scale illumination. Totally enclosed detachable magnetic focusing coils. All connections to rear sockets. Ideal TV monitoring unit as used by many amateurs. Used, but in very good condition, tubes guaranteed O.K. £11/10/0 carriage paid.

Brand New, Individually Tested, Fully Guaranteed
LOW - VOLTAGE, HALOGEN - QUENCHED, GEIGER - MUELLER TUBES 25/- post free

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- This is a later type than those previously available. A really serious job of sound design, crystal controlled, 10 mile range, transmitter and receiver covering any one frequency between 4125 and 7100 kcs in 25 kcs steps with standard crystal supplied—or any spot frequency between 3600 and 9000 kcs with special crystal supplied to order. Brand new, complete with headphones, throat mic., whip-antenna, plugs and leads. Size: 12 x 4 x 6 1/2 in. Weight 8 1/2 lb.
- Price, with standard crystal **£3/10/0** carriage paid
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- Batteries required: 150, 1.5, and 3 volts. Transistorised converter to operate from 6v. or 12v. D.C. **£8/10/0** extra

ELECTRIC STOP-WATCH OPERATOR

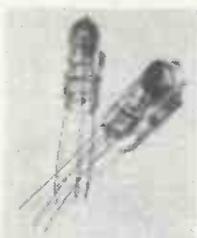
Simple aluminium stand 4in. square and high with powerful twin solenoids operating a pivoted bar that depresses knob of stop-watch when it is fitted into clips provided on front panel. Designed for precise remote control by 24 volt line to terminals at rear, but works satisfactorily off 12-volt supply. A very useful buy (without watch) for 11/6 post free.

TRANSISTOR AMPLIFIER KIT

Printed circuit, 500 milliwatt push-pull output. Input and output transformers of 3 ohms impedance with two OC.71 and two OC.72. Supplied complete with all condensers, resistors, volume control, etc. **52/6** post paid Input 9 volts. for only

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A sub-miniature cold cathode valve developed by Ericsson primarily for computer work, these GTR.120W tubes have great possibilities in a number of experimental electronic automatic control circuits. They have an Anode-Cathode running voltage of 95 to 140 at 4.5 mA, and at 290 anode volts require a trigger current of only 250 microamps to cause the anode to take over the discharge. Typical ionization time = 90 microseconds. They will withstand up to 310 v. with zero trigger voltage without self-igniting. Supplied complete with full performance data in original packs of 100 at the Special Price of **£5** per 100 post paid



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- TRANSMITTER £4 10 0 Carriage Paid.
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- RECEIVER ... £1 10 0 DETAILS.

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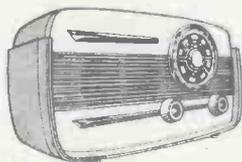
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A medium and long wave superhet, incorporating two I.F. stages modern 89 valves (UCH81, UBF89, UCL83, U785), built-in ferrite rod aerial. All you need supplied, from theoretical wiring diagram to last nut and bolt (main components ready mounted), including an attractive contemporary styled cream plastic cabinet with gold trimmings. Size 11½ x 4½ x 6½ in.

PRICE £6.12.6. Post 3/6

STEREOPHONIC AMPLIFIER £5.10.0

Complete with 2 Loudspeakers

Plus 4/6 P. & P.

This is a compact amplifier embodying the latest features and giving a high standard of reproduction, with ample volume. Supplied complete with valves (ECL82, ECL82, EZ80), panel, knobs, etc., and two specially selected 3Ω matched loudspeakers. We only have a few, and we will never be able to repeat this offer at such a low price! Don't risk disappointment! Order now!

MONAURAL AMPLIFIER



This amplifier as illustrated, made by a leading manufacturer. Mullard valves—ECC83, EL84 x EL84, EZ80. Bass Treble and Volume on remote panel. Elegant Knobs. OUR PRICE one month only £4/16/6, plus P. & P. 3/6.

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50 mixed P.F. Condensers and 50 mixed Resistors. An assortment of useful values. All popular sizes—all new—a must for the serviceman and constructor **ONLY 10/-** P. & P. 1/-.

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Complete and ready for your cabinet, 4 valve superhet chassis. Complete with valves, ferrite aerial, dial and knobs. Valve line up—UCH81, UBF89, UCL83, UY85. Long and Medium wave coverage.
PRICE **£4.19.6** P. & P. 3/6.

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New purchase offered at still lower price. I.F. 33-38 Mc/s. Complete with PCC84 and PCF80 valves and 8 sets of Coils for 5 Band 1 channels and 8, 9, 10 Band III. New and unused. Value over £7.
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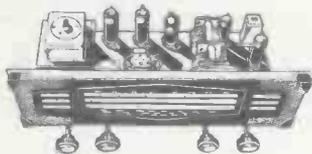
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A few only—Transistor record player cases in light grey cloth—complete with motor board. Size: 12 x 8 x 6 in. 18/6 each. P. & P. 1/9.

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A pair of midget 465 kc/s I.F. transformers, plus LW and MW coils. OUR PRICE 10/- per set. P. & P. 1/9. Set of I.F. transformers for transistor superhet. 12/6. P. & P. 1/9.

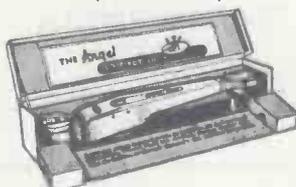
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A chassis of distinction, by a famous maker. Covering Long, Med. & Short Waves, plus gram position, this chassis (Size 15½ x 7 x 6½ in. high) incorporates the latest circuitry, using fully delayed A.V.C., and negative feedback. Controls:—Tone, Vol.-On/Off, W/Change (L.M.S. & Gram) Tuning. Tapped input 200-250 v. A.C. only. An attractive brown and gold illuminated dial with matching knobs, make this one of the most handsome, in addition to being one of the best performing chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads etc. OUR PRICE ONLY **£9.19.6** plus 4/6 post and packing.

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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 PL6-21

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. 30 watts peak; speaker impedance, 4, 8 or 16 ohms. Sensitivity: 4M/V on pickup, 3M/V on tape, 100M/V on tuner, Intermod. distortion 1% at 10W equivalent Sinewave output. Maker's price £28/10/-. **OUR PRICE** 19 gns. Post and packing 10/-.

AVANTIC SP11 Stereo Amplifier

A twin channel amplifier and pre-amp., push-pull output, 10W peak each channel, rumble filter speaker impedance 4, 8 and 16 ohms. Tape output: 100M/V. Continuously variable treble and bass, stereo balance control. Input sensitivity: for 7W, 100M/V radio; 100M/V tape; 650M/V pickup. Manufacturer's price 28 gns. **OUR PRICE** 19 gns. Post and packing 10/-. **STEP 11** stereo pick up pre-amp. unit £4/14/6. P. & P. 2/6. **STEP 21** stereo tape pre-amp., £4/14/6. P. & P. 2/6.

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A FEW ONLY

STEREO REPRODUCERS

3 watts each channel. Using 2-ECL82, 1-EZ80, separate balance and tone controls, volume on/off switch, designed for crystal pickup, two tone cabinet 13 x 11 x 5in., blue and grey or beige and grey, 2 matching corner speaker cabinets 10in. wide, 20in. high, 7in. deep, with 3 x 5in. Hi-Flux speakers complete, price £13/19/6. Carr. and packing 5/-.

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 * Complete with small cream knobs. Full *
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 * **SPECIAL CELESTION** 8 x 6in. elliptical *
 * high flux loudspeaker to fit. 30/- plus 1/- *
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MERCURY II switched FM/TV sound tuner in kit form for building into cabinet, including valves, £10/10/-. Power pack kit, £2/14/9.
EVEREST 6 s/het transistor portable, p/pull output, high quality speaker, matched transistors, neatly designed case, aerial input for use in car, complete kit £13/19/9.
EVEREST 7 transistor s/het portable, p/pull output, high quality speaker, extra RF stage, neatly designed cabinet, aerial input for use in car, all components complete £15/18/9. 2/6 post and pkg. on all the above, S.A.E. for details.

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 40M/V for 10 watts, output impedance, 4, 8 and 16 ohms, spare supply for tuner, 200/250V, A.C. Pre-Amp. valve EF86. **INPUTS** Radio 100M/V, tape 100M/V, GRAM LP 50M/V, 78 60M/V, MIC 10M/V, output socket for recording direct to tape recorder Treble between -10DB and +12DB at 10KCS. BASS between -10DB and +12DB at 20CS. Finished in grey, green, stone enamel, control panel in gold lettering, fully guaranteed. Original price 20 gns. **OUR PRICE** £14/19/6. P. & P. 7/6.

ANOTHER MANUFACTURERS SURPLUS BARGAIN

The Cossor 4 valve s/het portable. L. and med. wave bands, 5in. speaker, using Ever Ready B126 90VHT, 9AD35 1 1/2 VLT batt. Attractive 2-tone finish in red and grey. Dimensions 9 x 8 1/2 x 4 1/2in. Original price 15 gns. Our price £7/19/6 plus P. & P. 3/-, Batts. 10/- extra. Also suitable mains unit. Original price 63/-. **OUR PRICE** 39/6 plus 2/- P. & P.

COSSOR BATTERY ELIMINATOR

39/6 plus 2/- Post.

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 7 1/2 I.P.S. output 5 mV/mts at 1 KC at 7 1/2 I.P.S. Erase heads low impedance. Only 39/6 per pair. Post 1/-. State upper or lower track.

TAPE DECK OFFERS

B.S.R. MONARDECK, uses 5 1/2" tape spools twin track. Single speed, 3 1/2 I.P.S. at £8/19/6 Post & Pkg. 5/-.
 Suitable tape amplifier for B.S.R. deck. Completely assembled, 3 watt o/p/ut, valve line up ECC83, ECL82, EL84, metal rectifier, magic eye level indicator, frequency response 60 c/s—9,000 c/s, inputs for radio, gram, mic., superimpose, idea for monitoring impedance, tone control, volume control. Dimensions 11 1/2in. x 4in. deep x 6 1/2in. high. **OUR PRICE** £9/15/-. P. & P. 3/6.

FOR TAPE RECORDER CONSTRUCTORS

The new Collaro studio tape deck, using 3 motors 3 speeds at 1 1/2, 3 1/2 and 7 1/2 I.P.S., will take 7in. spools, push button controls, £12/19/6, 5/- post and pkg. Well designed tape recorder amplifier (not a kit) for the studio deck, incorporating Mic/Gram/Radio inputs, ext. loudspeaker, superimposing switch, with matching knobs, separate mounted mains transformer. Frequency response 60-10K/c3DB at 7.5 I.P.S., magic eye level indicator. Using ECC83, ECL82 and EM85 and metal rectifier. Assembly instructions. The 2 units £25/10/- complete. Crating and insurance, 17/6. Suitable Acos mic. 40 for above; 25/-.
 A repeat of our previous popular offer. The Collaro Mk. IV tape transcripitor tape deck £17/10/-, crating and carr. 11/6.

The new **ARMSTRONG TAPE RE-AMPLIFIER PABO-3**, high quality unit, can be used with any Hi-Fi equipment will operate most tape decks, equalisation for tape speeds 3 1/2, 7 1/2, 15 I.P.S. can play pre-recorded tapes. Valve line up, EF86, ECC82, EM81 and OA81 diode, freq. response 30-17,000 C.P.S., at 15 I.P.S. 40-13,000 C.P.S. at 7 1/2 I.P.S. Mic./radio/gram inputs. 20 watts maximum power required, attractive control panel. Complete 16 gns. 3/6 post & pkg. Power pack £2/19/6 extra.

BRAND NEW TV TUBES CHEAPER THAN REBUILDS

All brand new in famous maker's cartons. (1) 17in. rectangular aluminumized 6. HRTS. 3 A. current; max. anode voltage 16 kV. Usual price £17/5/-. **OUR PRICE** £7/19/6. Crating and carr. 15/-.
 (2) 14in. rectangular Tube, 6.3 heaters; 3 amp current; max. anode 14 kV.; ion trap; external conducting coating; B12A base. £7/9/6. Crating and carriage 12/6.
 (3) Ferranti 9in. Tube, round white fluorescence 4 v. heater, max. anode voltage 7 kV. **OUR PRICE** 25/-. Crating and carr. 11/6.

A SNIP FOR CONSTRUCTORS

Build the Labgear Audio Output meter, Two ranges—25 milliamps to 1 watt, 1 watt to 100 watts. Accuracy 5W. Input impedance 3, 15 and 600 ohms. Printed circuit. All components including 0-1MA moving coil meter and silver hammerstone enamel case. Kit complete with instructions 59/6, post and pkg. 1/6.

FOR STEREO ENTHUSIASTS

The new Eagle Stereo balancer audio watt meter will balance your stereo speaker system, compensating for variation of acoustics and unmatched speakers. Ideal for monitoring audio outputs, suitable as a recording level indicator for your tape recorder, an improved advantage over "magic eyes." **THE AUDIO WATT METER** assists in aligning AM and FM receiver, meter is calibrated for 0-30 watts for both 3 and 15 impedances. Cabinet in grey. 7 Gns. P.&P.2/6

TRANSFORMERS

POTTED C CORE

Pri:z 230v. 50 c/s. Sec.: 450-0-450v. 220 mA. 5 v. 3 amps., 6.3 v. 5 amps., 6.3 v. 3 amps. £2/10/-
 Pri: 230 v. 50 c/s. E.S. Sec.: 500-0-500 v. 500 mA. 6.3 v., 500 mA., 6.3 v. 5 amps., 5 v. 6 amps. £3/10/-

Pri:z 230 v. 50 c/s. Sec.: 6.8 v. 5 amps., 6.3 v. 1 amp., 6.3 v. 3 amps., 6.3 v. 1.5 amps. £2/10/-
 2 amps., 6.3 v. 3 amps., 6.3 v. 4 amps. £1/12/6. Carr. 5/- each item.

MAINS ISOLATING TRANSFORMER (Gresham). Pri. 230/250 v. Secs. 240-0-240 v. 1.5 amps., 5 v. 12.5 amps. Potted. Size 7in. x 7 1/2in. x 10 1/2in. Weight 50 lb. Ideal for obtaining TWO ISOLATED 240 v. lines at 360 watts each. Perfect condition. 80/-. Carr. 10/-.

L.T. TRANSFORMERS for Battery Chargers etc. All Pri.: 200/250 v. Tapped 50 cycles. Type 048B. Sec. 24, 30, 36 v. 6 amps. 4 x 4 x 4in. £2/9/6. Type 066A. Sec. 18, 24, 30, 36 v. 8 amps. 4 x 4 x 5in. £3/12/6. Type 053A. Sec. 12, 24, 30 v. 10 amps. 4 x 5 x 5in. £4/4/-.

AUTO TRANSFORMERS. 0-110, 205, 225, 245 v. Fully shrouded. Terminal block connectors.

Type 063A. 500 w., 4 x 5 x 5in. £3/7/6. Carr. 3/6.
 Type 064A. 750 w. 4 x 6 x 5in. £3/17/6. Carr. 3/6.

Type 065A. 1,000 w. 4 x 7 x 5in. £4/17/6. Carr. 5/-
 6 kV/A. AUTO TRANSFORMER. 250/110 v. 50 cycles (fully tapped primary and secondary). Capable of 25% over actual rating. Brand new and unused. £15. Carr. 20/-.

20 kV/A. AUTO-TRANSFORMER. 230/115 v. 50-60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition. £20. Carr. 20/-

CONSTANT VOLTAGE TRANSFORMER 190-260 v. primary, sec. 115 v. at 1 1/2 kV/A. (listed at 2 kV/A). Brand new and unused. £25 or £45 per pair. Carr. 10/- each.

E.H.T. TRANSFORMER. 8,000-0-8,000 at 400 mA. Primary 230 v. 50 cycles. Oil filled. New and in original crates. £25. Carr. 10/-.

E.H.T. TRANSFORMER. 1,800-0-1,800 at 1 kV/A. 230 v. 50 cycles primary. Fully tropicalised. New and boxed. £6/10/-. Carr. 10/-.

E.H.T. TRANSFORMER. 1,100-0-1,100 at 250 mA. plus 4 v. L.T. Pri. 200/250 v. at 50 cycles. £5. Carr. 10/-.

HEAVY DUTY REGULATING RESISTOR. 0.25 ohm. 200 amps. Wheel control. £4/15/-. Carr. 10/-.

CONDENSER, oil filled. 240 mfd. 230 v. A.C. or 600 v. D.C. Made in U.S.A. Size 2 1/2in. x 5 1/2in. x 9in. Brand new in original cases. £7/10/-. Carr. 5/-.

ROTARY CONVERTER. 24 v. D.C. input. 230 v. A.C. output at 250 watts. Complete with starting switch. New and unused. £15. Carr. 7/6.

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused. £8/10/-. Carr. 7/6. Ditto, 100 watts £6/9/6. Carr. 7/6.

ROTARY CONVERTER. Ex-Govt. 12 v. D.C. input, 230 v. A.C. output 50 cycles at 135 watts. Complete in carrying case with lid. Voltage control, sliding resistance, mains switch and 0-300 v. A.C. flush meter. In good condition. £10. Carr. 10/-.

Motor only, without case, etc. Brand new and unused. £8/10/-. Carr. 5/-.

S.T.C. SELENIUM METAL RECTIFIERS. F/B, FOR BATTERY CHARGERS, ETC. NEW AND FULLY GUARANTEED.

6 or 12 v. 1 amp. 5/-; 24 v. 1 amp. 10/-;
 12 v. 2 amp. 7/6; 24 v. 2 amp. 15/-;
 12 v. 2 1/2 amp. 12/6; 24 v. 3 amp. 25/-;
 12 v. 4 amp. 15/-; 24 v. 4 amp. 30/-;
 12 v. 6 amp. 20/-; 24 v. 6 amp. 32/6;
 12 v. 10 amp. 35/-; 24 v. 10 amp. 70/-

A.C.-D.C. RECTIFIER POWER SUPPLY UNITS

110/230 v. A.C. 50 cycles input, 100/110 v. D.C. output max. 2 1/2 amp. Brand new and unused. £4/10/-. Carr. 7/6.

230 v. A.C. 50 cycles input, 200/220 v. D.C. output at 3/4 amps. approx. Good condition. £10. Carr. 10/-.

200/250 v. pri. 110 v. sec. at 4 amps. max. Brand new and unused. £8/10/-. Carr. 10/-.

Type 67. 200/230 v. A.C. 50 cycles input, 240-0-240 v. D.C. output at 1 1/2 amps. (Valve rectification.) Fitted with switch fuses, regulator and overload controls. Brand new in maker's original crates. £10. Carr. 10/-.

R.C.A. AR88-D RECEIVER

32 Mint condition. Freq. coverage 540 Kc/s., 32 Mc/s., £50. Carr. 20/-. Also L.F.'s available. Freq. coverage 75-550 Kc/s., 1.5-30 Mc/s. £45. Carr. 20/-.

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Kc/s. to 8,000 Kc/s. (158-37.5 metres) in two ranges, 1,900 Kc/s. also 4,000 Kc/s. also 8,000 Kc/s. Supply 6 v. D.C. input. Complete with twin crystal, spare vibrator, headphones, original instruction manual and transit case. Condition as new. £5/5/-

EVERSHED AND VIGNOLES MEGGER

CIRCUIT TESTER (low reading ohm meter). 2 ranges 0-3, 0-30 ohms. The perfect meter for continuity and polarity testing, complete with test leads and ready to use. Brand new. Only £4/17/6. P. & P. 3/-.

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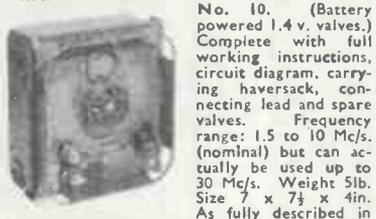


Series 2 in perfect condition. 250 v. £22. Carr. paid. Leather case available at 20/- extra.

MARCONI SIGNAL GENERATOR. TYPE

TF511-F/1. Covering 10-18 Mc/s. 33-58 Mc/s. 150-300 Mc/s. In very good condition. Complete with full technical data and instructions. Unrepeatable at only £12/10/-. Carr. 20/-.

BRAND NEW CRYSTAL CALIBRATOR



No. 10. (Battery powered 1.4 v. valves.) Complete with full working instructions, circuit diagram, carrying haversack, connecting lead and spare valves. Frequency range: 1.5 to 10 Mc/s. (nominal) but can actually be used up to 30 Mc/s. Weight 5lb. Size 7 x 7 1/2 x 4in. As fully described in "Practical Wireless." Dec. issue, pages 691-693. Only £4/19/6. P. & P. 2/6.

MULLARD BRIDGE. Type GM. 4140/1.

Mains operated from 100-250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pf. to 10mf. Good condition and complete with instruction booklet. £6/19/6. P. & P. 2/6.

TAYLOR VALVE TESTER Model 47A.

Input 200-250 v. A.C. Will test all types of English and American valves with filaments from 1.1 v. to 117 v. Perfect condition. Complete with full instruction manual. £12/10/-. Carr. paid. Also MODEL 45A available at £10/10/-.

VALVE TESTER TYPE 4. 200/230 v. A.C.

input. Ex-Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve holders for Brit. 4, 5, 7 pin and Octal, U.S., 5 and 7 pin, 1/Octal, side contact large Brit., 4 and 9 pin. Acorn and diode. Housed in substantial wooden case with hinged lid. Few only, to clear at £5/19/6. Carr. 7/6.

G.P.O. RACKS

19in. Heavy duty all steel Standard drilling. 5ft. 6in. angle uprights. £3/10/-. Carr. 15/-.
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10-LINE TELEPHONE SWITCH-BOARDS.

For the complete control of 10 extensions (Tele. "F" etc.). Complete with jacks, leads and operator's hand set. Good condition. £9/19/6. Carr. 10/6.

TELEPHONE SETS (TELE "F")

Housed in Bakelite cases, complete with built-in ringing generators and batteries. Ideal between two or more positions up to practically any distance. Tested before despatched. ONLY 70/-. P. & P. 3/6. 2 sent for £6/10/-. Carr. paid.

TELEPHONE CABLE. Twin one-mile drums

(Don 8), £5. Carr. 20/-. Single one-mile drums (Don 3), 50/-. Carr. 7/6.

12 VOLT D.C. AMPLIFIER (Parmeko, Ardente).

As new. 15 watt output with 2-EL35's in push-pull. Mike and gram. inputs, tapped output transformer. £9/19/6. Carr. 10/6.

EXPONENTIAL HORNS by famous manufacturer of P.A. systems, 15 watt, 25in. long, 20in. square flare 15 ohms speech coil. (Tannoy). Good condition. £7/10/-. Carr. 10/-.

NEW P.M. HEAVY DUTY SPEAKERS.

Complete with O.P. trans., in all steel blue-grey double grided cabinet. 6in. 30/- 8in. 32/6. Carr. 3/6 each.

RE-ENTRANT LOUD HAILERS (Ex-Govt.).

Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx.). Good cond. £6/10/-. Carr. 10/-. Ditto. Brand new, £8. Carr. 10/-.

HEAVY DUTY ALL STEEL TRIPOD STANDS (as illus. Sept. issue). Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage.) Suitable for outdoor speakers, public address systems, flood-lighting, etc. OUR PRICE £3/10/-. Carr. 5/-.

TRUVOX/TANNOY LOUD-HAILERS.

With 180 ohm line transformer and condenser. Impedance 7 1/2 ohms, handling capacity 8 watts. Complete in slope-front wooden case. Brand new 25/- Carr. 4/6.

BAKERS "SELHURST" SPEAKERS ALL BRAND NEW.

SPECIAL NEW ARRIVAL! "15in. VIS-COUNT AUDITORIUM." 15 ohms at 400 c.p.s., 35 watts. Flux density 18,000. OUR PRICE £15.

"12in. P.M." 15 ohms, 15 watts, 30-14,000 c.p.s. Our price £4/10/-.

"AUDITORIUM" 12in., 15 ohms, 12 watts. 35-16,000 c.p.s. Flux density 14,500. OUR PRICE £7/10/-.

"SUPER HI-FI 25" 12in., 15 ohms, 25 watts 25-20,000 c.p.s. Flux density 17,600. OUR PRICE £9/9/-.

Full descriptive specification available. S.A.E.

MOVING COIL MICROPHONE. Complete with 12ft. screened lead. £2/10/-.

CRYSTAL MICROPHONE. Complete with 12ft. screened lead. £2/2/-.

Both are recommended for professional use.

MICROPHONE STAND (Telescopic). With heavy 8in. dome black crackle base, chromium stand with screw top extends to 5ft. 4in. Will fit above mikes, etc. £2/10/-. Carr. 3/6.

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Brand new in original cartons 3 speeds. 1 1/2, 3 1/2, 7 1/2 i.p.s. 3 motors, digital counter, etc. Complete with 7in. spool instructions and fixings. A.C. 200/250 v. operation. SPECIAL PRICE £12/10/- only.

RECORDING TAPES. Super quality P.V.C.

1,800ft. L.P. 7in. spools, 30/-; 1,200ft. Std. 7in. 19/-; Empty 7in. spools 3/9 each. Send S.A.E. for current Tape Bargain List.

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12 v. 25 A.H. 45/-. Carr. 7/6.
 2 v. 100 A.H. 75 actual (ex-Govt.) with carrying handle. Size 6 1/2 x 6 1/2 x 3 1/2in., 15/- each. Carr. 3/6.
 2 v. 16 A.H., as above. 7 1/2 x 4 x 2in., 5/- each. P. & P. 2/- 6 for 24/- P. & P. 10/-.

AIRBORNE TRANSMITTER RECEIVER

TYPE 1986. A mobile 10-channel crystal controlled V.H.F. Tx/Rx. covering 124.5/156 Mc/s. I.F. band width 23 kc/s. Complete (less external attachments) in metal case, with all valves and 24 v. rotary power unit. Used but in first-class condition. ONLY £8/10/-. Carr. paid. Also, complete with control box and all necessary connecting leads, £12, carr. paid.

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160 kc/s-10 mc/s..... £200 0 0

R.C.A. Waveform Type TE149. Accuracy .005%.
2 kc/s-20 mc/s. New, unused. Complete spares and technical manual in transit case..... £10 10 0

BENDIX Type Frequency Meters:-
BC/221, 125 kc/s-20mc/s..... £50 0 0
TS173, 90-450 mc/s..... £175 0 0
TS174, 20-250 mc/s..... £175 0 0
TS175, 80-1000 mc/s..... £150 0 0
LM. Freq. Meters, 125-20 mc/s..... £45 0 0
TS188D Freq. Meter, 100-10,000 mc/s. Write for quotation.
TS869/AP, 250-1000 absorption..... £45 0 0

LAVOIE LA6 100-500 mc/s. Accuracy .001%. Write for quotation.

MULLARD High Speed Valve Tester with cards... £85 0 0

MARCONI Audio Oscillator 195L..... £55 0 0

MARCONI Universal Impedance Bridge Type 373D..... £55 0 0

SIGNAL GENERATOR EQUIPMENT

AIRMEC AM FM Type CT212. AM 85 kc/s-32 mc/s. FM 16 kc/s-32 mc/s. 1 microvolt 0.1 attenuator meter set mod. and set carrier 0-30 kc/s. F.M. deviation. 150-250 a.c. or 12 V. d.c. operation. AS NEW complete..... £45 0 0

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Type 801A, 10-310 mc/s..... £135 0 0
782C/2, 465-900 mc/s..... £120 0 0
782C/2, 300-600 mc/s..... £120 0 0
144C, 85 kc/s-25 mc/s..... £65 0 0
380G, 16 mc/s-150 mc/s..... £35 0 0
517, 150-300 mc/s..... £35 0 0
923, TV Sweep Generator £45 0 0
913, FM Test Set..... £70 0 0
888, Portable Receiver Tester..... £75 0 0

E.M.I. Type QD/051, 30 kc/s-100 mc/s..... £22 10 0

ADVANCE Type D1, 10-310 mc/s..... £45 0 0

R.C.A. Type 710, 370-560 mc/s..... £35 0 0

BOONTON Type 84, 300-1000 mc/s..... £220 0 0

HEWLETT PACKARD Type MI-18733 Range 520-1300 mc/s. Accuracy ±1%. Output voltage 1/4V to 100mV. Impedance 50 ohms. Reconditioned completely; with calibration charts and guaranteed accuracy..... £100 0 0

Type 200 AB, Audio Oscillator, 20 cps-20 kc/s in three bands. Output, 5 watts into 50, 200, 600, 5000 ohms. Metered input an output. Calibrated attenuator..... £85 0 0
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COSSOR Type 339..... £35 0 0
1035..... £115 0 0
1048..... £125 0 0
1052..... £70 0 0
ERSKINE Type 13..... £45 0 0
DUMONT Type 241..... £35 0 0
MULLARD Type E800..... £35 0 0

DUMONT

USM-32 Miniature Oscilloscope 115v. AC power supply. 24in.-24in. tube. 0.1v. RMS volt/inch. 10 cps-4 mc/s. ±2db freq. response. 1 megohm. 28 μμf impedance. 16-200,000 μs timebase. 1-10,000 μs marker. Calibrated vertical amplifier. Trigger 1-2 μs, 45 cps-516 kc/s. RFS. Attenuator. Cathode follower. Detector probes. NEW..... £125 0 0

SOLARTRON made monitor Type 56. High speed pulsed triggered Oscilloscope. Time base 10-20,000 microseconds. Time intervals measured by calibrated X shift ±2%. Y shift meter (up to 500 volts). Ex-Govt. Reasonable condition, complete with power supply..... £10 0 0
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CT52, 2 1/2in. screen. 10 cps-10 kc/s. time base. Amplifier 0-5v/cm. 3db. 25 cps-150 kc/s. 1.6v/cm. 3db. 25 cps-1 mc/s. 0.5μs delay line. AS NEW..... £65 0 0

MICROWAVE EQUIPMENT

BC1277, Signal Generator 2700-3400..... £95 0 0
TS14, 3200-3370 mc/s... £50 0 0

MARCONI Spectrum Analyser, TF884 2,900-3,150 Mc/s. Valve, type 707A, 728A, from, each..... £5 0 0

WAYNE KERR 8 Band Q Meter. Designed to measure the time constant, and therefore the "Q" of any 8 band echo box having a time constant between 1 and 3 μs. AS NEW condition. Price and details on request.
228 Klystrons. Magnatrons. Waveguide and Microwave components.

X BAND **SYLVANIA** Spectrum Analyser, TYPE TSX-4SE, 8630-9550. Write for quotation.
Test Set TS45/AP, 5700-9525, 10 mv. per. 0/μp. Test Set TS13/AP..... £50 0 0
9-285-9, 465 mc/s. 1.200c/s. FM square wave, 0.2-0.5 micro/sec. pulse 10-200 micro/sec. delays..... £110 0 0
Klystrons Type 2K25, 723/AB. CV129. Xtals. IN23, 1N21B. etc.

K BAND TS259 Signal Generator, 25,500-24,500 mc/s. -40 to -60 dbm. power output. +10 to +50 dbm. power input. Valves 2k33 Xtals 1N26. Write for quotation.
IN26. Tuneable Cavity Valves. NEW. Unused 3 cm..... £5 0 0

K BAND TS259 Signal Generator, 25,500-24,500 mc/s. -40 to -60 dbm. power output. +10 to +50 dbm. power input. Valves 2k33 Xtals 1N26. Write for quotation.
IN26. Tuneable Cavity Valves. NEW. Unused 3 cm..... £5 0 0

Further details of the above and comprehensive catalogue and Supplement of Equipment available to laboratory engineers.

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Circuit Analyser..... £14 0 0
30A, Oscilloscope..... £22 10 0
32A, Oscilloscope 2 cps-100 cps. with triggering..... £50 0 0
45C, Mutual Conductance Valve Tester..... £25 0 0
45A, Valve Tester..... £9 0 0
45B, Valve Tester..... £15 0 0
65B, Signal Generator, 100-20 mc/s..... £9 10 0
67A, Signal Generator, 100 kc/s-240 mc/s..... £27 0 0
94A, TV Waveform and Alignment Generator 4-220 mc/s..... £50 0 0
92A, Sweep Oscillator, 0-250 mc/s..... £24 0 0
171A Electronic Testmeter T.V. Pattern Generator. Type WG44. New 622. Our price, as new..... £37 0 0
171A Ditto, Band One only..... £25 0 0

BEAMAC Cathode Ray Tube Tester. New 849. Our price, as new..... £30 0 0

AVO Valve Characteristic Meter..... £45 0 0
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Latest Valve Data Book for both..... £1 10 0
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E.C.L. Bridge, as new..... £25 0 0
Model 49 AvoMeter..... £12 10 0
Model 7 AvoMeter..... £14 0 0
Model 8 AvoMeter..... £19 0 0
AvoMinors AC/DC..... £6 0 0
AvoMinors, AC/DO, latest type..... £8 10 0

ALFA Meter. AC/DC 0-1200 V. New, complete with leads, 0-2 milliamper range..... £5 0 0

FERRANTI AC/DC Meters, 0-600 v. 0-25,000 ohms..... £3 10 0

MURPHY Pattern Generators, Band I only..... £45 0 0
Band I and III..... £70 0 0

HAM RECEIVERS

R.A.C. AR88LF..... £45 0 0
AR88D..... £50 0 0
MARCONI CR100..... £20 0 0
CR150..... £50 0 0
EDDYSTONE 640..... £22 10 0
740..... £30 0 0
840..... £40 0 0

HAMMARLUND Super Pro..... £30 0 0

HALLICRAFTERS 8X28..... £40 0 0
New S38E..... £28 0 0
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ZENITH 1000 Transistor Portable All-Wave Transoceanic. AS new..... £110 0 0

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AS NEW..... £225 0 0

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MARRIOT Rec/Play Head £1 0 0

B.S.R. TC8 Xtal cartridge..... £1 5 0
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FURZHILL 0-10 kc/s... £20 0 0
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SMALL CRYSTAL OVEN, 3 1/2" x 3" x 2 1/2". 230 v. A.C. and 12 v. type, each..... 15 0 0

PLEASE NOTE

All equipment under Laboratory heading is reconditioned to makers' specifications and guaranteed.

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Our laboratory can undertake reconditioning of electronic instruments or realignment of receivers to original specification complete with 6 month Guarantee.

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Type AN/APRA. UHF Receiver. Range 40-2,000 mc/s. 115 v. A.C. Sensitivity 35-60μV. This Receiver can be supplied with main I.F. stage and R.F. heads, 4 complete or separately Write for quotation.
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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. 18-19 or 33-38. Also can be modified as an aerial converter (instructions supplied). Complete with knobs.

32/6 Plus 3/6 P. & P.

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To suit the above, 200-250 v. 6/- Plus 1/6 P. & P.

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4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Internixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12 1/2 in. x 10 1/2 in. Space required above baseboard 4 1/2 in., below baseboard 2 1/2 in. Fitted with Ful-Fi turnover crystal head. 26/19/6. Plus 5/- P. & P.

STEREO HEAD 27/19/6 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. Complete with culcruit diagram.

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All with tapped primaries 200-250 volts.

0-160, 180, 200 v., 60 ma., 6.3 v., 2 amp., 10/6, 280-0-280, 80 ma., 6.3 v., 2 amp., 6.3 v., 1 amp., 10/8, 350-0-350, 70 ma., 6.3 v., 1 amp., 6.3 v., 2 amp., 10/8, 250-0-250, 70 ma., 6.3 v., 2 amp., 10/6. Postage and packing on the above 3/-.

SURFACE BARRIER TRANSISTORS

type SB 305, 15 Mc/s. 7/6 each.

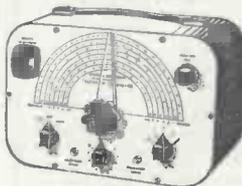
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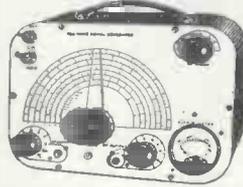
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£6/19/6

SIGNAL GENERATOR

Coverage 120 Kc/s.—230 Kc/s., 300 Kc/s.—900 Kc/s., 900 Kc/s.—2.75 Mc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—66 Mc/s., 24 Mc/s., 84 Mc/s. Metal case 10in. x 6 1/2 in. x 4 1/2 in. Size of scale 6 1/2 in. x 5 1/2 in. 2 valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F. Output continuously variable, 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. £4/19/6

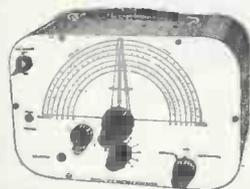


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Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6. Coverage 7/6 Mc/s.—210 Mc/s., in five bands, all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.



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I F 34/38 Mcs. 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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Plus GERMANIUM DIODE and PRINTED CIRCUIT

Size 3 1/2 x 4 x 7/8 in.

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%

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COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

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£4.19.6 Plus P. & P. 7/6.

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PORTABLE AMPLIFIER

On printed circuit for A.C. Mains 200/250 v. Size 4 in. x 3 in. with tone and volume control. Valves: ECL82 and EZ80, 39/6. P. & P. 2/6

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115 v. A.C., 1/8th H.P., variable speed box 0-166. Size of unit, 14 $\frac{1}{2}$ x 9 $\frac{1}{2}$ x 8in. £8/10/- Carr. 10/-

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AMERICAN L.T. TRANSFORMERS. Potted type, finished in black crackle and very conservatively rated. (1) 230 v., input 2 x 6.3 volts CT, at 3 amps. and 6.3 volts at 3 amps. output, 18.3 each. (2) 250 volt input, 2 x 6.3 volts at 3 amps., and 6.3 volts CT, at 3 amps. output, 17/6 each. (3) 230 volts input, 28 volts at 2 amps. and 2 volts at 1 amp., 12/6 each. (4) 230 volts input, 3 x 6.3 volts at 3 amps. CT, 1, 6.3 volts 3 amp., 22/6 each. (All these transformers are new and boxed, please include postage 3/6 each.)

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VARIABLE RESISTORS, 3 ohms 10 amp., 18/6 each. Post 3/-

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APRESA RECEIVER. 1,000 to 6,000 Mc/s., 35s each.

L.Z. FREQ. METER AND SIGNAL GEN. BC 1277A, £25 each.

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INDICATOR UNIT, with two 5FP7 tubes, etc. £2. Post 3/6.

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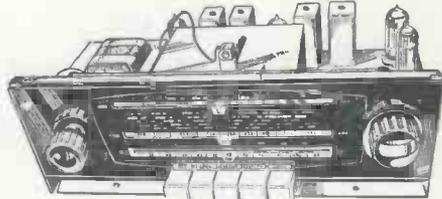
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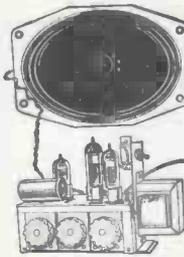
BRAND NEW AM/FM (V.H.F.) CHASSIS AT £13.6.8. (P. & P. 10/-)



Tapped input 220-225 v. and 226-250 v. A.C. ONLY. Chassis size 16 x 8 $\frac{1}{2}$ x 6 $\frac{1}{2}$ in. high. New manufacture. Dial 14 $\frac{1}{2}$ x 4 $\frac{1}{2}$ in. in gold and black. Pick-up Extension speaker, Ae, Ee, and Dipole sockets. Five "piano" push buttons - OFF, L.W., M.W., F.M. and Gram. Aligned and tested. With all valves & O.P. Transformer, Tone-control fitted. Covers 1,000-1,900 M., 300-500 M.; 88-99 Mc/s. Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker and Cabinet to fit chassis. 47/6. 10 x 6in. ELLIPTICAL SPEAKER, 20/- to purchasers of this chassis. TERMS:—(Chassis £5/7/6 down inc. carr.—and 6 Monthly Payments of 30/- or with Cabinet and Speaker £5/10/- down and 7 monthly Payments of 32/- Some tarnished but fully working unused chassis at £10 (10/- carr.).

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 6 $\frac{1}{2}$ x 3 x 2 $\frac{1}{2}$ in.; with 7 x 4in. elliptical speaker or 6 $\frac{1}{2}$ in. round (Goodmans); state which. ONLY 67/- (3/- P. & P.).



STUPENDOUS OFFER! 13-CHANNEL TUNER

I.F. 34-38 Mc/s. complete with valves PCF50 and PCC84. Removed from chassis but in working order. 15/- (2/6 P. & P.) Knobs 2/6 extra. Some tuners less valves 7/6.



50 SILVERED MICA AND CERAMIC CONDENSERS, 10/- 50 RESISTORS 5/- ALL NEW

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.

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By well-known manufacturer for superhet TVs with 35-38 Mc/s. I.F. For all areas; covers all 13 channels. Switch gives BBC and two I.T.A. selections. Suits G.E.C. sets BT45-43, 4544 5144, 5147, 5543, 5642 and 6641 without alteration. Easily adapted as aerial convertor, and instructions can be provided free. Has I.T.A. and BBC co-axial sockets and separate gain controls. WITH VALVES PCF50 and PCC84, 22/6 (P. & P. 3/-). Some without valves at only 12/6 (P. & P. 3/-).

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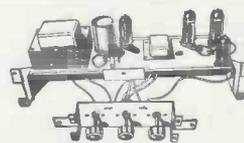
with 5in. SPEAKER. On Fabric-covered Baffle 12 $\frac{1}{2}$ x 6in. Mains and Output Transformer, EZ40 and EL41 Valves. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed. Two Knobs supplied. Ready to play. Useful for Stereo. ONLY 57/-, post 3/-.



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 5w. Chassis 12 x 3 $\frac{1}{2}$ x 3 $\frac{1}{2}$ in. With o.p. trans. for 2-3 ohm speaker.



A Quality Tape Recorder. Valves EZ80, ECC83, ECL82, DM70 Record Level Indicator, Acos Crystal Mike, 850ft. Emitape. Extra spool, 3 $\frac{1}{2}$ in./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 x 11 $\frac{1}{2}$ x 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. Terms include cart.



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Fully built V.H.F./F.M. Set. Mullard permeability tube. 88-95 Mc/s. Metal (Blue and grey) cabinet 12 x 7 $\frac{1}{2}$ x 6in. ONLY £8/8/- (4/- carr.). Cheap room dipole 10/-, 300 ohm twin feeder, 6d. yd. With 12 months' guarantee. Valves ECC85, 2-EF91, ECL82 & 2 diodes.

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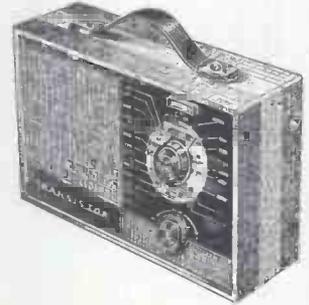
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A really remarkable 2-Band 6-Transistor Superhet Kit as displayed at the Radio Hobbies Exhibition.

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 1200-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.
(or our BUY AS YOU BUILD SCHEME, any parts sold separately.
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. 22 Mfd. 2% 1/4. 1 Mfd. 10% 1/7. 500 v. Wkg., 630 pF., 1,000 pF., 1,500 pF., 2,200 pF., 7d. each. 3,300 pF., 8d. 5,000 pF., 8,200 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% 820pF., 1,500 pF., 2,000 pF., 8d. each. 5,000 pF., 6,500 pF., 9d. each. .022 Mfd. 10d. 1,000 v. Wkg., 1,500 pF., 9d. 6,500 pF., 10d. .01 Mfd., 1,600 v. 1/. .12 Mfd., 15 Mfd., 1/1 each.

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4 pin U.X. 7d. 7 pin Brit. Fax. 3d. 7 pin Brit. Porc. 4d. Int. Octal Fax. 3d. Internat. Octal McMurdo 6d. Mazda Octal Fax. 3d. Locals 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. B8A Pax. 6d. B8A Cer. 10d. B8A Cer. with saddle and valve retaining spring 1/-. B9A Cer. skirted 1/-. B9A Cans. 6d. B9A printed circuit 10d. B7G Valve cans 6d. EY88 High Voltage holders 1/3.

VARIABLE GANG CONDENSERS

Twin Gang .0005 Mfd. 2½in. x 2in. x 1½in. Spindle ½in. 4/-. Min. Twin Gang .0005 Mfd. 2½in. x 1½in. x 1½in. Spindle ½in. 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.

TRANSISTOR COMPONENTS

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. 10 v., 25 v., 2 Mfd. 6 v., 15 v., 70 v., 4 Mfd., 12 v. 5 Mfd. 25 v., 8 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 Kcs/plus Oscillator coil.
As specified for Mazda Circuits 23/8 complete.
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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.

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(Diameter ½in. SHORT SPINDLES) 2/6 each.
100Ω, 250Ω, 400Ω, 500Ω, 1k., 2k., 2.5k., 5k., 10k., 25k., 50k., 100k., 250k., 500k., 1M.

SUB MINIATURE METALLISED PAPER CONDENSERS ½in. x ½in. 100 v. working.

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Knurled knob and 6BA fixing holes. Diam. ½in. 100Ω 5K., 10K., 25K., 50K., 100K., 200K., 250K., 500K., 1.5M., 2M., 1/3 each. 25K wirewound 1/6.

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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. 1.5 amps., output, 5/6; 3 amps. 9/6. Charging Transformers, tapped all voltages 2 amp., 14/3; 4 amp. 18/6.

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1C3 .12/6	6B76 8/-	6V80 7/-	12S47 8/6	185BA 14/-	EA76 7/6	EP38 14/-	GZ33 19/11	PL39 .22/6	U30 . 8/6	UY1N 18/7	12, 13, 14,
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6AU6 10/6	6S7 .7/6	12K5 17/11	78 .6/6	DL94 7/6	EC38 9/6	EZ40 7/6	PC68 8/6	FX4 .10/6	FX4 .10/6	FX4 .10/6	FX4 .10/6
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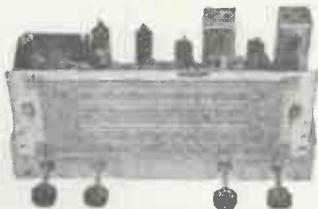
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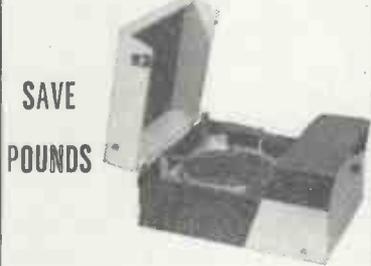
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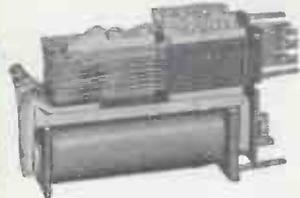
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Z530023	2	2B 2M	1.3 v.	12 6
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HOUSING ASSISTANCE MAY BE POSSIBLE

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Applications to be sent to:—Technical Personnel Officer, c/o Dept. C.P.S., English Electric House, Strand, London, W.C.2, quoting reference WW1399.

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Guided Weapons Division
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Experience in one or more of the following:—
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There are vacancies in the Instrument Department for men with experience in the maintenance of instruments for the measurement of pressure, flow and temperature, electronic instruments, radar and television and for electricians with experience in the maintenance of temperature recorders and electromagnetic relays.

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A well known Company in the Midlands, Manufacturers of Radio and Television Equipment, has vacancies in its Design and Development Laboratories for experienced:—

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for expanding Contracts and Commercial programmes. Opportunities exist for development work on all types of Radio Communications and colour television.

Applications stating qualifications, experience and salary required should be addressed in confidence to the Personnel Manager, Box No. 2489 c/o "Wireless World."

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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.

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Successful applicants will be offered positions, on the monthly staff at Intermediate or Senior level according to previous experience and qualifications (from H.N.C. to advanced degrees).

Quarterly assessments of progress will allow the able man to proceed rapidly to the high income range. Some financial assistance towards the cost of removal to the London area will be offered where appropriate.

To those whose applications seem suitable, full descriptive literature will be sent with an invitation to meet Dr. Pinkerton, Research Director, at our laboratories in North West London.

Write giving details of career to:

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Men aged 19 or over for interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids at aerodromes and radio stations in the U.K. Fundamental knowledge of radio or radar with some practical experience essential; training provided on special types of equipment. Salary according to age and station, approx. £670 at age 25 rising to £795. Prospects of permanent pensionable posts. Good opportunities for those who obtain O.N.C. in Elec. Eng. or certain C. and G. Certificates for promotion to posts with maximum salaries of £950, £1,085, £1,335. Apply to the Ministry of Aviation (Est. 5(a)/RT), Berkeley Square House, London, W.1, or to any Employment Exchange (quoting Order No. Westminster 3552).

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CANDLER has taught MORSE CODE by correspondence for 50 years.

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Men between the ages of 20-35 are required to work in Central London on installing and maintaining telephone apparatus and transmission equipment. Older men, up to the age of 45, will be accepted, if they have the experience which is particularly suitable. Commencing pay is £9 16s per week rising to £12 2s. Men who show ability to progress, will be given every opportunity to qualify for Technical Officer posts on which the salary is £400 a year rising to £850. Further promotion is available.

Apply in writing stating age and experience to:—
Chief Regional Engineer (Ref. S/D2A(XB)),
London Telecommunications Region,
Waterloo Bridge House,
Waterloo Road,
London, S.E.1.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

THE RADIOCHEMICAL CENTRE
AMERSHAM, BUCKS

requires

ELECTRONIC INSTRUMENT TECHNICIANS

In the Instrumentation Section of the Physics Department.

POST I

To be responsible for the calibration and maintenance of the wide range of electronic instruments used for radiation measurements throughout the Centre. A National Certificate and supervisory experience would be an advantage.

POST II

To assist with the above work.

Applicants for both posts should have served a recognised apprenticeship or have had equivalent training. The work requires considerable experience of pulse, high voltage or electrometer circuit techniques.

The Centre manufactures and distributes radioisotopes and is situated 25 miles N.W. of London on the edge of the Chilterns.

SALARY: Post I: £1,015—£1,160 p.a.
Post II: £845 (at age 20)—£1,015 p.a.

Assisted housing and a superannuation scheme; 5-day week.

Send POST CARD for application form to: The Personnel Officer, The Radiochemical Centre, Amersham, Bucks., quoting reference 155/45.

CENTRAL ELECTRICITY GENERATING BOARD, SOUTH WESTERN DIVISION

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 semiconductor 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 Division Secretary, 26, Oakfield Road, Bristol, 8, should be completed and returned by 10th February, 1961. Please quote reference WW/AV/176/60.



U.K.A.E.A.

INSTRUMENT ENGINEERS

are required by the United Kingdom Atomic Energy Authority, Development and Engineering Group, at Risley near Warrington, to take charge of small teams of Assistant Engineers and Draughtsmen in the Instruments Design Office.

The duties call for experience in the physical or electronic fields of instrument engineering. A sound understanding of automatic control theory and application is necessary. For the electronics posts knowledge and experience of automatic information processing and logical switching techniques is desirable.

The work is concerned with the design, installation and commissioning of measuring and control systems for chemical plants and nuclear reactors. The most modern techniques are employed and the engineers selected must be imaginative, forceful and receptive to new ideas.

Candidates must either have an Honours Degree or equivalent in Physics, Chemical or Electrical Engineering with at least three years appropriate industrial or research experience, or they must be corporate members or be currently applying for corporate membership of a senior professional Institution. They should be able to direct the work of others and able to control project instrumentation from the preliminary estimate to final acceptance testing.

Starting salary will be assessed on the scale £1,370 to £1,825, according to qualifications and experience. This scale is at present under review.

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Send postcard for application form quoting reference 432/J48, to

THE APPOINTMENTS OFFICER,
U.K.A.E.A.,

Development and Engineering
Group Headquarters,
Risley, Warrington, Lancashire
Closing Date: 31st January, 1961.

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AO/L

Aquila, Golf Road, Bromley, Kent

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A number of vacancies, offering good career prospects, exist for:—

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Write, giving details of education, qualifications and experience to:—

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Box No. 3019 c/o "Wireless World"

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EXCELLENT CAREER PROSPECTS

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Applicants should hold suitable qualifications, e.g. a university degree, associate or graduate membership of a professional institution, Higher National Certificate, Final or Full Technological Certificate of the City and Guilds of London Institute.

NO TUITION FEES

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For details write immediately, quoting S/19, to either

The Director, Bolton Training College, Manchester Road, Bolton.

The Director, Huddersfield Training College, Holly Bank Road, Huddersfield.

The Principal, Garnett College, 83 New Kent Road, London, S.E.1.

The Director of Education (Wolverhampton Training College), Education Offices, North Street, Wolverhampton.

RADIO POLICE INSPECTORS OF POLICE (SIGNALS)

required by GOVERNMENT OF NYASALAND

Choice of contract terms for 1 tour 2-3 years with 10% gratuity or permanent and pensionable terms. Commencing salary according to age and experience in scale rising to £1,285. Initial outfit grant and annual uniform allowance. Free passages. Liberal leave on full salary.

Candidates of good education and physique, normal vision without glasses, must have sound knowledge of H.F. and V.H.F. fixed and mobile simplex and duplex radio telephone systems and low power petrol/electricity chargers and alternators.

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/50901/WF.

RADIO MAINTENANCE TECHNICIAN

Police Department, GOVERNMENT OF NORTHERN RHODESIA

requires Radio Maintenance Technicians on agreement for one tour of 3 years with prospect pensionable employment. Salary according to experience in scale rising to £1,260 a year. Pending the outcome of salaries review a special interim allowance at rate of 5% of salary is at present payable. Prospects of promotion to Telecommunications Officer (maximum salary £1,315) and Chief Telecommunications Officer (maximum salary £1,490). Married accommodation, with heavy furniture available immediately at sub-economic rent, e.g., on salary of £745 rent is £45 a year. Free passages. Liberal leave on full salary.

Candidates should be between 22 and 35 years, of good physique, and possessing maths. and physics at G.C.E. "O" level standard. They should have sound knowledge of installation and maintenance of modern low and medium power V.H.F. static and mobile equipment, H.F. transmitters and receivers including S.B.B. and petrol generator and diesel electric sets.

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/50829/WF.

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There is a continuous demand for test equipment caused through the increasing complexity of modern valves. We require an experienced electronics engineer to design such test equipment.

Experience of pulse circuits and a sound fundamental knowledge of oscilloscopes is essential.

Preferably applicants should possess a degree in electrical engineering or physics or equivalent qualifications and be within the age range 25 to 40.

Salary will take into account experience, qualifications and age.

Send brief résumé of experience, qualifications, etc., to—
Group Personnel Services,

THE ENGLISH ELECTRIC COMPANY LTD.
English Electric House, Strand, London, W.C.2
quoting ref WW1590C.

BROADCASTING ENGINEER TRAINING

Required by the GOVERNMENT OF UGANDA Information Department. Appointment on contract for 1 tour of 30/36 months in first instance. Commencing salary according to age and experience up to maximum in scale rising to £1,566 a year. Salary scales under review. Outfit Allowance £30 payable in certain circumstances. Free passages. Liberal leave on full salary.

Candidates must have teaching experience, ability to give theoretical instruction in telecommunication subjects and practical instruction in maintenance and operation of medium-power broadcasting transmitters, studio control and recording equipment.

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/50941/WF.

TECHNICAL CORRESPONDENT

(25/50)

required to join existing team in busy Service Department office. Sound knowledge of good-class domestic radio and TV receiver principles and defects and ability to dictate advisory letters to dealers essential.

38½-hour week (Monday/Friday); staff canteen; pension and insurance scheme.

Please apply by letter giving age, education, experience, salary required, to

**M. J. H. BRADY, ESQ.,
BUSH RADIO LIMITED,
MORTLAKE ROAD,
KEW, SURREY**

The Manchester College of Science and Technology

Sackville Street, Manchester, 1

A Senior Technician or a Chief Technician required in the Chemistry Department to join a chemistry research group and specifically to control and operate a High Resolution Nuclear Magnetic Resonance Spectrometer. Previous experience in this technique is not essential, but candidates should have a good knowledge of electronics or applied physics, and be interested in the further development of the technique for use in chemical research.

Salary—Senior Technician £700-£765 per annum (with additions for approved qualifications).

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40-hour week. Superannuation scheme.

Applications with full details quoting reference No. C.6, to The Bursar.

Closing date: 14th February, 1961.

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Experience Tektronix and Hewlett-Packard preferred but not essential. This is a Staff appointment with 37½-hour week and non-contributory pension and life insurance scheme. Employment initially at Highgate, after April at Camden Town, where canteen facilities will be offered. Write in confidence or telephone.

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LIVINGSTON LABORATORIES
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Retcar Street, London, N.19.
ARC 6251

ASSISTANT ENGINEERS (RADIO) URGENTLY REQUIRED BY DIRECTORATE OF CIVIL AVIATION EAST AFRICA HIGH COMMISSION

Appointment on contract for one tour of 36 months in first instance. Salary according to age and experience in scale, (including Inducement Pay) rising to £1,341 a year. A Salaries Revision Commission is in East Africa and this salary scale is likely to be increased early in 1961. Gratuity 13½% of total salary drawn. Outfit Allowance £30. Free passages. Liberal leave on full salary.

Candidates over 28 years of age, should possess at least two second year and preferably one third year C. & G. Certificate in Telecommunications Principles or Radio and have had at least 3 years' experience in erection and maintenance of ground station transmitters, radio and radar navigational aids and aerial systems.

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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Told by MELANIE SCOTT

Complete Set of 4 Reels containing 16 different stories

Price: 29/6 per 5" Reel of Four Stories

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With the continuing expansion of our Southampton Works, opportunities are available for Design Engineers to enter the field of Transistor and other Semi-Conductor device manufacture. Successful applicants would be concerned with the design and development of automatic equipment for both D.C. and R.F. testing of the Semi-Conductor devices being developed. Applicants should be of H.N.C. or degree standard and preferably having some experience in the Electronics Test Equipment field. However, a period of training will be given, in order to familiarise those chosen with the new techniques involved.

Applications in writing, giving experience to date, age and full personal details to the Personnel Officer, Mullard Southampton Works, Millbrook Industrial Estate, Southampton, quoting reference T.19.

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**Development
Engineers
and
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The Laboratories of the Domestic Equipment Division of the Company are concerned with the development of the complete range of domestic radio and television. The high standard of design and development engineering achieved has resulted in increased demand for the services of the laboratories. This, in turn, has created a number of vacancies at all levels of staff connected with the design of:

**RADIO, TELEVISION
CAR RADIO
TAPE RECORDERS**

In these positions every opportunity exists for demonstrating individual ability leading to increased responsibility and advancement. If you feel that you have the necessary ability to work on any of the above equipments and that you can show evidence of reasonable success in the fields of development engineering on domestic radio and television or mechanical design, we will be pleased to receive details of your qualifications and experience which should be addressed for the attention of the

**PERSONNEL MANAGER, THE PLESSEY COMPANY LIMITED
VICARAGE LANE, ILFORD, ESSEX**

**£800 - £1,000
AND EXPENSES FOR
PRIVATE CAR FOR
HIGH GRADE TELEVISION
SERVICE ENGINEERS**

Must be fully equipped technically with sound practical background and have eye to future prospects.

IMMEDIATE VACANCIES
Write with full details.

Box No. W.W. 3071
c/o "WIRELESS WORLD"
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This Company specialises in the production of high quality optical instruments for use in spectrum analysis and has an international reputation as a leader in this field. At all stages of manufacture the best standards of workmanship are needed.

We have vacancies for men with electronic experience for testing. Radar and Radio Technicians with fault finding experience would be suitable.

If you have the kind of background which you think would fit you for this interesting work in a pleasant University City, please let us have full details of your qualifications and experience.

Write to: **The Works Manager,
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quoting reference E.S.48.**

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**A. V. ROE & CO. LIMITED
WEAPONS RESEARCH DIVISION**

**ELECTRONIC TECHNICIANS
AND
LABORATORY ASSISTANTS**

vacancies are available for persons able to:—

- (a) layout and wire prototype and experimental electronic equipment to sketches and verbal instructions and/or
- (b) capable of testing experimental and prototype equipment.

The Division is situated on an airfield in rural Cheshire, close to housing and shops and on main bus routes. A superannuation scheme is in operation and there are good Canteen facilities.

Applications quoting Ref. No. WRD/R64/W should be addressed to:

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LOUDSPEAKER DESIGN ENGINEER

An Engineer is required by The Gramophone Company Ltd., for loud-speaker design and development. In addition to the development of domestic loudspeakers the post involves the design of professional loudspeakers and enclosures.

Applicants should have some experience in this field and should have at least O.N.C.

Please write, quoting ref.: GR/D/3 to:—

Personnel Manager,
E.M.I. Ltd.,
Blyth Road,
Hayes, Middx.



SEMICONDUCTORS

The Research Laboratories of The General Electric Company Limited, East Lane, Wembley, Middlesex, are extending their laboratory dealing with reliability studies on semiconductor devices of all kinds. Vacancies exist in this new work for men or women as follows:—

1. Graduate Statisticians.
2. Electronic Equipment Designers—Graduate or H.N.C. level.
3. Technical Assistants—O.N.C. or "A" level in Mathematics or Science subjects.
4. Laboratory Assistants—"O" level in Mathematics or Science subjects.

Please apply in writing or by telephone to the Staff Manager (ref.: RGB/254/T), giving age and brief particulars of experience and qualifications.

DIGITAL COMPUTERS

Resulting from continued expansion in the computer field, a number of vacancies have arisen for *Graduate Electronic Engineers and for*

Technicians of O.N.C. standard.

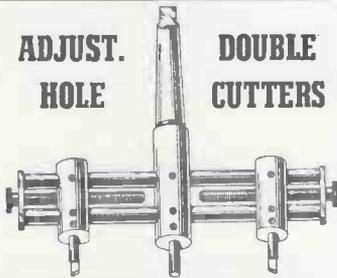
The additional staff are needed for technical supervision and maintenance of Digital Computer Installations.

Vacancies exist in London and Birmingham, Manchester and Hull.

Training will be provided for this interesting work and there are opportunities for rapid promotion to positions of responsibility. Salaries are generous and in proportion to ability.

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Personnel Manager,
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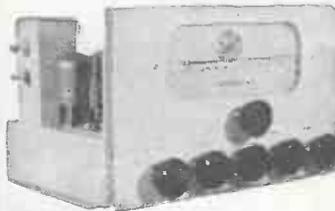
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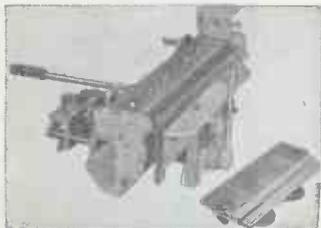
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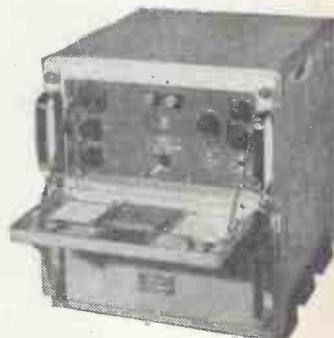


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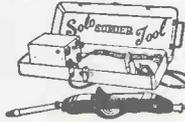
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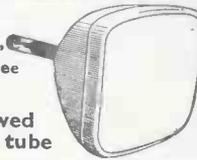
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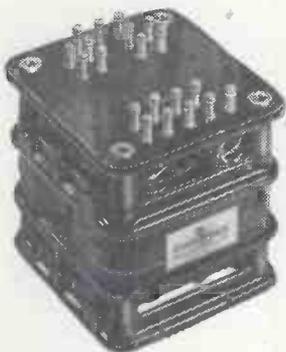
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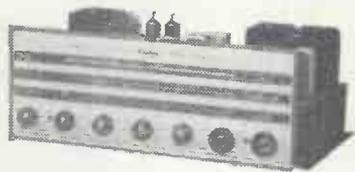
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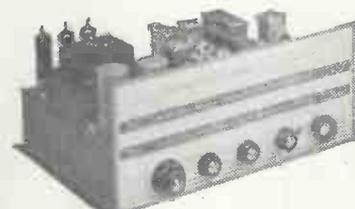
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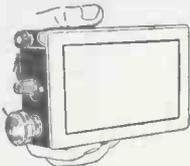
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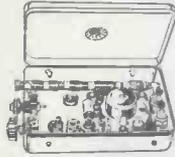
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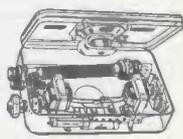
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