RADIO and ELECTRICAL Review

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PRICE 2/3

VOLUME 17 NUMBER 5

JULY 1 1962

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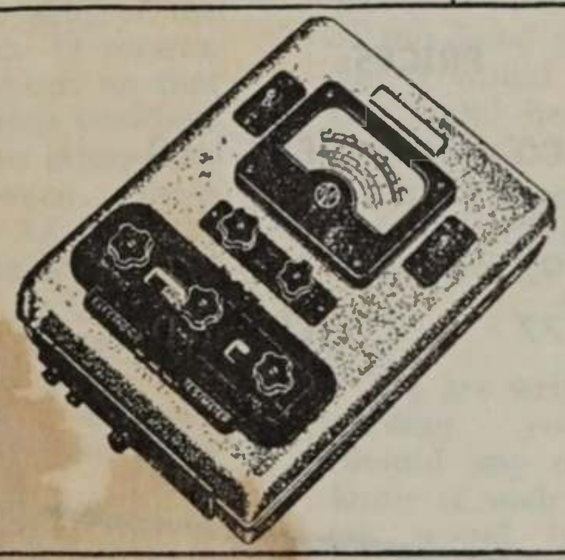

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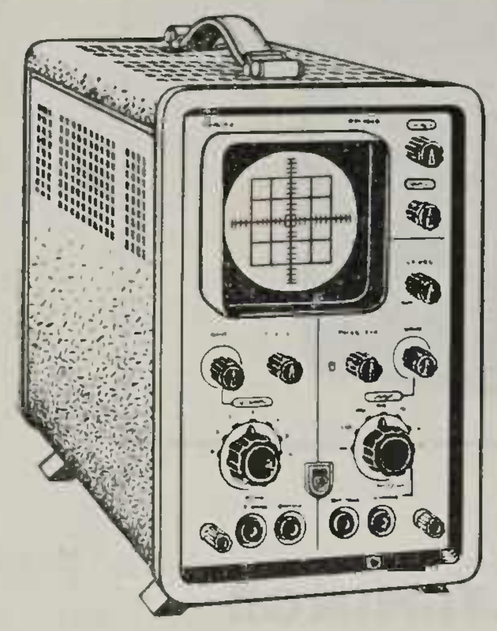

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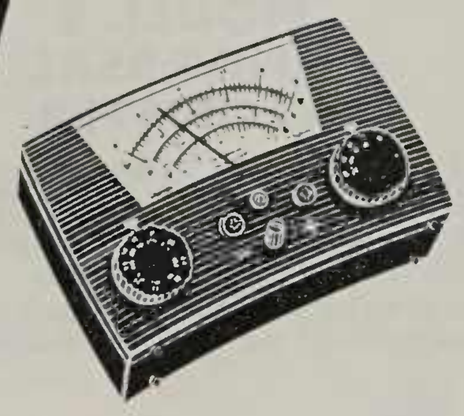

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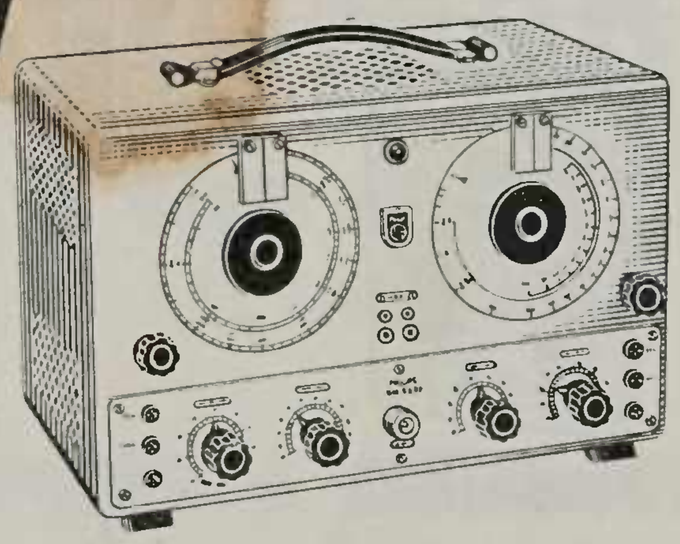

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Letters from Readers

Sir,

I am writing to you in connection with the Local Frequency Standard V.F.O. described in your Shortwave Survey in February issue of Radio and Electrical Review.

I have built the unit very carefully and it appears to function satisfactorily although at certain settings a spurious oscillation appears. However, the main problem is one of calibration. The intention was to do this from S.W. stations of known frequencies (Radio Australia, etc.) but I am finding this most difficult. I should be grateful if you could let me know how you did it, and also if it is necessary to calibrate for each S.W. Band, as I thought one calibration of say 150Kc to 250Kc would suffice for all bands.

It would be appreciated if you could assist me in these matters.

I sincerely hope that you will be able to continue your monthly articles from your new location — I enjoy them and find them most interesting.

BILL JEFFERIES.
Manurewa.

As regards the spurious oscillation in your new V.F.O. This may be due to your receiver admitting one of the off-hand harmonics of the oscillator as an "image" particularly on the higher frequencies where your receiver's image rejection may fall off.

Alternatively, the VFO may be "squeezing" due to an excessive voltage on plate of the first section of the 6SN7. I presume you are using a VR150 and that it is lighting as it should. Incidently I trust you connected this tube's socket pins 3 and 7 together. This connection was unfortunately omitted in the circuit diagram published in February but is indicated in all the standard valve manuals.

If the plate voltage of the 6SN7 does not exceed 150V it may be necessary to remove part of the IF bobbin winding between the cathode of the oscillator tube and earth. The 30-50pf variable or the 180pf fixed condenser would then be increased to return the tuning to approx. 200k.c. as indiated by harmonics falling on broadcast band frequencies, 800k.c. (compare with 1YR Rotorua!) 1000k.c. (1 ZD Tauranga), 1200k.c. (2XA Wanganui), etc. This modification however should not be necessary with plate voltage of 150V as regulated by the VR150.

Now to the matter of calibration. It is necessary to calibrate for each band because we are dealing with harmonics. For instance, a variation of 1k.c. to 200k.c. produces a variation of 2k.c. at 400k.c. (first harmonic). That is why I suggested setting the full band spread for the 49 metre band or the 60 metre band as the higher frequency bands would be accommodated in progressively smaller variations of tuning capacitance. I use full spread on the 60 metre band. This means that I cannot read 30k.c. of the 90 metre band and 50k.c. of the 120 metre band. As these are rarely used, the gain in spread on the higher frequency bands seems more important. My own dial is semi-circular with the higher frequency markings on the outer semi-circle to allow more room for the divisions.

A plain knob with a home-made wire pointer is mounted onto the condenser shaft.

To begin with, adjust as closely to 200Kc with the pointer set at a marked point approx. one-third from the high frequency end of the dial. With the instructions given this will be on the right hand side of the dial. After comparing with the broadcast band stations mentioned, finely tune the 30pf variable to zero beat with WWV leaving the dial set as before.

When this is done, the oscillator will deliver harmonics at intervals of 200 Kc throughout the spectrum.

Suppose you choose to have the 49 metre band as full spread. At this stage the oscillator will give marker frequencies of 6000 and 6200 on this band. Locate these on the receiver and between these tune Yugoslavia between 6.30—7 a.m. 6090 between 8-10 a.m. or on 6100 or Australia on 6.30 — 9.45 p.m. Even Wellington on 6080 can be used for this first adjustment. Having tuned to one of these, swing the pointer and attempt to zero beat with the station at each end of the dial. If you cannot reach the frequency on the high frequency side reducing the trimming capacity across the 150pf tuning gang and re-tuning to 200k.c. should adjust.

If variation is deficient on the low frequency side increasing the capacity of the 30pf trimmer in series with the 150 pf gang and re-tuning to 200k.c. should adjust. Always use the 30 — 50pf single gang variable condenser to re-tone to 200k.c. in each case.

If there is too much variation, .ie., 6100Kc is tuned with the pointer some disttance from either end, reverse the above adjustments of the trimmers.

Note that each adjustment to either side of the 200k.c. scale point will have an effect on the other and a compensating adjustment to the other trimmer will probably be required. After each adjustment retune to 200k.c. before checking afresh.

Having arranged a spread of 100k.c. each side of the 200k.c. point on 49 metres, tune several stations on that band marking their positions on the dial. Then interpolate divisions between these known points. At least 23 English speaking stations at present operate on this band and have been reported in "Shortwave Survey" and these should give adequate confirmation of your interpolations.

Without disturbing the adjustments made, except to ensure that the VFO remains tuned to 200k.c. mark on the dial stations observed on the 41 metre band and interpolate divisions between these.

Repeat on the 31 metre band. (There should be no shortage of check points here!)

As the 25 metre band occurs at twice the frequency of the 49 metre band the 100 Kc variations on that band, i.e., 6050k.c. and 6150 on the 49 metre band. And the 10Kc divisions on the latter will coincide with 20 Kc divisions on the 25 metre band.

A similar relation applies between the 19 metre and 41 metres, 16 metres and 31 metres, 13 metres and 25 metres although the relationships are approximate only. The' frequency divisions should be pencilled in at first, then confirmed by observation on the bands and corrected.

You will find that the method is not as long-winded as it appears by this description and the finished instrument is a very convenient means to determine the frequency of any station operating on or near the the calibrated bands.

I wish you every success with your project and would be pleased to hear from you again regarding reception at your listening post.

MIKE BUTLER.

* * *

AMPLIFIER FROM 1948 ISSUES OF "R. & E."

Sir,

I have just completed building the 'Radel Economy Ten Watt Amplifier' as shown in the April and March 1948 issues of 'Radio and Electronics'.

I have had considerable trouble in getting the bass control to function. My friend tells me that you people amended the circuit in a later issue to a better one. As I have no knowledge of this issue nor of the circuit, I would be grateful if you could help me on the amended circuit.

I am enclosing a stamped addressed envelope for your convenience.

A. C. VERRY.
Hastings.

We are writing to you regarding your problem. Should any of our readers know of such a modification we would be pleased to hear of it and can then pass it on to Mr. Verry.

* * *

DISC RECORDING AND CUTTING EQUIPMENT

Sir,

I am wondering if you could help me. I am trying to locate some firm in N.Z. which handles disc recording and disc cutting equipment. So far I have been unable to find one.

Would you be able to supply me with the name of such a Company?

D. C. S. COPPARD.
198 Cambridge Road,
Hillcrest, Hamilton.

We are not able to locate a source of disc equipment. If any reader knows of the existance of a supplier, he may like to let Mr. Coppard know direct.—Ed.

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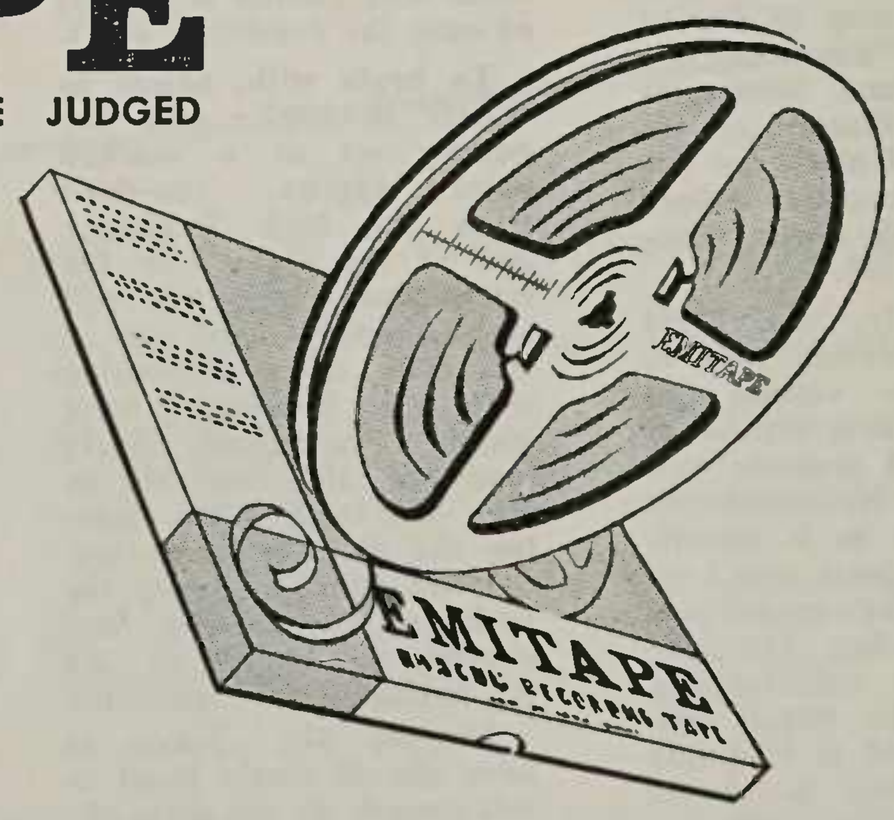

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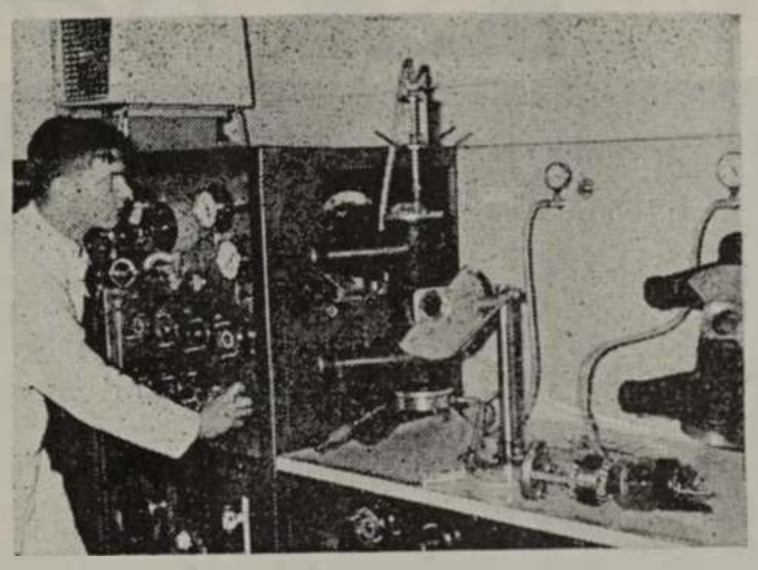
On Our Cover



AN A.W.A. X-RAY TUBE PROCESSING LABORATORY

X-Ray tubes are staggeringly expensive and, to make matters worse, they are subjected to fantastic surges of current and to voltages of up to 125,000 volts during normal diagnostic work. To survive these operating conditions the X-Ray tube must be processed to work in what is electrically a perfect environment. An X-Ray processing laboratory has been constructed by Amalgamated Wireless (Australasia) N.Z. Limited, to achieve this with utmost reliability. The installation costing thousands of pounds, is housed in an air-conditioned atmosphere. It is a complex system of vacuum and pressure gauges, high voltage generating equipment and oil filtration plants and is capable of processing three X-Ray tubes simultaneously. As part of his training as an engineering cadet with A.W.A., Bill Grace, from Wanganui, learns the principles of X-Ray technology and is given practical experience in assembly and processing of high voltage tubeheads, and on X-Ray Installations in Hospitals.

Featured Next Month

- ☆ Construction — A Grid Dip Oscillator with Magic Eye Indicator
- ☆ Construction — A TV Aerial for Channel Two
- ☆ Looking at Bonded Shield TV Picture Tubes
- ☆ Regulated Power Supply

OVERSEAS NOTEBOOK : NEW PRODUCTS : SHORTWAVE SURVEY : TECHNICAL JOURNALS CONTENTS

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H.O.—308

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Extension

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WELLINGTON C.1,
5th January, 1962.

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Manufacturer:	Automatic Telephone and Electric Co. Ltd.
Serial Number of equipment tested:	1
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J.C. Greig

(J.C. GREIG)
Engineer-in-Chief.

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After the Triumph — some sobering reflections . . .

As we go to press, two dramatic actions by the United States scientists have made their impact on a world already reeling under a cloud of new scientific developments.

The first—the explosion of the high altitude nuclear bomb, which has become a major controversy amongst the world's leading scientists, proved to the world the power and impact of such a device. With the auroral effects being seen as far north as Hawaii and as far south as this country, the extent of the radiation must have carried over most areas to a lesser degree.

Several points become immediately apparent. One of these was the short lived effects of the explosion on normal radio propagation conditions. Research workers in this country observed that the obvious effects only persisted for an hour or so, and the lesser effects seemed to disappear after half a day. This was much less serious than the predicted period of 24 or more hours, based on the effects of the tests in 1958.

Conceivably, such results were expected by the scientists in the U.S.A. but we will not know probably for some time. However, a second more serious problem exists. It seems that the radiation from the nuclear explosion has produced another radiation belt similar to the now recognised "Van Allen" belt. Whether this will be short lived, or persist for a long time, and whether it will constitute any danger to further space exploration work, both by satellite and manned vehicles, it is yet too early to decide. The only effects noted are that the radiation has had some effect on some of the satellites passing through the region.

In such an experiment as this, conducted exclusively for military reasons, there must, however, be other results, which, for security reasons, cannot be divulged. Consequently, the true scientist, whilst he is not aware of all the facts and results of the experiment, should be cautious, in supporting or condemning such an experiment until more of the facts are known.

The second great scientific achievement of the week is the successful launching, and the subsequent excellent performance of the communication satellite "Telstar." Some of the details of this experiment were covered in our April issue, whilst a further article on the link equipment is planned for our next issue.

At this juncture, perhaps we should take a look at one problem associated with future communication satellites.

In 1963 the Extraordinary Administrative Radio Conference that will be convened at Geneva, will discuss the problem of the rapid development of Communications Satellites.

Telstar appears to be so successful that Bell Telephone Laboratories says it probably will send up only one more experimental satellite of this type. The American Telephone and Telegraph Company officials add that they could have a full grown satellite commercial relay system operating within 3 years.

But neither this, nor any other satellite communication system will get under way unless the question of how to allocate frequencies for such systems is satisfactorily resolved.

This is why the Geneva meeting, where the issue will come up, is so important for communication satellite planning.

The United States suggests one plan of allocation which calls for the granting of two bands for satellite use—3,700 to 4,200 mc/sec. and 5,925 to 8,400 mc/sec.

Within these broad limits ,two narrow bands 7,650 to 7,700 mc/sec and 8,350 to 8,400 mc/sec.—would be for satellite purposes only. The other frequencies could also be used for microwave links on the ground.

For the shared frequencies, the main concern of the planners would be to ensure freedom from interference at ground stations.

The Russian engineers have proposed a more limited allocation—3,550 to 3,650; 4,350 to 4,700, and 5,160 to 6,170 mc/sec. This is rather strange in that it is felt that there may be little need for the Russians for satellite relays, since world areas important to them can be reached by overland lines. They are not short of cable capacity, as are the Atlantic communities. There is also some speculation that Russia may be reluctant to join a world-wide communication network for obvious reasons. There is also a hint of cold war manoeuvring in the fact that the Russian proposals cover channels at present being used by American military radar systems.

Whatever the reasons, Russia has not taken up the United States' offer to join in communication satellite development. They even refused to discuss this in talks on joint space projects a few months ago.

The "Telstar" experiments have shown how well engineers, of several countries, can work together, to make a satellite relay work. It now remains to be seen whether the political negotiations to follow next year can proceed along as smooth a road in the course of their discussions.

I.H.S.

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	40	7 – 7.4	7 – 7.425
	20	14 – 14.8	7 – 7.425
	15	21 – 22.2	7 – 7.425
	10	28 – 29.7	7 – 7.425
	6	50 – 54	8.33 – 9
	2	144 – 148	8 – 8.222

Load impedance	50,000 ohms or more
Output voltage	5 volts RMS open circuit minimum all bands
Output connector	phono type socket
Controls	Function switch (STBY-OPR-SPOT) Frequency (Variable capacitor) Band switch
Tubes	6CH8 Oscillator cathode follower OB2 Voltage regulator
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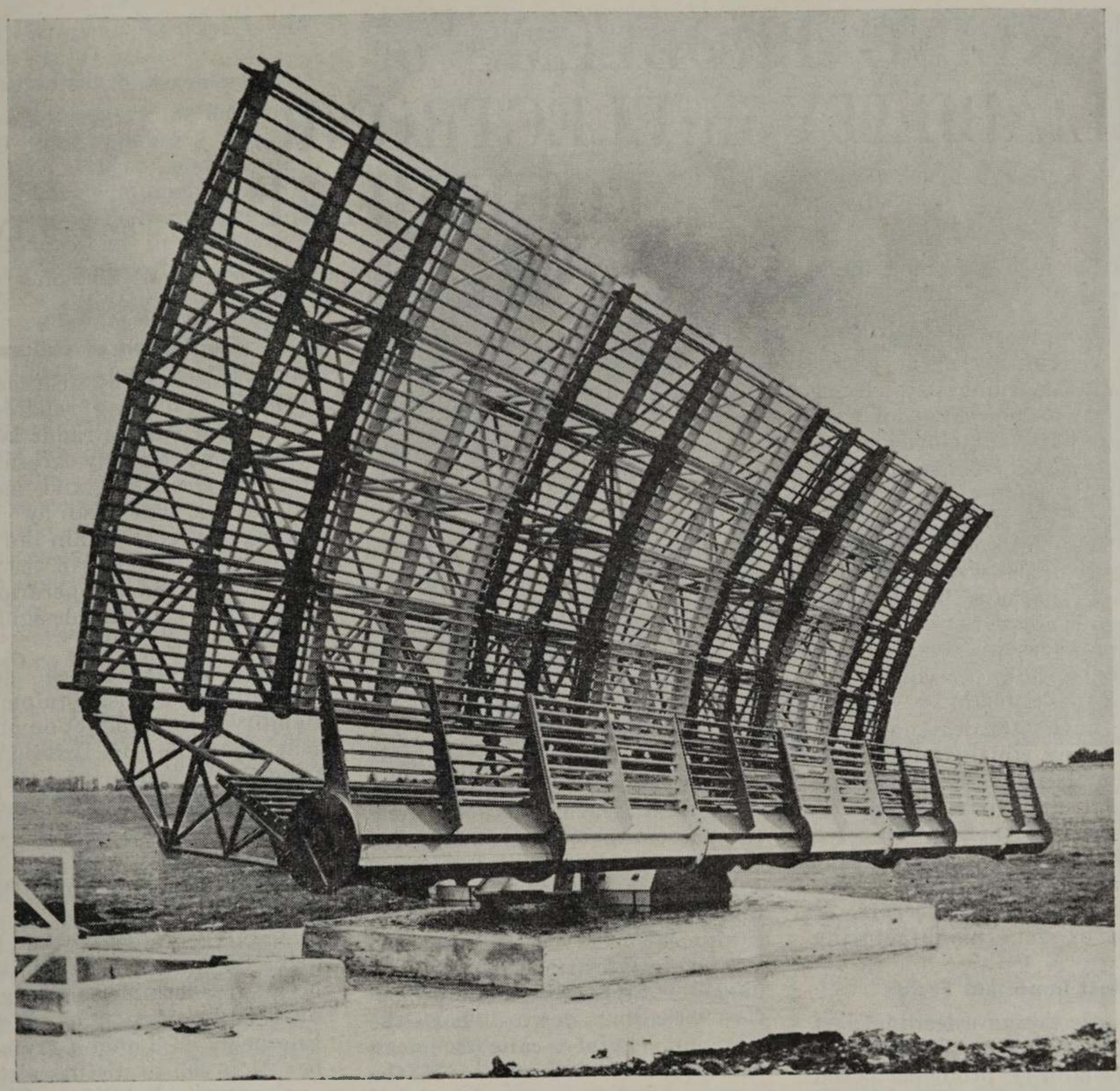


LONG-RANGE HIGH COVER RADAR AERIAL HEAD

Marconi's Wireless Telegraph Co. Ltd. has received a contract from the Ministry of Aviation to provide and install a dual channel high power surveillance radar type S264A/H at the U.K. Air Traffic Services Station, R.A.F. Hack Green.

The radar, which has a peak transmitting power of 500 kW, will be used to give surveillance over aircraft in the Northern Flight Information Region.

TACKLING PROBLEMS of RELIABILITY in ELECTRONIC EQUIPMENT

by J. STEWART

Some of the points made by this English writer are of interest following Mr. C. W. Salmon's article on Solid State Electronics (May '62 "R. & E.")

Many people form their view of the reliability of electronic equipment according to their experience of the operation of their domestic radio or television receiver. But the problems of making reliable domestic equipment represent only a tiny part of those confronting electronic engineers. They have to deal with equipment containing perhaps millions of components, compared with which a home broadcast receiver is childishly simple, however complex it may look to a layman.

They have to deal not only with receivers which stand undisturbed upon the table of a relatively cool, dry, living room, but with equipment which is subjected to the shock of a rocket firing, the salt spray on ship's decks at sea, the vibration of an aircraft, or the heat of some manufacturing process.

Most Important Factor

Britain is taking a leading part in investigating and solving some of the reliability problems posed by these conditions. This interest dates from 1946, when Britain was one of the first countries to appreciate that reliability was becoming the most important single factor in the design of complex equipments and in the success of new developments such as rocket and aircraft guidance systems, to quote just two examples, where a breakdown could have extremely serious results. More recently, reliability investigations have resulted in the production of computers and marine radar which have not only a high degree of reliability but also a corresponding high degree of performance.

In speaking of reliability, what exactly is meant? The generally accepted definition is that reliability is the probability of performing a specified function under given conditions for a certain period of time without failure.

It is important to understand that this means that an equipment which functions faultlessly in a missile which has a total life of, say, a few hours, might be useless in a submarine cable where it would be expected to function without failure for 20 years. Again, a component suitable for such a cable might be useless if subjected to the heat, shock and vibration of, for example, a radio receiver working in an army tank in the tropics.

How is reliability assessed? Hitherto it has been measured by using statistical methods to assess the percentage of a given type of component which will fail every 1,000 hours when used under certain stated conditions. Recently, equipment users have been asking increasingly for statements of how long an equipment will operate before breaking down—what the electronic engineer calls its "mean time between failures." If the component failure rate is related to the equipment rate, the result, to a layman at least, is surprising.

Suppose we produce a batch of components, and calculate from tests that only one will break down every hour out of a sample of 500,000.

This might be regarded as a very reliable component. But suppose, as is quite possible nowadays, that 500,000 of these components were put into a single piece of equipment—it could break down within an hour!

Remembering that the equipment would be made up of very large numbers of other types of components as well, each with its own failure rate, gives some idea of the kind of problem which is presented in making large and complex equipment really reliable.

Elimination of Failure

The success of British manufacturers in making reliable computers and marine radar has been achieved not only by careful attention to electronic and mechanical design, but also by special arrangements to obtain the results of users' experience of the failure which occurred in operation, and then modifying the design to eliminate them.

One of the most striking examples of British equipment reliability is the production of a submarine cable by Britain's Post Office, designed to operate for 20 years without a fault. Such high reliability is necessary because of the tremendous cost of locating a fault and raising the cable to repair it.

A further step in the British drive for increased reliability will be a three-day meeting organised by The Institution of Electrical Engineers in London from October 24 to 26, to discuss electronic equipment reliability. The first two days will be devoted to the presentation of papers and discussions by experts, but because of the growing interest in reliability the third day is planned to give background to electronic engineers who are not yet experts in the subject.

The meeting will start with a discussion on the economic justification for reliability—in other words, since the more reliable an equipment is, the more it costs, where does one draw the line to reach a satisfactory compromise between the two? An important paper in this section will come from the British Overseas Airways Corporation on the work which the Corporation is doing to improve the reliability of electronic equipment in its aircraft.

British European Airways is also working in this field.

Automatic Replacement

One of the more obvious ways of improving reliability is to arrange that if a component, or a section, of the equipment is faulty, a new component or section automatically switches in to replace it. Carrying a spare wheel on a car illustrates this principle — although we do not yet have wheels which change automatically! But to keep down cost, thought is now being given to methods of using the "spare-wheel" principle with the least possible number of extra components. The session on the design of reliable systems will include a paper from the University of Birmingham summarising what can be done by this technique in computers.

One of the difficulties of assessing failure rates is that a great number of tests has to be done on many different equipments, and the results collated and analysed. The conference will hear a paper on work in this field carried out by the Royal Radar Establishment, one of a number of research organisations of the British Government, which has pioneered work on reliability. This paper will, for the first time, provide an analysis based on results obtained from computers, installations, aircraft apparatus, domestic radio, and other equipment.

"Microminiaturisation"

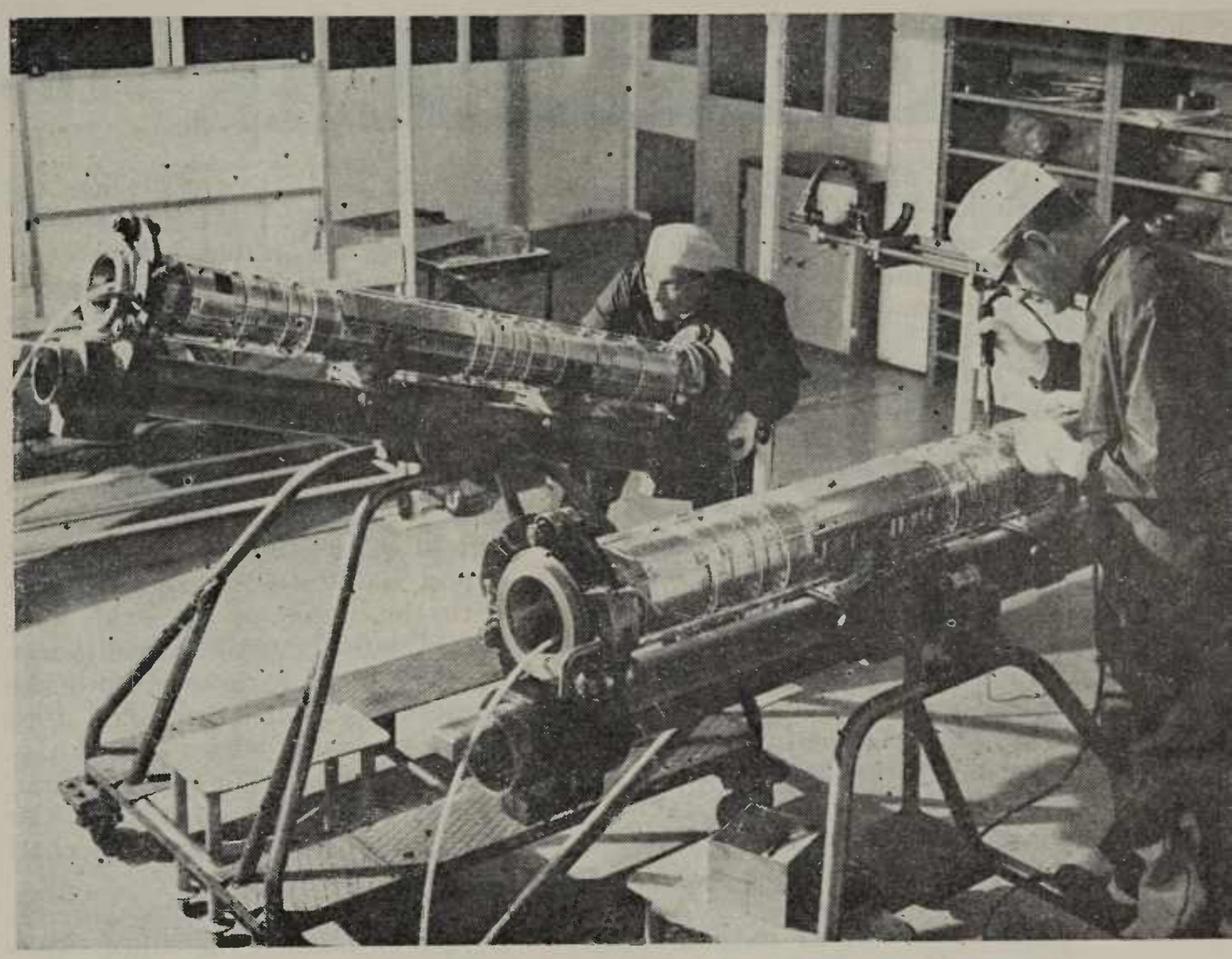
Looking to the future one sees an entirely new development which seems certain to lead to great increases in reliability. This is the technique of "microminiaturisation," the production of complete sections of equipment many times smaller than anything previously available. It is done by new processes which create an entire circuit at one time, without soldering together individual components. Such processes reduce the number of individual connections, are more simple, and can be more accurately controlled during manufacture. For these and other reasons they are expected to give startling increases in reliability, and improvements of many times are confidently expected.

These new circuits are being mainly used in computers, but already their use is spreading into other fields, such as the control of machines. At present they are expensive, but they are becoming cheaper. Whether they will ever be cheap enough to incorporate in domestic radio and television sets is a question not even the experts would like to answer at the moment.

The importance of "microminiaturisation" techniques is well realised and research, development and production are being undertaken both in government research establishments and in industry. This is one of many ways in which Britain is keeping in the forefront of reliability developments.

One requirement for progress is the provision of opportunities for the exchange of ideas between experts, so that they can learn from each other, and for passing on information on reliability to the many electronic engineers wishing to improve the quality of their products still further.

It is against this background that the importance of the forthcoming Institution of Electrical Engineers' meeting in reliability is seen.



Gold Plated Submarine Telephone Boosters on Show in Nigeria

Technicians, working in dust-free, air-conditioned workshops, assemble and test two telephone cable repeaters which are intended to be submerged, without attention, for many years.

Repeaters are simply small transmitter/receivers built into submarine telephone cables which pick up signals travelling along the cable, magnify the signal and boost it along the line to the next repeater, allowing telephone conversations to be conducted between distant countries.

Because of the difficulty and loss of revenue involved in lifting cables from the sea bottom for repair and maintenance, these are designed and manufactured to such meticulous standards that an unattended, submerged life of twenty years is expected from each repeater.

Tho mechanical design avoids local overheating and ionisation of the inert filling gas by the high voltages used for power feeding. Surfaces are gold-plated to minimise the growth of "whiskers" during the long, undisturbed life of the repeater. At every stage of manufacture, specially-selected personnel carry out rigid test routines which place reliability before all other considerations.

These gold-plated repeater units will be part of the exhibition staged by Standard Telephones and Cables Limited of Britain during the International Trade Fair at Lagos later this year.

LOOKING AT

The Miller Effect

Many of the latest electronic techniques are just applications of well known and long established principles. Miller effect is used in many electronic designs but dates back to 1919 — the year the principle was first elaborated by J M. Miller.

While the Miller equation can be found in any standard text, its derivation has become obscured to the point where it is almost impossible to find. It is for this reason that we intend to explore a little, the details involved in the derivation of the classical formula for Miller effect.

Miller observed that valves, when operating as amplifiers, frequently exhibited a grid circuit input impedance which was considerably more than should have been present, due only to the presence of the valves' natural capacitances. He evaluated that the input capacitance was in fact equal to the valve's grid to plate capacitance multiplied by a figure of (M + I) where M was the voltage gain of the tube.

The effect is produced by a combination of the capacity between the grid and anode of an electron tube and the voltage gain being developed through the use of the tube.

Looking at Fig. 1A we see the capacitances involved. Looking into the tube's input circuit, the grid-to-cathode capacitance is immediately encountered. This capacitance will act to bypass to earth, any high frequencies in the input signal, thereby decreasing the gain of the stage at the higher frequencies.

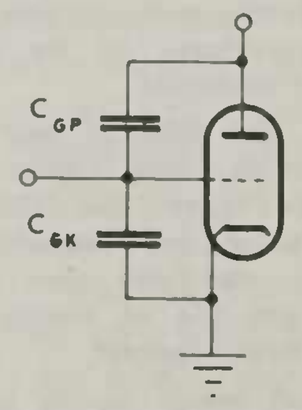


Fig. 1A. Triode Interelectrode Capacities.

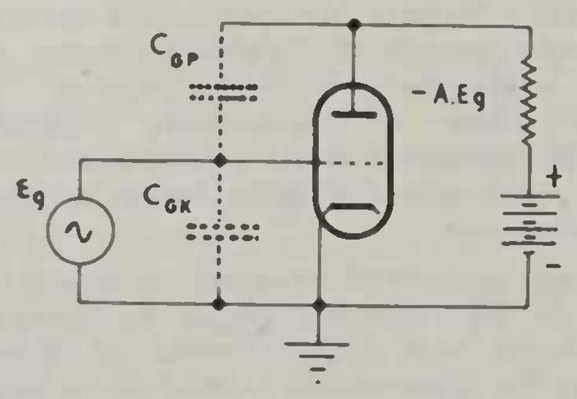


Fig. 1B. Equivalent Amplifier Circuit.

When a signal is applied to the input circuit, an amplified version of the input appears in the anode circuit of the tube. This amplified signal is 180 degrees out-of-phase with the signal of the grid, and, since grid to plate capacitances couple the plate to the grid, the amplified signal is coupled into the grid circuit where it will also act to decrease the input signal. The effect is the same as if the grid-to-cathode capacitance had been increased.

The next thing to be considered is just how much the input capacitance has been increased.

First consider the circuit of Fig. 1B. If we short out the plate load resistor the plate is virtually at earth potential for A.C. conditions, and there is no voltage gain. Therefore the grid to cathode capacity is in parallel with the grid to plate capacity, that is the input capacity is equal to Cgk + Cgp.

Now consider the same circuit with a very small value of load resistor, so that the voltage gain is 1. The voltage appearing across the grid to plate capacitance is now equal to the input grid voltage, but is is exactly opposite in phase, and thus the two combine to double the current through the Grid to Plate capacitance. This is exactly the same as if the Grid to Plate Capacitance were doubled.

The source of grid signal must furnish the extra energy to charge this capacitance in addition to that required to charge the grid to cathode capacitance.

So now with a voltage gain of 1, we have the input capacity equal CgK+(1+1)Cgp. Taking the subject one stage further, let the anode resistor be increased such that the tube produces a voltage gain of 2. In this case there is

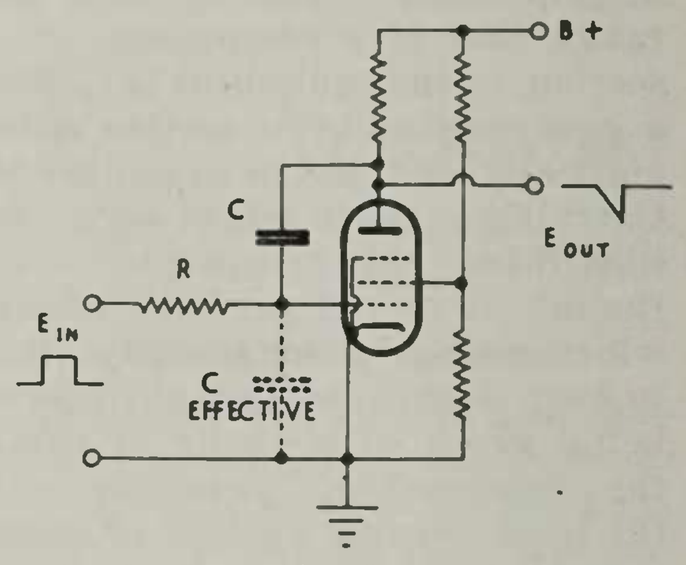


Fig. 2. The Miller Sweep Generator Circuit.

three times the current passing through Cgp. As far as the input circuit is concerned, the input signal has to supply the energy to charge the 3 times increased grid to plate capacitance, plus the grid to cathode capacitance. This can be written as

C In = Cgk + (2 + 1) Cgp.

These examples show that the capacitance due to Miller effect is in fact equal to the grid to plate capacity multiplied by a figure which is 1 more than the actual voltage gain of the amplifier.

Thus the formula becomes C In = Cgk + Cgp (A + 1) where A is the voltage gain.

Let us take a typical example. The I2AX7/ECC83 is a very common tube in audio amplifier service. A typical operating condition selected from the tube manual gives the following figures:

Plate supply voltage 180 volts
Plate load resistance 220k, ohms
Following grid resistance 1.0 megohms
Voltage gain 63
Grid to plate capacitance 1.7 pf
Grid to cathode 1.6 pf

Applying these figures to our formula for input capacitance

C in = 1.6 pf + 1.7 (63 + 1)
= 1.6 pf + 108.8 pf
= 110.4 pf.

This assumes that the grid to anode capacitance is that as shown in the book. But we have not taken into account any stray capacity, capacity between socket pins, etc. These extras could amount to several pf in value. Thus the figure would in reality

be closer to 500 pf. rather than the calculated figure. In reality the capacity from grid to catode is of negligible proportions compared with the Miller capacity. Another point is that the letter A in our formula indicates the actual gain of the stage. It is dependant not only on value characteristics, but on the applied voltage, plate load, following grid resistor, etc. The gain is also altered appreciably by the use of any negative feedback operating through the stage. This, as far as the Miller effect is concerned is if the feedback reduction factor is say 10 times, our 12AX7 gain figure would only be 6.3 not 63 as shown in the previous example.

Unless we take steps to alleviate

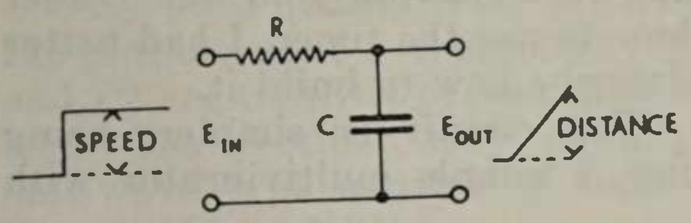


Fig. 3. Fundamental Integrator Circuit.

the effects of Miller capacity, drastic loss of high frequencies will occur when a high gain triode stage is operated with a high value of grid resistor. Examples of this are a typical case of a high mu triode, first-audio amplifier, being fed from a variable potentiometer as a volume control, or using a high value of grid leak as in contact potential biased operation.

To minimise treble losses, two courses are open:

1. Avoid valve and circuit conditions where high grid-plate voltage gain is combined with high grid-plate capacity

2. Ensure that the total resistive component between grid and ground is as low as practical under conditions where Miller effect is likely to be a source of trouble.

High-mu triodes are most likely to give trouble because as we have seen from our calculations, they combine a high figure for Cgp with high stage gain. Where treble loss is to be avoided, the grid-earth impedance should be reduced to 50,000 ohms or so. Low and medium-mu triodes such as the 12AU7/ECC82 suffer much less from the problem of Miller capacitance loss. Pentodes are the finest choice of all, because, although their stage gain is high, their grid to plate capacitance is reduced to only a few per cent of the value of the high-mu triode, providing they are operating correctly, and stray capacity is reduced to a minimum.

Miller capacity is used to advantage in many electronic circuits. Here are a couple of examples.

In figure 2 — the Miller sweep generator circuit — the plate to grid capacitance is augmented by a physical capacitor connected externally to the tube, and the stage gain is raised as high as possible by using a pentode. The effective capacitance from grid to ground is (capacitor C + Cgp + strays) multiplied by the stage gain. This large capacity is part of the timing circuit for the sweep oscillator.

The Miller effect also finds universal application in analogue computers performing the calculus operation of integration. Assume, for example, that it is desired to convert speed to distance. The simple circuit of Fig. 3 is capable of doing this. If the voltage applied to the left side of resistor R were proportional to speed, and the RC time constant of the circuit were sufficiently long, the charge on the capacitor at any given instant would be representative of the distance travelled at that instant.

Unfortunately, with reasonable capacitance values, the charging rate would be far from linear as time increased. By using a sufficiently long RC combination — at least 10 times the period of the integration — the accuracy of the integration can be improved, considerably, and the charge on the capacitor at any given instant would be a better analogue of the

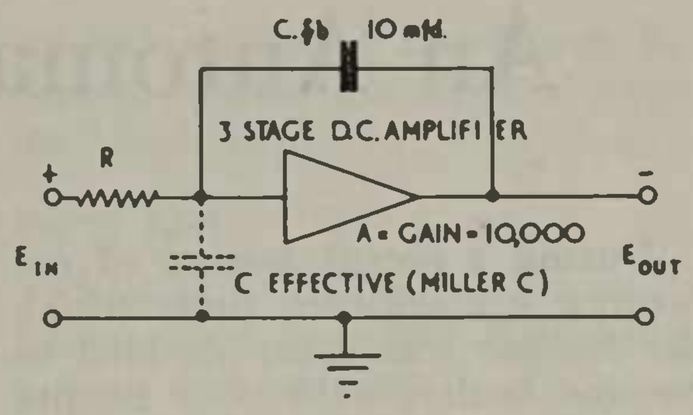


Fig. 4A. Integrating Amplifier Arrangement.

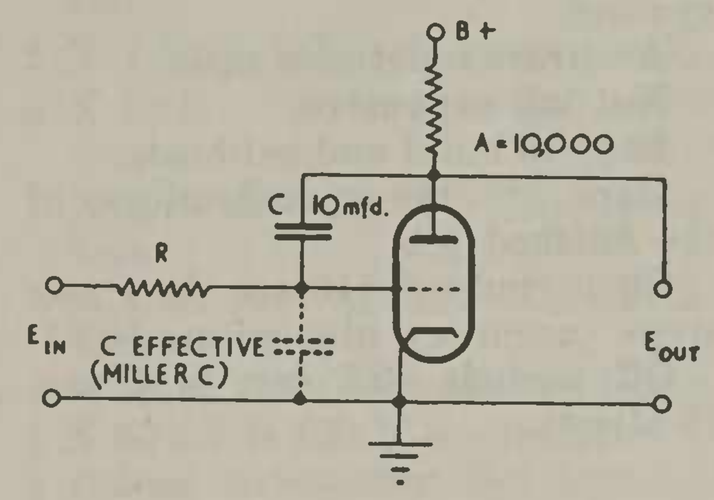


Fig. 4B. The Miller Equivalent of (A).

distance travelled. The problem here is to find a large enough capacitor. One of the correct size for the average application would fill half a room.

In practice, this large capacity is built up electronically with a device known as an integrating amplifier. The integrating amplifier and its Miller equivalent is shown in Fig. 4 In cases of this nature, where high amplifier gains and large feedback capacitors are used, the Cgk and 1 can be dropped from the Miller equation because they are negligible. The equation for the Miller capacitance produced by integrating amplifiers then becomes

C miller = CfbG

where C fb is the feedback capacitor and G is the amplifier gain. For the amplifier of Fig. 4 the Miller capacity would be 100,000 microfarads.

(Please turn to page 15)

An Automatic Enlarger Timing Switch

R. J. HALL

During a recent session of enlarging, a clockwork timer which the Author was using decided to become faulty, with poor results so far as the finished prints were concerned. Not being a clockmaker I decided to design and build an electronic timer, which I could at least repair if it went wrong. The following requirements were considered a must:

Adjustable exposure time, preferably in one second steps.

Automatic exposure/develop cycling.

Accurate repetition rate.

Not too expensive.

Easy to build and calibrate.

Here are the specifications of the finished job.

On periods: 0-110 sec. in 1 sec. steps (accuracy plus-minus 10%).

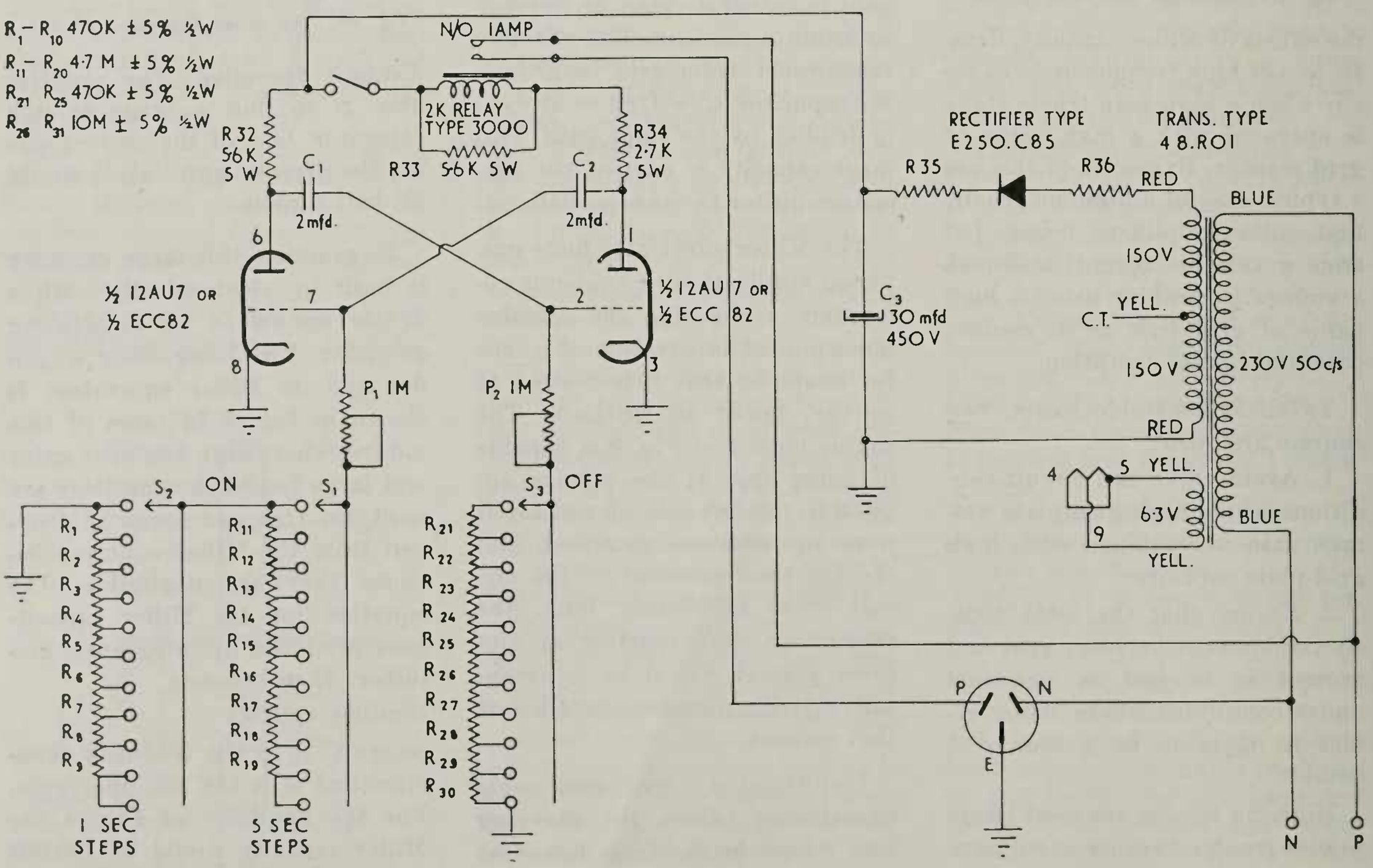
Off periods: 0-5 sec. in 1 sec. (5 steps).

5-120 sec. in 20 sec. steps. (5 steps).

Provision for holding in the off position until required.

As will be seen from the above specifications the maximum off period is the correct time for development of most bromide papers with the usual developer thus the procedure for doing a batch of prints from the same negative would go like this; after adjusting enlarger for size, focus, etc. (assuming a 12 sec. exposure time) place paper on printing board, adjust **on** period switches S1 + S2 to position No. 2 in each case (10 + 2 = 12 sec.) **off** period switch S3 to No. II (2 min.) switch the **hold off** switch to the **on** position. The timer will switch on the enlarger for 12 sec. then off, whilst the enlarger is off you take the exposed paper and place it into developer as quickly as possible then place a new sheet of paper onto the priting board and wait for the enlarger to come on again, then place the second paper into the developer again as quickly as possible, then without delay take the first switch which will have now had 2 min. in the developer and place it into the fixing bath, repeat the above operation until the required number of prints have been finished. For adjusting the enlarger focus, etc., place the **on** period switches in the **max.** position and the **off** switches in the **min.** position. To hold lamp off for a long period switch S4 off. Now having told the reader how to use the timer, I had better describe how to build it.

The circuit is simpler, being just a simple multivibrator with



switched time constructed in the grid circuits. The reader can build the timer up in any form to suit the available parts, chassis, cabinets, etc. There are a few points to watch, however, to assure a good job.

Use a good quality socket for the 12AU7, ceramic or nylon.
Use good quality resistors for R1-R31 as the final accuracy depends upon these and aim for 5% tolerence, if these are not available, 10% will do. (Even better 1% if you can afford them). C1 and C2 **must** be of the **highest** quality paper or polythene or even oil-filled paper.The leakage resistance **must** be better than 100 megohms, the capacitance volume is not very critical, plus/minus 20% will do as it is the purpose of P1 and P2 to correct any error in this direction.

Use a good quality relay for RL, the Author used a type 3000. P1 and P2 are DUCON pre-set type 1 meg. The rectifier may be any half-wave type capable of handling 30 MA at 250V.

S1, S2, S3, are 12 position Japanese wafer switches although any type having good quality insulation may be used.

To adjust timer after assembly.

Turn the on S1 and S2 switches to give a time interval of 5 secs. And the off S3 switch to give the same 5 secs. interval and then adjust P1 and P2 until the correct time intervals are obtained as measured on a stop watch or sweep second hand on your watch. This is all the calibrating required-

If the constructor keeps to the circuit as shown very good results should be obtained, the Author's timer has now given many hours of faithful service without any failures. Upon checking the time interval after a long period of use it was found to be exactly the same as when calibrated, giving a fair idea of what might be expected from such a circuit.

The Author would like in completion to say thank you to fellow technician, Mr. J. Quinn, for redrawing the circuit in a presentable form for publication.
P.S. Since the completion of this article and posting it to the Ed., the timer was connected to an electromagnetic counter and set to 2 secs. on and 2 secs. off and successfully completed over 300,000 switching operations before the author got tired of keeping check on it.

Parts List:

1 of 12 AU7.
1 2000 OHM Type 3000 Relay with 1 Amp spst contacts.
2 X 2 MFD. capacitors. See text. 350V or more.
15 X 470 K 5% ½ Watt resistors. See text.
10 X 4.7 Meg. 5% Watt resistors. See text.
5 X 10 Meg. 5% Watt resistors. See text.
1 X 20 Meg. 5% or 2 10-Meg. in series.
2 X 1 Meg. DUCON pre-set pots.
2 X 5.6K 5 Watt 10% IRC resistors.
1 X 2.7K 5 Watt 10% IRC Resistors.
1 X 1.5K 10 Watt 10% IRC Resistors.
1 X 1K 5 Watt 10% IRC resistors.
1 X 30 mFD 450 V electrolytic.
1 Selenium rectifier. See text.
1 X Beacon 48RO1 or eq. Transformer.
1 X SPST Toggle Switch (S4).
3 X 1 Pole 12 pos Wafer Switches.

LOOKING AT THE MILLER EFFECT — *(continued from page 13)*

The Miller principle, although dating back to 1919, is as pertinent today as it was then. Many new and unusual circuit configurations use and will continue to use it. The devices illustrated here have been selected to review the effect and develop a method of analysing circuits using the principle of amplified capacitance.

APPENDIX:

Here is the mathematical derivation of the formula for Miller capacitance. We have added it to this article for sake of completeness, but those of our readers who prefer to do so can omit this section: Reference should also be made to Fig. 1B. The total input capacitance is considered to be made up of two capacitances, the Miller capacitance caused by feedback and the actual physical capacity Cgk.

Now the charge on a capacitor can be expressed by the well known equation

$Q = CE$ ..... (1)

where Q is the charge in coulombs, C is the capacitance in farads and E is the voltage in volts. Therefore the charge on Cgk will be

$Q = Cgk\ Eg$ ..... (2)

where Eg = A.C. grid voltage.
Now the charge on Cgp will be

$Q2 = Cgp\ (Eg—(—AEg))$
$= Cgp\ Eg\ (A+1)$ ..... (3)

where A = stage gain.

Since the preceding stage must supply charging current to both capacitances, the charges appear additive at the input, therefore

$Q\ in = Q1 + Q2$
$= CgkEg + CgpEg$
$(A + 1)$ ..... (4)

As Qin is the total charge of the input capacitance Cin, this capacitance is related by

$Qin = CinEg$ ..... (5)

Combining Equation 4 and 5.

$CinEg = CgkEg + CgpEg$
$(A + 1)$ ..... (6)

Simplifying, and removing Eg we have

$Cin = Cgk + Cgp$
$(A + 1)$ ..... (7)

This is the well known Miller equation.

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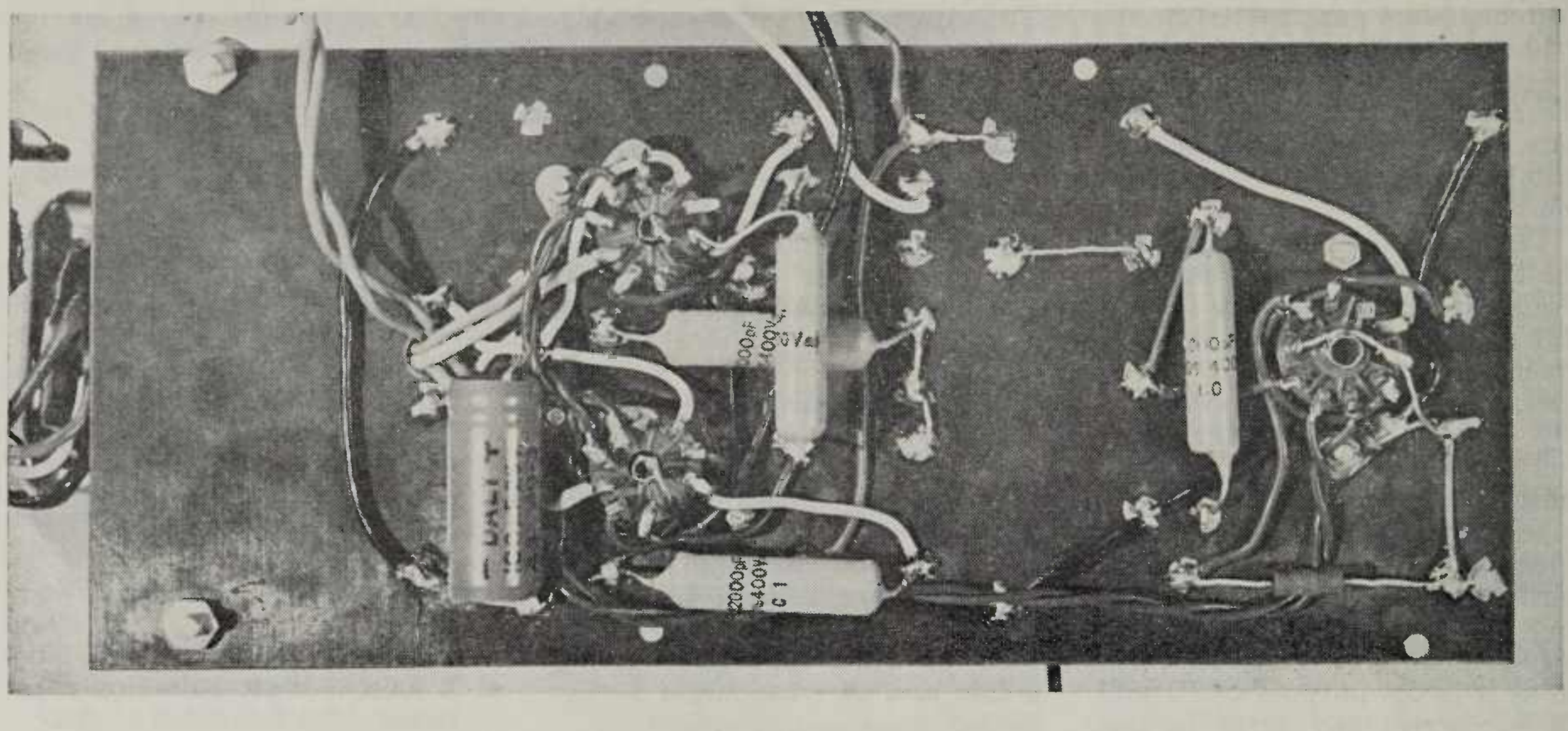
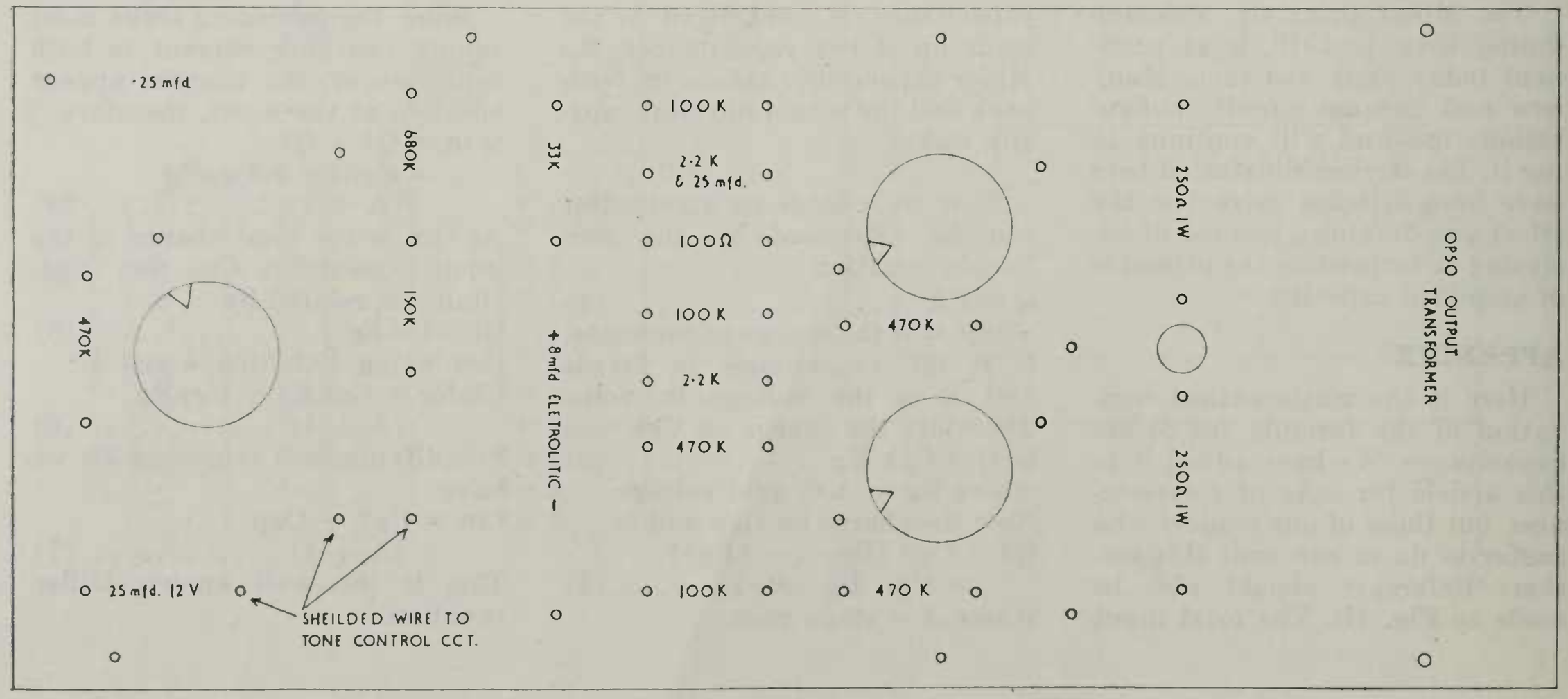


A DOMESTIC STEREO SYSTEM — PART THREE

This month we intend to continue the description of our stereo amplifier, together with one or two other points of interest for our readers.

As can be seen from the photographs, the main amplifier board is not only easy to assemble and wire, but is quite compact.

On the plan of the bottom view of the board, all the components are numbered, where ever wires have to be connected, with the exception of the filament lines, and the tone control circuits. The filament lines are wired together in twisted wire and run back to the power supply section, whilst the control circuits come off the top of the board direct to the tone controls and volume control. A further lead returns from the volume control to the grid circuit of the first triode section of the ECL86s



We have also included a diagram of the small sub-board for the tone control circuits. It will be seen that all the components are duplicated on this board because of the fact that there are two complete tone control networks to be connected to the tone controls which are themselves ganged potentiometers. Once again the points to be connected have been numbered.

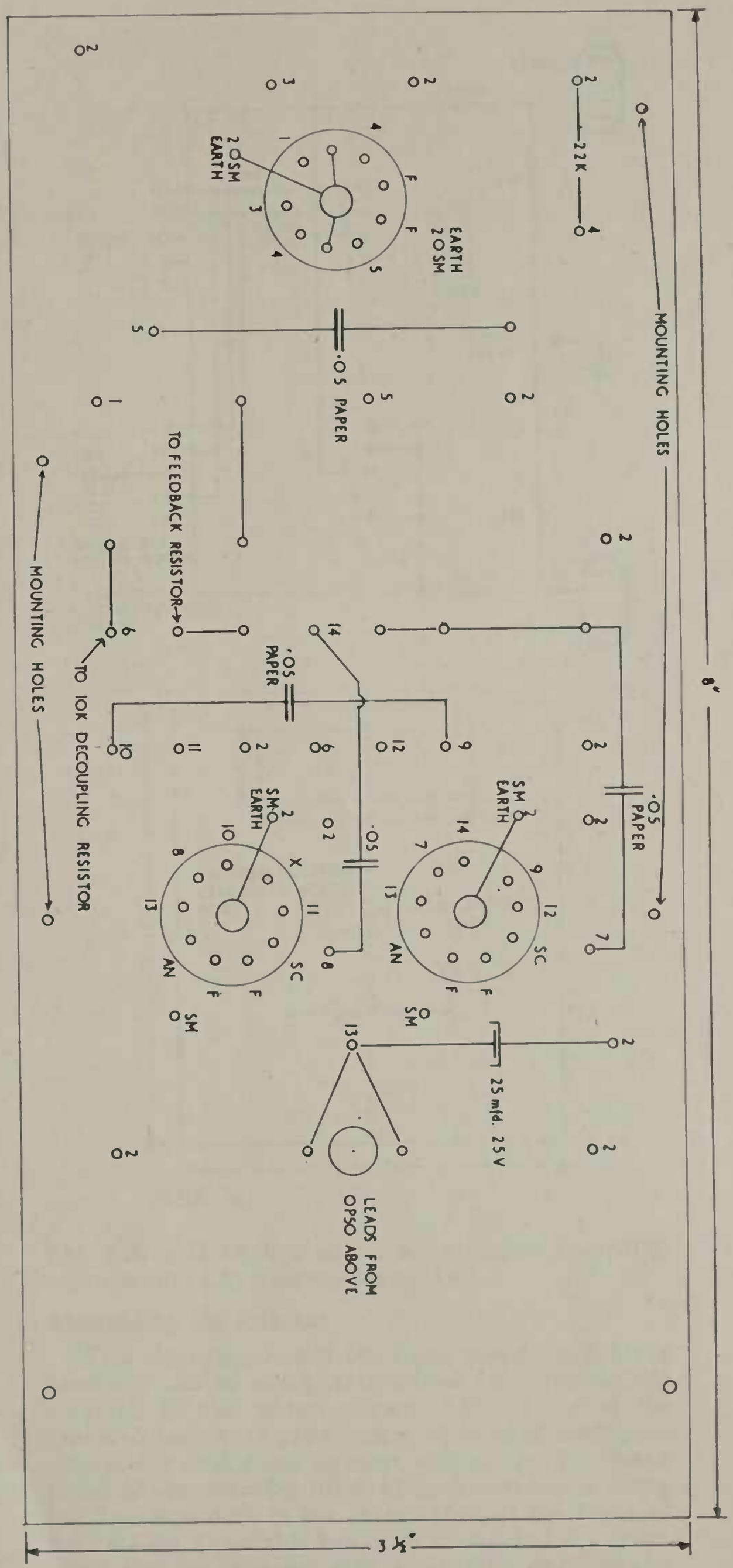
One point worth remembering when assembling and wiring these two types of board is that the wire pigtails of many of the components can be used as the connecting links between the eyelets on the boards, simply by bending the wire after it has been passed through one eyelet and feeding it back through the other eyelet. Do not solder any joints until all the components have been mounted.

When soldering, use a soldering iron with a small pointed tip, of about 25 watts rating. If an iron with too much heat, or a large bit is used, there is a likelihood that solder will spread between eyelets, or the excess heat will distort the board material.

The location of the gap in the noval sockets can be seen from the photograph. The only component which should be mounted a little above the board material is the cathode resistor for the pentode sections of the ECL86. This has to dissapate a certain amount of heat, so that if it is placed too close to the board, the heat will cause the board to buckle. The OP.50 output transformer should be firmly mounted on the board with two 4BA x $\frac{1}{2}$ inch or equivalent screws. These can be released and replaced when the board is firmly mounted on the main chassis. This is done as a precaution to avoid any strain on the leads which come from the transformer and pass through the $\frac{1}{4}$ inch hole in the board adjacent to the output tube sockets.

When wiring the primary leads to the OP50 it will be necessary to match up the respective sections of the primary. This can be easily accomplished with an ohmeter, or if this is not available, a $1\frac{1}{2}$ volt battery and a set of headphones can be used as a continuity tester, instead of the meter. There are two red, two orange, and two blue leads coming from the primary side of the transformer. The red leads will ultimately connect to the HT+, the orange leads to the screens, and the blue leads to the plates. But it is essential that the orange and blue of one winding connect to the respective elements of one tube. This can be done by checking with the reds isolated from each other and pairing off a blue and orange, connecting this to one tube, then checking, (this is not necessary but proves the point) that the other blue and orange are a pair. Finally the two red leads can be paired off and connected to the HT line, when the completed amplifier is finished.

Now, short lengths of 7/.0076 remit or hookup wire should be used to wire the pins of the tube sockets to the respective components on the board. Also one or two insulated jumper wires for the HT+ and earth line are necessary. The twisted pair of



SM Socket Mounting Screws or Rivets.
SC and AN of each socket wired direct from output transformer. (See text).
Point X and earth are shielded grid lead return from tone control section.

See next page

This side of the diagram on the previous page has been left blank so that any reader who wishes to use it as the basis of a templet for assembling his own amplifier board can do so without destroying the article.

wires shown in the photos is the filament line.

Once the amplifier is completed it should be checked against the circuit very carefully just to make sure that everything is correct. Remember that all components from the anode capacitor of the EF86, up to the grid circuit of the first ECL86 Triode section, are mounted on the smaller tone control board.

The tone control board can now be wired in a similar fashion to the amplifier board, the three ganged controls mounted through the respective holes in the panel and connected up to the board, using screened cable where it is shown in the circuit.

The power supply section for both sections of the amplifier is self explanatory and very simple. However, due to space considerations we are not able to show completed chassis together with the two boards finally mounted, until next month.

Input Compensation for Crystal Cartridge

Whilst most of the more common stereo cartridges such as the Garrard GCS10 have a relatively level response and therefore need little compensation, most monaural crystal cartridges need some compensation to give the correct frequency response. This subject was covered at greater length in our January issue of this year under the title "Looking At — the Crystal Pickup Cartridge". Here we recommend that the best method of compensation was to shunt the input circuit with a capacitor of about 1,000 pf.

One advantage of using this capacitor was the reduction in level due to the voltage divider effect. This is also advantageous as it tends to even up the level from the monaural and stereo heads. In the case of the writers' Garrard TPA 12 arm with the GC8 and GCS10 heads, the GC8 has approximately 4 times the output'of the GCS10.

The second method of compensation mentioned in the article referred to, introduces a falling response, starting at 3 db down at 8,500 c/s and dropping off at about 6 db per octave above this frequency. Although a 12AX7 tube was mentioned in the article, this effect is present, although to a lesser degree with an EF86, if there is any material length of shielded lead between the compensation network and the grid of the tube. Such an effect can be put to good use, should it be desired to play some of the old 78 records with their much higher surface noise. By inserting a 1.0 to 1.5 megohm resistor in series with the lead from the pick-up, a suitable amount of scratch filtering can be accomplished without adjustment of the previously set tone controls.

Accordingly we show a modified input circuit for our amplifier, with provision for monaural 78, and 33-1/3; stereo, stereo reversed and radio.

At this stage we felt that there was no great demand for provision for magnetic, low output pickups, in our design. It was the general feeling that such pickups should have an attendant pre-amplifier section — possibly transistorised, and powered from the main amplifier, to raise the level up to crystal

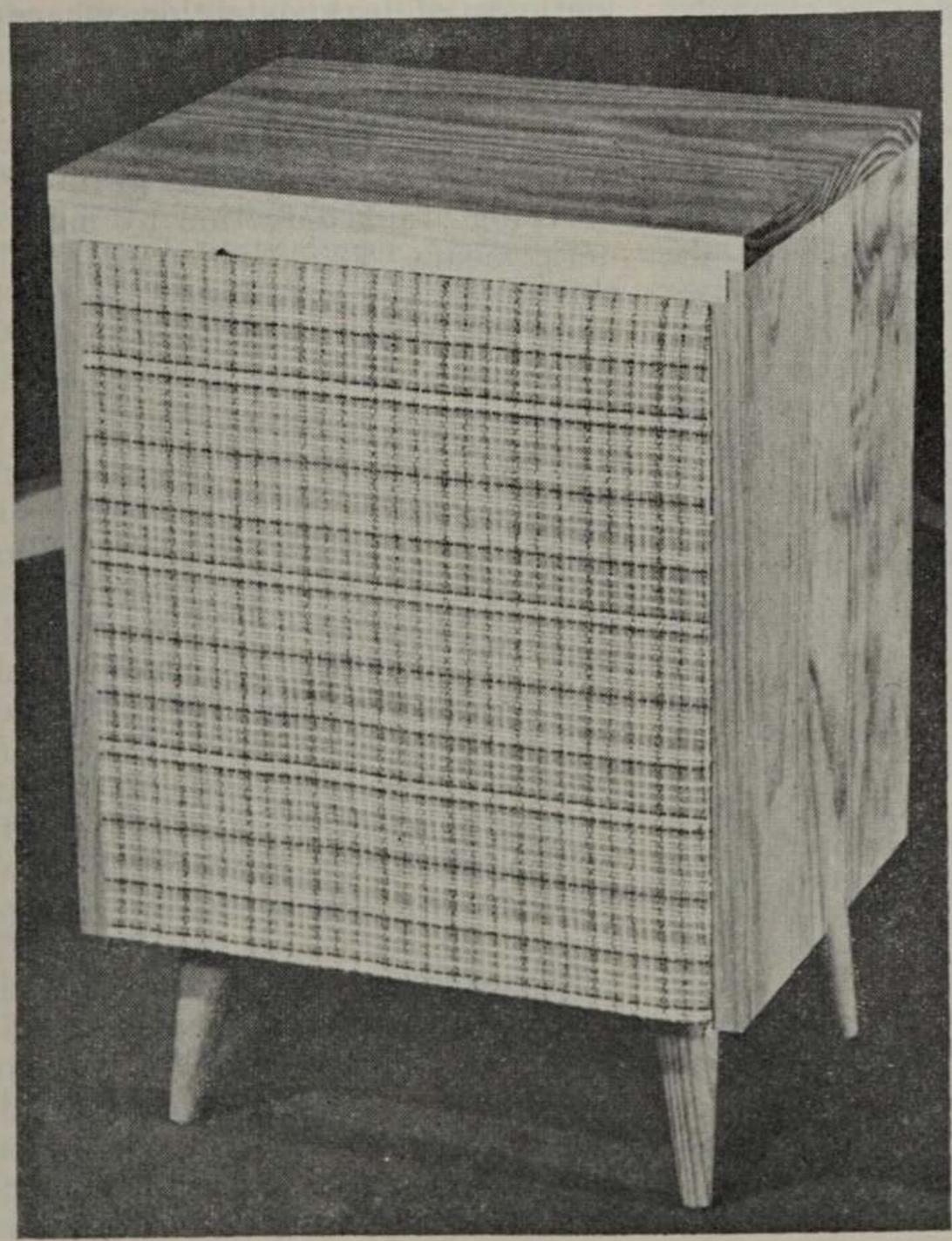
cartridge level. This could then be fed into our amplifier in place of the existing pickup system. Such an idea is steadily taking hold, and we hope to be able to present such a unit in a later issue.

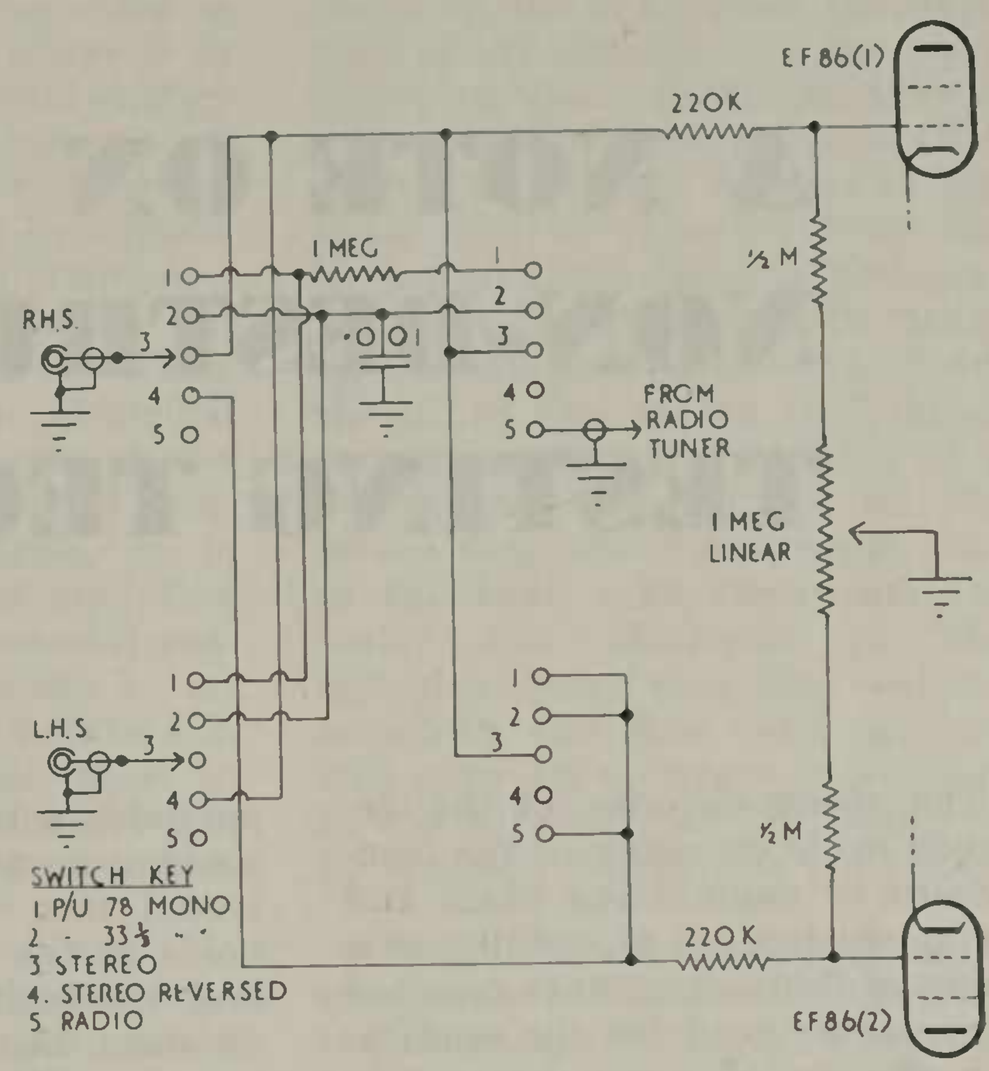
To realise the best performance from our projected two cubic foot enclosure it is necessary to use a crossover network to feed the woofer and tweeter with sound of the right frequency range.

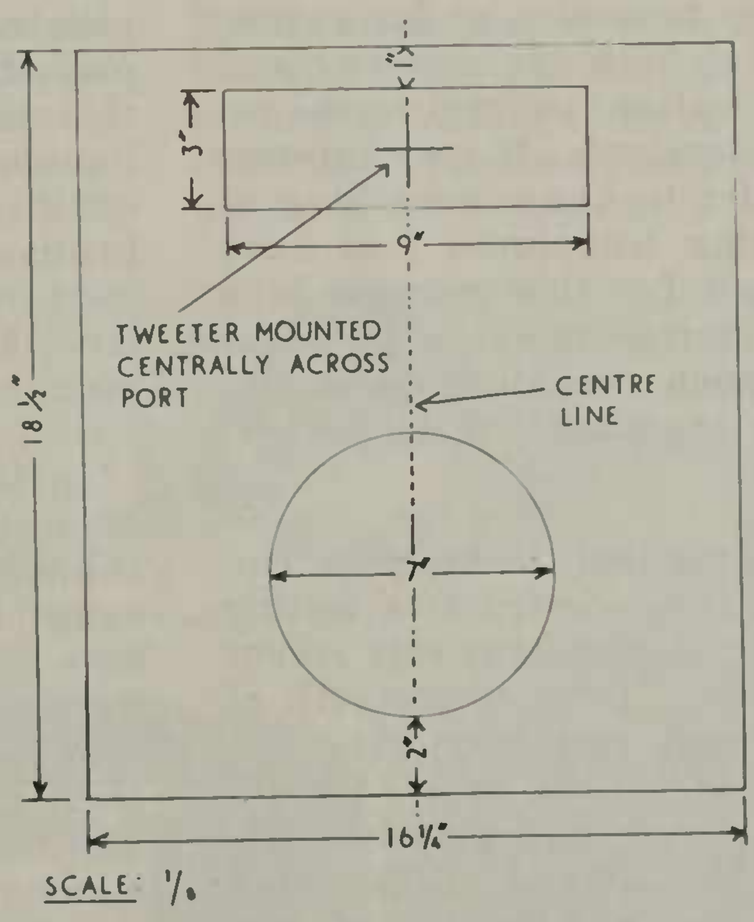
This subject has also been covered in a previous issue of this magazine, namely December, 1961, "Some Aspects of Hi Fi Crossover Networks". In that article we described two types of networks suitable for use with two speakers, one, a 6 db per octave network, the other twelve db per octave affair.

Listed below are the values of C and L for one such 6 db network:
Crossover frequency 2,500 c/s
Line impedance to speakers, 15 ohms
Inductance of choke, 1 mH
Capacitor, 5 mfd.

In Fig. 3 on Page 10 of December 1961 Issue, the circuit of this design is shown. To get a faster slope to the attenuation curve we can use a 12 db per octave filter which although slightly more costly gives better results. This is shown in Fig. 4 of the same article. For a crossover design frequency of 1500 c/s the following values are suitable.
Crossover frequency 1500 c/s
Line impedance for speakers, 15 ohms
Inductance 2.25 mH
Capacity, 5 mfd.







The 2.25 mH chokes are available, listed as JOI, manufactured by Beacon Radio Ltd.

Assembling the Cabinet

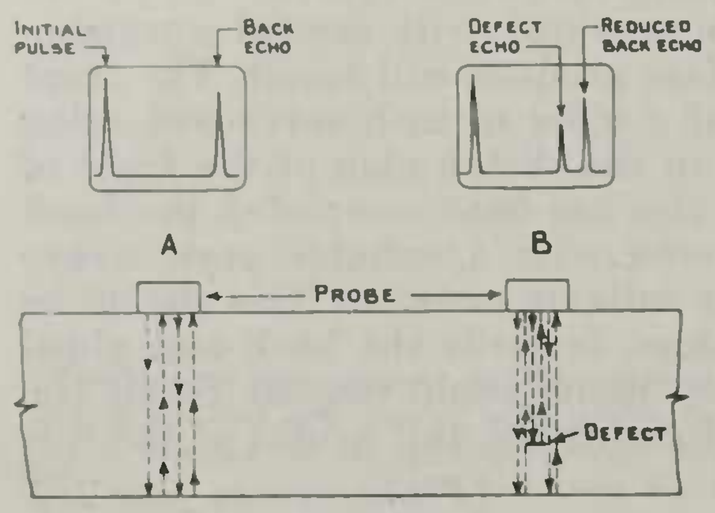
With the exception of the front panel the cabinet assembly can be easily determined from the details supplied by the manufacturers. Liberal use of the glue and hardware provided, with careful workmanship and a first class product will result. The front panel is cut out of a piece of inch coreboard using the details shown in the sketch plan of the front of the cabinet. Once this has been completed the front panel can be covered with a suitable open weave grill cloth or other suitable material. This should be turned over the sides, towards the back and glued and tacked in place, under slight tension. Small 1in. x 1in. side cleats running the full height of the side

(Please turn to page 23)

A NOTE ON NON-DESTRUCTIVE TESTING TECHNIQUES

The rising severity of the demands made on many of the components of engineering plant and the increasing use of welding as a means of fabrication have resulted in a greater need for the application of tests of a non-destructive character to ensure, as far as possible, that both the material and the fabrication conform to the required standards. It may interest the reader to know something of the testing techniques that have been used for this purpose to a rapidly increasing extent in recent years; such techniques are also used for examinations during service life.

The principal techniques employed in non-destructive testing today are of comparatively recent development. Prior to the turn of the century, two that were employed extensively were the oil and chalk test and age-old sonic test. In the oil and chalk test a thin oil was applied to the suspected part and wiped off after a suitable soaking period, then finely powdered chalk in a liquid suspension was applied to the surface. When the suspension medium had evaporated, the chalk particles acted as blotting-paper, soaking up any oil that had penetrated into the cracks or other voids in the surface of the metal and producing an easily visible oil stain. But the method was not very sensitive because of the poor penetrating ability of the oil employed, and the modern version of this test makes use of special liquids with highly penetrating qualities, generally containing brilliant coloured dyes, which are used in conjunction with a "blotter" that commonly consists of titanium oxide suspended in alcohol.



In the sonic test, the article to be tested was generally suitably supported and struck so as to cause it to vibrate, the audible note emitted by the vibration and its rate of decay giving a fairly reliable indication of freedom from major defects or otherwise. The technique has been used for many years by the railway industry: most readers will have seen a "wheel-tapper" in action at some time or another, striking the tyres of rolling-stock wheels and listening for a false "ring" that would indicate a cracked tyre. It is interesting to record that an "automatic" crack detection method is said to have been used by some American railways about 1913, which has been described in the following terms:

> "The plan was to drill a hole in a crank pin or axle for the length of the bearing. Then the hole was filled with some ungodly compound which would make angels weep and the hole plugged at the outer end. The stuff—it was sometimes red and sometimes yellow—was so penetrating that it would find its way through any crack and make it presence felt or smelt in a manner as unmistakable as it was disagreeable. It also kept its potency, so that if a crack developed at any later time, the engineman knew that he had either killed a skunk or cracked a pin somewhere."

This could be considered as being related to modern electronic methods of leak detection where the leak detector is known as the "sniffer."

In 1922 a patent was granted covering crack detection by magnetic means. The development of this technique was based on an observation that, when machining steel parts held in a magnetic chuck, small chippings were attracted to and bridged any cracks in the metal. Subsequently, a finely divided magnetic red iron oxide powder was developed and this enabled the technique to reveal the presence of extremely fine cracks. Magnetic crack detection is extensively used throughout the world today and has been employed for many years in the examination of a wide range of engineering plant.

Radiography came into prominence for the examination of metals after the First World War, primarily because fusion welding had come into extensive use about that time and the need arose for some form of examination whereby in-

ternal defects could be detected. Radiography has the advantage over penetrant and magnetic crack detection techniques in that it is capable of revealing defects contained entirely within the material. However, its ability to reveal crack-like defects is limited.

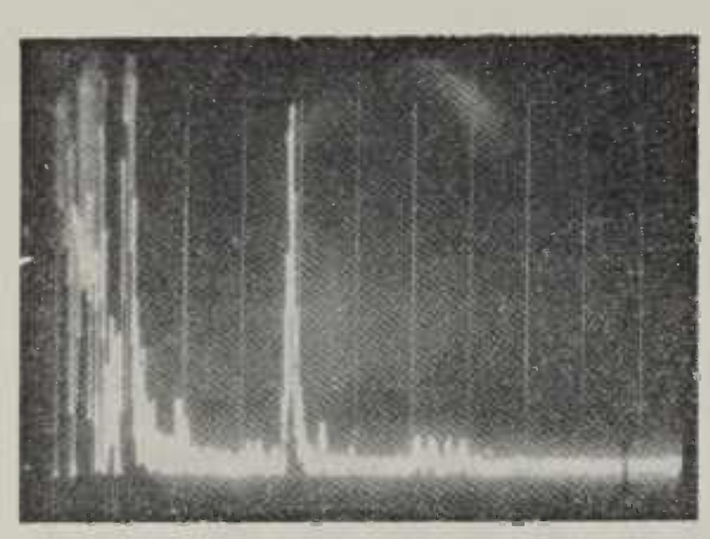
The year 1940 saw the introduction of fluorescent crack detecting "inks" for both magnetic and penetrant techniques, which greatly enhanced the visibility of defects when viewed under ultraviolet light and speeded up routine tests of large batches of components. In the main, penetrant testing is used for the examination of parts made from non-magnetic materials or such steel parts as do not lend themselves to the use of the more reliable magnetic crack detection technique. Both techniques, however, are only capable of detecting defects which outcrop at a surface or, in the case of some magnetic tests, lie just below the surface.

One of the most important developments which has occurred in the non-destructive testing field has been the introduction of ultrasonic testing. This technique is similar to the echo devices used on board ships, where ultrasonic waves are transmitted into the sea, and, knowing their velocity in water, it is a simple matter to calculate the distance of the ship from any object which reflects these waves.

As is implied by the name, the frequency of the waves used in ultrasonic testing is above the audible range, the term "supersonic" relating to speeds above that of sound. As employed in the more simple forms of test, they are essentially similar to sound waves. A pulse of high frequency electrical energy is generated within the testing instrument and transformed into mechanical vibrations by the crystal in the probe unit. These vibrations are injected into the material under examination by the probe via a couplant, such as oil, which eliminates the air from the gap between probe and material. The wave pulses so formed in the material are reflected by a boundary surface or by discontinuities and a small proportion is returned to the robe, where it is reconverted into electrical energy and fed back to the instrument. At this latter stage the electrical energy is so small that it requires amplifying before it is conducted to a cathode-ray tube in the instrument which renders the transmitted and received electrical pulses visible to the eye of the operator. As will be realised from this simplfied description, it is greatly to the credit of manufacturers that they have found it possible to make instruments of an extremely complicated nature sufficiently robust to enable them to be used with reliance under the arduous conditions that so often prevail on site.

The reader will doubtless appreciate the technique more readily if an example is given of an elementary application of ultrasonic testing. Figure 1 depicts a piece of material containing a defect as shown. When the probe is located at position **A** it picks up the echo from the back wall of the material and the trace shown on the cathode-ray tube is as indicated. If the probe is then moved to position B, part of the beam will be reflected from the back wall of the material and part from the defect, so that the trace on the screen will have the form shown in the sketch, indicating to the operator the presence of a defect. As the distance on the screen from the transmission echo to the back echo represents (to scale) the thickness of the material under test, the location in which the flaw echo appears will give an accurate indication, in the direction of the beam, of its position within the material.

One of the ultrasonic testing instruments available is known as the Universal Ultrasonic Flaw Detector and is illustrated in Fig. 2. This is an extremely versatile unit that has been designed to enable ultrasonic testing to be applied to the widest possible range of problems and incorporates certain



special features worthy of mention. The amplifier, which is virtually linear, is calibrated in decibels, so that flaw echo heights can be easily related to original sensitivity settings and this control, in conjunction with formulae recently developed on the Continent, enables the dimensions of defects to be calculated. If this control is used carefully the attenuation of the ultrasonic beam within the material can also be measured, an extremely important factor when dealing with coarse-grained materials. The large frequency range of 0.5 to 15 Mc/s permits the examination of a wide range of materials. One of the main factors which tends to confuse interpretation of screen indications is the number of minor echos which appear. Using this latest equipment, all echos of a height less than some pre-selected value can be suppressed, thus reducing operator fatigue and confusion. A scale expansion control is incorporated that can be used to magnify the indication on any section of the time base, i.e., the horizontal component of the trace on the cathode ray tube, which can be selected by means of an electronic "gate"; it is useful, for example, when examining shafts from their ends in order to detect cracks. A simplified version of the instrument described, which is sufficiently versatile to cover the requirements of most testing problems, is available for the more straight-forward class of work.

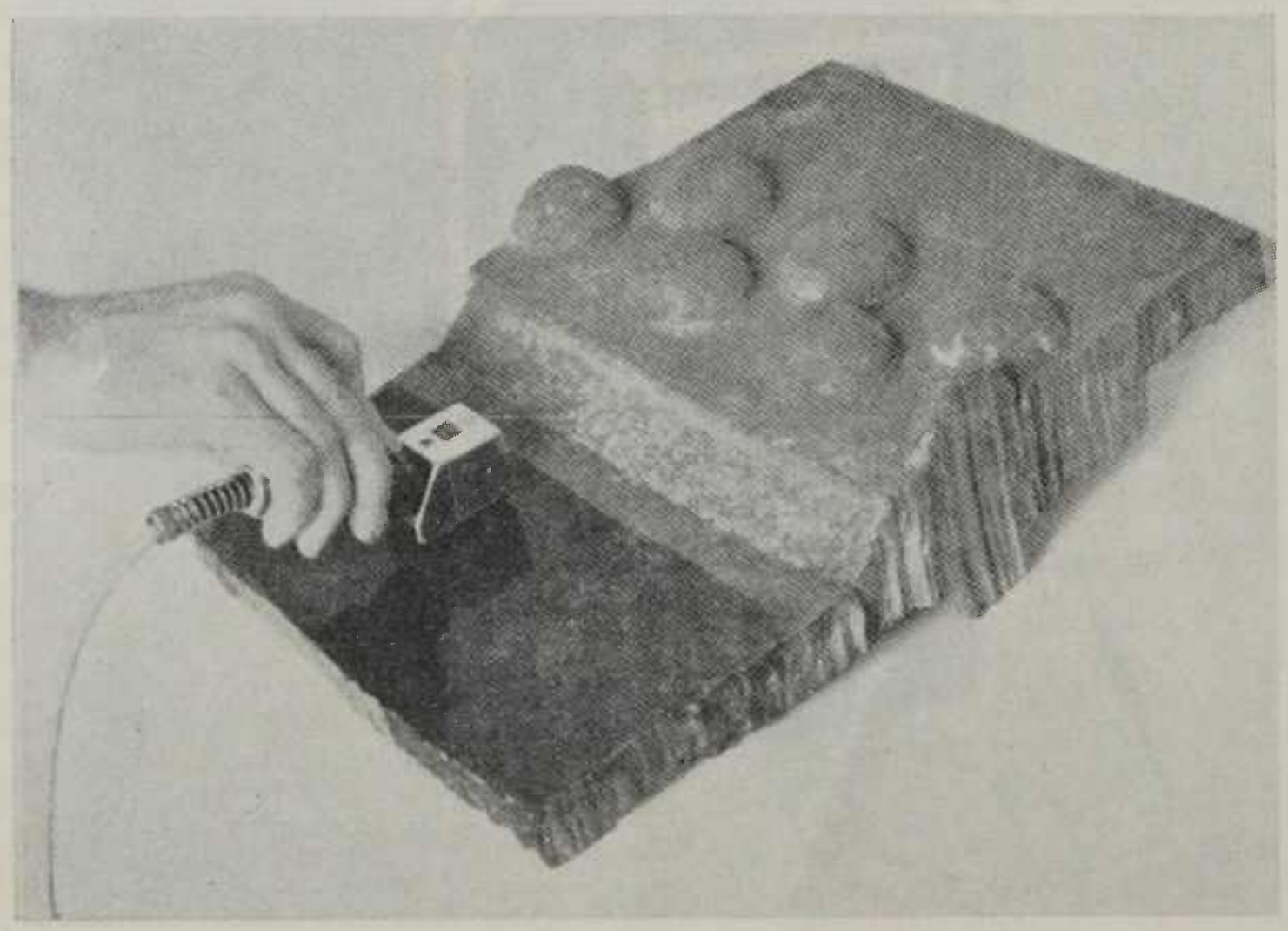
An ancillary to the instruments is an attachment known as the "Wall Thickness Gauge," which can be plugged into the instrument and gives a direct reading, from one side, of the wall thicknesses over a range of from 0.16 to 7.2in. in steel with an accuracy of+or—1%; the gauge can also be used for other materials providing the readings are corrected by a suitable factor, which is related to the velocity of sound in the material. Due to the extensive range of work to which the ultrasonic test has been applied, it has been necessary to purchase a wide variety of probes of various types, together with calibration blocks and other auxiliary equipment.

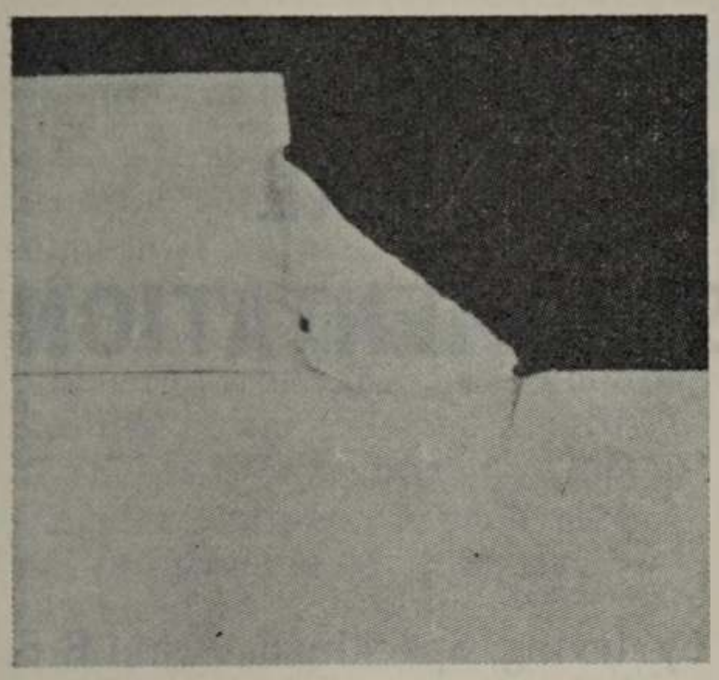
Ultrasonic testing is a technique that is rapidly gaining in importance and it will undoubtedly continue to do so for a long time to come. In certain applications it can be regarded as being complementary to radiography, as it is particularly well suited to the detection of crack-like defects, in which respect radiography has severe limitations. But it is a technique which requires to be applied with great care and discrimination, otherwise it can be extremely misleading, particularly in its ability to show defects which are not significant; for example, it is simple to reveal inadvertently the individual grains in coarse-grained materials. Reliable ultrasonic testing calls for first-class equipment in the hands of fully trained and experienced operators, and it is for this reason that great care should be taken in the selection of the apparatus to be used and in the training of the personnel who use it.

The following are two typical examples of cases where the application of ultrasonic testing is invaluable.

Two timber-impregnating vessels having exploded due to failure of the centre screwed spindles of the door securing gear, fatigue cracks having developed in localities not accessible for visual examination without complete dismantling, it became essential to ascertain as rapidly as possible if the spindles in a number of other similar vessels were cracked or not. They were tested ultrasonically from the exposed ends, thus obviating dismantling, when one of them was found to be cracked almost half-way through, the others being free from cracks.

In the course of a routine maintenance examination of a 9,600 hp motor of a special type, three small cracks were observed in the pole shoes. The application of ultrasonic testing showed that the trailing edges of all six poles were cracked and that the leading edges of four were similarly affected. The depth and configuration of these cracks was determined, which could not be ascertained by the magnetic test applied initially, and this enabled a method of temporary repair to be devised so that the motor remained in service until completely new pole-pieces could be made and





fitted.

An actual test plate is shown in Fig. 3 for a test taken in a steam vessel that had exploded under pressure. Faulty welding was suspected and in order to determine the extent of the defects the vessel was examined by ultrasonic means. The examination was carried out by means of Krautkramer Type U.S.I.P. 9 Ultrasonic Flaw Detectors employing 2 Mc/s 70° and 45° barium titante angle probes and medium grade machine oil as the couplant. When the angle probes were placed in a position similar to that shown in Fig. 4 the screen indication obtained was as is depicted in Fig. 15 and thus confirmed the presence of a crask at the toe of the fillet weld. The length of a crack was traceable by moving the probe parellel to the seam until the crack indication disappeared from the screen. In places, the cracks were found to extend into the plate material to a depth sufficient to prevent any ultrasonic waves passing through to the rivets, and subsequent sectioning of such localities showed that the cracks were approximately 1 in. deep and slightly angled to the plate surface. At every location where welding had been resorted to, cracks had developed along the toes of the welds for their full length, and, in most cases, they extended past the ends of the welds for approximately 2 in. During the examination of the fillet welds there were some indications of small cracks radiating from a number of rivet holes.

Due to the extend and severity of the defects revealed by the ultrasonic examination it was decided that the first accumulator should be taken out of service permanently and replaced, and that the ultrasonic examination of the other vessel, which was not affected so seriously, should be extended to ascertain if it was a condition that would justify repair.

The results obtained from this examination indicated that the circumferential seams of Nos. 1, 2 and 6 shell rings, as well as one end plate, were seriously cracked at nearly every rivet hole. Confirmation of the ultrasonic indications was obtained by removing several rivets and then magnetically testing the holes; in each case several cracks were detected, radiating in all directions. Further ultrasonic testing was carried out over localised areas in other seams and similar results were obtained, which were also confirmed by the removal of rivets and magnetic testing of the holes.

The above information was first published in "Technical Report" published by the British Engine Boiler and Electrical Insurance Coy. Ltd to whom our thanks are due.

A DOMESTIC STEREO SYSTEM

—from page 19

can be screwed to the back of the panel and these used to secure the front onto the sides. Care should be taken to ensure an airtight joint around the edge of the panel.

Once this has been satisfactorily completed, the speakers can be screwed in place. The tweeter is mounted centrally over the port, whilst the 8M is mounted tightly behind its own cut out.

The next point is to phase the speakers. This can be done with a 1½ volt battery. By touching selected leads from the speakers onto the positive and negative terminals, whilst the movement of the cone is observed, the connections which will make both speakers move forwards together, can be ascertained. This phasing should also be retained for setting up the two speaker cabinets, as these also must be phased correctly when connecting to the amplifier. The crossover networks can now be connected, making sure the respective branches to tweeter and woofer are correct. Make a small hole just sufficient to pass a length of tru-rip twin flex in the back, pass the wire through, connect up, then firmly fix the back in place, having retained some identification of the speaker phase on the external cable.

This completes the details of this part of the article. We will cover further details of our stereo project next month, in the fourth and final part.

NON-DESTRUCTIVE TESTING SERVICE TO THE AIRCRAFT AND HEAVY ENGINEERING INDUSTRIES

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Transistorised digital volt-ohm meter . . .

THE CASE FOR DIGITAL INSTRUMENTATION

by Irving Spackman, A.M.I.R.E.

In our July 1961 issue we featured an article by Mr. J. Stubbs Walker in which a section was devoted to a new approach to instrumentation — Digital Instruments. We, in this country had our first opportunity to see some of this equipment at first hand, when we were invited to a demonstration which we later reviewed in our November issue of the same year.

Since that time every month has introduced some new applications, styles and models, of digital instruments. Some we have featured in our new products column.

At this point we thought we could survey what has transpired in this field over the last two years or so.

The idea that the mind can assimulate measurements in numerical form faster, easier, and more accurately, than by reading the position of a pointer moving across a numbered scale, gave birth to the idea of the digital voltmeter as long ago as 1952.

Surprisingly, the benefits of the digital voltmeter (D.V.M.) were not immediately apparent to most electronic engineers in the early '50s. Now, however, the greater need for closer tolerance and more accurate electrical measurements have made it a basic tool in many electronic and industrial applications.

The digital instrument offers many advantages, that can result in quite extensive savings in time, money and energy. The basic purpose of such an instrument is to permit making a highly accurate measurement in an instant with virtually no chance of error. The measurement is displayed in numbers which are easy to see and can be automatically recorded with the correct polarity sign and with the decimal point in its proper place. Guess work is eliminated whilst operation is so simple that unskilled personnel can use it with confidence.

Types of Digital Instruments

Since the advent of the first digital voltmeter an entire family of digital measuring instruments has grown out of the original concept. The following is a brief description of some of the generalised types available, where they are used, and how they operate.

Digital Voltmeters: The D.V.M. which measures the absolute value of an unknown D.C. input voltage by comparing it to a highly precise internal reference voltage, remains the most popular digital measuring instrument. Today many types of D.V.Ms are available. They include instruments with and without automatic range polarity indication, with and without print out, and print control for data recorders, all electronic units for high speed measuring, models measuring down to millivolts without a pre-amplifier, and many others. Virtually all the current D.V.Ms can measure low level D.C. or A.C. voltages by adding accessories. Other accessories are available for forming measuring, or data logging systems, in association with D.V.Ms.

Digital voltmeters operate on an extension of a very simple principle — that of the laboratory potentiometers. In Fig. 1 we see a block diagram of a basic digital voltmeter which uses an electronic or electrical stepping attenuator to select the voltage measuring range. The reference voltage source will vary, depending on meter design and accuracy required. The potentiometric voltage is created by a voltage divider, connected to a stable reference voltage or working reference.

A 4 digit D.V.M. uses a 4 decade voltage divider, a 5 digit D.V.M. requires 5 decades and so on. Programmed switches vary the voltage divider setting until the

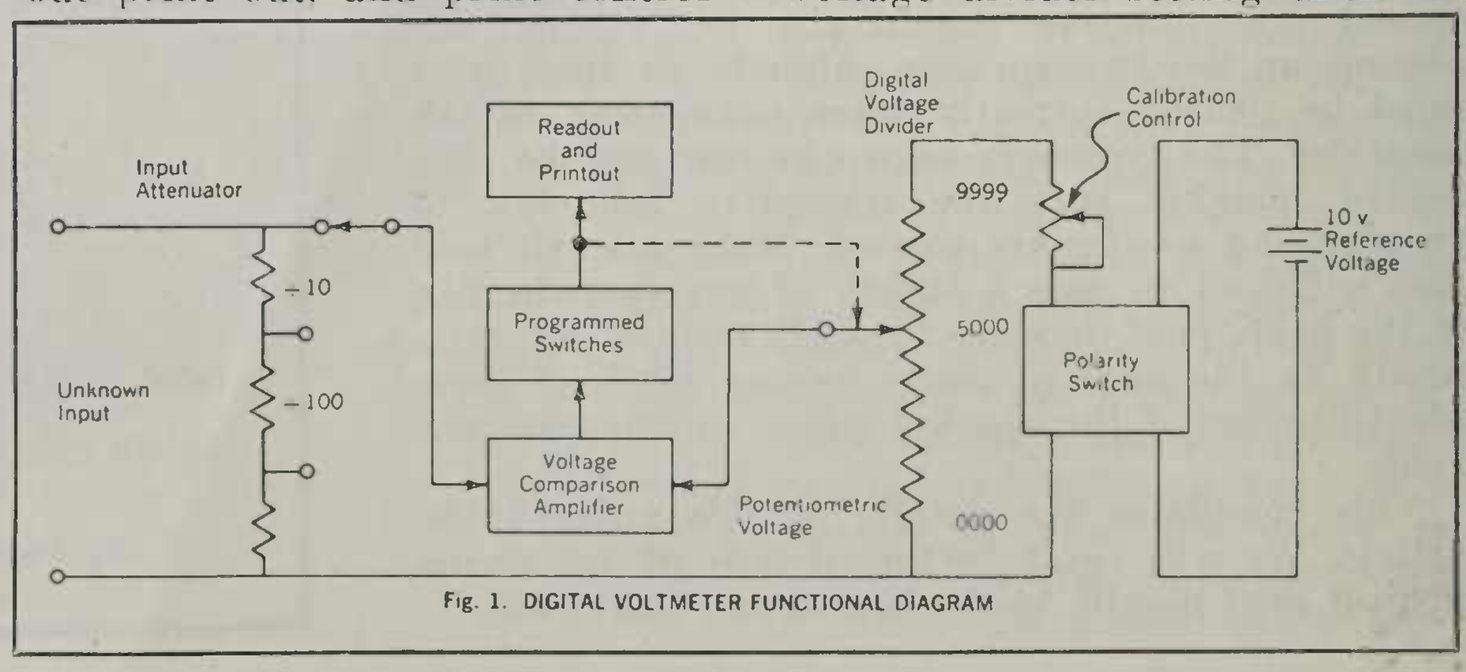


Fig. 1. DIGITAL VOLTMETER FUNCTIONAL DIAGRAM

potentiometric voltage is equal to the unknown input.

The "on-off" positions of the programmed switches give the numerical value of the measurement by operating a digital readout. The voltage comparison amplifier informs the programming circuits of the relative amplitude of the unknown input and potentiometer voltage at each step of the programme. A reference voltage polarity reversing switch permits measuring both negative and positive inputs. A range switch or range relays, vary the setting of an input attenuator so voltages greater than the reference voltage can be measured.

In Fig. 1, the basic measuring range is +/— 9.999 volts and the D.V.M. reading is 5.000 volts. Ranges of +/— 99.99 volts and +/— 999.9 volts are obtained by switching the range amplifier. In some D.V.Ms range changing is also accomplished by changing reference voltage values, generally to 1 volt or 100 volts.

All high accuracy voltmeters work in this fashion. Major differences between various D.V.Ms are in the reference voltage supply design, programming circuits, type of switches used (stepping switches, mercury-wetted contact relays or electronic switches), general construction, remote control features, and type of digital recorder output.

Digital Ohmmeters: (D.O.Ms) are essentially automatic, self adjusting Wheatstone Bridges. Their operation is very similar to D.V.Ms.

A voltage comparison amplifier detects any bridge unbalance and issues the instructions to programmed switches. These vary the setting of a digital rheostat in one arm of the bridge to achieve a balanced bridge. Bridge range is changed by automatically switched resistors in ratio arms of the bridge

Another method of measuring resistance is to connect a precision current D.C. source across the test resistance and measure voltage drop with a digital voltmeter. In such a case ranges can be extended if necessary.

(Concluded next month.)

SERVICEMAN'S COLUMN

by J. Whitley Stokes

At the outset it is realised that in order to keep a department such as this going for an indefinite period it is necessary to have the assistance of readers in supplying "Serviceman's Experiences", repair hints, pet gripes, suggestions and the "crazy" problems not found in the text book.

It is hoped to make this column a forum for the interchange of ideas amongst radio and TV servicemen. So how about it chaps? Short articles (about 100 words or so) covering any unusual experiences or repair tips, in fact anything that might be of interest or help to the "other fellow". It doesn't matter if you have never written anything before. Write in now!

. . . .

I have long ago learned not to get into arguments with customers but this week it was all I could do to refain from breaking my own rule when a customer informed me quite seriously that he knew the reason why it wasn't always possible to get good South Island reception. A friend who used to work in Broadcasting had told him that the local stations were arranged to radiate interference at certain times. From what I could gather the idea of this was to force listeners to use their local stations, but for what reason it was difficult to imagine!

The recent comment by the previous author of this page concerning output transformer failures prompts this comment from me. Most servicemen will agree that the biggest majority of O.P.T. failures occurs in the smaller mantel models using 2 or 3 watt transformers and is due in part at least to the smaller gauge of primary wire necessarily used, compared with the larger 6 watt types. In fairness to the component manufacturers, the call for smaller and cheaper transformers must tend towards a reduction in reliability. There is quite a lot more to this business of "green-spotting" of course, but it does seem that the dry wound type on moulded plastic formers is almost completely free of this trouble. From my own experience in using this latter type I have not had one failure over the past nine years (shorted turns excepted!)

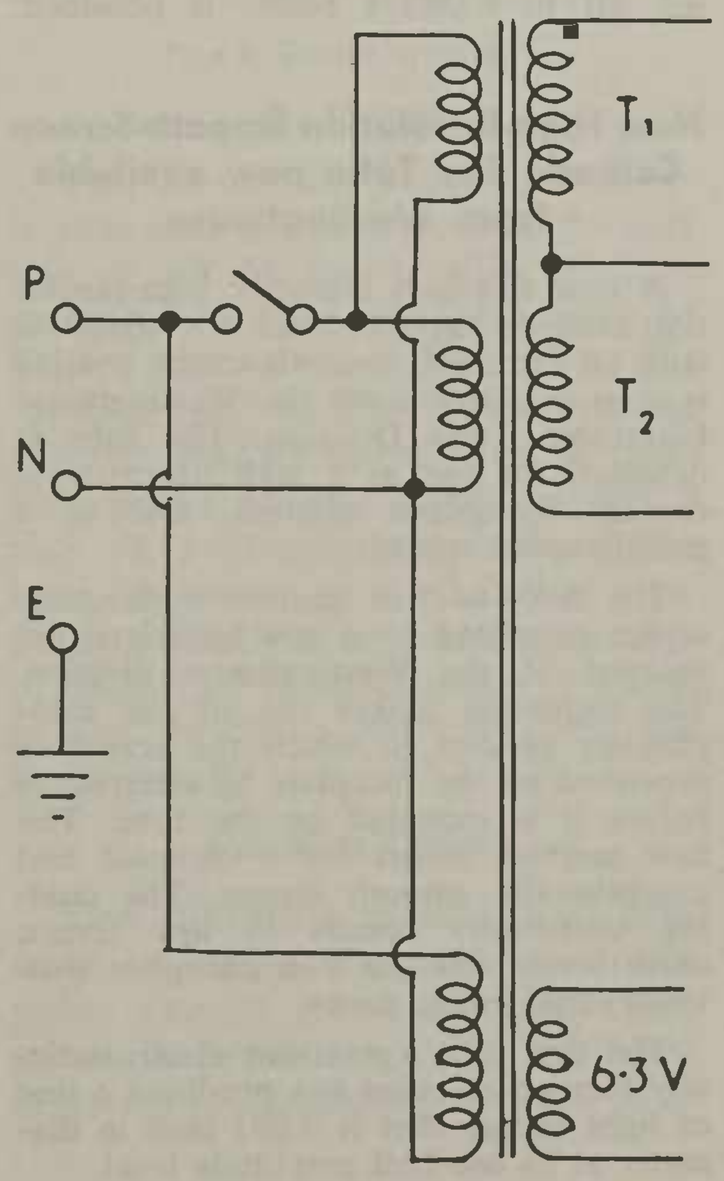
One of my biggest pet gripes:— O.P.T.'s rivetted onto P.M. speakers. Ugh! And whilst still on the subject here's this month's funny story.'

The following was related to me by the representative of a large radio manufacturer after I had enquired whether his firm could suggest that the speaker manufacturers stop using rivets. He said his firm had approached the manufacturers a long time ago and had received the reply that as their transformers were so reliable they practically never needed replacing so it was quite in order to rivet them on.

CORRECTION

In the April issue we published a circuit for the power supply for the 50 watt modulator shown on P. 21. There is a correction required in the circuit of the primaries of the power transformers.

There should be a junction on the neutral line between primary to T_2, and the neutral line running to T_1 and the filament transformer. The corrected circuit is shown herewith.



NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars, contact Advertising Manager, "R. & E.," Box 1365, Auckland.

New Marconi Studio or Outside Broadcast Mixer

To meet the many requirements of television production it has become apparent that a more versatile vision mixer is required. This has led to the development of the Marconi Vision Mixer Type BD. 920, a mixer matrix capable of catering for all foreseeable applications with regard to both systems and facilities.

The mixer can, by a suitable choice of wiring and auxiliary units, be adapted to give any known configuration; typical examples being A/B, A/B/Cut, Knob-a-Channel, Next Channel, etc.

The main features of the new mixer can be summarised as follows: (1) All requirements are met by the provision of 14 inputs and 6 outputs with complete flexibility of arrangement; (2) Plug-in relays are used. Additional contacts are available for cueing circuits; (3) Cuts can be arranged to take place during the field blanking period; (4) Sync. comparator board prevents accidental cutting to non-synchronous sources: (5) High degree of reliability due to the use of a simple, easily replaceable type of plug-in relay; (6) Semi-permanent taper pin connectors make for easy and quick installation and maintenance; (7) Composite or non-composite signals on 405, 525 or 625 lines may be switched: (8) Crosstalk protection in a 5 Mc/s channel is better than 50 dB; (9) HF response of + or — 0.2 dB to 6 Mc/s points is obtained.

* * *

New High-Resolution Smooth-Screen Cathode Ray Tube now available from Westinghouse

A new five-inch diameter high-resolution cathode ray tube, the WX-4647P16, with an extremely smooth screen coating is now available from the Westinghouse Electronic Tube Division. The tube is designed for use as a high-information-content flying-spot scanner, and as a photographic recorder.

The WX-4647P16 features a phosphor screen deposited by a new technique developed at the Westinghouse division. The technique makes use of the cataphoretic process in which the screen is deposited on the faceplate by electrolysis before it is mounted on the tube. The new method makes for a compact and exceptionally smooth screen. The coating uniformity results in low screen noise levels and the P16 phosphor provides rapid image decay.

The new tube's precision electrostatically focused electron gun produces a line of light energy that is 0.001 inch in diameter at its one-half amplitude level.

New Transistor Bench Supply (Below)

New Transistor Bench Power Supply as 870.3

—with Remote Sensing and Proportional Overload Protection.

Solartron Laboratory Instruments Ltd., announce the most recent addition to their series of Transistor Power Supplies — Bench Model AS 870.3 which provides a highly stabilised output voltage 0-30V (3 Amp) adjustable in 10, 1 and 0.1 V increments, by decade switching. Voltage is set to an accuracy of +/— 2% Remote sensing terminals enable the exact value of the set voltage to appear directly across the load, irrespective of the voltage drop in the power carrying leads. The output current, monitored by a built-in meter, can be limited to 75 mA, 150mA, 300mA, 750mA, 1.5 A and 3 A. A fully electronic proportional control system protects, not only the power unit, but also the circuit it supplies. A panel light gives overload indication. The supply automatically resets for current limit settings up to 1.5 A. The manual reset is required only for an overload on the 3 A range, which is indicated by a second panel lamp.

Other features include a transient response of 2 μsec, stability factor of 1000:1, ripple and noise 1 mV peak-to-peak, regulation approximately 0.1% at maximum output, output impedance less than 0.25 ohm up to 100 kc/s reverse voltage protection.

Television at Farnsborough

As well as the wide range of radar, aeronautical radio and navigational aids which Marconi's are exhibiting at the Farnborough Air Show *(Stands 19 - 23 inclusive), closed circuit television will also be featured.

The centrepiece of the latter exhibit will be a 'Dial a Question' unit on which visitors will be able to dial a code corresponding to one of a list of questions relating to closed circuit television, particularly in the field of aviation, and to obtain an answer in both visual and spoken form. The visual answer will be supplied from a Marconi Random Slide Projector and the picture will appear on a Marconi 21 inch monitor set in the back wall of the stand.

A radar bright display will also appear on the stand, showing on a 14 inch monitor, the picture from a remotely situated PPI console.

In addition, various items of closed circuit television equipment will be exhibited in a static display on the stand.

* * *

New Radio Link by Pye and TMC

An example of how separate Companies in the same Group can combine their varying technical skills was shown on the TMC stand at the recent I.E.A. Exhibition, Olympia. One display consisted of a completely self-contained, five-circuit VHF junction radio link incorporating a Pye PTC 810 FM Transmitter, a Pye PTC 820 Receiver and a TMC R4A Carrier Telephone Chanelling equipment with low-level frequency shift signalling.

Important applications for this new radio link will be found in P & T administrations, railway and oil company communication networks throughout the world.

Among the many optional features which can be built-in to the apparatus are 10W or 50W R.F. output, the facility to equip for uni-directional working only and access units for channel 'dropping' at repeater stations.

The units which comprise the TMC R4A section of the link are fully transistorized, use the most modern components and have been designed to enable maintenance engineers to have ready access to all circuits and components.

The overall frequency band of the TMC R4A equipment is from 0.3 to 28.3 kc/s audio bandwidths are from 300 to 3400 c/s and frequency stability is better than plus/minus 2 c/s with a plus/minus 10% supply voltage.

The equipment can be energized from 100-150V, 190-240V, 40-60 c/s and has a power consumption of 26W. Weighing 270 lbs. the unit measures 54in. x 25in. x 21in.

Computers . . . PART FOUR

P. L. WATTS
With acknowledgment to R. L. Currie, M.A. (Cantab.), B.Sc., of International Business Machines.

The last article described how certain operations in digital computers were performed. Most attention was given to circuits and elements within the Central Processing Unit and of the three main sections only the Control and Storage Units were considered. This final article will discuss firstly, to complete the three sections, the basic circuitry employed in the Arithmetic and Logic Unit, secondly, checking and error detection, and finally, applications of computers.

Arithmetic and Logic Unit

It will be recalled from the introduction in the last article, that calculations such as addition, subtraction, multiplication and division are performed in the Arithmetic and Logic Unit. At the same time, the operation of the bistable flip-flop was described and its use as a binary counter mentioned.

The Binary Counter

A single flip-flop circuit can only indicate either I or 0 in the binary system, consequently a counter consists of a number of these flip-flops linked together in series as shown in Fig. 1.

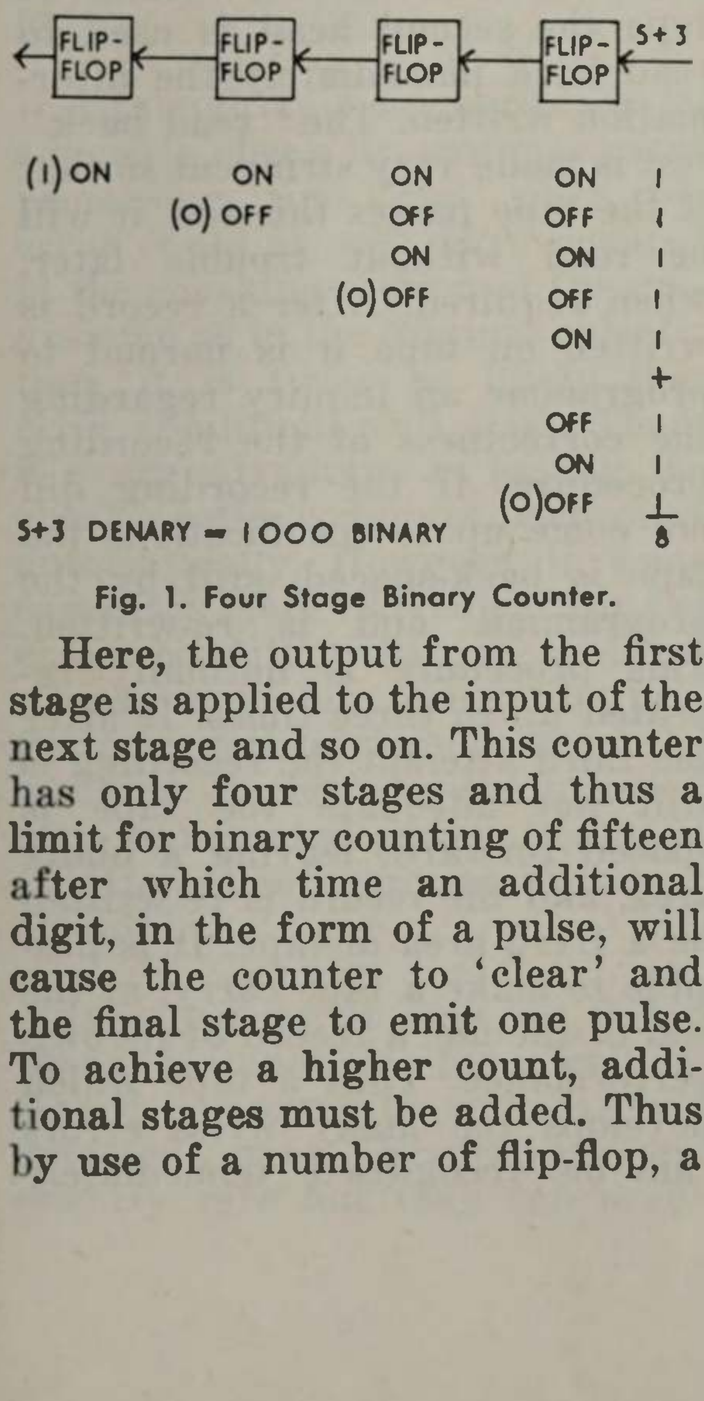


Fig. 1. Four Stage Binary Counter.

Here, the output from the first stage is applied to the input of the next stage and so on. This counter has only four stages and thus a limit for binary counting of fifteen after which time an additional digit, in the form of a pulse, will cause the counter to 'clear' and the final stage to emit one pulse. To achieve a higher count, additional stages must be added. Thus by use of a number of flip-flop, a vidual digits can be converted inseries of pulses representing indito their equivalent binary sum as well as being stored and accumulated. Illustrated in Fig. 1 is the sequential addition of five and three to result as a sum in the binary form of 1000.

The flip-flop binary is, however, not sufficient in itself to perform the many diverse functions required in the arithmetic section. Added to the flip-flop for such purposes as addition, subtraction, multiplication and division are switching and gating circuits, delay lines and "logic circuits".

These "logic circuits" are derived from the logical concepts of Boolean Algebra, which relates the laws of mathematics with logic and the idea of two states in the binary system. For example, in Boolean Algebra, addition takes on the characteristics of 'or' and multiplication can be represented by 'and'. The three logic circuits which concern us are called 'and-circuits', 'or-circuits' and 'inhibitor (or nor) circuits'. The idea of such circuits will be familiar to the reader, for instance, a light which may be switched on from either upstairs or downstairs is an example of an 'or-circuit'.

And-Circuit

As the name suggests, the 'and-circuit' will only produce an output if the first and second input pulses are concurrent. A basic arrangement using diodes is shown in Fig. 2. Here, a negative potential is applied to both inputs and because of the low forward resistance of the diodes, most of the voltage drop will occur across the load resistor but, at the same time leaving the output at a negative potential. This condition represents the 'off' state or 0 in the binary system.

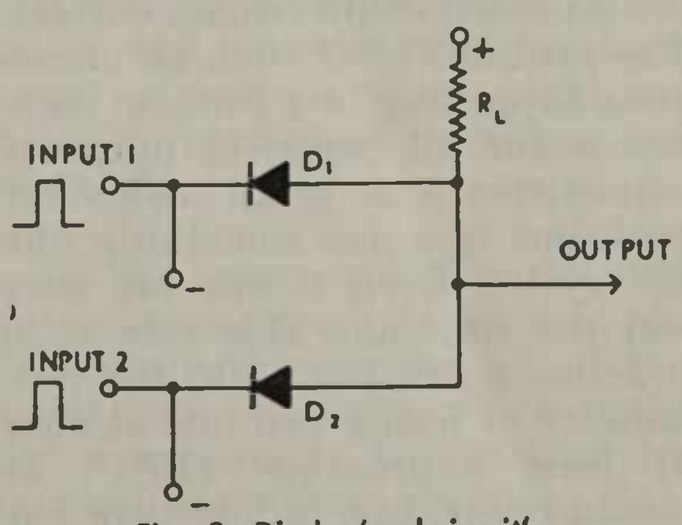


Fig. 2. Diode 'and-circuit'.

It is clear that if, at one input only, a positive pulse, sufficient to overcome the negative potential, is applied, it will be restricted because of the high reverse resistance of the diode. The small positive current thus following will not be great enough to overcome the negative potential present from the other input.

When similar positive pulses are applied to both inputs there is no negative potential flowing through the diodes or load resistor, and although the diodes have a high reverse resistance a small amount of current passes through to the output to produce a positive pulse. This constitutes the 'on' condition and represents 1 in the binary system.

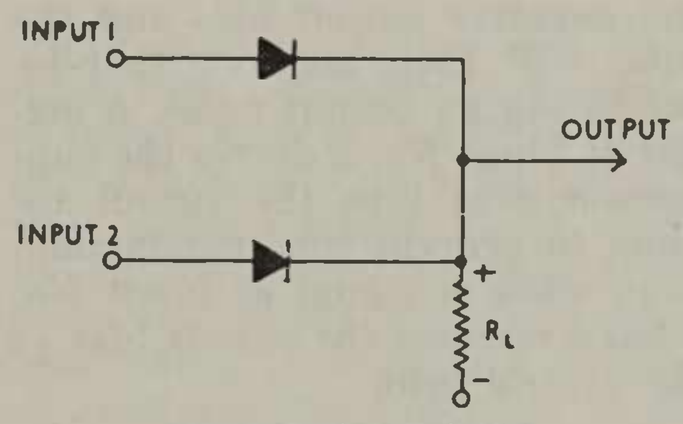


Fig. 3. Diode 'or-circuit'.

Or-Circuit

The 'or-circuit' has two or more inputs and a pulse applied to any one or all of these, will produce an input signal. Examination of Fig. 3 shows a similarity to the 'and-circuit' in Fig. 2, except for the reversal of the diodes. A positive pulse at one input causes a rise in voltage drop across the load resistor and thereby produces a positive output signal. Application of simultaneous positive pulses to both inputs give the same result.

Inhibitor Circuit

The inhibitor circuit will produce an output for any one input pulse except when an inhibitory pulse is present at the inhibitor input. The inhibitor circuit may

consist of an 'and circuit' in conjunction with a 'not-circuit' (phase inverter) in such a way as is shown in Fig. 4. The purpose of the 'not-circuit' is to invert the polarity of the pulse. A diode is used in connecting the 'not-circuit' so that the positive potential from V2 is blocked.

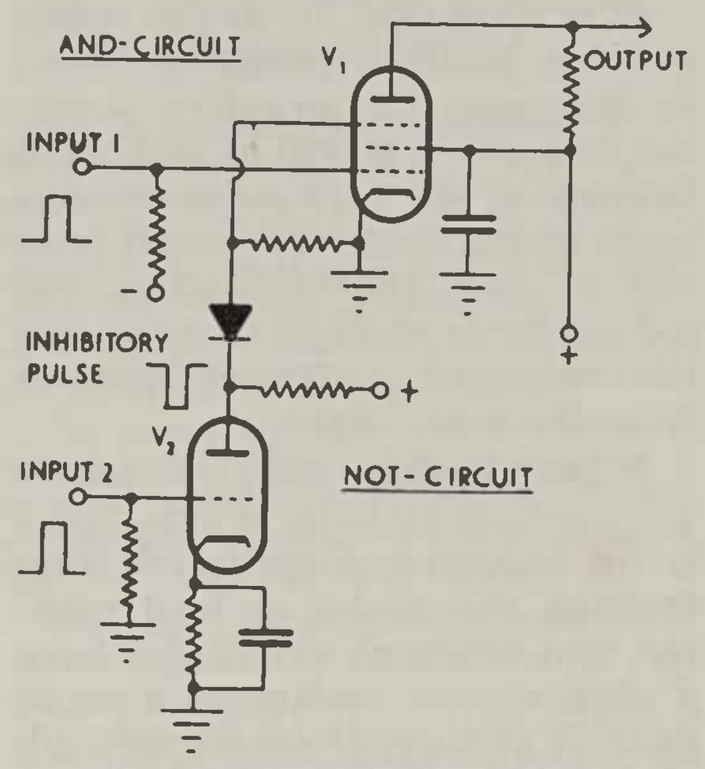


Fig. 4. And-Not Inhibiting Circuit.

If a positive signal is applied to the control grid of V1 at the input the positive potential overcomes the negative cut-off bias and the tube will then conduct thereby producing an output pulse. A signal at input No. 2 drives the suppressor grid into the cut-off region, to prevent tube conduction, even when a signal at input No. 1 has overcome the cut-off bias at the control grid.

Calculation Circuit

A single adder could be made using an 'or-circuit' but it could only be used for adding two binary numbers such as 1010 and 101 where there is no need to "carry" a number. A full adder uses a combination of 'or-circuits', 'and-circuits', 'not-circuits' and delay lines. The build up of these is too detailed for discussion here.

Similarly, subtraction could be performed in a simple way using an 'inhibitor-circuit' if it were not for the "carry" condition.

Multiplication and division are basically carried out by the methods of repeated additions and repeated subtraction, respectively.

Checking

In article two, magnetic core storage was used to illustrate the principle of data representation. The use of four cores of a group of six was described there. Their number values of one, two, four and eight are used to represent any digit. The fifth core is of no consequence in assessing the value represented by the core storage group, and is redundant from this point of view. Indeed it is often termed the redundancy bit. This redundancy or check bit is used solely for checking purposes. There is a finite, though extremely small chance that during transfer of data within the machine, a bit could be added or lost. For example, if the one, two and four bits were on and the others off, the number represented would be seven. However, should the two bit be lost then the number would be recognised not as seven but as five, and an error would result. To guard against this possibility, the check bit for each group is always set in addition to the data bits so that for any number the total number of bits on in the group is odd. Thus to represent one or two there is only the appropriate bit on. But to represent the number three, not only are the one and two bits both on but the check bit is on also. Whenever the transfer of a digit occurs in storage there is an automatic check that the total number of bits transferred is odd. Now if one bit is lost the error condition is immediately recognizeable and the machine instantly stops. The occurance of a redundancy error as it is termed, is extremely rare. However it is essential that the computer is right all the time, not just nearly all the time, and so the expense of providing an extra core for every storage is well justified.

It may be suggested that the check is not adequate because two bits could be lost at once and so the bit count could remain correct. The probability of such an occurance happening in a random manner is for all practical purposes non-existent. A small computer performs in a day something like 10^9 cycles. Even if one bit were lost per day, and this rate is in practice much too high, the probability of losing two bits at once at least approaches $(10^9)^2$, or would occur, say, in less than one in 10^8 days. This figure is acceptable by many orders of magnitude!

Validity checking is another form of checking which is widely used in digital computers. Circuitry is arranged so that if a bit configuration is encountered which does not correspond to a character in the character set of the computer an error condition is signalled. Further, the validity of every code which enters the operation register is checked and processing ceases if an invalid operation is encountered. Lastly, there is a similar check on every address which is accessed or developed by arithmetic, and an invalid address will similarly stop processing.

Input — Output Checking

It is not only the central processing unit which requires to be checked. It is useless to perform accurate processing on inaccurate data and it is equally necessary for the input and output units of the computer to be checked.

In a card reader it is normal to read each card at two independent reading stations and to check that the results are identical. Modern magnetic tape units are checked in a similar manner. A dual reading head is employed and circuitry checks that the information received from each head is identical. During the writing of tape the second head is used to read back immediately the information written. The "read back" test is made very stringent so that if the tape passes this test it will be read without trouble later, when required. After a record is written on tape it is normal to programme an inquiry regarding the correctness of the recording procedure. If the recording did not come up to specifications the tape is back-spaced, still by the programme, and is re-written. This procedure is normally repeated up to three times. If after the third attempt the recording is still not adequate the tape is spaced forward, leaving a blank area, and the record is re-written on a fresh area of tape. It is possible to make a tape carry, at the end of the file, a record of its own performance. Thus a tape which develops too many write errors can be recognised immediately

and is discarded. It should be pointed out, however, that the normal life of magnetic tape extends over a period of years.

In card punching a count is kept of the number of holes which should have been punched into each column on the card. The card is then read and the number of holes actually appearing in the card is counted. Any discrepancy here indicates an error condition.

In the modern high speed printer elaborate checks are made to ensure that every character requested to be printed actually was printed and that it was the correct character.

It will be seen from this account that every part and device of a computer is checked. It should be emphasized that not all the checks described here are performed in every computer. Moreover, in some computers the checks are performed completely automatically, but in others some of the checking is not automatic and must be programmed. For example if an arithmetic unit does not have internal checking then the calculation must be performed twice, preferably by two different methods, and the results are compared.

Although this accomplishes an adequate check it consumes extra processing time and since the error could as well have occured in the checking section of the programme as in the original calculation, it is twice as likely that error conditions will arise. There is every advantage in having the checking of a computer performed automatically. However, in some cases it is more convenient for the error condition to set a latch which may be tested in programme rather than to stop the machine. In this way the function may be repeated automatically in an attempt to overcome the error condition.

In summary it may be stated that it is impossible for a well designed computer to make an undetected error. Errors are extremely rare but they can occur and when they do appear they are detected by the computer's own error circuitry.

Applications

Computer men are often asked the question, "Why do you need such high processing speed?" We have all seen offices with a number of desk calculators working and it would be useful to have a calculator capable of performing several multiplications per second. Yes, we could manage to keep that machine busy several hours a day. But the high speed digital computer is capable of many times this speed. Calculations are performed in a matter of milliseconds or even microseconds.

It is commonly forecast that a computer when installed will have a lot of idle time, but it seldom works out this way in practice.

A computer is often seen first of all as a means of mechanizing existing procedures. An organization has many thousands of employees and requires to process their payroll. To accomplish the required calculations and print out the necessary information may take a time of the order of one second per person. Hence in a big organisation the weekly processing of the payroll could take some hours. Or a scientist has a lot of data upon which he must perform a number of tedious calculations. A computer will help him to complete these calculations quickly and accurately. It should be emphasised that, important as these types of calculations are, such use of the computer only touches on the border of the field which modern computation opens up. Both in the scientific and commercial fields it is found that the computer makes possible and practical many operations which could not be performed at all under manual methods.

In the commercial world, the computer makes it feasible to obtain much information about the operations of a firm which could not economically be obtained by manual operating methods. Further, the concept of management by exception is becoming more and more important. The computer examines all conditions according to criteria with which it is supplied. All normal operations are examined by the computer, but without comment. It is the out-of-line conditions which are reported and because these are not buried in a mass of figures, but are highlighted, the executive can instantly recognize the condition and proceed with immediate corrective action.

In science and engineering we have become used to the idea of using a computer for tracking the path of artificial satellites, or for the design of a new airliner, but we tend to assume that there is little scope for computation in the day-to-day operations of the scientist or engineer, especially in our own country. Experience is proving otherwise. Throughout New Zealand in scientific research and engineering projects, there is increasing dependence upon the results of computation.

For example, before such facilities were available to him, the engineer had to build in large safety factors to allow for the possible stresses which would occur in his structure but which he could not predict. To give just one illustration, it requires a number of mathematical equations to describe the multi-storey steel framework of a building. In the case of a large building the solution of these equations involves a prohibitive amount of computation if it is to be performed by hand. On the other hand the computer can provide the solution in comparatively few minutes. Because of the more detailed knowledge which this solution provides, the engineer is able to predict much more accurately the behaviour of his structure and so is able to specify less steel to form a stronger building. The saving in capital cost in such a case is often considerable.

In the last ten years tremendous advances have been made in the science of computation. It would be a bold man who predicted the advances which will be made in the next ten years.

Shortwave Survey

by MIKE BUTLER

a listener's guide to Broadcasts in English

With dozens of schedules from overseas broadcasters littering the table and a sheaf of magazines with short-wave notes on the floor, some of us would undoubtedly call quits or leave it to chance and wander the bands hopefully. To obviate this and to summarise the strongest signals currently received we invite you again to tune with us . . . .

AROUND THE CLOCK ON SHORTWAVE

GMT	Country/Organisation	Frequency—KC		
1800 – 1828	Vatican	11740		
1815 – 1855	China	7330	9785	
1820 – 1840	Italy	9575		
1830 – 1900	USSR	9775		
1830 – 1900	Yugoslavia	6100		
1830 – 2100	USA-VOA	6185		
1845 – 1915	Pakistan	9740		
1845 – 1930	Fiji	4755		
1845 – 2100	USA-VOA	9530	9765	
1900 – 1915	USA-VOA	9630	17795	
1900 – 1930	USSR	9640		
1900 – 2045	USA-VOA	6080	7205	
1900 – 2100	USA-WRUL	17845		
1915 – 2000	BBC	11820	11860	12095
1915 – 2000	USA-VOA	5975		
1915 – 2100	USA-VOA	6140		
1930 – 2000	Indonesia	9865		
1930 – 2000	USA-WRUL	17760		
1930 – 2000	USA-AFRTS	17780		
1945 – 2045	India	7235	9635	
2000 – 2015	Ecuador-HCJB	15115		
2000 – 2020	Japan	9525		
2000 – 2030	Aust. Regional	4920		
2000 – 2200	Australia	11840	15315	
2015 – 2030	USSR	9500		
2015 – 2045	Israel	9009		
2030 – 2100	China	11650		
2100 – 2130	USSR	17740		
2100 – 0015	Australia	15240		
2115 – 2130	Aust. Regional	6090		
2130 – 2145	USA-VOA	15225		
2130 – 2200	BBC	7150		
2130 – 2200	China	7480		
2130 – 2200	Australia	9660		
2200 – 2230	Ecuador-HCJB	15115		
2200 – 2230	USA–VOA	15130	15170	15225
2200 – 0300	BBC	9510		
2215 – 2300	New Zealand	15280		
2215 – 0015	Australia	15220		
2230 – 2245	Vatican	11740		
2300 – 0000	Australia	21540		
2300 – 2330	USA-VOA	15185	21745	
2345 – 0000	Philippines - Far East B'casting Co.	21515		
0000 – 0030	USA–VOA	15360	17745	
0000 – 0030	Philippines Far East Broadcasting Co.	21515		
0000 – 0245	USA-AFRTS	17815		
0015 – 0100	Aust. Regional	15425		
0015 – 0500	Australia	17870		
0030 – 0045	USA-AFRTS	15310		
0030 – 0045	USA-VOA	15405		
0100 – 0130	USA-VOA	17735	17765	21745
0100 – 0300	USSR	12030		
0100 – 0400	Australia	21540		
0100 – 0555	USSR	9690		
0130 – 0500	USSR	11735		
0200 – 0215	USA-VOA	15405		
0200 – 0230	Rumania	15380		
0200 – 0230	Philippines - Far East B'casting Co.	21515		
0200 – 0300	Ecuador-HCJB	11915		
0200 – 0300	BBC	12040		
0200 – 0300	Aust. Regional	15230		
0200 – 0700	USA-AFRTS	51210		
0215 – 0230	Rumania	11900		
0215 – 0230	New Zealand	15110		
0215 – 0230	USA-VOA	17845		
0215 – 0445	New Zealand	15280		
0215 – 0615	USSR	12010		
0230 – 0245	India	17830		
0230 – 0700	Australia	15240		
0300 – 0320	Japan	15105	17755	
0315 – 0330	Rumania	7195	11905	
0315 – 0330	Cuba	11840		
0315 – 0400	Spain	9360		
0330 – 0400	BBC	7185		
0330 – 0400	USSR	9770		
0345 – 0430	Portugal	6025	9740	
0400 – 0430	Hungary	9833		
0400 – 0515	BBC	12095		
0415 – 0500	Spain	6130	9360	
0415 – 0500	Switzerland	9535	11865	
0415 – 0545	USA-AFRTS	17825		
0430 – 0445	USA-AFRTS	15310		
0430 – 0515	Czechoslovakia	7345	9795	11990
0430 – 0515	BBC	9510		
0430 – 0545	Australia	17820		
0445 – 0500	Aust. Regional	15425		
0500 – 0510	Japan	17755		
0500 – 0600	BBC	9410	9580	
0500 – 0700	USA-VOA	9770		
0515 – 0530	Cuba	11840		
0515 – 0600	Spain	6130	9360	
0530 – 0600	USA-VOA	6080		
0530 – 0615	Japan	15235	17225	
0530 – 0630	USA-VOA	6025		
0530 – 1100	Aust. Regional	4920		
0545 – 0600	Canada	9585		
0545 – 0600	Philippines - Far East B'casting Co.	15300		

GMT	Country/Organisation	Frequency—KC		
0545 – 1100	Fiji	4755		
0600 – 0620	Japan	15195		
0600 – 0700	BBC (Pacific Service 25 and 41 metre bands)	6110	7120	11955
Sunday only				
0600 – 0730	Holland - Happy Station	9630		
0600 – 0800	BBC	9510		
0600 – 0915	Australia	9570	11710	
0600 – 1100	USA-AFRTS	6040		
0615 – 0715	USA-VOA	9720		
0630 – 0700	USA-VOA	5995		
0630 – 0700	Egypt	11915		
0630 – 0945	Aust. Regional	6090		
0630 – 1000	Ecuador-HCJB	9745		
0700 – 0730	USSR	9540		
0700 – 0800	Aust. Regional	9660		
0700 – 0800	BBC	11750		
0700 – 0900	Ecuador-HCJB	11915		
0700 – 1000	Ecuador-HCJB	6050		
0715 – 0800	USA-AFRTS	11830		
0730 – 0800	Philippines - Far East B'casting Co.	11855		
0730 – 0800	Japan	15235		
0745 – 0800	Aust. Regional	15425		
0745 – 0800	apan	15135		
0745 – 0900	USA-AFRTS	11930		
0745 – 1100	Australia	7190		
0745 – 1100	USA-AFRTS	9700		
0800 – 0815	Japan	11725		
0800 – 0945	USA-VOA	9545		
0815 – 1100	USA-VOA	6145		
0830 – 0845	Fiji	3980		
0830 – 0900	Aust. Regional	6150		
0830 – 0905	Canada	9630		
0830 – 0930	China	11650		
0830 – 1025	China	15060		
0830 – 1045	USA-VOA	5985		
0830 – 1100	Australia	11810		
0845 – 1100	USA-VOA	6075		
0900 – 0915	Japan	11725		
0900 – 0930	USA-VOA	7155		
0900 – 1000	USA-VOA	9650		
0930 – 1000	USSR	7280	9735	
0930 – 1000	Japan	15235		
0930 – 1015	Japan-Far East Network	6155		
0930 – 1015	USA-VOA	9665		
0930 – 1030	BBC Singapore	9725		
0930 – 1030	Japan	11875		
0945 – 1000	USSR	9610		
0958 – 1100	Australia	9570		
1000 – 1015	Japan	11725		
1000 – 1030	USA-VOA	7155		
1000 – 1030	Vietnam (People's Democratic Repub.)	9840		
1000 – 1030	Japan	11875		
1000 – 1100	USA-VOA	15335		
1015 – 1030	BBC	11750		
1015 – 1045	Thailand	11910		
1015 – 1100	Aust. Regional	9660		
1030 – 1045	Fiji	3980		
1030 – 1100	South Korea	9640		
1045 – 1100	Italy	17800		

GMT Country/Organisation Frequency

We would mention that the times given above are not necessarily the opening or closing times. The period given is the duration of satisfactory reception as recently checked at our listening post.

METRE BANDS

13	metres	21450 – 21750		kc
16	metres	17700 – 17900		kc
19	metres	15100 – 15450		kc
25	metres	11700 – 11975		kc
31	metres	9500 – 9775		kc
41	metres	7100 – 7300		kc
49	metres	5950 – 6200		kc
60	metres	4750 – 5050		kc

* * *

SURVEY BY COUNTRY

BULGARIA: A fairly strong signal from the Bulgarian Broadcasting Service's 120 kw transmitter on 9700 was observed from 0400 to 0430 but strong interference made listening difficult.

CEYLON: The Commercial Service of Radio Ceylon is the regular occupant of the 15265 channel between 0145 and closing time, 0330.

FIJI: In the April issue we outlined the developments then apparent in broadcasts from the FBC. In "Around the Clock on SW" this month you will notice that the 4755 frequency has become the best English language outlet. However, the position regarding the other frequencies has reversed. 3980 has re-appeared between 0545 and 1045 while the signal on 6005, which was so good previously, has vanished.

FRANCE'S European service in English can be sorted out amongst interference on 6145, 2030 – 2100. Try for this one before the signals on this band deteriorate as the summer months approach.

GREAT BRITAIN: Recent loggings for the BBC, not good enough for "Around the Clock" are: At 2145, European Service on 9770; at 2315 on 15255; at 0515 on 7140, European Service with their "English by Radio" session. Polish after 0530; 0600 – 0800, Pacific Service on 9640; 0615 – 0700, quite good on 11945; at 0630 on 17810, very poor, at 0700 on 15390, weak; 1000 – 1030, on 15435 very weak but may improve. Also on 15070.

HOLLAND was using 15220 when heard at 1030 (fair).

PORTUGAL: CSA66 on 17895 has again been audible for half-an-hour from 1830 (weak).

SWITZERLAND: Another early morning return is their 7210 outlet from 1845 (weak).

U.S.A.—Voice of America. Additional outlets: 1830 – 1900 on 7200: at 1915 on 21610: at 2015 using 15235 and WGEO on 15330; 2100 2130 on 6015, news at 2100; at 2145, United Nations programme on 15105; at 0015 on

(Continued overleaf)

Overseas Notebook . . .

Research on Modular Arithmetic Under way at Westinghouse:

Techniques and systems in modular arithmetic, a science known to the ancient Chinese, are being researched by the Air Arm Division of Westinghouse Electric Corporation's Defense Centre.

The recent revival of modular or residue class arithmetic provides science with a new tool for use in digital computer development. The purpose of the Westinghouse research is to apply modular arithmetic techniques to computation problems, and to design a digital computer which would make use of these techniques.

Some of the problems under study include division, overflow, conversion of binary or decimal from or to modular notation, magnitude comparison, and the development of suitable residue class computational logarithms.

Both decimal and binary arithmetic involve delays in transmission of carries from digit to digit in the calculation of sums or products. Modular arithmetic completely eliminates carries. This excludes the steps of propagating carries from stage to stage and deciding whether a previous carry causes a further carry.

Using modular arithmetic, multiplication requires no more time or is no more complex than addition. Although rounding off numbers remain a problem in certain computations such as division, a straightforward operation like addition or multiplication yields a result containing the same number of digits as the original data, providing exactly the same order of precision.

* * *

Kenya to have Television:

Kenya's first television station will be on the air before the end of this year. The transmitting equipment will include a 5 kW vision transmitter Type BD. 372A, a 3-stack super-turnstile aerial Type BD. 760 (giving an E. R. P. of 15kW), programme input equipment, a filterplexer, a water-cooled test load, harmonic attenuators and a considerable quantity of other ancillary equipment, all from Marconi.

Marconi studio equipment will comprise three Mark IV image orthicon camera channels, four vidicon camera channels Type BD. 871, a transistorized sound control console Type BD| 968, picture monitors, some master control equipment, film projectors and ancillary equipment. One of the BD. 871 camera channels will be used in the Announcers' Studio and the others for telecine purposes.

* * *

America Stipulates British TV Cameras for Historic Telstar Telecast:

It can now be stated that the first taped picture sent to the American Telephone and Telegraph Company's Telstar satellite on July 10th and the first "live" international transmissions from the United States to England and France were televised using Mark IV 4½in. image orthicon cameras.

For three days before the 170 lb. 34½ inch-diameter satellite was rocketed into space, Marconi cameras and Ampex video tape recorders were used to prepare background material for relaying in conjunction with the "live" broadcasts.

On the day of the experiment, Marconi Mark IV cameras were in position at strategic points at the satellite station at Andover. In Washington, D.C., three further Marconi Mark IV cameras were depioyed for live pick-up in an auditorium for the interviewing of such nationally-known figures as the U.S. Vice President.

* * *

Radio Shows for Jet Passengers

Passengers in many B.O.A.C. Rolls Royce 707 jetliners will soon be able to press a button and tune in to the aircraft's own "radio programme"—the first and only one of its kind in the world. The system, produced after years of work by British electronic engineers, is called "Hi-Fli."

A nonstop programme of music, talks, radio plays and other programmes will be available to the individual passenger without a sound reaching neighbours. The heart of the system is a radio transmitter in the aircraft itself, beaming two programmes ot tape-recorded entertainment on wavelengths which can only be heard inside the passenger cabin. Each passenger is offered a tiny personal receiving set, and a set of lightweight earphones.

The programme can be heard only when the earphones are in position, so that it cannot disturb other passengers, and the listener can switch on or off, or change programmes by touching a button. As there are no plugs or cords, the passenger can move around the aircraft without interrupting the broadcast. The programmes will include famous international performers and orchestras. From time to time, fresh programmes will be introduced.

The system—the first of its kind to be introduced by any airline in the world—will be installed initially on the Rolls Royce 707s which operate both trans-Atlantic services, and those around the world via the Middle East, India and the Far East.

* * *

Marconi Heads Italian Marconi:

Marconi Italiana, the Italian subsidiary of Guglielmo Marconi's original British company, Marconi's Wireless Telegraph Co. Ltd., is once again headed by a member of the Marconi family.

Recently, the Marchese Giulio Marconi, son of the founder of the company and of radio itself, became President of Marconi Italiana. He has worked for the company for the last 28 years both in Italy and for a time in U.S.A., and has been President of S.I.R.M. (Societa Italiana Radio Marittima), the Italian equivalent of the Marconi International Marine Communication Co., for nearly 20 years.

The British company has been linked with the Italian subsidiary since the very earliest days of radio, when Guglielmo Marconi opened a small works on one of the moles of Genoa Harbour in 1909.

* * *

'Empty' Solid used in Westinghouse Electronic Tube Research:

A solid so light that only one per cent of it is composed of anything is the latest material for constructing electronic tubes. The solid is a smoke deposit — a thin, fluffy layer only about a thousandth of an inch thick. It consists of tiny particles of a chemical (potassium chloride) almost identical to common table salt. So porous is the deposit that 99 per cent of its bulk is simply empty space — a vacuum.

That's why Westinghouse scientists have found the deposits so useful in building special kinds of electronic tubes. The porosity enchances the material's inherent ability to multiply a stream of electrons — the basic "pieces" of matter that all electronic tubes depend upon for their operation.

Such electron multiplication is the key to some of the most advanced types of electronic tubes, especially those for electronic image brightening, high-speed electronic counting and image storage.

The low-density layer of potassium chloride is a ten-times-better electron multiplier than any previously known.

Experimental tubes. employing this and other low-density materials, already have been used to:

(1) Brighten light images far too dim to be seen with the naked eye;
(2) Yield a direct visible picture of the atomic structure of matter as revealed by X-rays;
(3) Detect and count nuclear particles at speeds up to one-billionth of a second.

* * *

Circuits Cuts TV Warm-up Time:

A novel circuit arrangement devised by Mullard engineers is said to cut "warm-up" time of a television set from the usual one minute to less than 15 seconds. The circuit is simple and needs no extra components in the set, but merely an "ON-OFF" switch with three positions instead of two. In the extra, or "Stand-by", position the high voltages within the set are switched off, but the heaters of the valves and tube are maintained at half power so that when the switch is turned to "On" the heaters very quickly attain their correct operating temperature. Once the set has been warmed-up initially it can be left switched to "Stand-by" during intervals between viewing, ready to give picture and sound almost immediately it is switched fully "On". Used fully, the quick heating circuit would add about a penny a day to the viewer's electricity bill. The firm say it has a negligible effect on the life of the valves and tube. (Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.)

SHORTWAVE SURVEY

(continued from page 31)

15210 News session: at 0145 on 15245; 0200 – 0315, WBOU on 15325; 0315, Tangier on 11875, foreign language session after 0330; 0330 – 0335, Spacewarn announcements on 15265. This signal mixes with Ceylon, on the same frequency, just before 0330; at 0415 until closing 15 mins. later, Munich on 11840; at 0500 on 5960; 0500 – 0700 on 11805; 0600 – 0700, "Breakfast Show" on 15270; 0630 – 0715, Tangier on 11875; at 0915 on 15250; at 1000 on 9665. Reception of these transmissions was inferior to those listed in "Around the Clock." However the position may well change with the season.

The Voice of America as many of our readers will know publishes a quarterly schedule for each of six areas. The schedule they send to N.Z. is the Asian one. Your correspondent thought that this would be a convenient way to obtain a comprehensive list of their outlets audible here—that is until this list was compared with actual reception. It was found that not only was a considerable proportion of the stations listed consistently inaudible but much of our best reception was obtained from services to other areas. Further, the booklet dealt with sessions in the English language during the following periods only: 2100 – 2130, 2200 – 2230, 2300 – 2330, 0000 – 0030, 0100 – 0130, 0900 – 1030, 1100 – 1200 and broadcasts between 1200 and 1630 which are generally unsuitable in N.Z. If you compare these sessions with the ones set out in this month's article you will realise what could be missed if their schedule was taken as a guide to VOA reception here. Quite apart from this, your correspondent enjoys the VOA "Music, USA" programme arriving here for the Australasian breakfast and the "Breakfast Show" coming in for dinner (0500 – 0730) – which were not mentioned in that Programme Schedule anyway!

* * *

All time being noted in Greenwich Mean Time, please add 12 hours for N.Z. Time or 10 hours for Australian Eastern Time.

TECHNICAL JOURNALS

Contents List

Electronic Engineering—July, 1962 —U.K.

"A Wide Band Transistor Logarithmic Amplifier at ·45 Mc/s," by R. N. Alcock, B.A., of Mullard Research Laboratories.

"A Constant Impedance Variable Equalizer," by D. G. W. Ingram, B.Sc., A.M.I.E.E., of G.E.C. Co. Ltd. Telecommunications Research Laboratory.

"Avalanches in a Free-Running Multivibrator," by A. C. Bull, B.Sc., and J. E. Houldin, B.Eng., Ph.D., of Chelsea College of Science and Technology.

"An Active R.C. Filter Using Cathode-Followers," by P. J. W. McVey, M.A., A.M.I.E.E., of Battersea College of Technology.

"A D.C. Inverter with C.R. Timing," by J. R. Nowicki, M.I.R.E., A.M. Brit. I.R.E., of Mullard Ltd.

"A Transistor Voltage-to-Frequency Converter," by O. De'Sa, M.Sc., and L. Molyneaux, Ph.D., of University of Durham.

"A Simple Method of Measuring Frequency Deviation," by N. T. Cox, Road Research Laboratory D.S.I.R.

"A Direct Current Switching Amplifier," by J. P. Eadon Smith, Dip. Tech. (Eng.), of G.E.C. Co. Ltd., Electronics Research Laboratory.

"The Determination of the Admittance Matrix of a Linear Three-Pole," by K. G. Nichols, B.Sc., of University of Southampton.

"The Measurement of Small Signals in the Presence of Common Mode Interference," by L. V. Mayhead, of Digital Measurements Ltd.

"A Transistor Staircase Generator," by S. S. Hakin, Ph.D., B.Sc., A.M.I.E.E., of Lanchester College of Technology.

Radiotronics — July, 1962 — Australia

'Interpretation of Voltage Ratings for Transistors," by C. R. Turner.

"The T.R.8"—a Compact Low Cost Transistorised Stereo Amplifier.

"A Useful Output Meter," by B. J. Simpson.

British Communications and Electronics — July, 1962 — U.K.

"Magnetic Films for Storage of Information," by R. C. Kell, B.Sc., A.M.I.E.E., A.Inst. P., of G.E.C. Ltd., Central Research Laboratory.

"The Electrical Protection of Semi-conductor Devices," by G. D. Perkins, B.A., Dip. Ing., M.I.E.E., of Belling and Lee Ltd.

"Measuring Salinity in Coastal Waters," by K. Fletcher, of the Wayne Kerr Laboratories Ltd.

"A Novel Computer Output Printer," by A. W. Wallens, of Creed and Co. Ltd.

"The Cathode Ray Oscilloscope," by R. Brown (a survey of available British Instruments).

Q.S.T. — July, 1962 — U.S.A.

"Radio Teletype Test Equipment," by J. E. Magnusson, WOAGD, of E. F. Johnson and Co.

"Using the Helical Antenna at 1215 Mc/s," by E. A. Scott, W4VSN, and H. E. Santa, W4SGI.

"The Pi-h. Plate Circuit in Kilowatt Amplifiers," by Raymond F. Riviando, W6KEV, of Eitel-McCullough Inc.

"V.H.F. Repeaters—Problems and Possibilities," by J. P. Green, K6QNY.

"An All-transistor Keyer and C.W. Control Unit," by S. D. Lyon, K5VIJ.

"Combination Fundamental and Overtone Crystal-Oscillator Circuit," by W. L. North, W4GEB.

"Nuvistor Converter for 220 Mc," by J. M. Filipezak, K2BTM, of R.C.A. Electron Tube Division.

"Plate Modulation for the 150 Watter," by L. G. McCoy, W1ICP, Technical Assistant A.S.I.

Electrical Review — U.K. — — 8 June 1962

"Instrument Design Trends," by H. B. Wood (Standard Telecommunication Laboratories Ltd.).

"Progress in Electronics," by I. G. Cressel (Marconi's Wireless Telegraph Co. Ltd.).

Electronic Technology — U.K. — July 1962

"Crystal Diode Modulators," by G. J. Phillips and R. G. Manton (B.B.C. Research Department).

Journal of the British Institution of Radio Engineers — June 1962

"Detection of Nuclear Explosions," by I. Maddock (Atomic Weapons Research Estab., Berkshire, U.K.).

"Transistorised Television Receivers," a Group Discussion Meeting as follows:—

(1) "Tuners," by J. K. Brown (A.B. Metal Products Ltd.).
(2) "Video Amplifiers and Line T.B. Sync. Circuits," by M. C. Gander and P. L. Mothersole (Mullard).
(3) "I.F. Amplifiers," by E. G. Chardin (Pye Ltd.).
(4) "Line Time Base Circuits," by R. W. A. Scarr (St. & C. Ltd.).
(5) "A.G.C. Operation," by J. R. James (formerly of Semiconductors Ltd.).

Journal of the Institution of Electrical Engineers — U.K. — June 1962

"Tracking in Insulation," by N. Parkman (formerly of the E.R.A.).

"Is Automation Making Satisfactory Progress?" by Prof. A. Tustin (Univ. of London).

Measurement and Control — U.K. July 1962

"Raid Measurement of Moisture in Soil," by S. Handel.

"Radioactive Isotopes in Measurement and Control," by R. G. Pay (Asstd. Ed., M. and C.).

"Measurement of Level for Monitoring and Control."

S. & J. — U.K. — June 1962 (Student Journal of the I.E.E.)

"Automatic Television Assembly," by T. L. Harcombe (Courtaulds Ltd.).

On Our Bookshelf . . .

Mullard Circuits for Audio Amplifiers — Published by Wrightman and Co. Ltd.

This book will be of wide interest amongst nearly all members of this magazine. It describes the operation and construction of various amplifiers in detail, even to the point of chassis and component layout.

The first chapter, headed Amplifying Systems, describes some basic arrangements to be considered. Sources of distortion in recording and playing equipment are discussed in Chapter Two before a short treatise on High Quality Amplification, is made in Chapter Three. This latter section gives notes on distortion, hum, noise, negative feedback, loading for triodes and pentodes and pre-amplifiers. Chapter Four consists of methods and tips for general construction as regards sheilding, etc.

In the next eleven chapters are the circuits, photos and notes, under the following headings — Twenty-watt Amplifier, Ten-watt Amplifier, Three-watt Amplifier, Seven-watt D.C./A.C. Amplifier, Two- and Three-valve Pre-amplifier, Four-channel Input-mixing Pre-amplifier, Three-watt Tape Amplifier, Tape Pre-amplifier, Seven-watt Stereophonic Amplifier, Three-valve Stereophonic Amplifier and finally Stereophonic Pre-amplifier.

We recommend this book, without hisitation, particularly for those interested in amplifiers.

Our copy by courtesy of Technical Books Ltd.

* * *

"Radio and Electronic Laboratory Handbook" by M. G. Scroggie, B.Sc., M.I.E.E. Published by Illiffe Books Ltd., London — A 'Wireless World' Book.

This revised and enlarged edition of an earlier book is one which is assured of a permanent place on the writers' shelf even though the old edition is still in use. The book has been extensively revised primarily because of the ever increasing use of semi-conductor devices, including transistors in the modern instrument.

Also instruments have increased in number, cost and complexity and therefore there is a great need for a book such as this, to give guidance on the fundamental principles, techniques, and uses for such equipment.

The book opens with a discussion of the reasons for electronic laboratory equipment, and the methods for establishing a laboratory depending on requirements.

The fundamental processes of measurement, and the sources of power, and test signals for laboratory use are treated thoroughly. This is followed by a section on the various types of indicating instruments, which together with a section on standards, and the care and use of such instruments makes an interesting section.

A large section comprising 3 chapters totalling nearly a hundred pages details the methods used in measuring the many and various circuit parameters, signals and equipment characteristics. This is complemented by two chapters, one on V.H.F. measurement, a technology which is advancing very rapidly, and a final chapter on the maximum benefit from the laboratory work.

The book concludes with an excellent chapter comprising a large collection of data for reference use. This and the quite extensive index give this book its real value as a laboratory handbook rather than a textbook.

Our copy from Technical Books Ltd.

NEWNES

THE NEW TRANSISTOR RADIO SERVICE MANUAL

★ Contains data for CROWN, GLOBAL, HITACHI, LARK, NATIONAL, NIVICO, SHARP, SONY, SANYO, STANDARD, TOSHIBA and TELEFUNKEN.

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WHAT'S NEW IN COMMUNICATIONS

A new Canadian 1,300 mile microwave communications system stretches from Grand Prairie, Alta., to Mount Dave on the Yukon-Alaska border. It vastly improves telephone and telegraph communications along the length of Canada's Alaska Highway, and forms a link in a high-quality communications system between the United States and Alaska.

Roadside Warning Signs turned on and off by Radio from a Central location will soon be guiding motorists on the New Jersey Turnpike. The signs, which will show drivers six basic messages, are part of a 290,000 dollar system which will also provide linked and extended two-way communications coverage along the 131-mile turnpike. Motorola Communications and Electronics, Chicago, Ill., is the system supplier.

Communications with Computers: A new communications system, using computer techniques, has been unveiled by the ITT Information Systems Div. It blends communication and computer technologies to process and switch telegraphic messages and data at speeds running up to at least 1,000,000 bits per second. The computers' memory contains such information as lists of all possible addresses or messages received or sent, instructions as to steps to be taken with regard to messages bearing any of these addresses, instructions as to priority, etc. Thus, the President of an international company, for example, could dictate a duplicate message to each of the branches of a certain division of his company throughout the world and have them delivered at 9 o'clock the same morning, which might be several days later, with correction for the International Date Line.

The device is expected to have great value in processing and reporting international information for companies or other organisations.

Mercury Signals Received: Natural Radio signals have been reported from Mercury, the innermost planet of our system. The signals were picked up at the Radio Astronomy Observatory of the University of Michigan by a team consisting of Drs. William E. Howard, Allan H. Barrett and Fred T. Haddock. Chief difficulty, the radio astronomers reported, was to separate Mercury's signals from those of the sun, which are more than 3,000,000 times as powerful.

Mercury is the fifth planet from which signals have been received, various observatories having heard from Venus, Mars, Jupiter and Saturn.

First Private Microwave multichannel Radio Telephone System in Britain: As part of the British gramme, its North-Eastern Region is to be equipped with a super-high - frequency multi - channel radio-telephone system between the two important railway centres of York (where the North-Eastern Region has its headquarters, and Newcastle, via Darlington—a distance of 78 miles (125.5 Km.). This will be the first multichannel radio communication installation to be used by British Railways, and, indeed, the first "private" microwave multichannel radio telephone system in Britain.

The Radio equipment is being supplied and installed by Marconi's and the carrier equipment by Automatic Telephone and Electric Co. Ltd. The system is designed for a maximum capacity of 300 telephone channels, but initially 180 will be in operation. It will handle the telephone traffic between the regional centres, with full facilities for through subscriber trunk dialling; ultimately its use may be extended to provide facilities for high-speed data transmission — for example, it could be used as a means of centralising account systems and for other matters of a similar nature.

The installation is duplicated to operate on a main/standby basis, with automatic changeover in the event of failure. In this connection, particular features of the equipment are the relatively low number of valves used and the simplicity of the r.f. transmission circuits, which employ one microwave klystron per unit equipment, both factors which greatly reduce the probability of equipment failure.

Two repeater stations will be used, one between York and Darlington, and the other between Darlington and Newcastle. Three channels will be dropped in each direction between each of the repeaters.

Earth Has Magnetic waveguides: Recently discovered ducts in space surrounding the earth can bend radar beams, channeling them in a near-circular path back to earth in the opposite hemisphere. A radar beam aimed at a carefully selected point in the sky in North America produces an echo that could have come only from a point near the southern tip of South America.

The ducts follow the lines of the earth's magnetic field, and are thought to be composed of electrons strung out in thin fibrelike patterns along the lines of force of the earth's field. The signal follows these threads of electrons.

The ducts were discovered by Dr. Roger Gallet, of the Bureau of Standards laboratory in Boulder, Colorado.

ATCO Standard Power Transformers

FOR RADIO AND AMPLIFIERS, AVAILABLE IN FLAT OR VERTICAL MOUNTINGS

Except where stated all 230 V. Primary

PT	**1**	150/150 V	30 Ma.	6.3 V	2 Amp.		
PT	**2**	220/220 V	40 Ma.	6.3 V	2 Amp.		
PT	**3**	260/260 V	60 Ma.	6.3 V	2 Amp.		
PT	**4**	280/280 V	60 Ma.	6.3 V	2 Amp.	5 V 2 Amp.	
PT	**5**	350/350 V	60 Ma.	6.3 V	2 Amp.	5 V 2 Amp.	
PT	**6**	115/115 V	65 Ma.	6.3 V	1 Amp.		
PT	**7**	115/V ½ Wave	65 Ma.				
PT	**8**	280/280 V	80 Ma.	6.3 V	3 Amp.	5 V 2 Amp.	
PT	**9**	310/310 V	80 Ma.	6.3 V	3 Amp.	5 V 2 Amp.	
PT	**10**	350/350 V	80 Ma.	6.3 V	3 Amp.	5 V 2 Amp.	
PT	**11**	310/310 V	100 Ma.	6.3 V	4 Amp.	5 V 2 Amp.	
PT	**12**	350/350 V	100 Ma.	6.3 V	4 Amp.	5 V 2 Amp.	
PT	**13**	310/310 V	125 Ma.	6.3 V	4 Amp.	5 V 3 Amp.	
PT	**14**	310/310 V	150 Ma.	6.3 V	5 Amp.	5 V 3 Amp.	
PT	**15**	400/400 V	150 Ma.	6.3 VCT	5 Amp.	5 V 3 Amp.	
PT	**16**	400/400 V	150 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.
PT	**17**	450/450 V	150 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.
PT	**18**	450/450 V	200 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.
PT	**19**	500/500 V	200 Ma.	6.3 VCT	2 Amp.	5 V 3 Amp.	6.3 V 4 Amp.
PT	**20**	595/595 V (500 V DC)	350 Ma. Choke Input				
PT	**21**	890/890 V (750 V DC)	250 Ma. Choke Input				
PT	**22**	295/295 V	360 Ma.	6.3 V	10 Amp.	5 V 3 Amp.	Sec. Tapped 240/240 V

Suitable for use with either RCA or Philips TV Kits Primary 0.210, 220, 230, 240 V.

PT 23 Deleted

PT 24 Pri. 0-230-270 V — 6.3 V 5 Amp. — 6.3 V 5 Amp. — 5 V 2 Amp.
Used in TV Receiver with Mains Rectification.

PT 25 115 V 360 Ma. 12.6 V 5 Amp. CT used with Silicon Diodes in Voltage Doubler Circuit.

PT	**26**	280/280 V	80 Ma.	6.3 V	4 Amp.	6.3 V 1 A.
PT	**27**	280/280 V	125 Ma.	6.3 V	5 Amp.	CT 6.3 V 1 A.
PT	**28**	280/280 V	175 Ma.	6.3 V	4 Amp.	CT 6.3 V 4 A. CT 5 V 3 A.

CONSTRUCTORS! The OP50 Output Transformer used in the R. & E. Twin Ten Stereo Amp. described on pages 30–33 was a new model obtained from our modern factory.

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Record Review

by Professor C. G. F. Simkin

KEY:

- ● Not recommended because of poor performance or recording.
- ★ Recommended although the performance or recording has faults.
- ★★ Strongly recommended because both performance and recording are excellent.

BEETHOVEN, String Quartets:

★(a) No. 7 in F minor, Op. 59 No. 1 (RZ6021);

★(b) No. 8 in E minor, Op. 59 No. 2 and No. 11 in F minor, Op. 95 (RZ6027;

★★(c) No. 9 in C major, Op. 59 No. 3 and No. 10 in E flat major, Op. (RZ6033);

all played by the Hungarian String Quartet and recorded for the Record Society.

Others, besides myself, must have been puzzled by the disparity between the extraordinarily fine performances of Beethoven given by the Hungarian Quartet during their recent tour in New Zealand and their recordings, which have been not unfairly criticised as lacking proper feeling — as too slick or mechanical. The disparity can hardly be explained by greater maturity in an already rather old quartet and it is improbable that the accession, since the recordings, of a new and most talented second violinist has made all the difference.

Nor can it be explained by any fault on the part of the recording engineers. They have, in all these records, done a magnificent job. The sound is clear, properly resonant, free from distortion and so live that it gives the performance real presence in the listener's room. One could not, that is, wish for for better recordings, and it is a very worthwhile achievement to have included, on the same disc, No. 8 and No. 11 and No. 9 with No. 10. From these standpoints the discs are good value.

The music itself is also magnificent. Beethoven has had no superior in this, as in other, musical forms and the three quartets for Count Rasoumovsky are supreme achievements both separately and as a subtly integrated cycle. No. 10 is brilliantly effective, but more worldly than spiritual. No. 11 was thought by Mendelssohn to be the most characteristic of all Beethoven's works—a serious and passionate work with flashes of tender feeling.

But what of the performances? They really have considerable merits; faultless technique, a sympathy between the players which makes the ensemble sound like a single instrument, clean execution, accurate tempi, and virtuosity subordinated to strict interpretation. But for all this skilful and elegant musicianship there is a want of intensity or passion. This is more noticeable on the first two discs. The first movement of No. 8 appears duller than it should, and the beauty of its andante is by no means fully expressed. The second disc is better, but the romantic beauty of No. 8, and more especially the mystery of the first and second movements, are not really captured. Nor is there sufficient vigour in the interpretation of the compact, masculine No. 11. The third disc,however, can be given a double star; here the interpretation seems better, perhaps because the third Rasoumovsky is more straightforward, and because the glittering brilliance of No. 10 is more suited to the virtues of the Hungarian Quartet; but even the haunting melancholy of the strange andante of No. 9 is well brought out.

A final word of praise should be given to the excellent notes which are not only scholarly but also genuinely helpful to the ordinary listener.

★★HAYDN: Symphony No. 93 in D major, and No. 94 in G major; played by the Royal Philharmonic Orchestra, conducted by Sir Thomas Beecham. World Record TZ170.

Haydn, "the father of the sympathy", wrote nothing better in this form than the twelve symphonies commissioned by the London impresario Salomon. They had triumphant performances in his own day, and have never slipped from popularity since then. Here Sir Thomas Beecham gave fresh, attentive recordings of the corrupt texts of the first two Salomon symphonies.

No. 93 gets a most attractive performance, helped by fine recording which is marred only by occasional fuzziness in the trio and in the finale. Beecham brilliantly evoked Haydn's sunny genius, and the great orchestra he did so much to shape responds sensitively to every nuance of interpretation from the amicable opening movement to the intricate last movement. The winds give a particularly good account of themselves.

No. 94 is even better. The first movement has splendid contrasts of tempi, and is most lyrical. Beecham's interpretation of the second ("Surprise") movement has been criticized as too fast for an andante; but it is a set of variations and I found the performance a delightful revelation of Haydn's wit. The country dance quality of the minuet and the waltz flavour of the trio are also well brought out, as, on a different level, is the complex modulation of the final allegro. The recording is, again, very good.

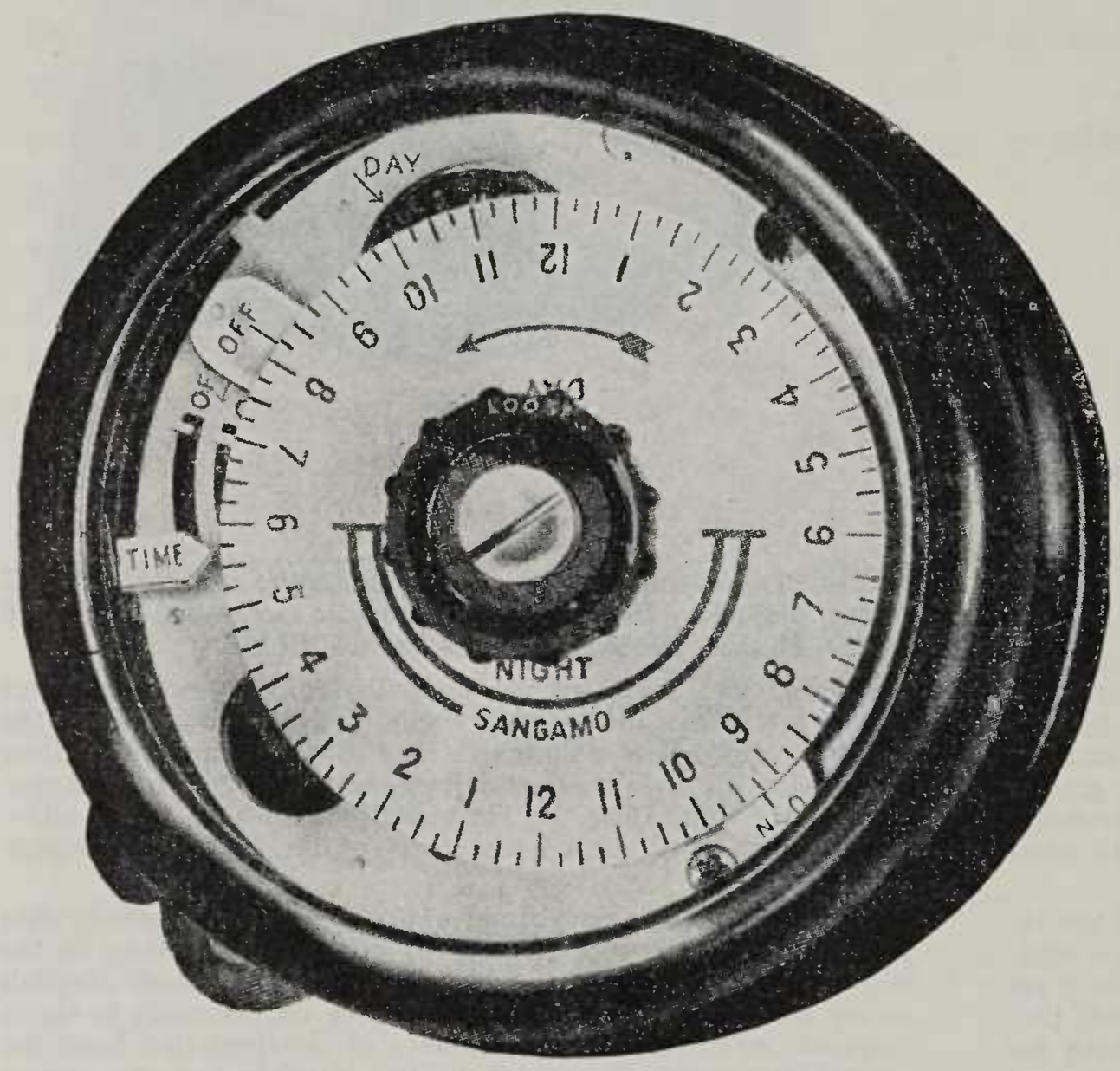
No one who is at all responsive to orchestral music should neglect this disc, and it is, of course, a must for any fan of Beecham.

* * *

★★SIBELIUS: Symphony No. 5 in E flat major, Opus 82 and and Karelia Suite, Opus 11; played by the Sinfonia of London, conducted by Tauno Hannikainen, World Record, TZ161.

In the March issue of this journal I gave a double star recommendation to the World Record disc (TZ142) of Sibelius' second symphony, played by the same orchestra under the same conductor. This is an equally fine performance and recording. The fifth symphony is perhaps second only to the first two in popular appeal; it is a heroic work, conveying much of the strange, harsh magnificence of Finland and its association with the sea. The Karelia suite is a much lesser work in every sense, but has long had wide appeal. All admirers of Sibelius will want to have this disc, and can be confidently recommended to buy it, both because of its quality and because of another authoritative performance under Hannikainen.

SANGAMO WESTON



TIME SWITCHES

SYNCHRONOUS and SPRING RESERVE

Sangamo Time Switches are now available with or without spring reserve. The spring reserve enables them to function for a period of at least 18 hours after interruption of electricity supply. When the supply is on, the mechanism is driven by the mainspring through an escapement, and this escapement is synchronously controlled. This synchronous control feature is patented and is one of the outstanding merits of the design ensuring absolute accuracy of timekeeping.

The mainspring is kept fully wound without the use of any slipping clutch device which could wear and become erratic. During supply interruption, the switch continues to function, being driven by the mainspring controlled by the escapement.

Any spring reserve model is interchangeable with its corresponding standard synchronous model without the necessity for changing the base of the switch or the wiring. To accommodate the increased depth of the spring reserve model, a new cover is required.

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Mobile Teleprinter Successfully Demonstrated

FIRST demonstrations of the transmission of printed messages to a moving vehicle have just been given in Sydney.

Policewomen transmitted messages from the New South Wales Police Centenary Exhibition to a Police vehicle as it moved about Sydney and suburbs.

The messages were transmitted on teleprinter equipment assembled and part manufactured in Australia by Amalgamated Wireless (Australasia) Ltd. This was used in conjunction with a standard FM base station and other equipment designed and manufactured in Australia by the Company.

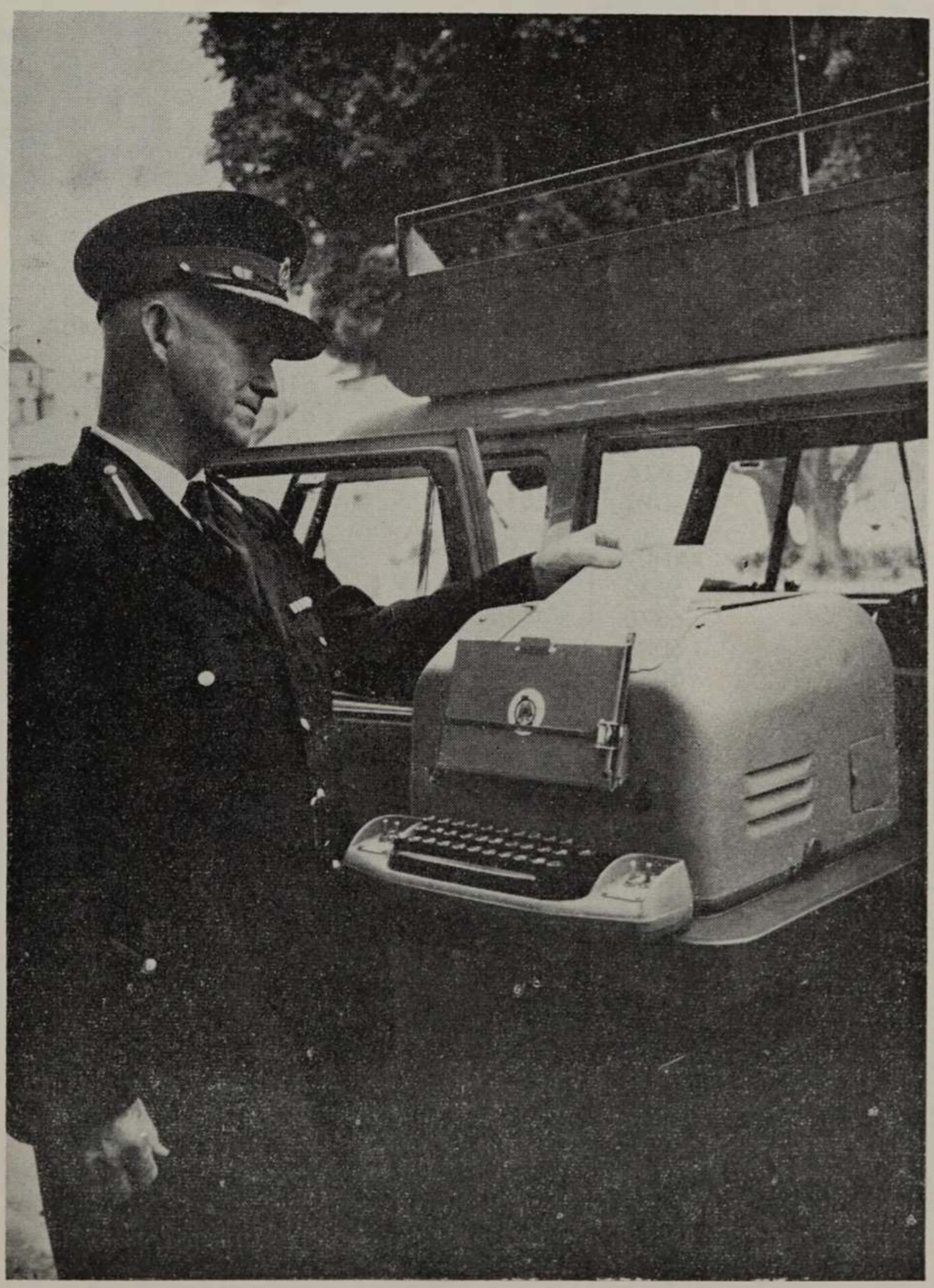
To enable the use of the Police Department's normal radio-telephone base station, A.W.A. had developed a small transistorised module which converted the signals from the base teleprinter into a form suitable for transmission over the radio-telephone wavelength of the Police Department. As these signals were received in the vehicle, a corresponding device converted them back into normal teleprinter impulses, operating the vehicle teleprinter.

One extraordinary feature was the ability of this tough machine to receive and print messages perfectly while the vehicle in which it was housed was travelling at high speeds over bumpy roads. It was pointed out that this feature, exclusive to these particular machines, would also enable perfect reception (and transmission) by teleprinters in launches at sea and in planes and railway trains, whatever the extent of the vibration being encountered.

Reception by teleprinter did not interfer with the normal telephone reception in the vehicle enabling printed and oral messages to be transmitted simultaneously.

Police officers were shown the advantages of the equipment in that written messages can be received without the need for a policeman to attend to the machine, or to take and transcribe notes. All developments are recorded as they occur thus enabling rapid assessment of information and redirection at once of Police operations if considered necessary. At the same time, there is the highest degree of secrecy.

New Zealand Assistant Police Commissioner, Mr. F. Brady, watches messages transmitted from the N.S.W. Police Centenary Exhibition at a Sydney store being received on radio-telephone-radio-teletype apparatus installed in a Police communications vehicle which stopped in Hyde Park during a tour of Sydney and suburbs.



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Electron Tube Interchangeability Guide

PART FOUR
(FINAL)

In this country we have electron tubes from many sources and duplication of types with differing numbers has been a major source of confusion. This chart is intended as a general guide for interchangeabilty for receiving and industrial tubes. Compiled originally by Mullard Ltd. and International Electronics, the chart naturally cannot be all inclusive but presents some of the more common tubes that are in general use both in New Zealand and Australia and also the Northern Hemisphere. The preceding sections in our March and April issues, together with this final part, make up a set which could well be cut out and filed for reference.

European	U.S.	European	U.S.	European	U.S.	European	U.S.
DB7-36	3WP11	EF74	6391	OA73	IN616	TY6-5000W	5923
DB13-2	5CP11	EN32	2050	OA79	IN541	TY7-6000A	6961
DR13-34	5ADP11	EN70	5663	2-OA79	IN542	TY7-6000W	6960
DB16-22	7AHP11	EN91	2D21	OC70	2N279	TY12-50A	6078
DC70	6375	EN92	5696	OC71	2N280	TY12-50W	6077
DF60	5678	EN93	6D4	2-OC72	2N282	XG1-2500	5559
DF61	6611	EY84	6374	OC73	2N283	XG5-10	6786
DF6-2	1AD4	JN2-25W	7292	OC76	2N284	XG5-500	5557
DG7-5	3ALP1	JP9-15	2J42A	OC77	2N24A	XH3-045	3C45
DG7-32	3AMP-1	JP9-50	2J56	OCP71	2N577	XR1-3200	5544
DG7-36	3WP-1	JP9-75	6972	QQV02-6	6939	XR1-6400	5545
DG13-2	5CP1A	KS9-20	723A/B	QQV03-10	6360	XR1-6400A	6807
DG13-34	5ADP-1	KS9-20A	2K25	QQV03-20A	6252	Z300T	1267
DG16-22	7AHP1	M8079	6058	QQV04-15	832A	Z803U	6779
DH3-91	1CP1	M8080	6100	QQV06-40A	5894	Z900T	5823
DL70	6373	M8081	6101	QQV07-40	829B	85A1	OE3
DL620	562	M8082	6156	QQZ04-15	5895	85A2	OG3
DM160	6977	M8083	6064	QV03-12	5763	85A3	5783
DP13-2	5CP7A	M8100	6096/5654	QV05-25	807	108C1	OB2
DP13-34	5ADP7	M8136	6189	QV06-20	6146	150B2	6354
DP16-22	7AHP7	M8137	6057	QY2-100	813	150C3	OD3
DY70	5642	M8161	6065	QY3-65	4-65A	150C4	OA2
E1T	6370	M8162	12AT7WA	QY3-125	6155	5636	5636
E80CC	6085	M8167	7001	QY4-250	6156	5644	5644
E80F	6084	M8190	5783WA	QY4-500A	4X500A	5651	5651
E80L	6227	M8196	5725	QY5-500	6079	5718	5718
E81L	6686	M8204	5727/2D21W	QY5-3000A	6076	5820	5820
E83F	6689	M8212	5726/6097	QY5-3000W	6075	5840	5840
E88CC	6922	M8223	OA2WA	RG4-3000	6693	5899	5899
E90CC	5920	M8224	OB2WA	RR3-250	3B28	5902	5902
E91H	6687	M8232	6J4WA	RR3-1250	4B32	5949	5949
E180CC	7062	M8245	6005	RY12-100	8020	6021	6021
E180F	6688	MB13-1	5FP11	TD03-10	5861	6080	6080
E181CC	7118	ME1401	5802	TD2-3000A	7004	6205	6205
E182CC	7119	ME1403	5889	TY2-125	5866	6211	6211
EA52	6923	MF13-1	5FP7A	TY3-250	5867		
EA76	6489	MW6-2	3NP4	TY4-350	833A		
EC70	6778	MW13-35	FP4A	TY4-500	5868		
EF70	6487	MT5545	5545	TY6-800	7092		
EF73	6488	OA70	IN87	TY6-5000A	5924		

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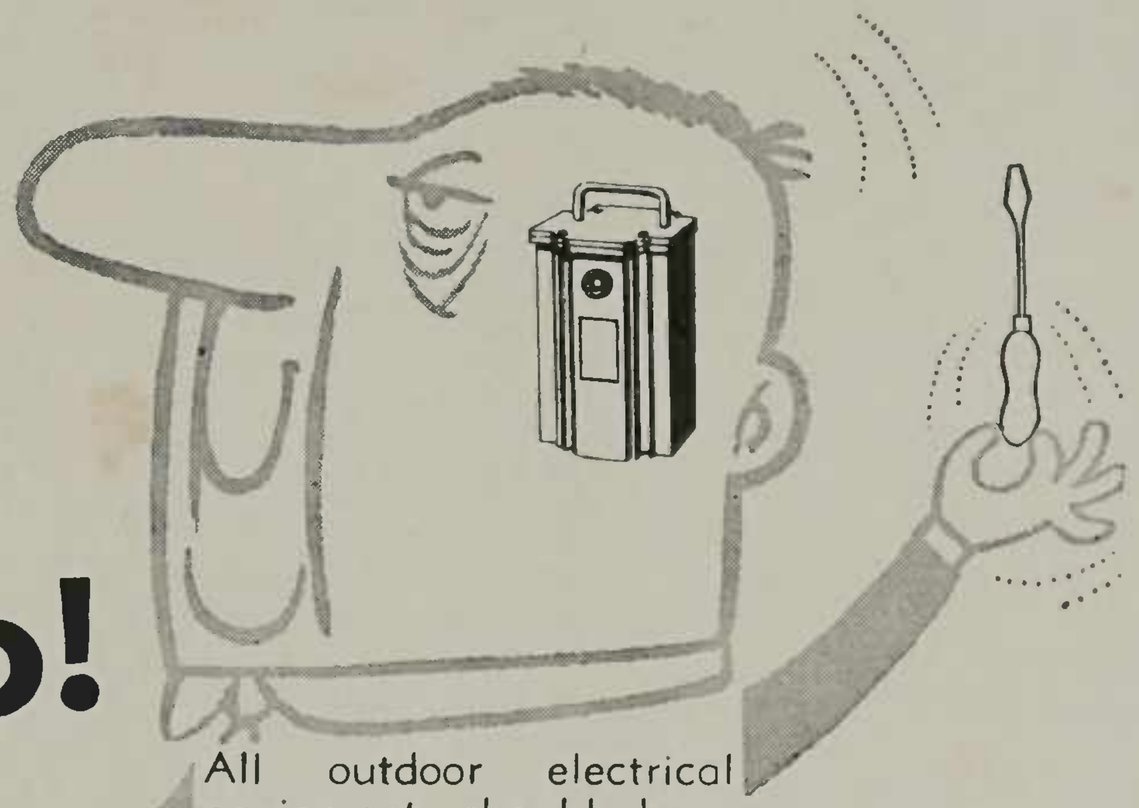

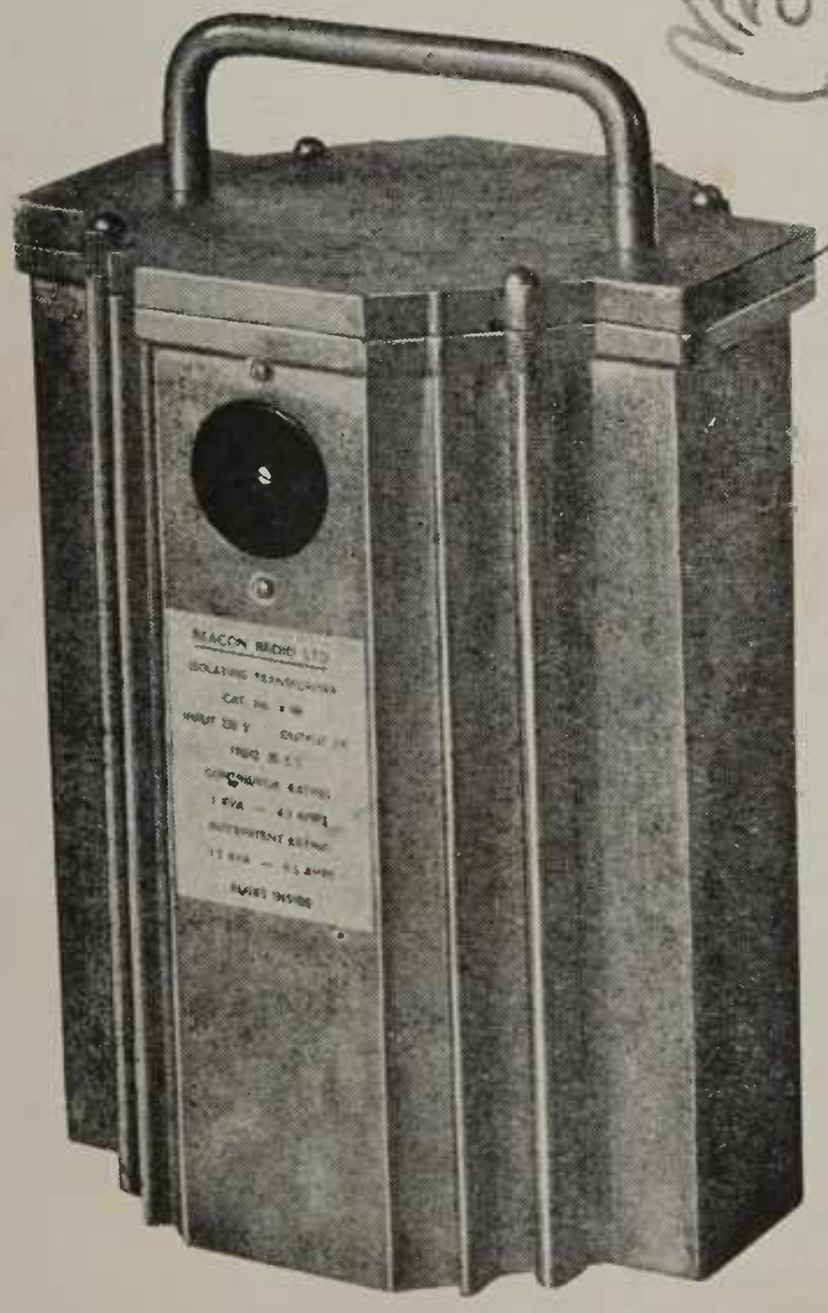

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