wireless world

JUNE 1976 35p

CD–4 demodulator
Wireless across space

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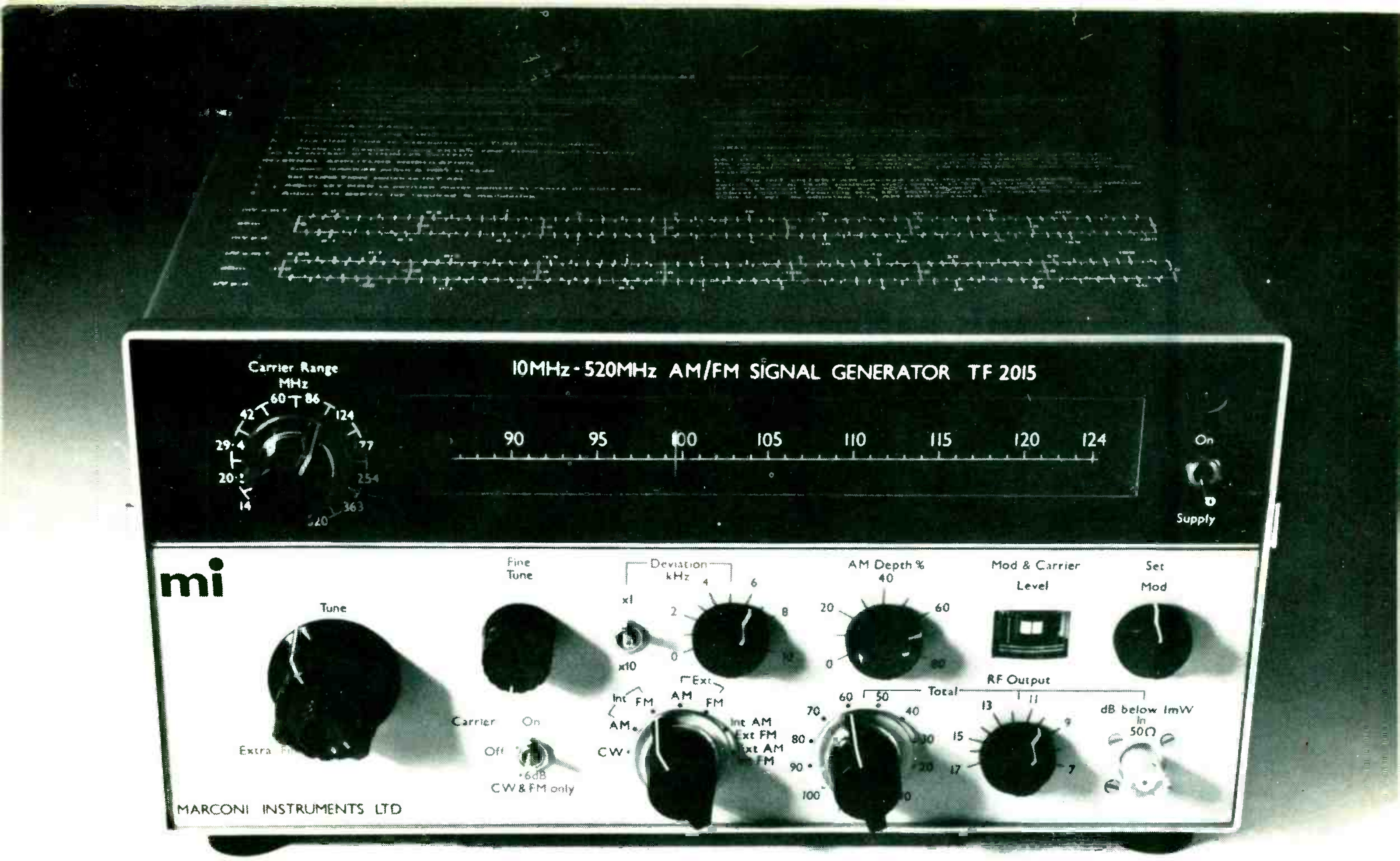

mi's TF 2015 a wider view of signal generation...

The TF 2015 is a versatile 10-520 MHz signal generator with calibrated a.m. and f.m. and an accuracy of output level setting normally found only in instruments costing three times as much. A special system gives very fast tuning across the bands yet provides smooth control within the narrowest of passbands. Leakage radiation is carefully screened out to enable accurate measurements to be made even at levels below 1μV.

Matched Synchronizer

The clip-on Synchronizer TF 2171 transforms the performance of TF 2015 into the equivalent of a synthesizer at less than half the comparable cost. The frequency is locked to crystal stability and can be dialled in 100 Hz. steps. Tuning is quick and easy – set the decade dials, switch to "lock" and tune the generator to the approximate frequency and the synchronizer will finish the job for you. Now you can change the frequency by up to 2% using the decade dials **without touching the generator** - and all to an accuracy of 2 parts in 10^7. It stays locked all day and doesn't degrade **any** aspect of the generator performance.

I.F. Probes

These are an invaluable aid to the testing of receivers with squelch or battery economiser circuits. These circuits are inactivated when the crystal-controlled signal from the probes is brought into the proximity of the receiver's i.f. strip. This makes it easy to tune the generator to a receiver when its channel frequency is unknown. The probes can also be used to check exact tuning by adjusting for zero beat.

mi: THE SIGNAL GENERATORS

MARCONI INSTRUMENTS LIMITED

Longacres, St. Albans, Hertfordshire, England, AL4 0JN · Telephone: St. Albans 59292. Telex: 23350.

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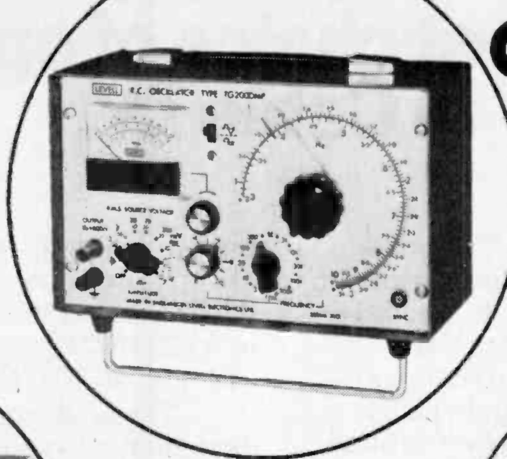

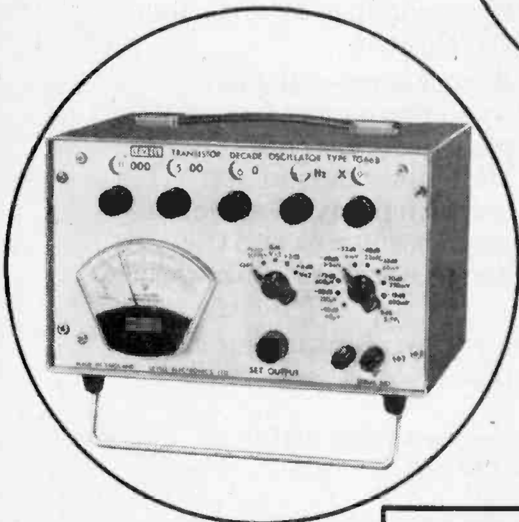

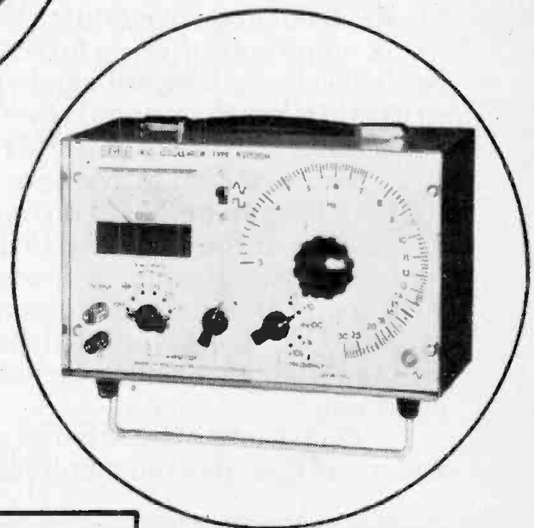

FREQUENCY	1Hz to 1MHz in 12 semi-decade ranges. 0 to 1% fine control included on TG200DMP.
ACCURACY	±2%±0.03Hz.
SINE OUTPUT	7V r.m.s. down to <200µV with Rs =600Ω.
DISTORTION	<0.1% to 5V, <0.2% at 7V from 10Hz to 100kHz.
SQUARE OUTPUT	TG200D, DM & DMP only. 7V peak down to <200µV. Rise time <150nS.
SYNC. OUTPUT	>1V r.m.s. sine in phase with output.
SYNC. INPUT	±1% freq. lock range per volt r.m.s.
METER SCALES	TG200M, DM & DMP only. 0/2V, 0/7V &−14/+6dBm.
SIZE & WEIGHT	260mm x 130mm x 180mm. 4.3kg.

TG200	TG200D	TG200M	TG200DM	TG200DMP
£66	**£70**	**£80**	**£84**	**£88**

FREQUENCY	0.2Hz to 1.22MHz on four decade controls.
ACCURACY	±0.02Hz below 6Hz. ±0.3% from 6Hz to 100kHz. ±1% from 100kHz to 300 kHz. ±3% above 300 kHz.
SINE OUTPUT	5V r.m.s. down to 30µV with Rs=600Ω.
DISTORTION	<0.15% from 15Hz to 15kHz. <0.5% at 1.5Hz and 150kHz.
METER SCALES	2 Expanded voltage &−2/+4dBm.
SIZE & WEIGHT	260mm x 190mm x 180mm. 5.6kg.

TG66B Battery model **£180**

TG66A Mains & battery model **£195**

FREQUENCY	3Hz to 300kHz in 5 decade ranges.
ACCURACY	±2% ±0.1 Hz up to 100kHz, increasing to ±3% at 300kHz.
SINE OUTPUT	2.5V r.m.s. down to <200µV.
DISTORTION	<0.2% from 50 Hz to 50kHz.
SQUARE OUTPUT	2.5V peak down to <200µV.
SYNC. OUTPUT	2.5V r.m.s. sine.
METER SCALES	0/2.5V &−10/+10dB on TG152DM.
SIZE & WEIGHT	260mm x 130mm x 180mm. 3.4kg.

TG152D Without meter **£53**

TG152DM With meter **£66**

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Moxon Street, High Barnet, Herts. EN5 5SD
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WW—051 FOR FURTHER DETAILS

EMI offers the widest choice of options in Cable T.V.

EMI Colorline Cable TV equipment provides long reach, low distortion and high channel capacity. It is based on the RE 1000 range of modular VHF trunk amplifiers offering full two-way facilities. Basic forward bandwidth is 40–300 MHz with optional reverse bandwidths of 5–30 MHz or 5–100 MHz.

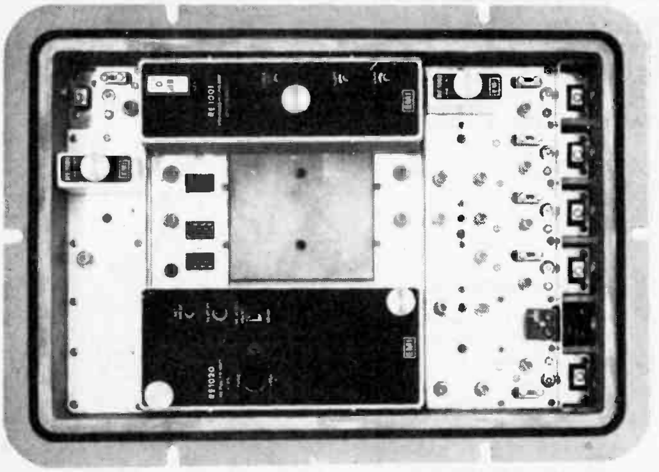
And now EMI introduces hybrid VHF/UHF systems based on our new RE 1037,* a unique VHF/UHF distribution converter. It enables up to seven VHF trunk channels to be converted into the UHF bands for local distribution together with unconverted VHF channels.

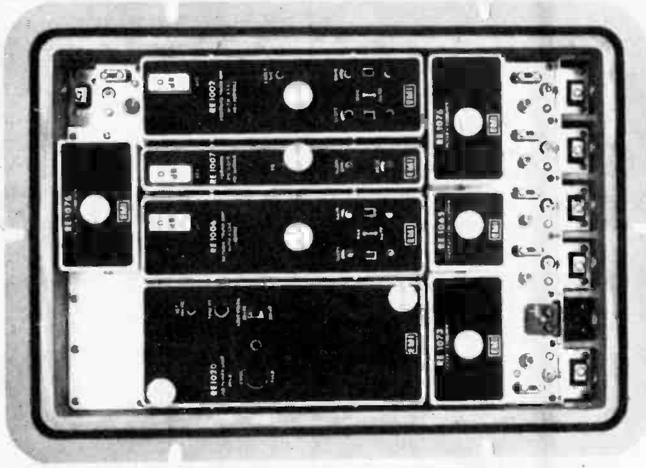
Then there's the ME 670, an ultra wideband distribution amplifier covering the range 40–860 MHz and incorporating its own line or mains power supply. Also covering the same range are the new RE 1022 ultra wideband Subscriber Tap and RE 1032 Splitter.

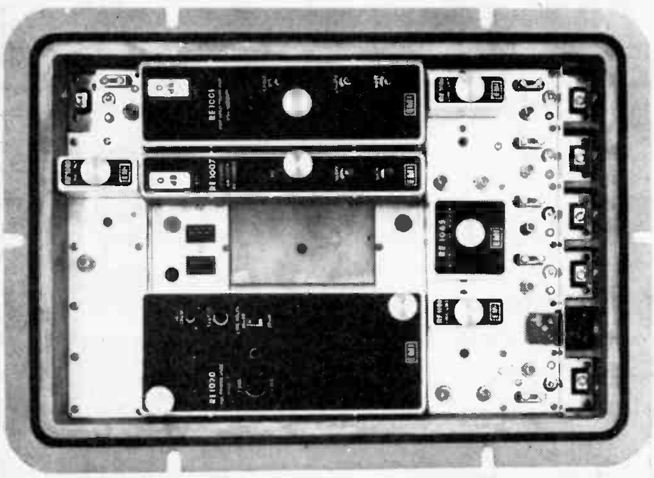
These are just some of the new developments you can expect from EMI, who cover virtually every requirement for VHF and UHF distribution networks, together with unrivalled technological and design resources and the most comprehensive service facilities in the business.

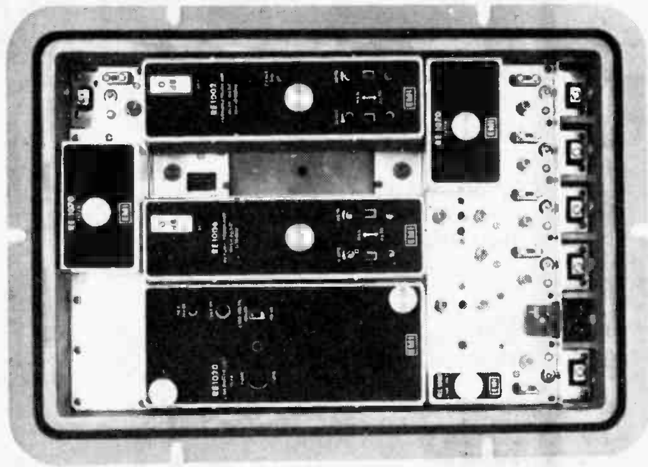
So when you're planning for cable television contact EMI, the specialists.

*The RE 1037 is manufactured by EMI under licence from the British Post Office.









EMI

EMI Sound & Vision Equipment Ltd.,
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International leaders in music, electronics and leisure.

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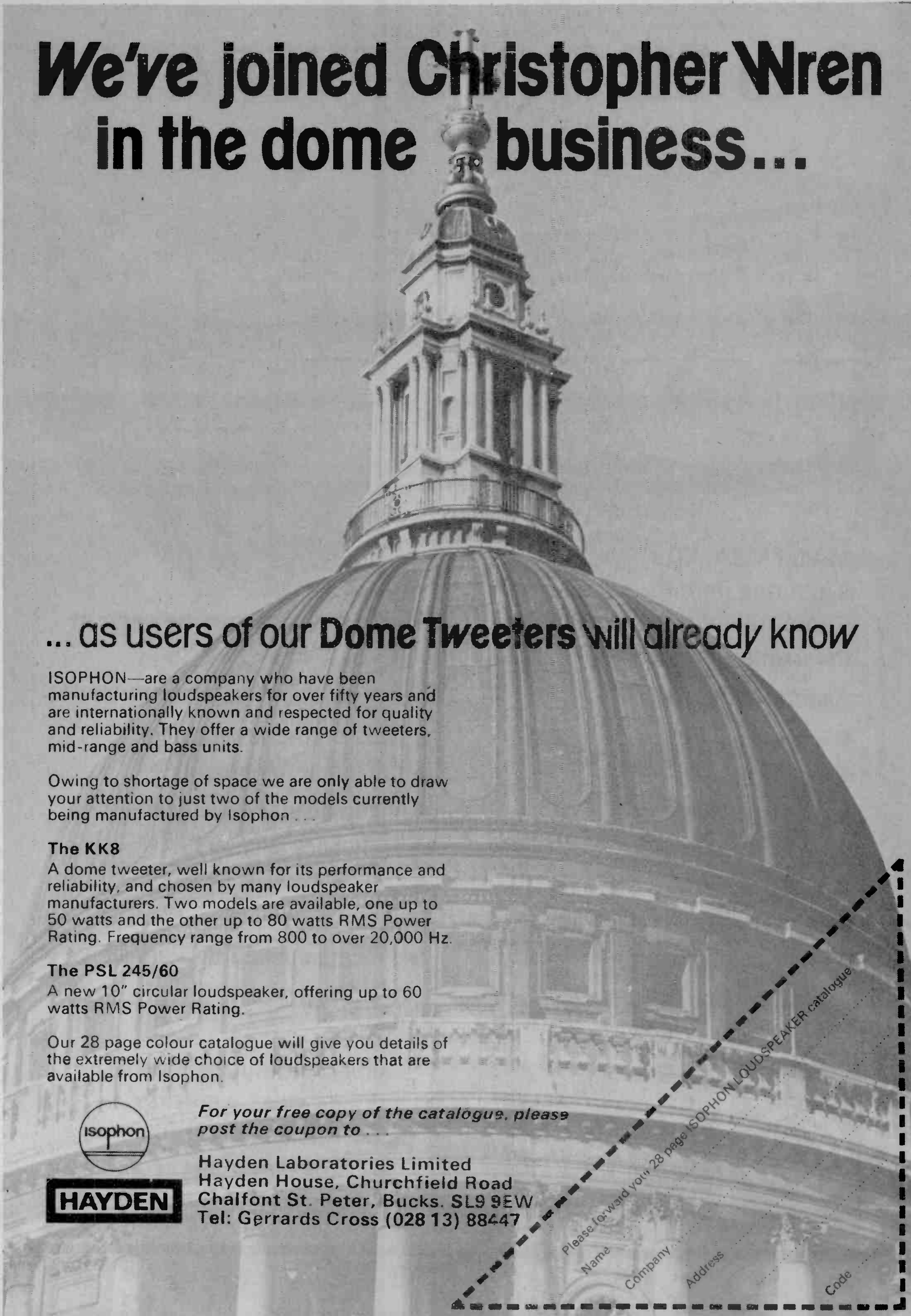
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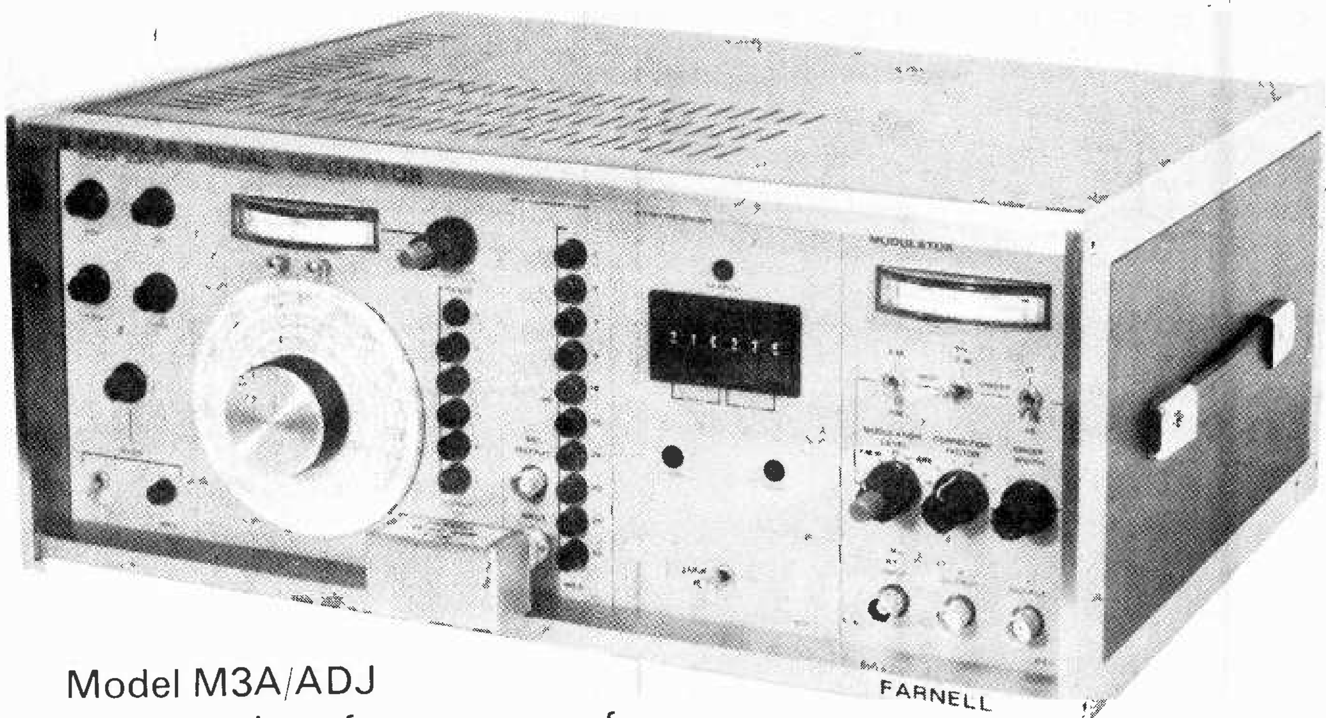

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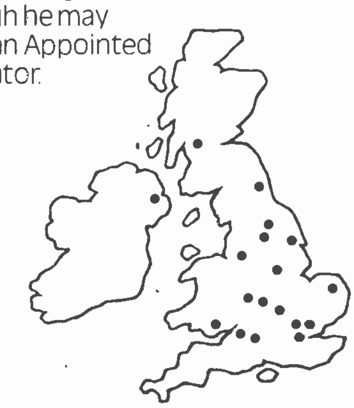

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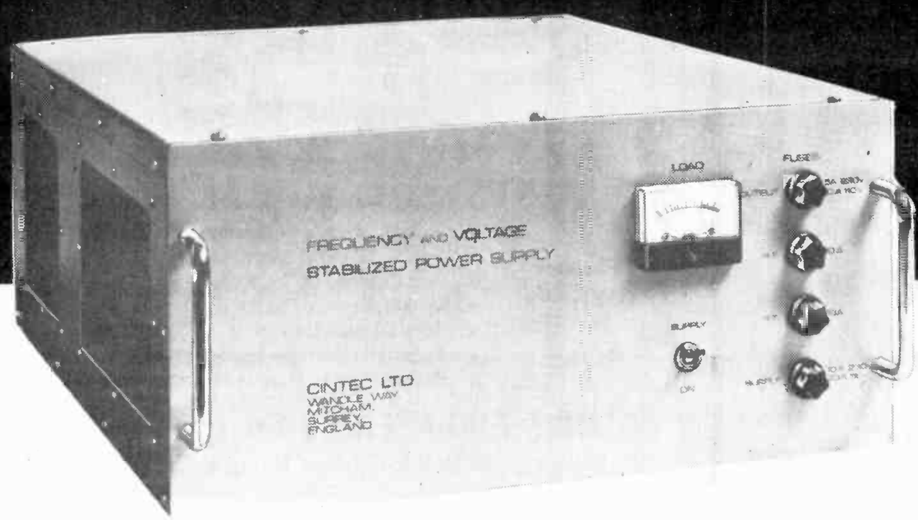
WW—056 FOR FURTHER DETAILS

THE CINTEC SINUSOIDAL FREQUENCY AND VOLTAGE STABILIZER



APPLICATIONS

* SOUND RECORDING
* VIDEO RECORDING
* MEDICAL
* MARINE
* COMPUTERS
* NAVIGATIONAL SYSTEMS

★ SOLID STATE
★ HIGH STABILITY
★ ROBUST
★ VERSATILITY
★ RELIABILITY
★ SINUSOIDAL

Reliable Frequency & Voltage Stabilization

The efficient operation of sophisticated electrical and electronic equipment is, in many instances, dependent upon an electrical supply which is stable in both frequency and voltage.

In many overseas countries and even in the United Kingdom, during periods of heavy demand, the variation in the frequency and voltage is sufficient to introduce errors and the malfunction of such items as Recording equipment, etc. Likewise, in certain areas, the only source of supply is from a Generator, the output of which can vary considerably when different loads are imposed. This has precluded the use of a wide range of equipment in many countries. Voltage Stabilizers are readily available but these do not stabilize the frequency of the supply which, in many instances, is essential.

The CINTEC FREQUENCY & VOLTAGE STABILIZER provides the answer to both these problems.

When the supply frequency is fluctuating wildly, between 40Hz and 60Hz and the voltage by more than 10% the output from the Stabilizer will not vary more than .01% from 50Hz or 1% in voltage, even when different loads are imposed.

It opens up new markets for the manufacturers of a wide range of equipment for use in Recording Studios, Offices, Hospitals, etc., and in particular, when it is required for mobile operation.

The CINTEC FREQUENCY & VOLTAGE STABILIZER is also available for supplies of 100-125 volts, 40-60Hz with an alternative output of 50Hz or 60Hz at 115 volts or 230 volts and as a dual frequency model with a switchable output for 50Hz or 60Hz.

The Stabilizer may also be used as a frequency converter. For example, the supply to it can be any frequency between 40-60Hz and the output can be switched to either 50Hz or 60Hz. In hotels, overseas visitors frequently arrive, bringing with them Audio-Visual equipment which they wish to use, only to find that the frequency of the supply in the hotel is unsuitable.

Applications for the use of the CINTEC FREQUENCY & VOLTAGE STABILIZER are more numerous than can be listed. Therefore, if you have a supply problem, contact CINTEC LIMITED whose engineers will be only too pleased to assist.

SPECIFICATION

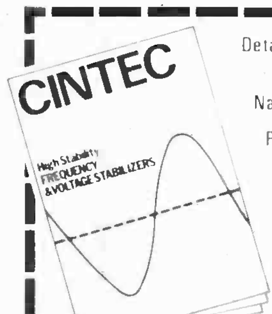
INPUT:	100-125 volts or 200-250 volts at 40-60Hz
OUTPUT:	115 volts or 230 volts (adjustable within ±5%)
STABILITY: Voltage:	± 1% No load to full load
Frequency:	± 0.01% No load to full load
FREQUENCY:	50Hz or 60Hz. Single or dual versions
WAVEFORM:	SINUSOIDAL
DISTORTION:	2% Max.
AMB. TEMP.:	—20° to +40° C
DUTY:	Continuous
DIMENSIONS:	432 (W) x 196 (H) x 508mm (D) (17" x 7¾" x 20")
WEIGHT:	33Kg. (72 lbs.)
CONSTRUCTION:	Cabinet or rack mounting
TERMINATION:	Barrier strip connections at rear of case.

24V DC Inverter

Inverter versions of the Stabilizer are available with output ratings of 500w, 250w and 150w, at 230 volts or 115 volts at 50Hz or 60Hz. The output stability has an accuracy to the same specification as for the A.C. versions and the Unit is housed in a case of similar design and size.

Certificate of Calibration

The Stabilizer has been tested in accordance with National Standards by Bradley Services of London (Certification No. K5149/5832)



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Position ____________________

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CINTEC LTD

Wandle Way, Mitcham, Surrey CR4 4NB. England. Telephone: 01-640 2241 Telex: 946177

WW2

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G5

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a high accuracy solid state sine/square wave generator with 600 ohm attenuator output or low impedance output delivering 3 watts into a 5 ohm load.

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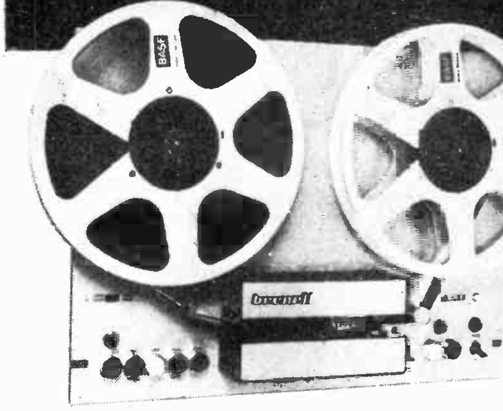

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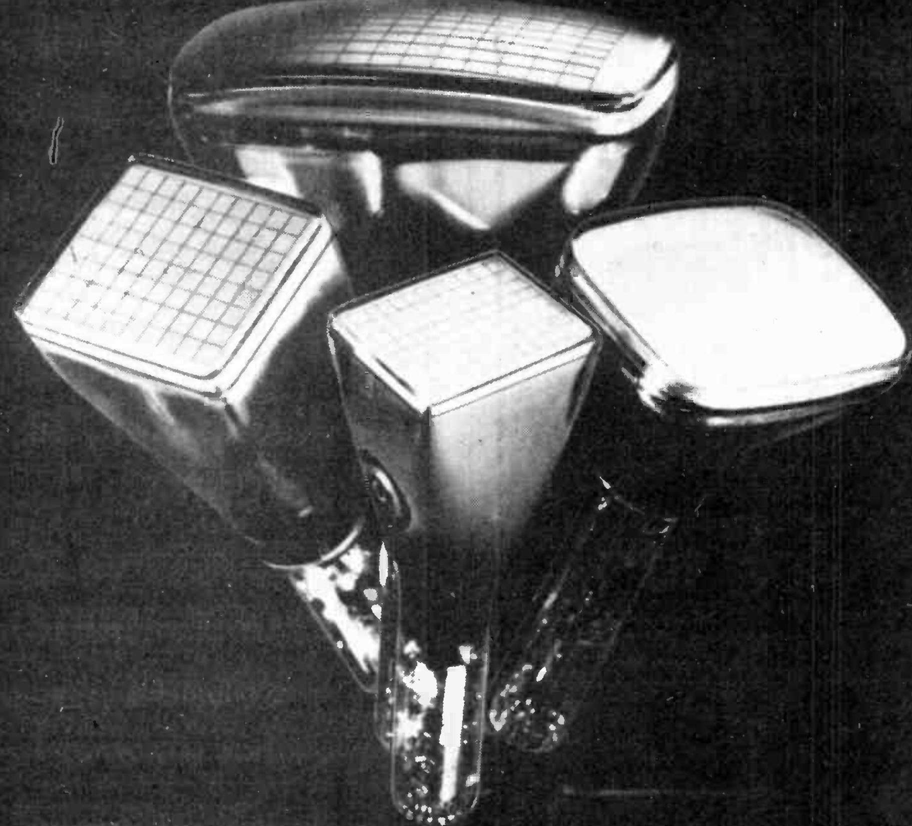

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- for high-performance scopes :

Tube ref.	Useful screen area cm x cm	Overall length cm	Typical frequency MHz	Capacitance pF	Writing speed mm. ns	Deflection factor X_1X_2 Y_1Y_2 V. cm^{-1}
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TH 8206	10 x 12.5	38	100	8	15	6.5 2.8
TH 8207	10 x 12.5	40.5	175	8	25	6.5 2.6

- for large-screen wideband monitors :

Tube ref.	Useful screen area cm x cm	Overall length cm	Deflection angle Θ°	Sensitivity V. cm^{-1}
TH 8000	25 x 19	44	70	9
TH 8201	18 x 13	35	85	7.5

Rugged versions available.

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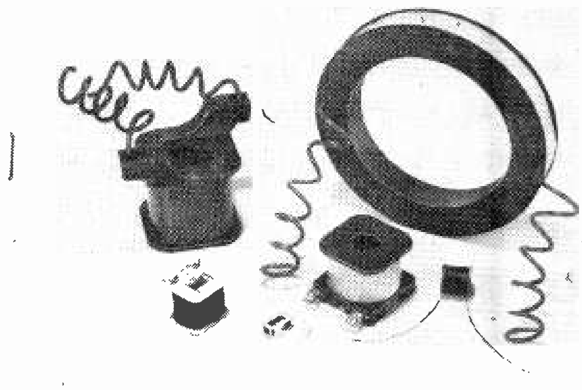

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J2	5	0—111,110	1	30.50
J3	4	0—111,100	10	25.10
J4	4	0—11,110	1	24.80
J5	3	0—11,100	10	20.60
J6	3	0—1,110	1	20.50
J60	6	0—1,111,110	1	37.20
J70	7	0—11,111,110	1	43.70

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	Decades	pF Range	pF Resolution	£
JC1	3	100—111,000	100	22.20
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	Decades	Ohms Range	Ohms Resolution	£
R3	4	0—1,111	0.1	50.85
R4	4	0—11,110	'	50.53
R5	4	0—111,110	10	49.67
R7	5	0—1,111,100	10	61.71
R9	5	0—111,110	1	62.35
R10	5	0—11,111	0.1	62.89
R11	5	0—11,111,000	100	71.81
R20	6	0—1,111,110	1	74.71
R21	6	0—111,111	0.1	75.68
R22	6	0—11,111.1	0.01	82.24
R30	7	0—11,111,110	1	94.39
R31	7	0—1,111,111	0.1	87.72
R32	7	0—111,111.1	0.01	88.37
R41	8	0—11,111,111	0.1	107.07
R42	8	0—1,111,111.1	0.01	102.88

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R603	6	0—11,111.1	0.01	128.70
R701	7	0—11,111,110	1	140.70
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R703	7	0—111,111.1	0.01	148.10
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Variables

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1

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2

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3

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4

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5

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6

The system gives a pre-determined amount of noise reduction which is realistically useful (set at 10 dB).

7

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8

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9

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10

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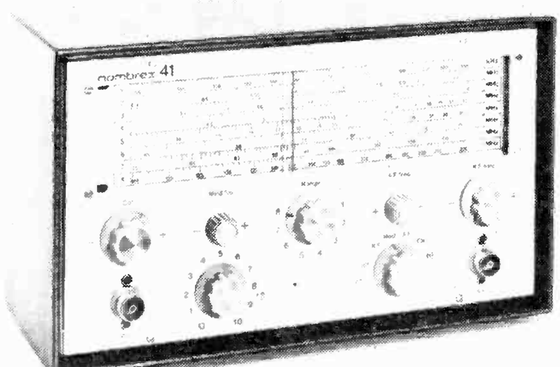

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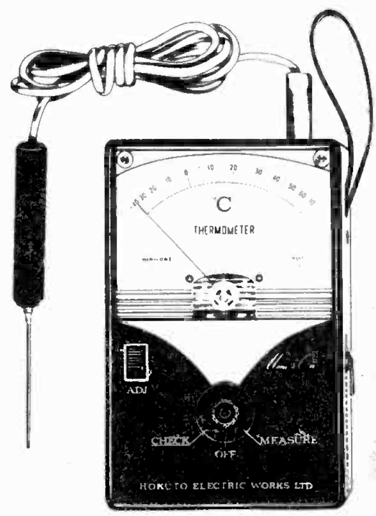

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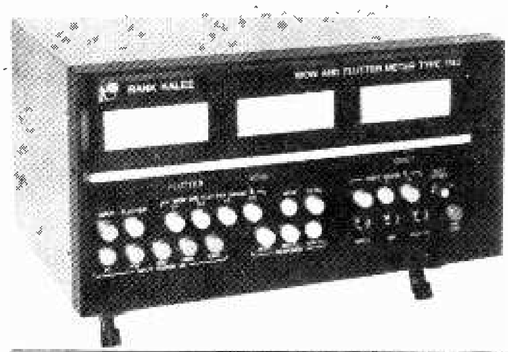

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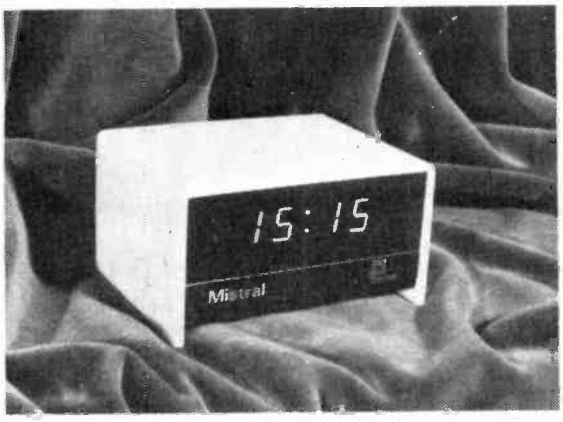

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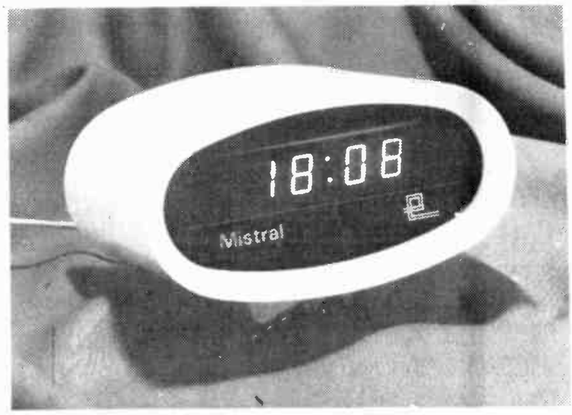

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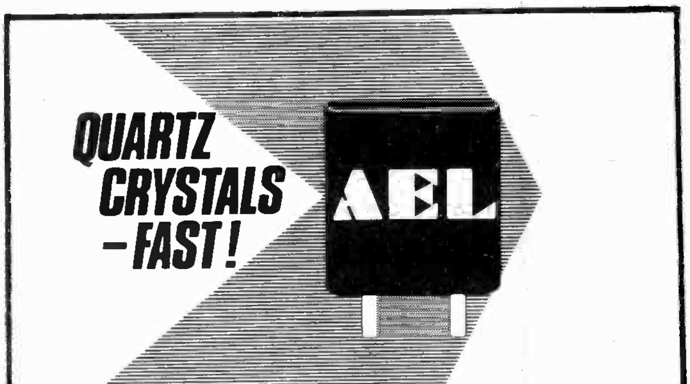

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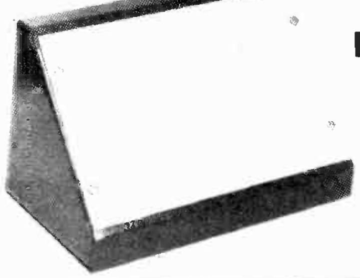

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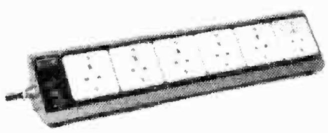

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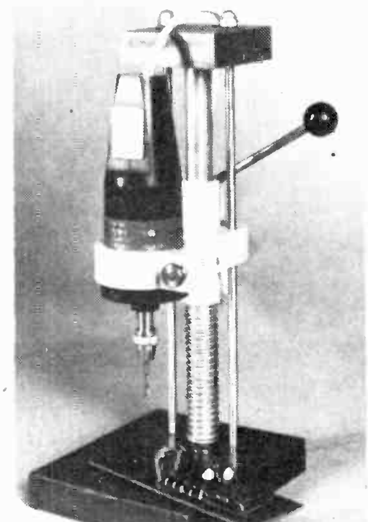

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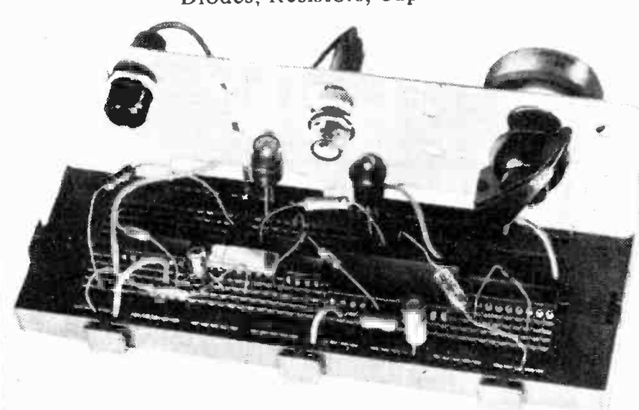

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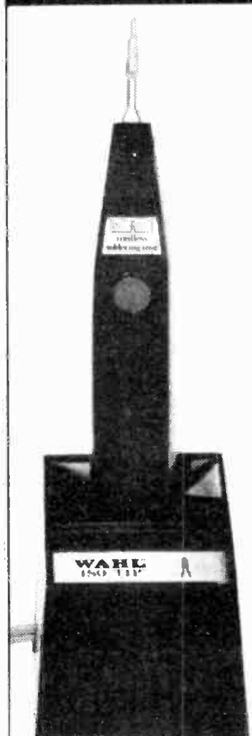

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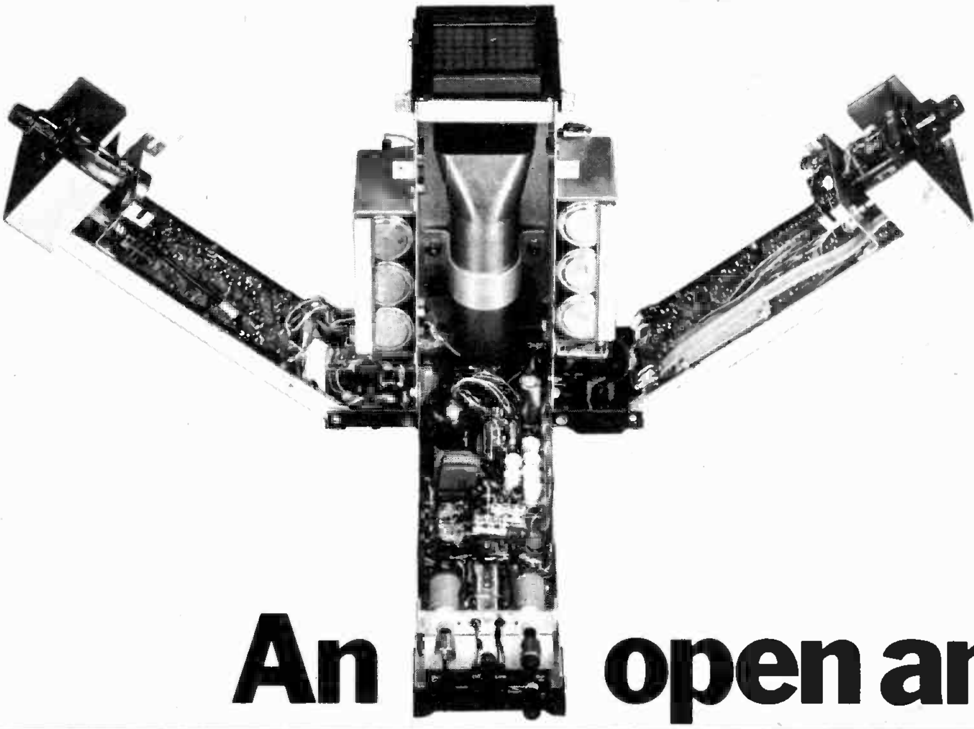

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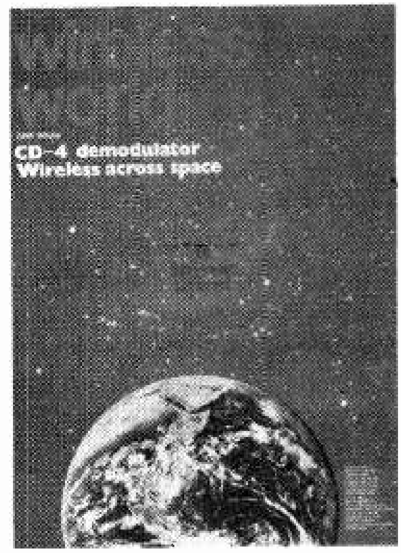

Front cover is a reference to Dr Tang's article "Wireless across space," which examines the feasibility of communication with beings on planets of other stars **(photographs by Richard Knox (stars) and AP (earth)).**

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Why should scientists want to get in contact with possible intelligent beings in other solar systems? The author of "Wireless across space" in this issue does not set out to answer this question – he is writing a technical article. Yet the question is a legitimate one to ask. Much time, money and effort has been expended on this work. One answer could be in the "because it's there" category – the possibility exists, so we must take up the challenge. Another answer could be scientific curiosity. Science is part of university life – which is justified by education and passing on the culture – and science needs problems to work on. The psychologists might suggest that we have an inner wish to find life elsewhere: we are really seeking more evidence to demonstrate purpose and design in the universe, to reasure us that life on this planet is not just an isolated molecular accident.

Practical people will say these are specious answers. But when you try to find the basic motivation behind so much of our science and technology you find yourself among similar, apparently vague and mystical explanations. Technology, in particular, is supposed to serve the needs of man (such as for more communication channels). But the needs of man, beyond those of sheer survival, are largely generated by his visions of himself – in fact by myths. (Here "myths" is not intended to mean things that are not true, but expressions of ideas by which we act and live.)

Behind much of technology is the myth of human progress – that we are on some road that will eventually lead us to perfection if we work away hard enough at our gadgets. And there are also myths of perfection operating in the specialized areas of our progress. Take sound reproduction, for example. Frequency and phase response, harmonic and intermodulation distortion, signal-to-noise ratio and so on are ultimately all measurements – nothing more than meter deflections and points plotted on paper, symbols representing concepts. Yet those of us who feel we cannot rely on our own ears believe that if we make all the measurements absolutely right by sufficient expenditure of money and technical effort, the reproduced sound must necessarily be absolutely right also. This is an example of the myth of objectivity.

Technologists and scientists should always be aware that objectivity is a myth. It is so easy to fall into the trap of imagining that the laws of nature, of logic and mathematics somehow exist independently – that they existed before anyone was around to think them. As the eminent molecular biologist Jacques Monod points out in his book *Chance and Necessity*, the principle that objectivity is necessary for truth is in fact an ethical, and therefore wholly human, decision. Our myths and maths go hand in hand.

Wireless across space

Communication with possible intelligent beings on planets of other stars

by Tong B. Tang, M. Tech

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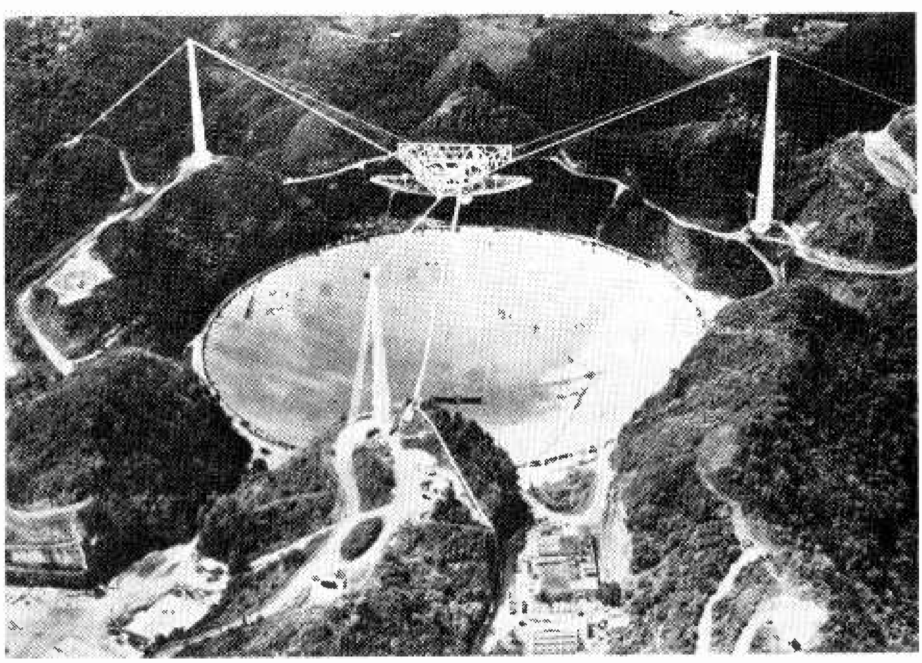
When the Viking lander-orbiter space-probe reaches the planet Mars in July 1976 we may receive the first confirmation that life exists not only on Earth but on extra-terrestrial bodies as well. It is extremely unlikely, however, that we shall find *intelligent* life either there or on other planets in the solar system. On the other hand, it is statistically likely that among the 10^{11} stars constituting our galaxy (the Milky Way) many have planets which are inhabited by intelligent beings of one form or another and at various levels of social and technological development.

As yet we know of no physical principle which suggests that space travel at speeds faster than light can be implemented. The distances between stars are enormous. The star nearest to the sun is 4.29 light-years away, a distance of a quarter of 10^{14} miles and nearly ten thousand times our distance from the outermost planet of the solar system. While interplanetary travel could be possible within fifty years, launching interstellar spacecraft, whether manned or unmanned, will at best be grossly inefficient, even after all the technological advances we can foresee have been achieved.

Communication by electromagnetic waves will remain the most convenient and fastest method of making contact between stars. It is also the cheapest, requiring only the expenditure of electrical power, granted that the antennae and associated electronics used for transmission and reception exist already. Using 1970s technology and prices, a ten-word telegram costs less than 10 pence if the antennae are 45 metres in diameter and 10 light-years apart [1].

Extra-terrestrial civilisations could possess technology much more advanced than ours and make use of telecommunication means which we cannot implement (modulation and demodulation of gravitational waves or neutrino beams, etc.) or cannot imagine. But they would understand that, while some civilisations on other planets could be still more advanced than themselves, some could be behind them. Counting from the dating of the earliest known fossils of living things on Earth, we have been evolving for three thousand million years, and radio technology has been with us for less than a hundred years. Hence, to maximise the chance of achieving contacts, as primitive a communication technique as possible should be used by civilisations; this I shall call the "principle of presumed modesty". That is, every civilisation in attempting communication will try to make things as easy as possible for the other side, irrespective of whether the other side is in fact very advanced, because it does not know beforehand one way or another. Assuming that everywhere technology develops in the same overall sequence [2], we need therefore consider only radio communication.

Fig. 1. The radio telescope at Arecibo, Puerto Rico. The paraboloidal reflecting dish, 300m in diameter, is constructed within a natural valley in limestone mountains. The feed is supported 137m above ground by cables attached to three pillars. By moving the feed the telescope is made semi-steerable (at 1.42GHz, to any direction within 20° from the zenith).



Feasibility of interstellar radio communication

Our first television broadcasts took place at Alexandra Palace, London, nearly forty years ago. Within a distance of twenty light-years of our sun there are about a hundred stars and star components. It is not absolutely impossible that they all possess planets, on which there are civilisations who have built radio receivers sensitive enough to pick up those television transmissions. The people who sent out the television programmes, may therefore expect at any time now "replies" from up to a hundred different directions in the sky!

Returning from such speculation, we now show that indeed we already possess radio equipment capable of maintaining point-to-point communication with a planet of another star. Its technological advancement need be no higher than ours. (If it is more advanced the issue does not arise at all.) There is a definite low-noise "window" for the reception of interstellar radio signals, in the microwave region from 1 to 10 GHz (u.h.f. to radar s.h.f.). The window is determined on the low-frequency side by the onset of intense radio frequency cosmic radiation and on the high-frequency side by that of atmospheric thermal noise. As far as we are concerned, if the interstellar radio station is built on the moon, then the upper frequency limit will be extended to the infra-red, where absorption by dust and debris in the interstellar space begins to be serious. By the "principle of presumed modesty" we should ignore this possibility. Further, the atmospheres of planets where life has evolved to advanced forms must have similar constituents (oxygen and water vapours) and therefore similar noise characteristics.

We now derive an equation for the maximum range of radio communication. If the transmitting antenna radiates a total power P_1 over a bandwidth Δf in all directions with equal intensity, then from a distance l away the power received by an antenna of "effective" area A_2 will be

$$P_2 = P_1A_2 / (4\pi l^2)$$

When l is of the order of interstellar distances, it is obvious that with reasonable values of P_1 and A_2 (reasonable by earthly standards), P_2 will be far too small to be detectable. However, the transmission can be beamed and made highly directional. If then a radio telescope with a parabolic reflector is used, there is a gain over the isotropic radiator of [3]

$$G_1 = \pi^2(d_1/\lambda)^2$$

where d_1 is the diameter (aperture) of the reflector dish and λ the operating wavelength. (For simplicity it is assumed that it is radiating "uniformly", otherwise a numerical coefficient slightly less than 1 has to be included.)

Likewise, the receiving antenna will be a parabolic type and will have a gain G_2. If its aperture d_2 is large, as should be the case, its effective area is close to the physical area:

$$A_2 = d_2^2\pi/4$$

If now P denotes the minimum detectable signal power at the receiver, and L the maximum range of communication, which we want to find, we can write

$$P = P_1G_1A_2/(4L^2)$$

$$= (\pi^2 / 4^2)\, d_1^2d_2^2P_1 / (L^2\lambda^2)$$

$$\text{so that } L = \frac{\pi\, d_1d_2}{4\ \lambda}\sqrt{\frac{P_1}{P}}$$

P will depend on the background and receiver internal noises, characterised as noise temperatures[4]. Without going into the details we can reasonably take P as 3.2×10^{-24} watts per hertz. Within the window mentioned earlier the interstellar background noise[4] is nearly constant at 3.2×10^{-22} watts per hertz

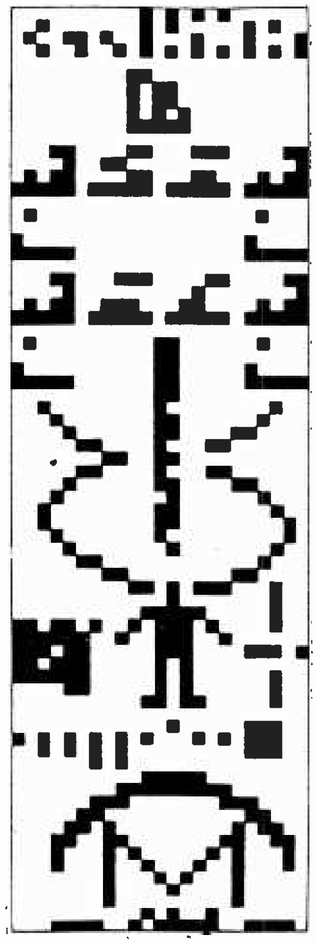


Fig. 2. Earth's first message to the stars (from ref. 23). The first bit sent is at the upper right-hand corner. The sequence continues from right to left and down.

(except at a few specific frequencies like 1.42GHz). In addition, since the receiving radio telescope will be pointing towards a star, microwave-frequency radiation of the star will add to this noise. However, if the star is more than ten light-years away it will be quite negligible[30]. By using masers or parametric amplifiers, and signal processing techniques such as time integration, frequency cross-correlation[5] and phasor detection[6], it is possible to dig out signals which are as much as 20dB weaker than this constant noise.

Now, let us assume the receiver passband has been adjusted to be the same as the signal bandwidth Δf so that P in watts is $(3.2 \times 10^{-24}\,\Delta f)$, with Δf in Hz. Take λ representatively as 10cm, corresponding to a frequency of 3GHz. Further, assume d_1 and d_2 both to be 300m, the same as the aperture of the Arecibo radio telescope (Fig. 1) which is the world's largest in operation at present, so that $G_1 = G_2 \approx 80$dB. Then if P_1 is 0.25MW, the present limit in our technology, a little arithmetic will show that

$$L = 2 \times 10^4/\sqrt{\Delta f}\ \text{light-years}$$

The interested reader can draw graphs of L against P_1 for various values of Δf at selected values of λ and ds. If one uses log-log scales they will be straight lines of slope -0.5.

It is seen at once that a larger L is obtained with a smaller Δf, though not quite proportionally. This is because reducing Δf diminishes the background noise power. Δf is limited by the frequency stability of the local oscillators of the transmitter and receiver, as it must be larger than the frequency drift. Using state-of-the-art quartz crystal oscillators and phase-locked loop systems for subsequent frequency up-conversion, Δf can now be made as small as 0.1Hz on s.h.f. waves. If this value of Δf is adopted, L is more than sixty thousand light years. In other words, two Arecibo-class radio telescopes, placed almost anywhere in the galaxy, could maintain communication with each other.

Problems and solutions

Interstellar radio communication is not, however, without problems. The first few concern Δf. The maximum amount of information obtainable from a radio transmission lasting a period of time t is, in bits,[7]

$$I = \Delta f.\log_2(1+\alpha).t$$

$$\approx \Delta f.\alpha.t/\log_e 2$$

$$\approx (3/2)\,\Delta f.\alpha.t$$

where α is the received message signal-to-noise-ratio and is assumed to be small. As an illustration, to send 3 megabits, which is the average amount of information contained in one book [8], to be received up to points where α is 1, then if Δf is 0.1Hz time t will be nearly 8 months. Unless we merely want to transmit call signals, which are of low I and serve only to advertise our existence and that we send call signals, then the chosen Δf cannot be too small so that the transmission time t will be reasonable. Moreover, signals of low I may be mistaken to be not artifical but of natural origin [9]. Here it is interesting to note that when the stellar objects called pulsars were first observed there were speculations that they were radio beacons for interstellar navigation – but their emissions pulse with extremely regular periodicity and nothing else. The speculations did not last long.

Also, on the receiver side, the time-constant of the passband determining filters is set to be $1/\pi\,\Delta f$. If Δf is very narrow the time τ_i required for a single signal recording (the "integration time") becomes inconveniently long, especially if the signal-to-noise-ratio is low.

More importantly, in the frequency domain, reducing Δf increases the total number of possible channels. Communication is achieved, of course, only if both the transmitter and the receiver are tuned to frequencies within the same channel. The trouble is that each side is ignorant of the other's choice of frequency before the contact. Within the 1 to 10 GHz window there will be nine thousand channels if Δf is 1MHz, but ninety thousand millions if it is 0.1Hz.

Fortunately, this problem of frequency compatibility seems to be tractable. Within that window there are particular frequencies which have special significance. Although each civilisation does not know beforehand how the others think, to maximise the chance of contact each should in its planning converge on those points which can be identified by all the others; this has been referred to as the "principle of anti-cryptography".[10] For us, the first such "watch frequency" to be so identified is the 1.42040575GHz spin-flip emission line of neutral hydrogen. As a physical property of matter, its value is universal and known by all other civilisations. Its significance comes from the observation that hydrogen is the most abundant element in the universe, so that it may be regarded as one fundamental constant of nature. However, for the same reason, it is unusually noisy. There has been a suggestion that its second harmonics (2.84GHz) should be chosen instead.[11] Also suggested [12], later, are the 1.667358 GHz radio frequency line of the hydroxyl radical and two "naturally" derived frequencies in the "water hole"[13] between it and the hydrogen line. (Water is composed of hydrogen and the hydroxyl radical, and it is most probably the basis of life anywhere in the universe.) All these frequencies lie near the low-frequency end of the window, an additional advantage since $L \propto 1/\lambda$.

There is an analogous problem in the time domain – the synchronisation of the transmitting and the receiving radio telescopes. As mentioned earlier, high gains on the telescopes, and therefore longer L, are obtained by making them highly directional. Hence, they are at one time transmitting or listening to only some small solid angles in the sky – in fact, $(4\pi/G)$ steradians, where G is the gain of the telescope concerned. (The whole sky extends by definition 4π steradians.) For communication to be achieved the two telescopes have to be in the same line of sight and pointing at each other. The probability of this happening by pure chance is $(1/G_1G_2)$. If G_1 and G_2 equal 80dB, it becomes 10^{-16}, an exceedingly small probability. (A field of view of $4\pi/10^8$ steradians is so narrow that generally at most one star lies in it.)

One solution is to reduce G_1 and G_2, which however decreases L as well. Another solution is the simultaneous use of vast numbers of transmitting and receiving telescopes, pointing in different directions. Practical proposals are not lacking [14]! Even if neither is feasible, the problem may still turn out to be solvable. In the same way that certain frequencies are special and, obviously to all, should be those used for interstellar communication, some astronomical phenomena in the galaxy may be suitably exploited as "time markers" and used for synchronisation purposes. One example is, for binary stars (two suns circling each other), the times when the two stars are nearest and farthest away [15]. Another, I propose, is the occurrence of a supernova[16] (a star "blowing up"; and this is, incidentally, the event responsible for the generation of the heavy chemical elements and the cosmic rays which in turn are requirements for the appearance and evolution of life.)

After the interstellar signals have been located, yet another problem is presented by the demodulation process. Which modulation method has been used by the transmitting civilisation? For reasons of simplicity and obviousness, the information must have been in binary form. According to one analysis[10], the optimum binary modulation process (and by "the principle of presumed modesty" the one to be used) is by sense-switching of the circular polarisation of the radio waves. This means that the waves will be circularly polarised, in the clockwise and anti-clockwise directions alternatively to represent 0 and 1. To use amplitude, frequency or phase modulation will be less efficient.

Assuming that we have got the message (as a sequence of 0s and 1s), we have to start decoding it into intelligent information. Much has been discussed about this subject of "interstellar cryptography". The information may be pictorial as was the first interstellar transmission by us (see later: Fig. 2). It may be more sophisticated and high-level, and it will not be so straightforward to interpret and translate into our own concepts. However, the transmitting and the receiving civilisations share quite a few things in common, irrespective of their differing systems of concepts (which in any case all reflect the same objective world). They are the message itself, the "same" understanding of physics (albeit with different "names,,' notations and unit systems), and the (universal) conception of arithmetic (counting one, two, three, etc.). A language of high expressional power can be defined, starting from them and nothing else. A long message can consist of, in the first part, the construction of such a formalised syntactic language, followed then by "books". The reception and deciphering of such a message will have unimaginable effects.

Lastly, there are a few "tactical" problems. The transmitting and the receiving planets will be rotating as well as travelling in space, so that they are moving relative to each other. Hence, there will be a time-varying Doppler shift in the signal frequency, equal to the (varying) relative velocity divided by the speed of light. However, this can be eliminated easily if each side separately compensates for its contribution to the total shift, by using for example a phased frequency-scanned antenna system [17]. Another problem is due to the fact that interstellar space is not exactly a vacuum, so that dispersion of the radio signal occurs. The lower frequency components of the signal have slightly lower propagation velocities, resulting in distortion. However, with an unusually small Δf, it will not be serious unless the propagated distance is very large ($>10^4$ light-years).[1]

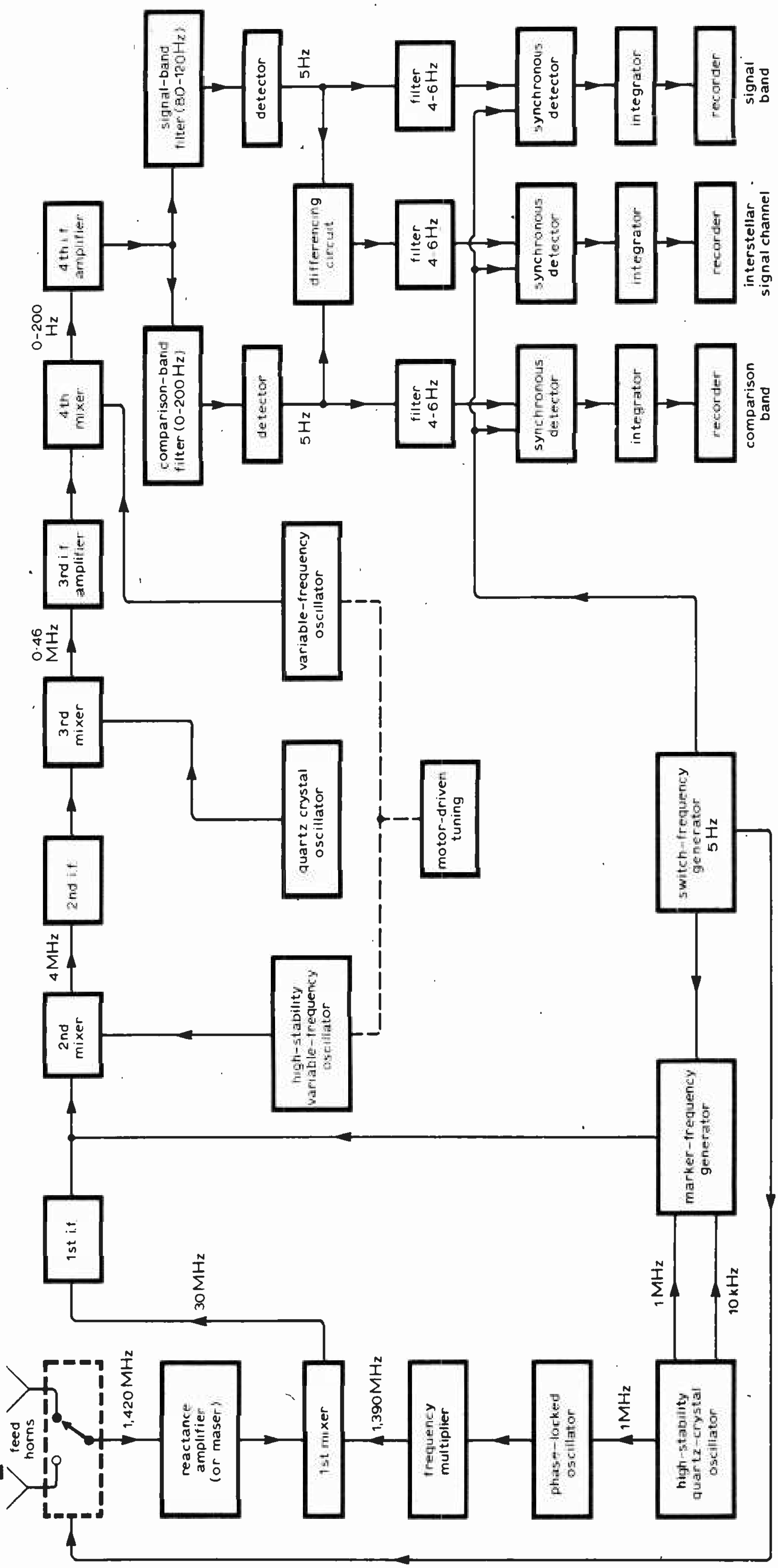
The receiving system

Let us now consider the radio telescope receiving system (sometimes referred to as a "radiometer") in some detail. Its basic function is to amplify, within a specified bandwidth at a selected frequency, the signal-carrying electromagnetic waves collected by the telescope. After appropriate demodulation the signal drives an output recorder.

Its front end will consist of a low-noise pre-amplifier – inevitably a parametric amplifier or the more expensive liquid-helium cooled maser [18] – which is usually placed right in the telescope to reduce feeder transmission loss. (A discussion of "noise temperature" and front-end amplifiers can be found in reference 4.) To eliminate misleading outputs due to internal drift in the system characteristics, the input to the pre-amplifier is switched between the telescope feeder and a standard noise source. The pre-amp is followed by several stages of superheterodyning intermediate-frequency amplifier, and

Investigator	Observatory	Frequencies	Targets
Troitsky	Eurasian network, USSR	0.6, 1 and 1.875 GHz	Entire sky
Zuckerman, Palmer	Green Bank, USA	1.420 GHz	Some 600 nearby sun-like stars
Kardashev	Eurasian network, USSR	Several	Entire sky
Bridle, Feldman	Algonquin Radio Observatory, Canada	22.2 GHz	Several nearby stars
Drake, Sagan	Arecibo, Puerto Rico	1.420, 1.653 and 2.380 GHz	Several nearby galaxies

Fig. 3. Project Ozma receiving system schematic (adapted from National Radio Astronomy Observatory diagram).



then by the detector, which is synchronised to the pre-amp switching frequency, so that signals from the feeder which are pulsed at the same frequency will be demodulated but receiver noises etc. which are not will be ignored. An integrator comes after the detector stage. It averages the signal over an interval τ_i equal to its set time-constant, to give successive recordings. The root-mean-square deviation in a single recording is inversely proportional to $\sqrt{\tau_i \Delta f}$, so that a longer τ_i leads to more significant digits in the reading. In the search period, before the signal has been detected, square-law (energy) detectors are used. After the signal has been found, however, a coherent or homodyne detection method is used to retain the phase information. The recordings usually go through analogue-to-digital converters and then are stored on tapes, to be dumped into a computer later. Sometimes, signal processing processes such as frequency-correlation are performed in real time immediately after the integrator, by a digital correlator[19].

The first attempt by mankind to listen for extra-terrestrial radio messages (Project Ozma) was made fifteen years ago.[20] In the last five years there were three more publicised searches.[21, 22] Project Ozma used a telescope of $d = 26$ metres, and searched at frequencies from 1.4202 to 1.4206GHz with Δf from 40 to 100Hz. The other three had d ranging from 26 to 50 metres, frequencies at 1.420 and 0.927GHz, and Δf at various values from 13Hz to 2MHz. Results were all negative, which is hardly surprising as these efforts were on very small scale. Using the Arecibo radio telescope ($d = 300$m) the first radio signalling to other stars was carried out in 1974, just before the first man-made objects to leave the solar system would have left. (These were the Pioneer 10 and 11 space-probes, travelling more than a hundred thousand times slower than the radio signals.) The radio message[23] has 1,679 bits and therefore can be broken down into a two-dimensional picture in only two ways, either as 73×23, or as 23×73 which is the intended one (Fig. 2). The frequency of transmission was 2.38GHz, Δf was 10Hz and the transmission time lasted 169 seconds. Binary frequency modulation was used, the effective average power was 3×10^{12}W, directed towards the Great Cluster in Hercules, a group of some 300,000 stars 2.4×10^4 light-years distant. The Doppler shifts in the signal frequencies due to motions on the Earth side had been continuously compensated.

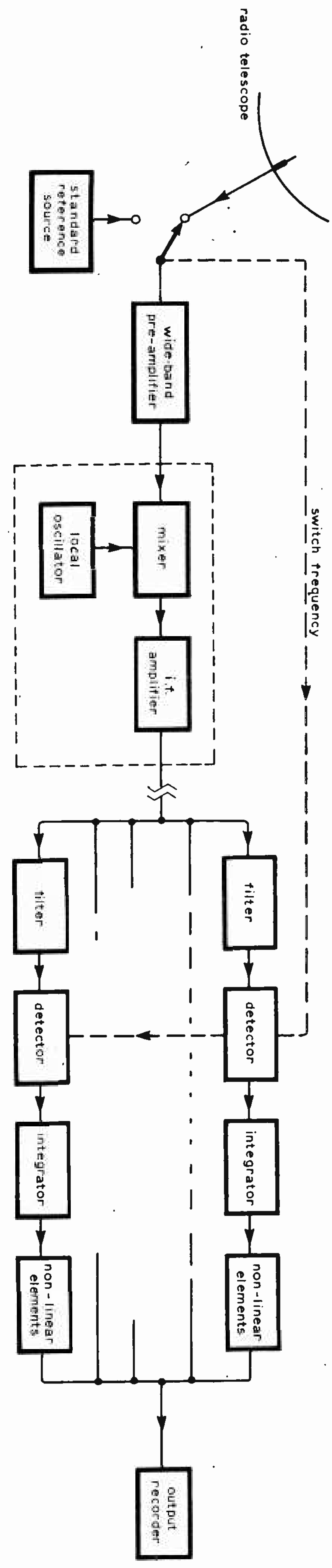


Fig. 4. Multi-channel receiving system

The functional block diagram for the receiving system used in Project Ozma, which will be representative, is shown in Fig. 3. Two horn antennae are connected by waveguides to an electronic switch, and the signals from them are fed alternately to the pre-amplifier. They are placed above the telescope reflector dish, so that one "looks" effectively at the star of interest and the other at a point in the celestial sphere just next to it. The second horn serves as a comparison noise source. The detectors on the right-hand side of Fig. 3 respond only to signal pulses synchronised with the switching frequency. In this way receiver internal drifts, and terrestrial interferences which are collected by both horns, are eliminated, since they are not synchronised.

The quartz crystal oscillator for the first mixing stage is kept at a very stable temperature in an oven-within-oven, and has a frequency drift of less than 1Hz in 1GHz. Its output is up-converted in frequency to 1.39GHz by a phase-locked loop system.

After the fourth i.f. amplifier, two filters pick up one broad (0-200Hz) and one narrow (80-120Hz) band of signals. Their attenuations are in the ratio of 5 to 1, so that if the signals are broad-band their outputs are the same. In this case, the differencing circuit and thus the "interstellar signal channel" will have zero output. (The signal-band filter is shown as passing a Δf of 40Hz, but it can be easily and quickly re-adjusted and in the actual experiment Δf had varied from 40 to 100Hz.) Only when there are signals of bandwidth less than 200Hz will the filters' outputs be different. The other two outputs, shown as "comparison band" and "signal band," serve as checks on system performance.

The other receiving systems used in the search for extra-terrestrial radio messages are similar in construction, except that they are multi-channel so that a number of watch frequencies can be scanned simultaneously. Fig. 4 is a schematic of these systems. There is the radio telescope, and a standard reference source for noise comparison purpose. After going through the switch and the wide-band pre-amplifier, the signals pass several stages of mixers and i.f. amplifiers and are then selectively allowed through a number of pass-band defining filters. After detection and integration they are summed by non-linear circuit elements and go to an output recorder. Multi-channel one-bit digital correlators[24] are also sometimes incorporated. Each channel can be searched individually, and the data from several adjacent channels can be combined to represent a wider channel without any loss of information or sensitivity.

(It may be interesting to compare the receiving systems just described with a home-made one operating at 0.2 and 0.45GHz and for less sophisticated purposes[25], which, while being much simpler, contains all the essential ideas.)

To be continued

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News of the Month

New video recording system

When is a video disc not a video disc? The multiplicity of answers to this question seemed to have escaped the organizers of Video Disc 76, a recently held conference in London. For by choosing this title, they automatically excluded at least one system from being presented that has equal, if not more, potential than the best disc systems announced so far. A question and answer period however allowed Mr Sarason Liebler, president of Digital Recording Corporation, to give a brief description which were later expounded to *Wireless World* (more details next issue).

The system is an optical one that can store live colour television signals in digital form at a density of 300 million bits per square inch, a density that allows 30 minutes of TV programme to be stored on a 5 × 7in record. Mr Liebler told *Wireless World* that for consumer TV playback large-scale production could bring manufacturing cost down to $120 per unit, as only relatively inexpensive components were required. But a large consumer market was seen to be a long way off, and application is more likely to be in other areas such as archival information storage and retrieval, military situations, and professional areas where high signal-to-noise ratio and a high bit rate or density is desirable.

Material to be stored is converted to a digital code and written as a series of micron-sized dots (or bars) and spaces on a photosensitive plate. For playback, which can use the same unit as for recording, digital tracks are scanned by a light beam. The modulated beam is converted by photodetector and a conventional digital-to-analogue converter to reproduce the original information. Scanning is achieved by a spinning scanning head that has several apertures in its periphery. An optical distributor switches the light beam in such a way that the data at the end of one track are picked up at the start of the next track by the next aperture. It is the scanner that translates, the record remaining fixed.

Eye-direction recorder in Britain

Accurate "eye direction" recording has posed difficult problems for researchers trying to find a system in which the measurement process itself does not interfere with the normal activity of the subject. The "remote oculometer", demonstrated recently in London, is claimed by its designers, Honeywell Radiation Centre, to overcome this problem.

The oculometer, which is the result of 10 years' research at the company's laboratories in Lexington, Massachusetts, uses a beam of infra-red light, aimed at the subject's eye, to operate a special TV camera. This camera locates the position of the eye's corneal reflection, which moves within the pupil area according to the direction of the line of sight. A small computer translates the position of the corneal reflection into a precise "measure" representing the point at which the subject is looking. This measure can be recorded and/or displayed on a TV screen showing the fixation point within the viewed area.

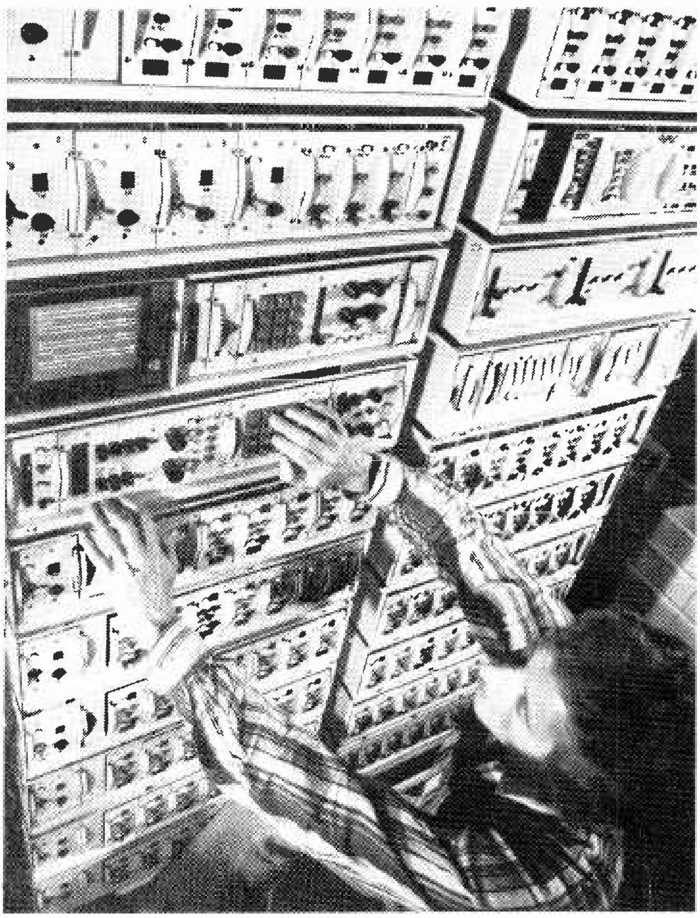
Video tape recording showing a viewer's "eye fixation" on a TV commercial. The fixation point — shown as a white dot on the woman's mouth is superimposed on the screen by an oculometer computer.

There are two basic types of oculometer; one which requires the subject's eyes to stay within one cubic inch of space, and another which, using a two-axis moving mirror and a servo-driven focusing lens automatically controlled by the computer processor, allows movement within one cubic foot of space.

The oculometer, Honeywell says, can provide objective data in many applications such as training and evaluation of aircraft pilot or air-traffic controllers' skills, instrument panel design, driving and road safety research, design of TV commercial and other advertising copy, and reading analysis. The U.S. Air Force are presently using a cubic-foot unit for study into the use of eye control as an alternative to conventional hand control, and oculometers have been purchased by a variety of other research centres, armed forces and universities in both the States and Europe. Honeywell's own Systems and Research Centre uses an oculometer for analysing the viewing pattern of shoppers asked to watch a series of TV commercials, and also for the National Highway Traffic Safety Administration for a night-driving study of headlight effectiveness.

Post Office install electronic director

The first electronic 'director' equipment to be installed in a London telephone exchange is being tested under live traffic conditions. The original director equipment designed for London and other large cities in the 1920s, used Strowger two-motion selectors and



Final checking of the Pye TMC electronic director equipment (see news item) before delivery to the Post Office for field trials.

uniselectors to convert the three digits of the exchange code dialled by the subscriber into the necessary routing digits for directing the call across the particular city to the destination exchange. This equipment, which enabled a universal numbering scheme to be employed, has worked efficiently but does not provide some facilities now considered desirable by the Post office. Pye TMC was awarded a contract by the Post Office to design and develop a system which could not only replace the existing electromechanical equipment but would also incorporate additional facilities.

The new equipment, designed using m.o.s. l.s.i. techniques, is much more compact and has a translation store of 2,000 individual routing instructions. Any or all of these can be electrically rewritten, providing for the routing of traffic to several hundred local exchanges, to the trunk network or the various information centres as desired. The translators are triplicated for reliability. An added advantage for the maintenance staff will be the reduced noise level in the exchange to improve working conditions.

The first production TXE4 exchange is now carrying public traffic. Between now and March 1980, the Post Office expects to spend about £330M on electronic exchanges at current price levels.

(As pointed out in "Centenary of the Telephone", March issue, the TXE4 is not fully electronic, relying on reed relays. See also "Electronic telephone exchanges", June, July 1974.)

Touch for iron and steel

A touch-sensitive display is taking a role in the investigation of data processing systems and information display techniques being carried out by the British Steel Corporation. Under a contract received by Marconi Radar Systems Ltd, a Digilux touch-sensitive display unit and a television alphanumeric display are being supplied to the Control and Human Factors Department of the BSC's Corporate Engineering Laboratory. The Digilux will be used in conjunction with the laboratory computer, a PDP11/45, to evaluate data processing systems and programmes developed for specific steelworks applications one of which is the operator guidance system for 'basic oxygen' steelmaking control.

The planned experimental programme being carried out by the Corporation also incudes comparative evaluations of equipment and an investigation of the display parameters such as desirable contrast ratios, character size, alphanumeric data format design and techniques of graphical display. Digilux does not rely on physical contact between finger and a bare wire conductor but uses narrow infra-red beams to form an invisible grid over the display screen. At each of the intersection points a small stud is let into the screen and above each stud an item of data to serve as a label is written electronically on the tabular display screen. By touching the appropriate stud, two beams at right angles are intercepted and the data designated by the label is signalled to the computer. This data is then written on the screen and at the same time a new set of labels designating the next stage of information to be fed in, is written above the studs.

Cartridges to Tokyo

Goldring are feeling pleased with themselves as a result of a Japanese order for their new G900 pick-up cartridge. They first sold cartridges in Japan to Sony, with their 850 model, a derivative of the million-selling G800 series. But the 900 cartridge is a completely new design. Though the chemically-etched laminations of the pole shoe assembly, first introduced by Goldring in 1969, improved the mid-range droop of earlier cartridges, it still left a fairly heavy pick-up. The 900 uses the moving magnet technique enabling magnet size and weight to be reduced drastically, resulting in a cartridge weighing only 5gm. The cantilever stylus support has also been reduced in weight – the tube wall measures 0.9 "thou" – and a smaller diamond tip is used. Tip mass is said to be 0.32mg. The coil and pole shoe assembly is also improved with finer laminations and a coil construction technique that avoids the usual bobbin former; inductance of the pick-up is 640mH at 1kHz and 630mH at 10kHz. Droop at 5-10kHz is kept to within −1dB, giving an overall response of 20Hz to 20kHz ±2dB.

Local radio for the army

The Ministry of Defence is purchasing a mobile sound broadcasting facility which will enable the British Army deployed anywhere in the world to provide a local radio service of general interest and current news content. Two medium wave sound broadcasting transmitters together with studio equipment, h.f. receivers, antenna arrays, a demountable mast, an aerial tuning unit and a range of associated test equipment are being supplied by Marconi Communication Systems Ltd. All of this equipment is to be mounted in two Army containers so that the resultant station can be transported by air by Support Command to any destination and brought into operation at short notice.

One of the containers will be fitted with two Marconi type B6023 1kW m.f. sound broadcast transmitters with a paralleling unit to provide 2kW of power. This container will also hold the drive units which will provide the choice of either crystal oscillator or synthesizer frequency control and a patching panel. The second container will function as the sound broadcasting studio and will be fitted with a

12-channel sound mixer, microphones, disc reproducers, tape recorders and sound monitoring equipment. A separate compartment within this container will mount h.f. receivers operating in space diversity to enable overseas broadcasts to be received and re-transmitted as required.

I^2L in volume

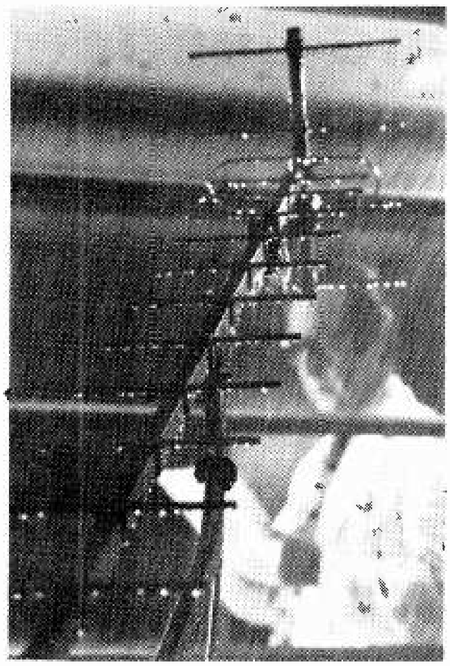
Claimed to be the first European based volume production facility for I^2L devices, a facility of ITT Semiconductors at Footscray is approaching a production rate of one million devices per year. At this time, a significant proportion of these devices are for use in digital watch applications where the significant reduction in package size coupled with the capability to directly drive l.e.d. displays give I^2L devices advantages over other comparable processes for certain applications. These advantages have potential for other applications and sample products are being evaluated by manufacturers in the telecommunications, TV, control systems and automotive markets. ITT inform us that development is now well advanced on a new range of consumer time pieces which use new circuit and packaging design techniques.

New tape format

A consortium of Japanese manufacturers consisting of Sony, Matsushita and Teac have announced a new tape format. Called the Elcaset, it consists of a tape cassette containing ¼in tape in a plastics housing of similar appearance to a compact cassette. Designed to run at a speed of 9.5cm/s, the Elcaset is a contender in the professional recording field alongside the BASF Unisette.

The principle difference between this new cassette and its competitor is that the tape is removed in a large loop by the recorder, thus isolating the cassette reel friction from the section of tape passing across the tape heads. Additionally, the track configuration allows for four conventional tracks and two control tracks down the centre of the tape. These control tracks can be used, one in each direction of tape travel, to carry synchronizing pulses for slide projectors, pilot-tone for film projectors, or a numeric code enabling selection of recorded items to be made using a programmable control unit. Automatic selection of bias and equalization is provided for three types of tape, by moulded lugs on the rear edge of the cassette.

Subsequent to the initial announcement, Aiwa and Victor (JVC) also announced agreement to adopt the format. The first machines using this format are expected to appear in the winter of 1976.



Artificially produced showers are among the extreme stress conditions to which Siemens communications equipment is subjected for environmental testing.

Underwater inspection completed

An unmanned undersea inspection vehicle has completed a visual examination of the massive new Brent Spar oil storage and loading buoy for Shell UK Exploration and Production. The vehicle, equipped with colour and black and white television and stereo still cameras, inspected parts of the Spar Buoy in 25 hours of underwater operation. The buoy, whose underwater structures extend 109m below the surface of the sea, is 29m in diameter and can contain 320,000 barrels of oil. A British Aircraft Corporation team operated Consub 1 from a barge tethered alongside the structure. All areas were illuminated by lamps on Consub and real time television pictures were relayed and recorded on videotape at the operator's console on the barge for assessment by engineers.

Broadcasting Convention 1976

The organizers of the biennial International Broadcasting Convention 76 to be held at Grosvenor House, London from September 20 to 24, have announced an excellent response to the call for papers. More than sixty papers by leading experts around the world will be presented during the fourteen sessions of the technical programme. They cover new techniques, systems, developments and trends which will be of interest to engineers concerned with all aspects of broadcasting.

In addition to conventional broadcasting techniques there will be two sessions concerned with new information systems utilising the domestic television receiver for information display. Papers will be presented on Teletext, Viewdata and Text Television, the experimental system of NHK in Japan. A special session will highlight 'Electronic Journalism' using lightweight camera, recording and transmission equipment specially designed for this purpose and now being produced by many manufacturers for increasing use around the world to cover new events for television. The exhibition at IBC 76 at which leading manufacturers will display and demonstrate an extensive range of professional broadcasting equipment will complement the technical sessions and enable delegates to get up-to-date information and firsthand experience of the latest equipment. Over 2000 delegates from 44 countries attended IBC 74.

Marine electronics conference

The Society of Electronic and Radio Technicians, in association with the Institution of Electrical and Electronic Technician Engineers, has organised a three-day symposium on marine electronics at the University of Southampton. The symposium, which is to be held from 5th to 8th July, covers five sessions. The first session will deal with maritime communications and will include papers on ships' aerials, speech processing for high frequency communications and satellite communications. Other sessions will deal with navigation and radar, automation and computers, education, training and future developments of marine electronics, and safety at sea. Eighteen papers are to be presented, the authors being drawn from marine companies, manufacturing companies, government departments and corporations, shipping industries, shipbuilders and colleges. In addition to the papers, technical visits will be arranged and a full social programme is planned. Registration fee is £68 plus 8% v.a.t. (£50 plus v.a.t. for members inclusive of attendance, board and the volume of published papers. Amongst the chairmen are Sir Edward Fennessy, managing director of telecommunications at the Post Office, Air Commodore Alec Morris, Director of Signals (Air), Ministry of Defence, R. M. Billington, Maritime Radio Services at the Post Office, and Col. J. D. Parker, Secretary General, C.I.R.M.

Briefly

Approval for calibration centre. The MSL Calibration Centre of Hunting Gate, Hitchin, Hertfordshire has been approved by the British Calibration Service.

Surround-sound decoders — 1

System details and circuit description of CD-4 demodulator

by David Heller, B.Sc.(Eng)

The Compatible Discrete 4 system (CD-4) was introduced in 1970 by the Victor Company of Japan. As its name implies, it was developed to allow four separate signals to be recorded on a disc record, at the same time having playback capability in stereo and mono when played through existing equipment.

A CD-4 record is cut in the familiar stereo format. Each of the two groove walls are cut at a 45° angle with the disc surface and at a 90° angle with respect to each other. Conventionally, the inner wall closest to the record centre is recorded with the left channel information. Modulation of the walls is perpendicular to their surfaces and, because of their 90° relationship, can be traced by a pickup to produce independent electrical outputs that correspond to the undulations of the wall.

Two signals are recorded on each wall side of the CD-4 disc: a sum signal, $L_F + L_B$, occupying the base band up to 15kHz, and a difference signal, $L_F - L_B$, modulated onto a 30kHz carrier. This last-mentioned signal occupies the 20 to 45 kHz band.

If a CD-4 disc is played on a normal two-channel stereo system, only the sum signal is detected. Information contained in either the left or the right channel is processed and appears in either the left or the right channel as a normal stereo disc. To obtain four audio channels from a CD-4 disc, a high frequency pickup and demodulator are required to recover the f.m. signals and thus obtain the difference signals. By combining these with the sum signals, four independent audio signals are obtained. Although the encode/decode principle used in the CD-4 system is basically simple, certain refinements have to be used in the difference signal processing to ensure that the signal-to-noise ratio is not substantially degraded over that obtainable in a normal stereo disc system.

Recording system

Fig. 1 is a block diagram of a CD-4 recording system. Four independent signals are fed into the input matrix amplifiers. The sum signal, delayed by about 40μs to compensate for the delay of the difference signal during replay, is passed to the RIAA equalizer.

Before modulating the carrier, the difference signal is compressed and emphasized. To understand why this processing takes place it is necessary to explain two major sources of difficulty encountered in the difference signal path. Noise in the difference signal is caused because the wavelength of the modulated carrier is so short that the ratio of record particle size to wavelength is no longer negligible, and with angle modulation the noise spectrum corresponds with the particular modulation curve used. Angle modulation has a number of unique characteristics. In a frequency modulated signal, the noise density or noise power per unit bandwidth increases as the modulation frequency increases. Carrier deviation caused by the noise at a particular modulating frequency is directly proportional to that frequency. Theory and experimental evidence show that noise from an f.m. signal is greater at the upper frequency end of the sonic spectrum. However, noise from a phase modulated signal is flat throughout the sonic spectrum. Experiments using the best record material available were undertaken by JVC to derive the noise spectrum, and Fig. 2 shows both the theoretical and experimentally-obtained noise spectra; in the frequency range above 2kHz the signal-to-noise ratio and dynamic range are reduced.

Crosstalk occurs between the two modulated signals recorded on the two walls of a 45-45 record groove. It is impossible to entirely eliminate crosstalk between the two channels, but it is possible to minimize it. With modulated carrier systems, crosstalk causes beats between channels on playback and distortion of the sound because of leakage. To minimize this, the frequency and phase of the left and right-channel carriers must be the same and to prevent distortion due to leakage, the modulation index should be no greater than 1.9. The choice of the modulation index is, however, a compromise. Fig. 3 shows the frequency spectrum of several modulated signals for various values of the modulation index (m). For signals in the middle and low frequency ranges, the spectrum is mostly within the range 30 ±1kHz. As the frequency increases above 1kHz, the spectrum becomes wider. To ensure that 95% of the energy falls within the frequency limits shown in Fig. 3, it is necessary that the value of m be greater than 1.9 at frequencies lower than 500Hz.

Distortion due to signal leakage depends on the amount of crosstalk and the modulation index. The larger the index and crosstalk, the greater the distortion and, if the signal leakage is the same in both directions, the crosstalk signal leaking from channel A to channel B will be identical in size and spectrum to the signal leaking from channel B to channel A. Distortion becomes significant at frequencies below 500Hz where the modulation index is greater than 1.9. Crosstalk distortion peaks at around 700Hz, as shown in Fig. 4.

A frequency-dependent compression-expansion system reduces interference caused by noise and crosstalk. As distortion caused by crosstalk peaks at about 700Hz, while noise from the f.m. signal starts rising at about 2kHz, the noise reduction system is designed to operate over two frequency bands. In addition, the difference signal is phase modulated over a proportion of its frequency band to minimize noise.

The noise reduction system consists of a compressor in the recording system and a complementary expander in the playback system. To function effectively, it must automatically emphasize low-level signals at about 700Hz and over 2kHz in the recording mode and de-emphasize them by exactly the same amount in the playback mode. Figs 5 and 6 show the compression-expansion level and the frequency versus input level characteristics. The curves are generated by a compressor based on a two-band scheme, with a band-pass filter having 3dB corner frequencies at 200Hz and 2kHz, and a high-pass filter with a 3dB corner frequency at 2kHz.

Response time of the compressor is chosen to make the noise improvement

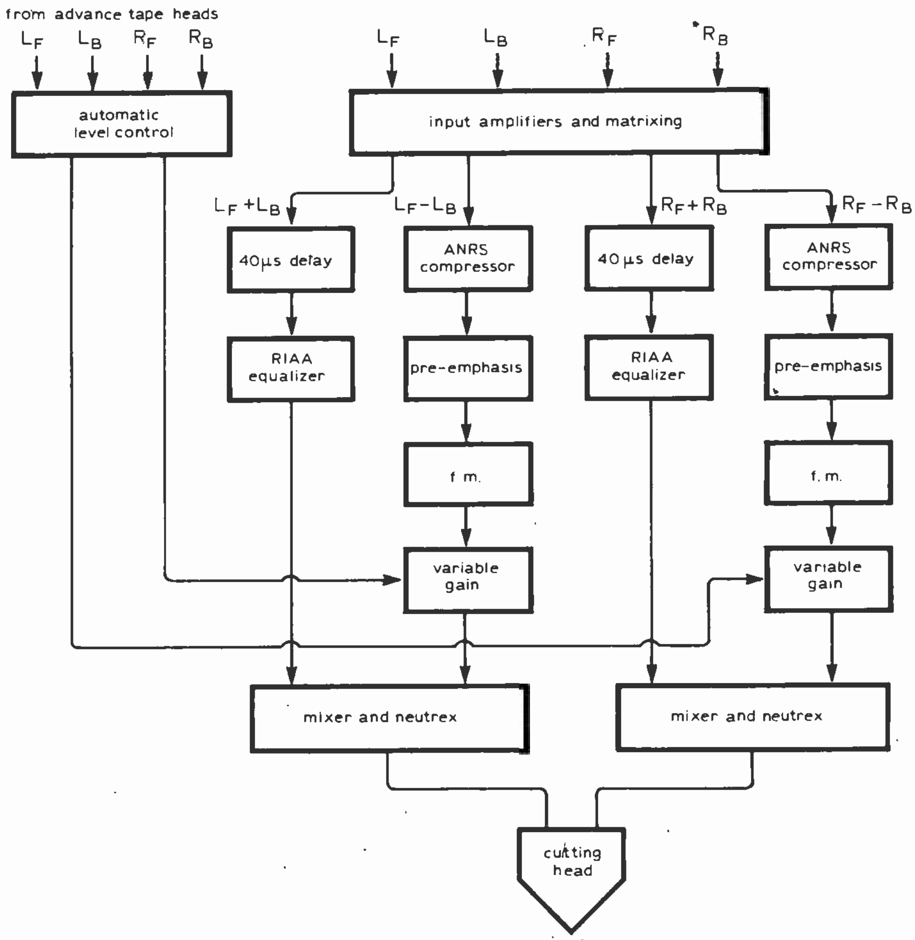


Fig. 1. Signal processing for CD-4 half-speed disc cutting.

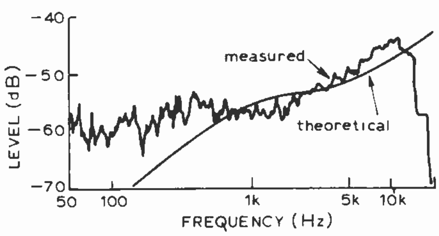


Fig. 2. Noise spectra of carrier channel for modulation scheme used.

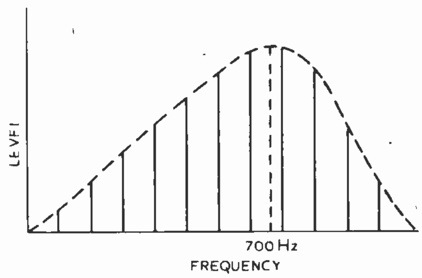


Fig. 4. Spectrum of crosstalk between carrier channels showing peak at around 700Hz.

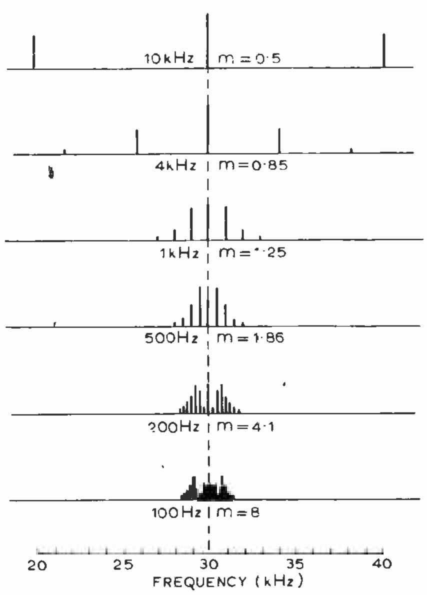


Fig. 3. Modulation spectra for different values of modulation index.

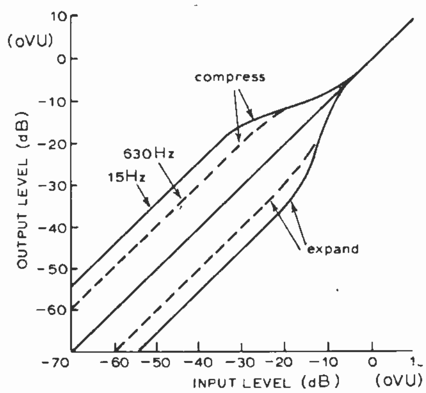


Fig. 5. Input-output characteristic of two-band compander.

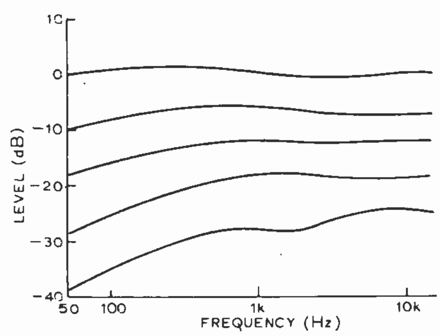
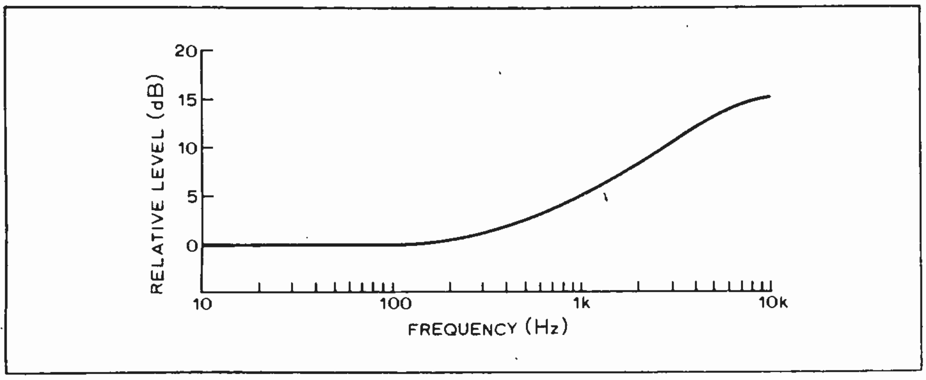


Fig. 6. Frequency-input level characteristic of two-band compressor.



arrangement as inaudible as possible during the automatic gain adjustments. At 630Hz, the rise time is specified at 5µs when the level is increased in a jump from −30 to −10dB and the restoration time is 100µs for the reverse transition. Above 2kHz, the rise time is decreased to 0.5µs for a step level change from −40 to −10dB and restoration time is 10µs.

Carrier deviation caused by the noise at a particular modulating frequency is directly proportional to that frequency. Consider a signal pre-emphasized with the characteristic of Fig. 7 and then used to angle modulate a carrier. The pre-emphasized signal is kept flat until 800Hz, boosted by 6dB per octave between 800Hz and 6kHz and flattened out thereafter. The total pre-emphasis operates over a range of a little less than three octaves, giving a total boost of 17.5dB.

When this pre-emphasized signal is used to angle modulate the carrier, the carrier is frequency modulated up to 800Hz. Frequency modulation is again resumed from 6kHz upwards. Between 800Hz and 6kHz, frequency modulation is carried out with a linear frequency boost – i.e. phase modulation. In a frequency modulated scheme, phase deviation decreases inversely with modulating frequencies. The same

Fig. 7. Static pre-emphasis scheme giving a combination of frequency and phase modulation.

amplitude signal at 2kHz will phase deviate the carrier half as far as a 1kHz signal. If the pre-emphasis counteracts this decrease by a corresponding rise in its amplitude, the phase deviation will be independent of frequency and will only depend on the modulating amplitude. Phase modulation gives excellent signal-to-noise performance at the higher frequencies since any increase in phase deviation is not accompanied by increase in noise.

The difference signal now modulates the carrier, chosen to be 19dB lower than the sum signal reference level to minimize interference between the frequency bands and to ensure cartridge pick-up trackability on replay.

If the high frequency end of the sum signal is large, mistracking of the pickup results, reducing the detected carrier level and raising the susceptibility to interference and noise. To compensate for this, an automatic level control changes the carrier level accordingly, operating from advance heads on the master tape recorder.

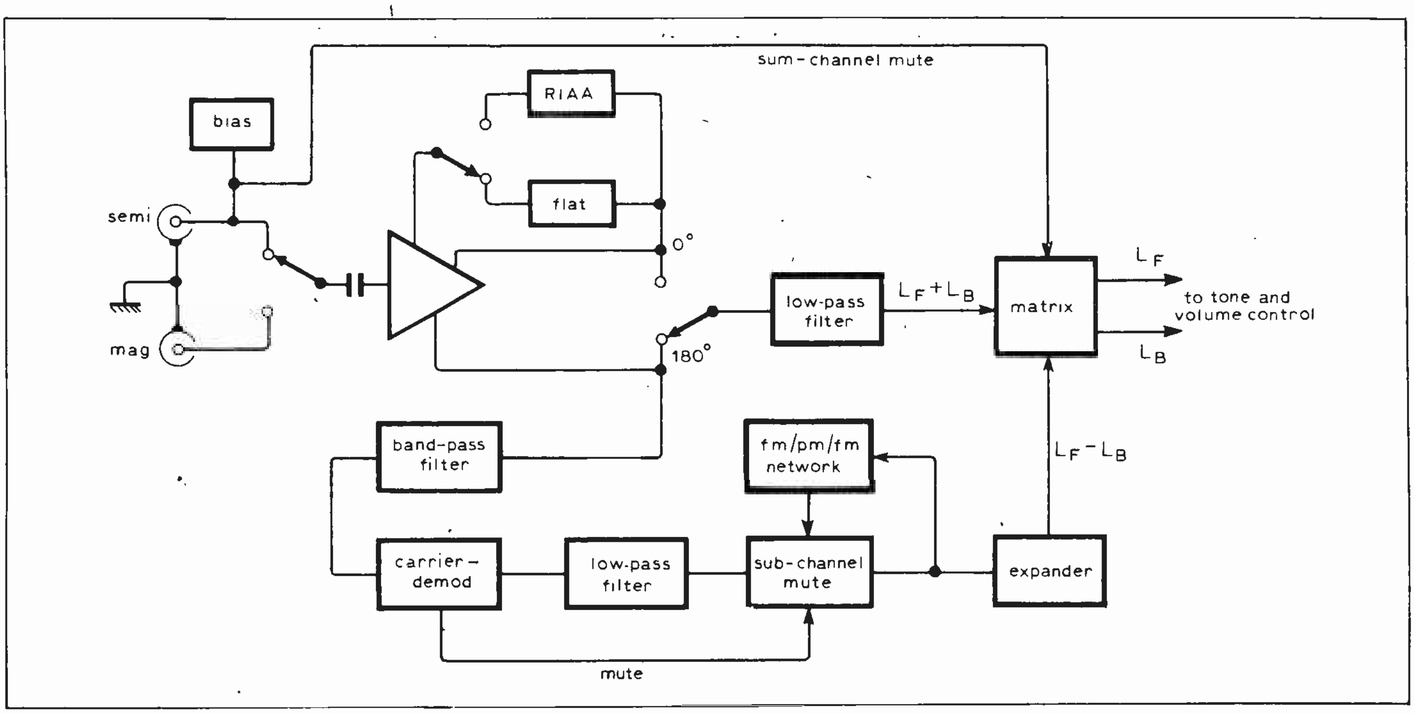
The base-band signal and the carrier signal are then added together in the mixer. At this stage, the shapes of the resultant waveform are predistorted to compensate for the distortion resulting from the tracing of the base band interfering with the tracing of the carrier, which would otherwise degrade the sound quality and channel separation (Neutrex).

Incidentally, because of the restricted frequency range of disc cutting equipment, the composite signal is formed at half frequency to allow half-speed disc cutting.

Circuit description

The demodulator is designed around an integrated circuit, QSI5022. Designed by Quadracast Systems Inc and manufactured by Signetics, it was chosen as it houses all the required functions, including preamplifier. Fig. 8 gives a block diagram of the workings of a complete side of one demodulator. The signal entering via the cartridge is fed to a pre-amplifier and is either RIAA compensated (for a magnetic cartridge) or is amplified at a constant level over the whole frequency range (for a semi-conductor cartridge). In addition, provision is made to use the pre-amp as a buffer/amplifier to accept tuner, tape and auxiliary inputs. The base-band signal is filtered (low pass) and passed to the output matrix. The carrier signal is fed to a bandpass filter and demodulated. The 30kHz carrier is filtered out of the demodulated signal and the resultant signal de-emphasized and then expanded to compensate for the compression which took place during cutting. This difference signal is now added and subtracted from the sum signal in the matrix to produce the resultant back and front signals.

Fig. 8. Block diagram of one channel of CD-4 decoder.



Preamplifier. The preamplifier, shown within the i.c. in Fig. 10, has antiphase outputs (pins 23 & 24). Its d.c. bias is determined by feedback from the non-inverting output, through R_4 and R_5, back to the preamplifier input at pin 25. The ratio of R_4 and R_5 is chosen to ensure that both of the output voltages sit at about 6 volts for a 13-volt supply rail. Components R_7, R_8, C_3 and C_4 determine the RIAA playback characteristic. The demodulated carrier signal is constant for any cartridge as it is a function of carrier deviation and not carrier amplitude. The baseband signal level will, however, vary from cartridge to cartridge. To add and subtract the baseband and demodulated carrier signals correctly, a variable gain is therefore necessary to adjust the gain of the baseband signal, and potentiometer R_9 allows the gain to be changed. Values chosen for R_9 and R_{10} allow the preamplifier to accommodate inputs from 0.7mV r.m.s to about 15mV r.m.s.

A magnetic cartridge can be a.c.-coupled to the input of the pre-amplifier by a capacitor but a semiconductor cartridge requires bias current. The Technics 450C or 451C cartridge requires 4mA bias current, and R_{41} and R_{141} supply this current while C_{38} filters out any hum. Components C_{33} and R_{40} form a network to maintain the proper direct voltage across the input capacitor, and R_2 matches the cartridge to the amplifier.

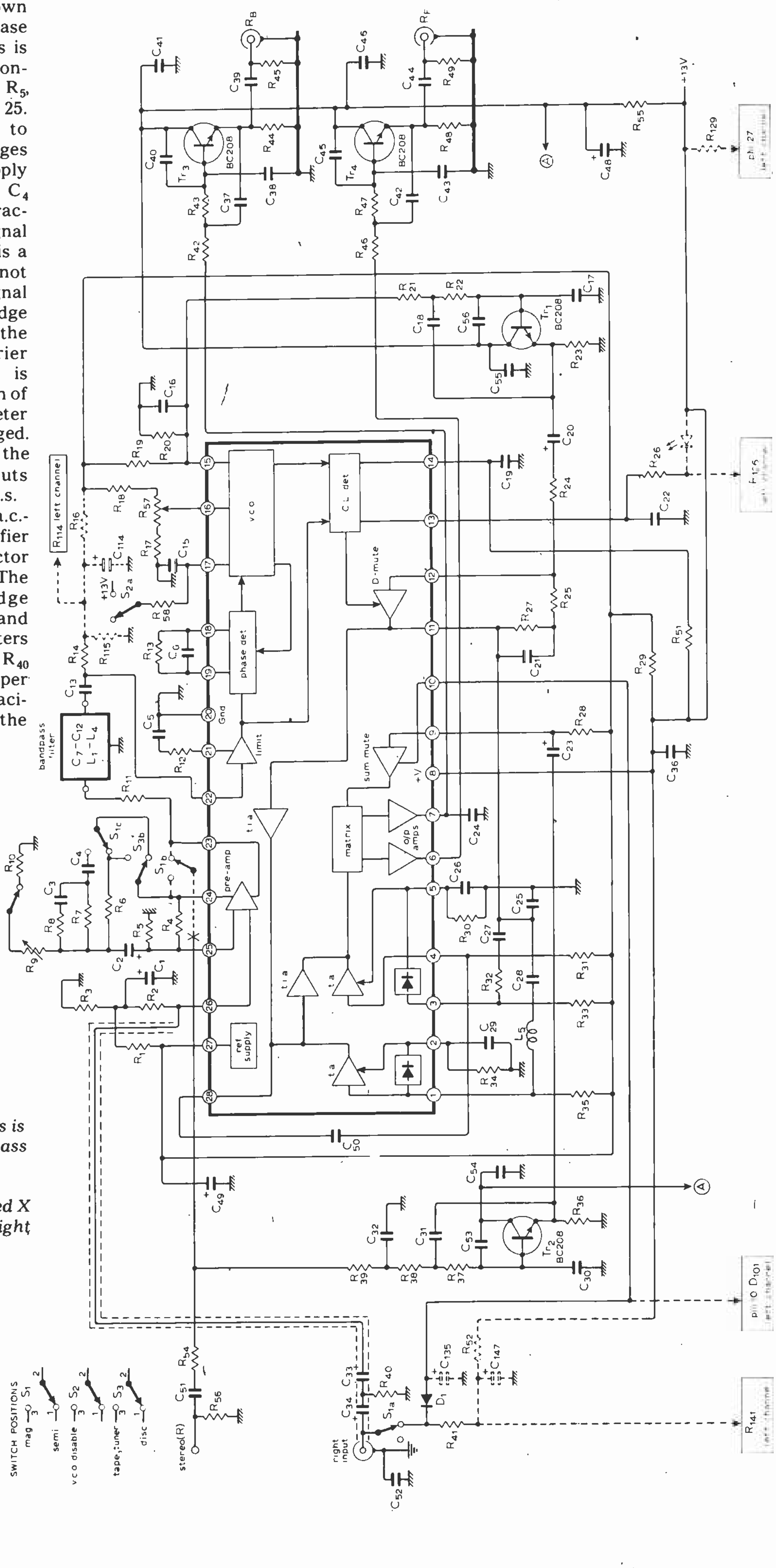


Fig. 9. Right-channel circuitry using QSI i.c. Circuit shown in broken lines is included in one channel only. Bandpass filter circuit, and component values will be given in part 2. Earth input socket at power supply. Point marked X is connected directly to pin 24 in right channel.

The non-inverting output is from a class A stage designed to drive the 15kHz low-pass filter, while the inverting output is a class B output stage, designed to drive the 15kHz low-pass filter and the 30kHz band-pass filter. The band-pass filter is matched by R_{11}. On the left side only, the non-inverting output is used for magnetic cartridge playback. The inverting pin is used for semiconductor cartridge playback. This is required because the left channel of a semiconductor cartridge needs phase inversion to be in proper phase relative to the right channel.

In addition, the preamplifier is used as a buffer amplifier for tape, tuner and auxiliary inputs. In this mode a flat feedback characteristic is applied by switching S_{3a} and S_{3b} to its open-circuit position, making R_9 and R_{109} gain controls ineffective, and by closing switches S_{3c} and S_{3d} thus applying a flat feedback characteristic to the preamplifier. A voltage gain of two occurs in this mode. Output is taken from the non-inverting output at pin 24 via R_{54} and C_{61}.

Limiter. The limiter's function is to provide a constant amplitude carrier to the demodulator and reduce the spike noise and amplitude modulation on the carrier. Components R_{15}, R_{16} and C_{14} determine the d.c. bias of the limiter; R_{14} is a matching load for the band-pass filter, coupled via C_{13}, and the bias feed. To reduce sum signal interference, C_{13} is chosen to allow maximum gain for the carrier signal but minimum gain for the sum signal. Components C_5 and R_{12} determine the overall gain of the limiter. The value of 20 ohms chosen gives a gain of approximately 50dB for this stage.

Phase-locked loop demodulator. Pins 18 and 19 of the phase detector and pins 15, 16 and 17 of the voltage controlled oscillator form the phase-locked loop circuit used for demodulation of the difference signal. The carrier signal from the limiter is fed into the phase detector along with the v.c.o. signal, and the product of these two signals appears at the filter terminals, pins 18 and 19. The filter performs three functions:

- it maintains a large d.c. tracking range for turntable speed variations
- it controls the a.c. tracking range for optimum audio pass band
- it reduces carrier feed through to the v.c.o., thus increasing interference rejection.

Resistor R_{13} determines the a.c. tracking range and, together with C_6, forms a 15kHz low-pass filter for carrier rejection. Varying the carrier input level to the phase detector or altering the value of R_{13} and C_6 varies audio passband response. Capacitor C_{15} is the v.c.o. timing capacitor, the value of which changes v.c.o. sensitivity or the audio output level. The only alignment required for the system is the v.c.o. adjustment. This can be done by adjusting the v.c.o. free-running frequency to 30kHz with pin 22 a.c.-shorted to ground.

Carrier level detector. With proper carrier level output of the limiter and the phase-locked loop locked to the carrier, the carrier level detector will unmute the difference sub-channel. Attack and release time is controlled by C_{19} of the mute. It is advisable in practice to connect pin 14 to the supply rail by a resistor R_{51}. This is not always required and depends on the batch of i.c.s produced. Using a value of 560kΩ, the detector should unmute automatically if a 30kHz carrier is present. The four-channel indicator drive is designed to drive an l.e.d. at a maximum of 25mA. Series resistors R_{26} and R_{126} minimize power dissipation in the i.c. The limiter gain and the preamplifier gain chosen allow the carrier level detector to unmute when the carrier input level is approximately 50μV.

Difference sub-channel mute. This consists of a gated amplifier with the gate control for the difference sub-channel mute coming from the carrier level detector. The amplifier serves the additional purpose of level matching between the phase-locked loop demodulator, the expander and de-emphasis. Components C_{21}, R_{25} and R_{27} determine the correction required for de-emphasis. Audio to the mute input arrives from the 15kHz low-pass active filter via filter matching resistor R_{24} and C_{20}.

Expander. The expander consists of two a.c.-d.c. convertors, two transductor inversion amplifiers (t.i.a.) and two gain control transconductance amplifiers (t.a.). One of each is used in the mid-band expander and the high-band expander. The system operates over two bands and expands according to the characteristics given in Fig. 5. Values of the external components are chosen for complementing the compressor curves. Parts used here are C_{27} for the high band with L_5 and C_{28} for the mid-range. The expander characteristics obtained are within ±3dB of the standard values stipulated by JVC.

Sum signal mute. Pin 24 of the preamplifier feeds the sum signal into a low-pass filter. This filter has exactly the same amplitude and phase characteristics as the low-pass filter placed in the difference signal channel. A sum channel mute (pins 9 and 10) is incorporated in the i.c. to facilitate the use of semiconductor cartridges. These cartridges when used with automatic turntables are likely to give a large spike into the preamplifier when lifting off the record. The mute circuit detects this spike before it passes through the sum channel and turns the sum signal off. When the cathode of D_1 or D_{101} is earthed, C_{35} discharges to 0.75 volts, thus muting the sum signal. The difference signal will already be muted by the loss of the carrier. When the cathode potential of D_1 or D_{101} is lifted, C_{35} is charged by approximately 100μA. When C_{35} is at about 1.4 volts, the sum channels unmute and the signals pass normally. The value of C_{35} is chosen for a delay long enough to allow the preamplifier to stabilize again.

Matrix amplifier. The matrix amplifiers recombine the difference signal and the sum signal to form the original front and back signals of a four-channel system. Output level is approximately 300mV r.m.s. for a 0dB (150mV) output from the preamplifier. Amplifier outputs at pins 6 and 7 are then fed into a second pole of a low-pass filter.

Reference supply. Pin 27 is a reference supply output from the i.c. This gives a voltage of around 5.8V which is used throughout the i.c. for reference and power purposes. The supply is filtered by C_{49}. Resistors R_1, R_{28}, R_{31}, R_{33} and R_{35} supply the appropriate circuits.

Filter requirements. The demodulator requires three filters for each i.c. There are two low-pass filters and a band-pass filter. It is essential that the low-pass filters should have a linear-phase response, i.e. a constant delay, and a flat amplitude characteristic to 15kHz. The two low-pass filters should be identical in all respects. The five-pole Butterworth active filter shown in part 2 is used but is split up so that the latter poles appear at the output of the demodulator, thus saving duplication. When a CD-4 disc is cut, the sum signal is delayed with respect to the difference signal. On playback, the difference signal is delayed with respect to the sum signal as it passes through the cartridge system. There are additional delays through the difference channel of the demodulator. In particular, the band-pass filter is designed to have an almost constant delay over its pass band so that the delays during the encoding/decoding process in both the sum channel and the difference channel cancel. The delay of the band-pass filter system shown in the second article is 32μs for signals between 18 and 45kHz.

Part 2 will give constructional details and performance using various pickup cartridges. A kit of parts for this and other decoder designs to be described subsequently is available from Compcor Electronics Ltd, 9 Dell Way, London W13 8JH. (See advertisement).

Antiphase or 180° phase shift?

A clarification

by S. W. Amos, B.Sc., M.I.E.E.

The 180° phase difference between the signals at the base and the collector of a common-emitter amplifier is well known. Indeed many of us have been aware of it for as long as we can remember; originally, of course, we knew it as the 180° phase difference between the signal voltages at the grid and anode of a valve, but the principle is the same. It is not surprising therefore that an engineer once designed a piece of electronic equipment in which the fundamental mode of operation depended on this phase difference. The equipment did not work and at the ensuing post mortem it was discovered that a common-emitter amplifier does not introduce 180° phase shift: instead it inverts the input signal and this is a fundamentally-different process.

Fig. 1 illustrates the difference. The waveform chosen for this illustration is a sine wave together with some second harmonic. The effect of adding the harmonic is to exaggerate the peak of one half cycle of the sine wave and to flatten the peak of the other so that it is possible to distinguish one half cycle from the other. Fig. 1 shows the effect of phase shifting this signal by 180° and of inverting it. The two results are quite dissimilar waveforms showing that the two processes are fundamentally differ-

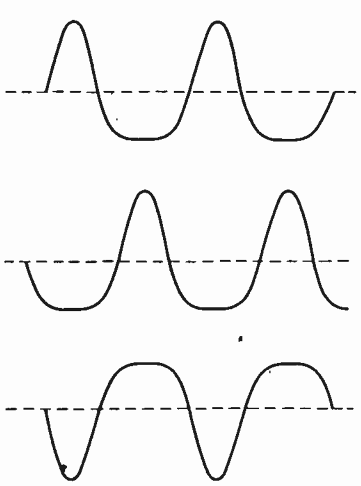


Fig. 1. The effect on an assymmetrical waveform (a), of phase-shifting it by 180° (b), and inverting it (c). Note that (b) and (c) are different.

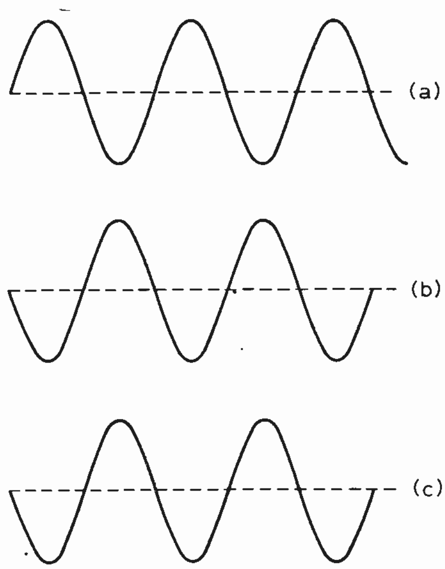


Fig. 2. The effect on a symmetrical waveform (a), of phase-shifting it by 180° (b), and inverting it (c). Note that (b) and (c) are the same.

ent. To facilitate comparison of the waveforms any increase in amplitude due to amplification has been ignored in this diagram and all the waveforms are shown with equal amplitudes. What has caused the confusion between 180° phase shifting and inversion is that, for a waveform which is symmetrical about the time axis, the effects give identical results; this is illustrated in Fig. 2 for a sine wave.

It is surprising that the myth of the 180° phase shift introduced by a transistor or valve should ever have gained credence. The only way of introducing phase shift is by the use of combinations of reactance and resistance e.g. capacitance and resistance or inductance and resistance. An ideal transistor or valve certainly contains resistance but it has no capacitance or inductance and cannot possibly therefore introduce any phase shift. All it can do is to invert the input signal and this has nothing to do with phase shift. In fact the term "antiphase" is a little unfortunate because it suggests that the process of inverting a signal has some connection with phase. "Signal inversion" might be a better phrase than "antiphase".

To summarise then, for a wave symmetrical about the time axis the effects of 180° phase shift and of signal inversion are indistinguishable; for an asymmetric wave the two processes give quite different results.

These considerations are of importance in the design of an oscillator which can be regarded in general as a combination of a maintaining amplifier and a frequency-determining network as shown in Fig. 3. The requirements to be satisfied for oscillation to occur are: (a) that at the frequency of oscillation the frequency-determining network must introduce signal inversion which, with the inversion in the maintaining amplifier, gives the overall positive feedback which is essential for oscillation and (b) that the gain of the maintaining amplifier must exceed any attenuation in the frequency-determining network at the frequency of oscillation.

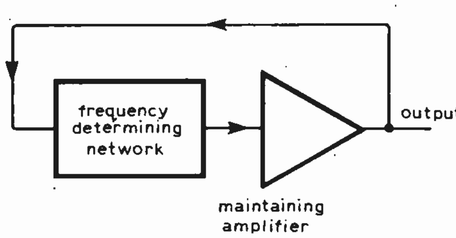


Fig. 3. A fundamental block diagram for an oscillator.

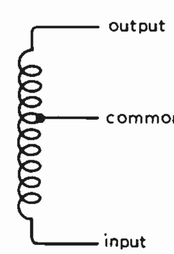


Fig. 4. A simple method of obtaining signal inversion using a tapped inductor.

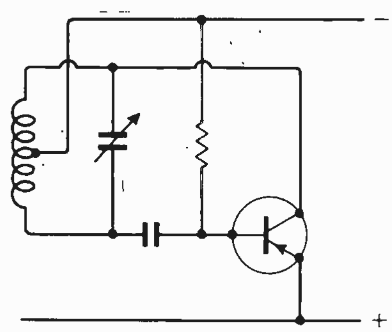


Fig. 5. A Hartley oscillator.

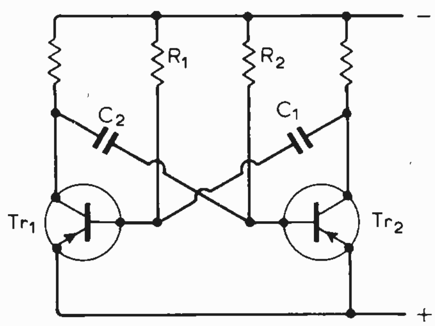


Fig. 6. An astable multivibrator circuit drawn in the conventional manner.

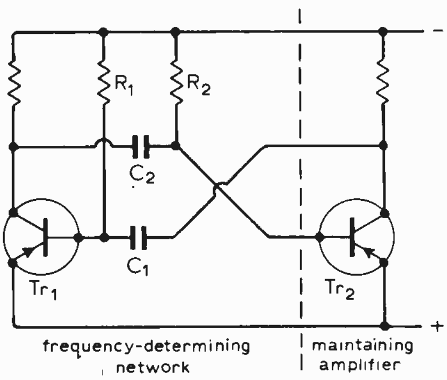


Fig. 7. The circuit of Fig. 6 re-arranged to show that it agrees with the basic form of the oscillator (Fig. 3).

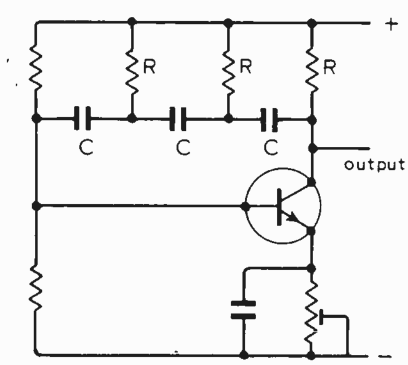


Fig. 8. An oscillator which relies on phase shift in the R-C filter for its operation.

The frequency-determining network must then give signal inversion at the oscillation frequency. One simple way of achieving signal inversion is by the use of a tapped inductor as shown in Fig. 4 and this can be tuned by a parallel-connected capacitor to give operation at a particular wanted frequency. By adding a common-emitter circuit as maintaining amplifier we obtain the familiar circuit of the Hartley oscillator shown in Fig. 5. In a similar way, by tapping the capacitive branch of a resonant circuit to obtain signal inversion, the Colpitts' oscillator circuit can be derived.

Any type of frequency-determining network can be used, and oscillation will result, provided the two conditions set out above are fulfilled. Thus a common-emitter amplifier can be used as a frequency-determining network. It introduces the necessary signal inversion but there is no attenuation. Instead there is usually considerable voltage and current gain at the frequency of operation and this, together with the gain of the maintaining amplifier, means that there is an excess of positive feedback — far more than is necessary just to sustain oscillation. As a result the oscillation amplitude grows rapidly until it is limited on one extreme by collector-current cut off and on the other extreme by the collector voltage falling to base potential and so applying a low-resistance shunt across the circuit. In other words this particular oscillator generates rectangular waves; it is, of course, a multivibrator and because of the symmetry of the circuit either transistor can be regarded as the maintaining amplifier or frequency determining network. The circuit diagram is shown in its familiar form in Fig. 6 but if it is recast as in Fig. 7 it is easier to visualise the circuit as a combination of maintaining amplifier and frequency-determining network. The components R_1C_1 and R_2C_2 are chiefly responsible for determining the free-running frequency which is given approximately by

$$f=\frac{1}{0.7(R_1C_1+R_2C_2)}$$

So far in this discussion on oscillators it has not been necessary to mention the word "phase" but there is a type of oscillator in which the frequency-determining network operates by introducing phase shift. This is a workable solution if a symmetrical signal is being generated because, as shown in Fig. 2, for such signals the effect of 180° phase shift and signal inversion are indistinguishable. Thus in one form of phase-shift oscillator the frequency-determining network consists of a three-stage RC filter each section of which introduces 60° phase shift at the required frequency of oscillation. The circuit diagram is given in Fig. 8. If all three frequency-determining resistors have the same value R and all three frequency-determining capacitors have the same value C, the oscillation frequency is given by

$$f=\frac{1}{2\pi\sqrt{6}RC}$$

and the current attenuation at this frequency is 29. The current gain of the transistor must hence exceed 29 for oscillation to occur but it should not greatly exceed this value, otherwise the oscillation amplitude will grow as in the multivibrator circuit and, if it is limited by circuit features such as collector-current cut off, the output will no longer be sinusoidal. As shown in Fig. 8 a preset resistor in the emitter circuit can be used to adjust the current gain to the critical value which gives a sine-wave output, but a system of a.g.c. which keeps the maintaining transistor operating in class A is perhaps the best method of securing a pure output waveform.

Sixty Years Ago

The tremendous transmission distances nonchalantly achieved by Marconi operators and the commonplace use of wireless in military form might tend to obscure the fact that communication was still, in 1916, chiefly telegraphic, using spark-gap oscillation generators. A review article in June 1916 covered the field of such generators and was one of the earliest articles to fully explain the valve oscillator, to be used for the transmission of speech.

"In 1884 Edison showed that an incandescent filament of carbon (such as a lamp filament) possesses the property of ionising the surrounding air, so that it becomes a unilateral conductor.

"This property has been turned to practical utility by Dr Fleming and others, and forms the basis of the well-known Fleming oscillation valves which are now often used as wireless detectors. Some of these values have characteristics (ie volt-ampere curves) which at some point are negative, like an arc characteristic, and hence it is possible to use such valves as generators of oscillations just as the arcs can be so used.

"The mode of operation of this type of apparatus may be briefly summarised as follows: The hot filament has the property of emitting negative electrons, and hence the combination of hot filament and cold plate in an exhausted vessel forms an electrical conductor, which will allow current to flow in one direction only — that is to say, it is a unilateral conductor, and therefore will exert a rectifying action on an alternating P.D. applied to it. Since the current passing through this vacuous space is carried by a stream of moving electrons, and since an electron is merely a negative electric charge, it is evident that the motion of the electrons can be influenced either by an electro-static or by a magnetic field, . . ."

SHURE®

COMMUNICATIONS MICROPHONES

SEE SHURE® AT COMMUNICATIONS '76 STAND 130

the vital link when the message must go through.

Shure Safety Communications Microphones are routinely subjected to 2-metre (6 ft.) test drops onto hard floors . . . over and over and over again, and even though they've been manhandled and abused

...THEY WORK

Shure Safety Communications Microphones are tested with violent vibrations up-and-down, side-to-side, and back-and-forth *simultaneously* . . . and even though we tumble 'em around for a while for good measure

...THEY WORK!

Shure Safety Communications Microphones are tested for level and response at a searing 70° C . . . often up to an incredible 85° C for day-long periods . . . and even though the inside parts are too hot to touch

...THEY WORK

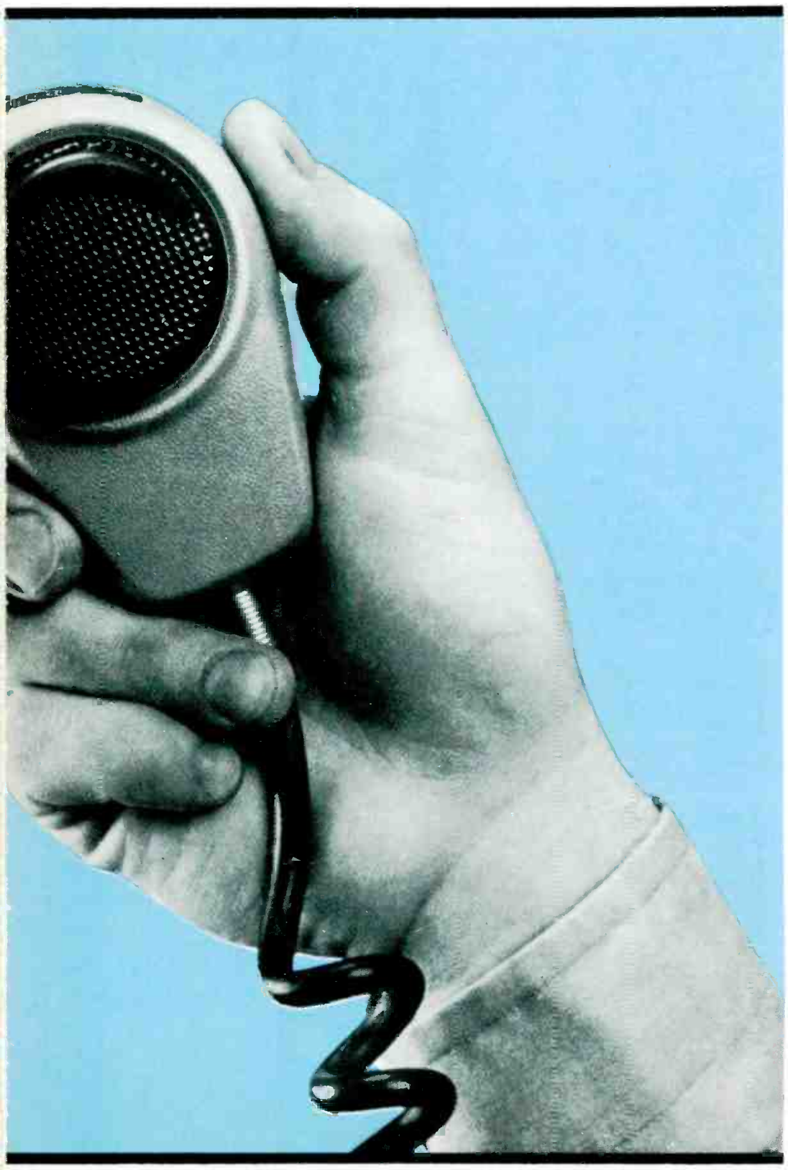
Shure Safety Communications Microphones are plunged to an appalling −45.6° C for half hour periods during severe temperature tests, and even though they're covered with frost

...THEY WORK

SHURE COMMUNICATIONS MICROPHONES:

THE STANDARD OF THE WORLD

A definite margin of extra reliability is the reason why, in the United States as well as in many other countries, Shure Mobile Communications Microphones are used with more public safety and professional business communications transceivers than all other brands combined. They are thoroughly field-proved. They perform when the chips are down, as they have been doing for over 20 years. Even after years of constant use and abuse in the most critical situations, often under the most adverse conditions imaginable, *they deliver* . . . they get intelligible messages through when it counts.



THE NEWEST BASE STATION MICROPHONE WITH POWER AND INTELLIGIBILITY!

Strong, Clear Transmission

The new Shure 526T Super Punch Base Station Microphone features a high-articulation dynamic element and a transistorized preamplifier that operates for hundreds of hours on a standard 9-volt battery. The variable output level control allows you to maximize transmitter modulation for increased "talk power," regardless of your speaking distance from the microphone.

Improved Intelligibility

The high quality dynamic transducer guarantees clear voice signals with a response that is optimized for maximum intelligibility with AM and sideband transceivers—even with a high background noise level. And the 526T is immune to hum pickup and radio-frequency interference.

All These Extras, Too!

- Includes a two-way NORMAL/VOX switch
- Push-to-talk switch—locks-in for lengthy transmissions
- Electronic or Relay switching
- High-impact Armo-Dur® case to withstand the roughest use

SPECIFICATIONS

Model 526T Transistorized Base Station Microphone

Type: Dynamic (with battery powered transistor preamplifier)

Frequency Response: 200 to 6,000 Hz, optimized for maximum vocal "punch" and intelligibility with AM and sideband units (See Figure C)

Polar Pattern: Omnidirectional

Output Impedance: 5,000 ohms

Load Impedance: 1,000 ohms minimum

Output Level: Adjustable from 0.63 to 14 mV for 1 microbar input

Battery Type: 9 Vdc

Battery Drain: 0.9 mA

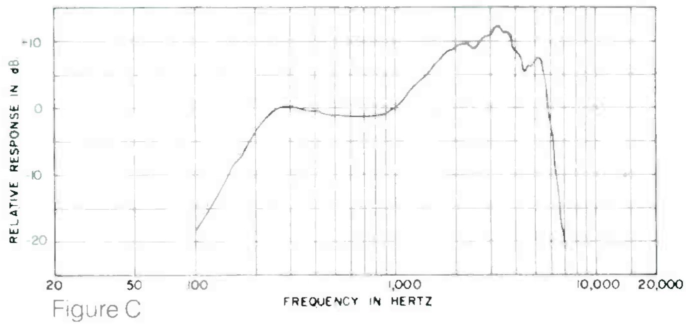


Figure C

Switches: Single-bar, locking or non-locking, push-to-talk switch. NORMAL/VOX, single-pole, double-throw slide switch

Cable: Non-detachable, 2.1 m (7 ft.), three-conductor (one conductor shielded), plastic-jacketed cable

Case: Black high-impact Armo-Dur®

Dimensions: 264 mm x 108 mm x 149 mm deep (10⅜ in. x 4¼ in. x 5⅞ in.)

Model 524C

Ranger 2

THE MICROPHONE ON THE MOVE...

The new Shure Ranger 2 Microphone serves double-duty: It combines the quality transmission of a dynamic-element microphone with the Shure reputation for rugged dependability in mobile and fixed-station microphones.

Internally, a silicon transistor amplifier provides a direct replacement for a carbon microphone with reduced sensitivity to hum pickup and susceptibility to interference. The Ranger 2's wide 300 to 5,000 Hz frequency response range and low distortion are specially tailored for unusually smooth, natural voice signals.

Externally, there's the famous Armo-Dur® case that's lighter and stronger than die-cast metal (and comfortable to hold at any temperature). The coil cord is jacketed with long-life neoprene. Constant use and rough handling won't affect the "million-cycle" leaf-type switch—it's engineered to withstand the severest conditions. All this in a compact size for easy handling.

Together, the superior performance and heavy-duty construction offer you the clearest choice in communications microphones today!

SPECIFICATIONS

Model 524C Transistorized Dynamic Hand-Held Microphone

Type: Dynamic (with transistor preamplifier for carbon microphone circuits)

Frequency Response: 300 to 5,000 Hz (See Figure A)

Output Level (at 1,000 Hz, 5/16 in.): −44 dB (6.32 mV) with 10 Vdc, 500-ohm load (0 dB = 1 volt per microbar)

Load Impedance Range: 250 to 2,200 ohms

Maximum Signal (with 10 Vdc, 500-ohm load): 118 dB SPL at 1,000 Hz produces 0 dBV (1.0V) at 10% THD

DC Supply Voltage Range: 2.5 to 35 Vdc

Switch: Double-pole, single-throw, leaf-type, push-to-talk

Cable: Non-detachable, 1.5 m (5 ft.), four-conductor, neoprene-jacketed coil cord

Case: High-impact Armo-Dur®

Dimensions: 52.4 mm x 72.2 mm x 39.7 mm deep (2-1/16 in. x 2-27/32 in. x 1-9/16 in.)

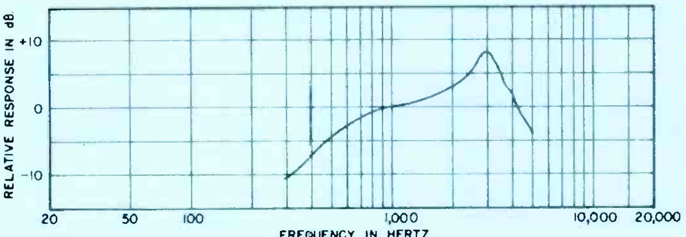


Figure A

Series 577

Sonobar

Microphones: Break the Sound Barrier!

Be heard, even when ambient noise levels are so high you can hardly hear yourself. The 577 Sonobar Noise-Cancelling Dynamic Microphones dramatically block unwanted noise and boost close-up voice signals. The 577s' noise-cancelling pickup pattern and "tailored" voice-range frequency response can discriminate against environmental noise so that the transmission sounds loud and clear—even in noisy factories, disaster areas, or airport ramp areas.

The 577 Series features three models: the 577A for high-impedance inputs . . . the 577B for longer cable lengths (low impedance) . . . and the 577C transistorized carbon replacement model.

All have the tough Armo-Dur® cases to repel oil, grease, fumes, salt spray, humidity, and rust! A "lifetime" hang-up button and mounting bracket, Triple-Flex coiled cable, and shock-resistant construction features are all part of the 577s' built-in durability.

SPECIFICATIONS

577 Series Noise-Cancelling Dynamic Microphones

Type: Dynamic, Noise-Cancelling

Frequency Response: 100 to 5,000 Hz (See Figure B)

Impedance: Model 577A: High impedance for connection to high-impedance inputs
Model 577B: Low impedance for connection to microphone inputs rated at 25 to 200 ohms
Model 577C: Transistorized for carbon microphone type circuits: Load Impedance Range: 250 to 2,200 ohms

Output Level
(at 1,000 Hz, 5/16 in.):

Open Circuit Voltage

Model 577A	**Model 577B**	**Model 577C***
−63.5 dB (.63 mV)	−84 dB (.062 mV)	−47 dB (4.5 mV)

(0 dB = 1 volt per microbar)
*With 10 Vdc, 500-ohm load

Power Level: −61.5 dB (Model 577B)
(0 dB = 1 milliwatt with 10 microbars)

DC Supply Voltage Range (Model 577C): 2.5 to 35 Vdc

Hum Sensitivity: (Equivalent to)
Model 577A: 44 dB SPL in 1 millioersted field
Model 577B: 32 dB SPL in 1 millioersted field
Model 577C: 27 dB SPL in 1 millioersted field

Switch: Double-pole, single-throw, leaf-type, push-to-talk

Cable: Non-detachable, 1.8 m (6 ft.), neoprene-jacketed Triple Flex coil cord
Model 577A: Three-conductor (one conductor shielded)
Model 577B: Four-conductor (two conductors shielded)
Model 577C: Four-conductor (non-shielded)

Case: Two-tone Grey, high-impact Armo-Dur®

Dimensions: 66.7 mm x 93.6 mm x 44.9 mm deep (2-5/8 in. x 3-11/16 in. x 1-25/32 in.)

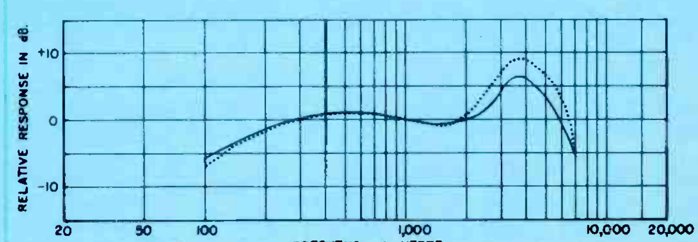
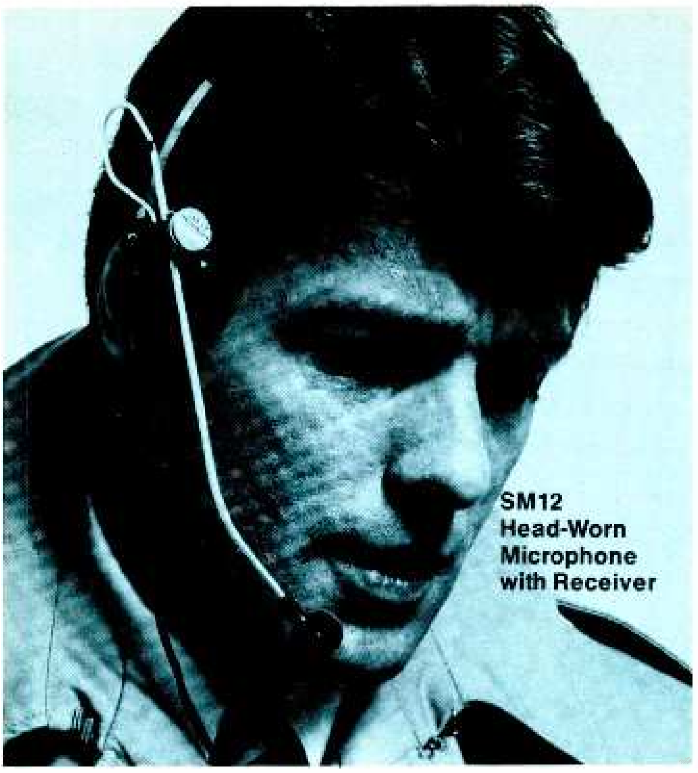


Figure B



HANDS-FREE TRANSMITTING with built-in noise control!

All new and field-proven! Shure's SM10 Head-Worn Microphone and SM12 Head-Worn Microphone/Monitor have every transmitting convenience you will need built into three ounces of comfort. Both microphones have high-power, clear-signal dynamic elements for maximum intelligibility. Yet, no batteries or cumbersome controls are needed—your hands will be free for note-taking or driving.*

The SM10 and SM12 are specially designed to reduce pickup of annoying background sounds without masking close-up voice signals. Unidirectional pickup pattern means only the sounds of your voice are transmitted. The anti-noise feature is further enhanced by a strong, natural voice frequency response (50 to 15,000 Hz) that minimizes low background rumble. A built-in windscreen filter eliminates other noise distractions.

Headset mouthpiece is designed to pivot and extend to fit any face. Adjustable frame and padded headband assure a pleasant fit for anyone, too.

*when used with a footswitch or other relay arrangement (not supplied with microphone)

SPECIFICATIONS

MICROPHONE (applies to both SM10 and SM12):

Type: Dynamic, Close-Talking

Frequency Response: 50 to 15 000 Hz (See Figure D)

Polar Pattern: Cardioid (unidirectional) response—uniform with frequency, symmetrical about axis (See Figure E)

Impedance: Microphone rating impedance is 150 ohms (200 ohms actual) for connection to microphone inputs rated at 25 to 200 ohms

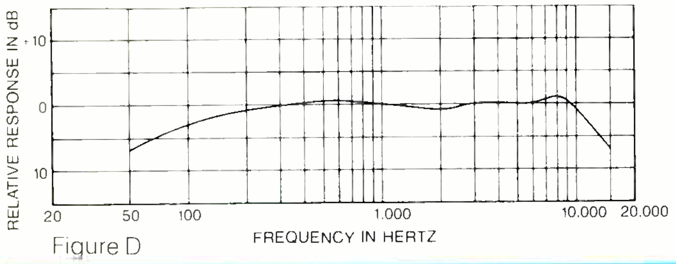


Figure D

Output Level (close-talked at 1,000 Hz):
Open Circuit Voltage . . . . –87 dB (.045 mV)
(0 dB = 1 volt per microbar)
Power Level . . . . –66 dB
(0 dB = 1 milliwatt with 10 microbars)

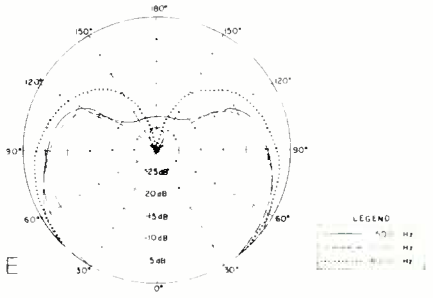


Figure E

Hum Sensitivity: Less than –62 dBm in 1 millioersted field

Phasing: Positive pressure on diaphragm produces positive voltage on pin 2 of microphone connector

Connector: Professional three-pin Male audio connector designed to mate with Cannon XL series, Switchcraft A3 (Q.G.) series or equivalent connector

Cable: Non-detachable 1.5 m (5 ft.), four-conductor, shielded, plastic-jacketed; additional 0.3 m (12 in.), two-conductor receiver cable attached to microphone connector on the SM12

Case: Black thermoplastic microphone and pivot housings, anodized aluminum end caps, stainless steel grille, ear tube and boom

Dimensions: 202 mm (7 15/16 in.) long; 44.5 mm (1 3/4 in.) maximum height (pivot housing).
Microphone: 15.9 mm (5/8 in.) diameter; 14 mm (9/16 in.) height

Optional Accessory: A10CH Cough Button

RECEIVER (SM12 Only):

Type: Dynamic

Frequency Response: 70 to 12,000 Hz

Impedance: 2,000 ohms at 1 kHz (200-ohm cartridge with matching transformer in phone plug)

Output Level: 106 dB SPL with 1.414V at 1 kHz (1.0 mW into 2 cc cavity)

Phasing: Positive voltage on phone plug tip produces positive pressure in ear tube

Connector: Phone Plug (contains matching 2,000:200 ohm transformer)

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SHURE®

Communication theory

3 — The digital revolution

by D. A. Bell

University of Hull

In speaking of the "digital revolution" I am not thinking of the proliferation of digital computers (though this has its impact on telecommunication through the need for data transmission) nor of the fact that a simple pocket electronic "digital calculator" is now in almost the same price bracket as a good slide rule, its analogue predecessor; I am thinking rather of the impact of digital techniques on television (mostly behind the scenes) and on the use of the Post Office telephone network for the communication of both data and speech, with developments in Viewphone as well. All of these digital developments depend on the flexibility which digital techniques allow in exploiting three key features of Shannon's communication theory, namely *redundancy*, the possibility of an *exchange between signal-to-noise ratio and bandwidth*, and a certain *symmetry between time and frequency* in the calculation of information rate and channel capacity.

The problem of television standards conversion became important in this country as soon as BBC2 was introduced with 625 lines while BBC1 continued to use 405 lines (see *Wireless World* May 1971.) Then the development of international exchange of television programmes, especially since communication via satellite has been available, has drawn attention to the fact that there are also differences between scanning standards used in different parts of the world: in North America they have 525 lines per picture and 60 (interlaced) fields per second, but in Europe we usually have 625 lines with 50 fields per second. (There are also differences in colour transmission, such as between N.T.S.C., PAL and SECAM.) Conversion between these standards requires storage, and storage of information is simple and reliable only when it is in digital form.[1] Since the development of l.s.i. (large scale integration) both semiconductor memories and shift registers have become comparatively cheap, so that the digital solution is also an economic solution. In the simplest case each picture element is represented by several bits (as described below for p.c.m.) and the number of bits is minimised by non-linear quantisation, using small steps for small signals but larger steps at each end of the scale.

There is also a great deal of redundancy in picture signals arising from the fact that neighbouring points are related to each other – they are said to be correlated. This correlation reduces the amount of information in the signal, but it is difficult to use because one must make provision for the occasional picture in which there is not much correlation – e.g. if the camera is panned across a scene. In most pictures, however, the difference between adjacent points in a line is much less than the full swing from black to peak white. It follows that for the same gradation of grey the signal conveying the difference between adjacent points will nearly always require fewer steps than would be needed to convey the absolute value of each point. So this *differential* p.c.m. (or d.p.c.m.) can use fewer bits per sample than direct p.c.m., which is particularly valuable if the picture has to be transmitted through a limited channel. The addition of vision to an ordinary telephone circuit ("Viewphone" in Britain or "Picturephone" in the Bell System, USA.) is a case where (a) economy of bandwidth is of great importance and (b) occasional momentary degradation of the picture may be tolerable. The addition of vision to an ordinary telephone channel may seem an extravagant luxury, but its supporters claim that it is justified by fuel economy if the addition of vision to the communication channel makes it an acceptable alternative to face-to-face meeting and so reduces travel. Bandwidth economy in television was the subject of a great deal of investigation some years ago[2] but in those days only analogue devices were considered for providing the storage from line to line or field to field which is needed to take advantage of the correlation in space between adjacent points or the correlation in time between the same points in successive scans ("picture difference" transmission)[3]. Now Post Office designers of Viewphone suggest digital

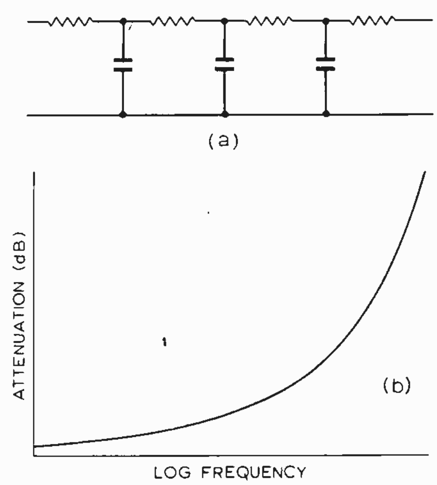

Fig. 1. (a) Lumped circuit approximation to an unloaded line. (b) Frequency response of such a network.

storage of a line in shift registers[4] so that use may be made of correlations between points which are adjacent vertically, in different lines, as well as that between adjacent points in the same line. A more elaborate system has been proposed for the American Picturephone, utilising correlation between successive scans. This has a buffer store of 67,000 bits (equivalent to about 4,000 words storage for a minicomputer using 16-bit words); and if movement in the picture destroys correlation to such an extent that a scan cannot be compressed into this size, the picture is deliberately degraded in two stages. First the scan is coarsened to use only half as many picture elements per line; and if that does not suffice the second stage is to omit a complete scan and instead re-transmit the previous scan.[5]

Another digital development in television is the transmission in the field blanking interval of alpha-numeric data. The system is called teletext (Oracle by the IBA and Ceefax by the BBC); and any viewer who has the appropriate adjunct for decoding, storage and character generation (as recently described in this journal) can choose at any time to have the picture on his screen replaced by a page of information consisting of latest news or any one of a hundred or so pages which may be available.

But in more mundane telephone communication, digital methods first came in with the use of p.c.m. on junction lines which are usually in the range of 10 to 30 miles long and employ multi-pair paper-insulated cables – the last kind of cable one would think of for the transmission of a wide frequency band or narrow pulses. These cables have very little inductance of their own so that ideally they would behave as CR circuits (Fig. 1a) with a frequency response which falls continuously for all except the very lowest frequency (Fig. 1(b).

The equivalent circuit of Fig. 1(a) with capacitors at intervals is only an approximation, since in fact the capacitance is uniformly distributed along the cable; but Pupin pointed out a long while ago that if one had inductance distributed along the line as well, or an approximation to this in the form of loading coils at intervals (Fig. 2(a), the cable became a lossy low-pass filter which passed all frequencies up to a definite cut-off but very little beyond. So most telephone cables have these loading coils at intervals so as to maintain a uniform pass-band with a signal/noise ratio better than 50dB which is then divided into telephone channels by frequency-division multiplex. Now a binary signal can tolerate a much lower signal/noise ratio and the signal after regeneration is independent of the signal/noise ratio. Therefore a binary signal can use a much wider frequency range in Fig. 1(b), and does not require the attenuation to be uniform within that range.

In p.c.m. we need to sample the analogue signal twice per cycle, but Nyquist says we can transmit two pulses per second per hertz of bandwidth: so there appears to be no change so far. But if we are to reduce the pulses to a binary scale, i.e. p.c.m., we need several pulses per sample; and in fact eight are used, seven to quantize the signal into 128 levels and one for synchronising and signalling. The bandwidth is increased eightfold; but the characteristic of the cable is such that the useable bandwidth increases more than eight times when one drops the signal/noise ratio from that required for a good telephone channel to that required for binary signalling, so there is a net profit on the exchange. In terms of communication theory, this is an example of trading signal/noise ratio against bandwidth.

Pulse code modulation is now in widespread use on junction lines.* It should be recognised that an important factor contributing to this is the availability of solid-state circuits for handling quantized signals which combine complexity of logic circuitry with small size, low power consumption and reliability. In the days of valve amplifiers the repeaters (line amplifiers) were usually housed in telephone exchanges, or occasionally in separate buildings. Such housing was necessary on account of their bulk, the need for a substantial power supply (with means of maintaining power in case of a mains failure) and the need for access for maintenance. Now, a solid-state regenerative repeater is put in whenever a loading coil is taken out. The loading coils were usually inserted at intervals of about a mile, and housed in cable-jointing chambers below manholes. A small solid-state regenerative repeater can be put there instead, and its small power requirement supplied along the telephone cable from the nearest exchange.

The spacing of repeaters is important. The signal must not be attenuated below the permissible signal/noise ratio

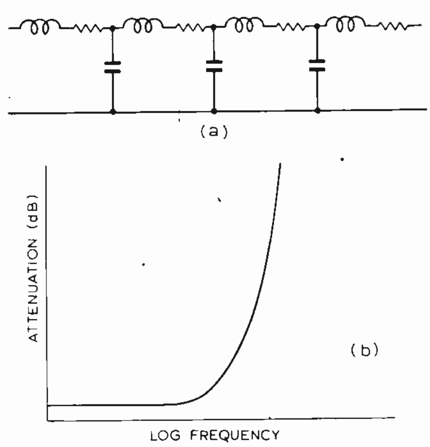

Fig. 2. (a) An inductively loaded line. (b) Bandpass frequency response of the loaded line.

before arriving at the next repeater; but the attenuation increases with frequency so that the maximum frequency which can be used depends on the closeness of spacing of repeaters.

For some thirty years engineers have been seeking an all-electronic telephone exchange. Note that I said "all-electronic" because the present generation of what are generally called "electronic exchanges" are really electronically controlled electromechanical exchanges. You must first understand that a telephone exchange has three functions: (a) to provide a switchable path for speech signals from an incoming to an outgoing line; (b) to receive, act upon and generate signals for controlling the speech path and (c) to interpret the signals and other data so as to provide speech paths efficiently. If we think of the old type of manual switchboard, (a) is provided by jack plugs and cords which can connect selected jack sockets, (b) depends on the senses and limbs of the operator (e.g. seeing a calling subscriber's light, switching ringing tone on a called subscriber's line) and (c) depends on the operator's brain.

In the past generations of automatic exchanges, (b) and what could be done towards (c) were implemented by relay logic, and this has been replaced by computer-like electronic circuits in the current generation of electronically controlled exchanges.[6] But there has been comparatively little success in the search for a solid-state replacement for the metal-to-metal contact in the speech-path switches, though the mechanical form of the contacts has changed from Strowger two-motion switches through cross-bar switches to the sealed reed relays used in the current electronically controlled exchanges.[7] The metal-to-metal contact has virtually infinite ratio of open to closed resistance, perfect linearity and no noise in normal functioning. Engineers became increasingly convinced that these characteristics could not be approached by any solid-state device and therefore solid-state switches could not be employed in an analogue speech path. But the use of digital signals such as p.c.m. makes the characteristics of the switches far less critical, so that solid-state switches would be useable.†

Once an analogue signal has become contaminated with noise, it can never be "cleaned"; and the noise components introduced at successive links in the route are additive. A digital signal, on the other hand, can be regenerated by threshold devices so that it leaves each repeater stage as a perfectly clean on/off signal. The Post Office therefore took the view that a future "System X", which will one day supersede the present generation of electronic-control - plus - reed - relay - switching exchanges, will employ digital transmission on the main trunk circuits. Preliminary trials on trunk transmission between Portsmouth and Guildford using high-speed p.c.m. have recently been initiated by the Post Office.[8] Again there has been an exchange of bandwidth against signal-to-noise ratio, since p.c.m. at 120Mbit/s is sent over a coaxial cable which could only be used up to 12MHz for f.d.m. The first consequence of this change to digital transmission will be that our familiar frequency-division multiplexing will be replaced by time-division multiplexing. Then instead of picking out a frequency channel with filters we shall pick out a time-slot by strobing. Some of the exchange switching can then be replaced by the matching of time-slots between incoming and outgoing lines, but some switching of circuit connections (known as "space switching") will probably be needed as well. But in view of the greater tolerance of digital signals, "cross-points"** could be solid-state.

* Lines 10 to 30 miles long which give direct connection between local exchanges, without using the trunk system.

† See section headed "Electronic exchanges" in "Centenary of the telephone", Wireless World, March 1976, p.92. — Ed.

** See Appendix for explanation of "cross-point".

A few years ago this was unquestioned and there seemed no hope for solid-state cross-points outside digital systems. Recently, however, there has been a revival of interest and a dozen manufacturers in the USA offer private automatic branch exchanges (PABX) using solid-state technology which offers the advantages of small size and little maintenance requirement. Most of them use four-layer devices, analogues to thyristors, as cross-points. But the point is that in this case the speech goes through only one solid-state switching system (or at most two if the subscriber at each end of the line has a solid-state PABX). This contrasts with the number of exchanges which may be involved in a long-distance call over a public network, and of course any noise or distortion arising in successive exchanges is additive.

An immediate advantage expected from digital transmission of speech is that data in binary form can immediately replace the p.c.m. signals. There has been much controversy over the question of whether we need a separate data network in addition to the telephone network. At present digital signals are usually fed into the frequency-division multiplexed analogue telephone system through modems (modulator-demodulators) which convert the on/off binary signal into a more or less complicated system of frequency-shift, phase-shift or multi-level amplitude modulation of an audio tone. It is much simpler to send binary digits straight to line, if the line is tailored to handle digital signals. Since the telephone network provides almost universal coverage, it seems uneconomic to set up another network alongside it just to handle data. So making telephoning digital confers a further advantage if it makes telephone traffic and data traffic fully compatible. (But it must be remembered that the telephone system is at times fully loaded, so that extra trunk lines and switching plant would be needed to enable it to carry a significant load of data traffic as well.)

A development in networks intended solely for data is called "packet switching." This arises because transmitting data has some of the characteristics of sending telegrams: there is no need for communication to be instantaneous and simultaneous with the origination of the information, though one would prefer that any delay in data transmission should be measured in seconds rather than hours. Given adequate buffering, data signals which arise at irregular intervals can be sent at a steady rate (most of the time) over the main transmission channel.

The idea is in fact very old since what we shall now call "a node in a packet-switching network" has as antecedent "a torn-tape relay station in a telegraph network." Telegrams are normally transmitted via punched paper tape and if they had to be sent through a relay station they could be received there on a tape perforator. Originally an operator would read the address on an incoming message and at its end tear off the length of tape and transfer it to an appropriate transmitting machine for its particular destination; but later the address was read by machine and the length of tape directed automatically into the appropriate channel for re-transmission, where it might join a queue of messages for that destination. The equivalent in modern technology is obviously to have at the relay centre a computer with appropriate buffer stores.

The torn-tape telegraph relay is not of great practical interest now because it is usually easier to switch electrical connections, so why has the principle been revived for data transmission? The first answer is that there is a considerable demand for transmitting small units of data, such as banking transactions of individual customers, which contain no more than a few hundred characters. At the present time it may take 15 seconds to set up a long-distance s.t.d. connection so if the data can then be transmitted in a similar or shorter time the whole process is rather inefficient. Secondly there is the problem of concentration of local traffic into trunk lines, which in telephony is achieved at present by frequency multiplexing. In the transmission of telephony by p.c.m. the sampling pulses are generated within the exchange, so that although there are problems of synchronism between exchanges in the proposed digital telephone network the timing is at least all controlled within the system. (Incidentally, one proposed method of matching time slots between different exchanges is called "pulse stuffing" and consists in inserting extra pulses into the signals from one of the channels. This clearly could not be used in data transmission).

So the idea is that data should be divided into units called "packets" of perhaps 1000 bits, each carrying a destination address. These would originate at sources of various types, ranging from a keyboard to a 48kHz line from a computer centre and would all be sent to a local switching centre or node on the special network. The computer here would take them into store, read the address, sort them into strings according to destination and transmit at high speed (of the order of 100 megabits/second) to other nodes in the network. Precautions have to be taken to see that no packet is lost and to see that the packets in a series constituting one message arrive in the right order. At the present time there is considerable activity in the development of data networks. The first was ARPA, set up by the United States Department of Defense to link a number of computer centres which each contain one or more powerful computers. It has also some access points in Europe. Part of the argument for such a network is that a computer centre may specialise in some particular type of work for which its computer is particularly suitable on account of features such as the balance between fast-access store, backing store, input and output facilities, etc. It is then economic to send different kinds of work to different computers and a communication network serves this purpose. In Europe the emphasis is more on data collection, as implied in the explanation of packet-switching above. The British Post Office has opened an experimental packet-switched service on the route London-Manchester-Glasgow to assess the commercial value of such a system; the European banks are proposing a network called SWIFT for the rapid transfer of information about international banking transactions; there are plans for a European Information Network (EIN); and a EURONET is proposed to link all major scientific research establishments in Western Europe.

It seems a far cry from Shannon to digital television and packet-switched data networks. But the same principles apply throughout:

(i) All information is finite and can therefore be digitised.

(ii) The maximum capacity of any physical channel can be specified in terms of its bandwidth, signal-to-noise ratio and the time for which it is available.

(iii) Within the bounds set by (ii) it is possible to exchange signal-to-noise ratio against the bandwidth-time product.

No doubt we shall see many further applications of these fundamental principles as time goes by.

Appendix: Cross-bar and cross-points

The Strowger system of automatic telephony is based on its two-notion switch. This first moves vertically to one of 10 levels and then horizontally to one of 10 positions in the level so as to select one out of 100 contact pairs. This is a direct mechanisation of the action of the manual exchange operator in

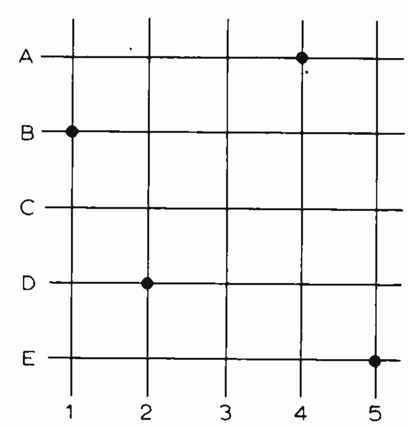

Fig. A. Principle of cross-point switch connecting any of inputs A, B, C, D, E to any of outputs 1, 2, 3, 4, 5.

selecting one out of a square array of jack sockets, but with one important difference. The whole of the Strowger switch remains engaged while the single call is passing through its contact field; but the operator after putting plugs in to make one connection can leave it and attend to other connections until she receives a signal to clear the first connection. The cross-bar switch, which is illustrated in principle in Fig. A comes nearer than Strowger does to simulating the methods of the human operator. The diagram shows input lines A, B, C, D, E crossed by output lines 1, 2, 3, 4, 5. At each point where the lines cross there is a switch, closing of which is indicated by a blob on the diagram. Thus the cross-bar switch can complete more than one circuit at a time: the connections shown are A→ 4, B → 1, D → 2 and E → 5. While the numbers of lines in each direction may be varied, the principle is now universal and the only question is what kind of switch or cross point should be used at each crossing. In the original cross-bar switches the contacts were metal-to-metal and operated by a mechanical system of solenoids, bars and latches; in the current electronically controlled exchanges they are reed switches; and there is an increasing probability of the future use of solid-state devices as cross-points in some applications.

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8. "High capacity p.c.m. system,". *Wireless World*, February 1975, p.92.

Literature Received

A guide to the range of thyristors, triacs and trigger devices made by Motorola is now available. Equivalents to other types are suggested and there is information on outlines and leads; application notes are listed. The guide is offered by GDS Data Centre, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks WW401

A price list of over 200 instruments, classified as signal sources, signal conditioners and analysers and measuring instruments, is produced by Lyons Instruments Ltd, Hoddesdon, Herts EN11 9DX WW402

Measuring instruments for hire are described and classified in the 1976 Livingston Hire Catalogue. Most common electronics laboratory instruments are listed, as well as a range of industrial equipment. The catalogue can be obtained from Shirley House, 27 Camden Road, London NW1 9NR WW403

High-voltage, stable and precise power supplies, intended for use with precision c.r.t. displays, photomultipliers and similar equipment, are described in a 4-page catalogue from CPS Inc., 722 E. Evelyn Avenue, Sunnyvale, California 94086, USA WW404

Memories, microcomputer kits and development systems (including peripherals) are briefly described, with prices, in a price list produced by Rapid Recall, all the components being by Intel. Rapid Recall Ltd are at 9 Betterton St, London WC2H 9BS WW405

"Foundation for a Career" is the title of a pamphlet, produced by the City and Guilds of London Institute, which outlines a scheme of courses to give school leavers vocational preparation. Five courses are described — construction, engineering, science industries, food industries and community care. Copies are available at 50p from the Sales Section of the Institute at 76 Portland Place, London W1N 4AA.

Digital, panel-mounted counters conforming to DIN43700 are produced by Orbit Controls and are described in their Industrial Electronic Instrumentation catalogue, available from Orbit at Lansdown Industrial Estate, Cheltenham, Gloucestershire GL51 9PL............................ WW406

A supplement to the Doram mail-order catalogue has been sent to us. New products include amateur radio modules, a 432MHz-to-28MHz transverter, a 70cm varactor tripler, a 500MHz prescaler and a 50MHz counter. Price reductions on small components are announced. Doram Electronics Ltd, PO Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds LS12 2UF WW407

Soldering irons, stands, de-soldering instruments and tools are fully described in a booklet from Adcola Products Ltd, Adcola House, Gauden Road, London SW4 6LH WW408

Hygrometers, dewpoint meters and moisture analysers made by Shaw are the subject of a catalogue recently received. Brief details are given of instruments for the measurement of moisture in a range of materials. Shaw Moisture Meters, Rawson Road, Westgate, Bradford WW409

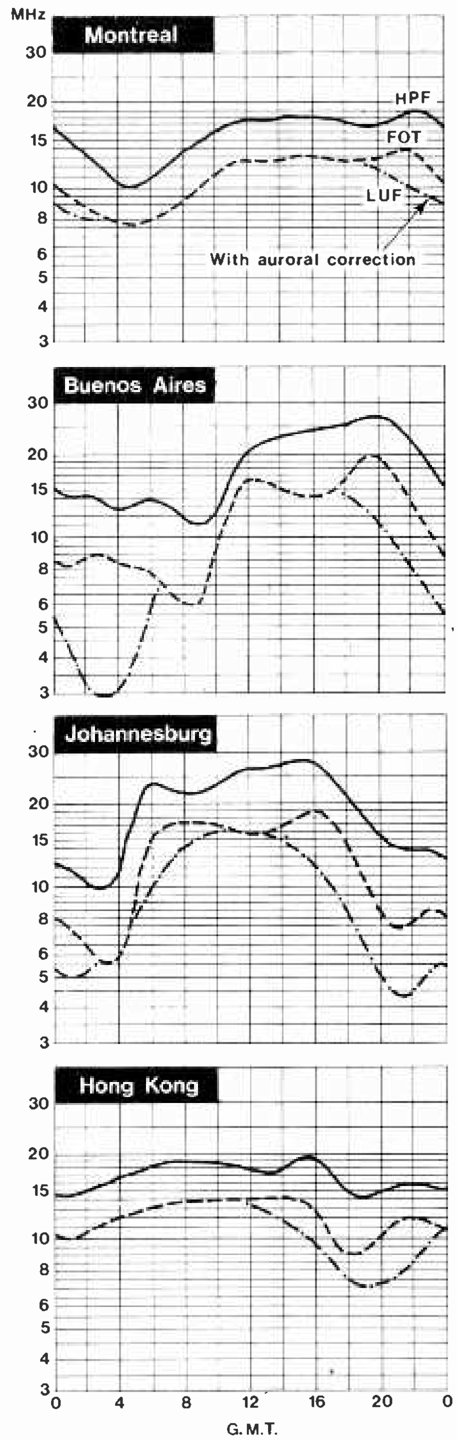
Coaxial connectors (Type N, BNC, 27, etc) and cables are illustrated and described in a new catalogue from Intel Connectors Ltd, R. F. Division, Henlow Trading Estate, Henlow, Beds. ... WW410

Thermistor materials, their resistance/temperature characteristics, tables, outline drawings and application information are presented in a new short catalogue by Fenwal Electronics. The catalogue can be obtained from Electrautom Ltd, Etom House, Queens Road, Maidstone, Kent WW411

Jitter when displaying data streams can be avoided by recognizing a selected data bit and generating an oscilloscope trigger at that time. Hewlett-Packard describe the 1620A Pattern Analyser, designed for this purpose, in application note 167-8, obtainable from King Street Lane, Winnersh, Wokingham, Berks WW412

HF predictions

Predicted disturbed periods are May 21 — June 2 and June 15–21. Seasonal trend and minimum solar activity combine to produce FOTs and LUFs which give a restricted choice of time and frequency for reliable day to day communication. This feature is most evident when both ends of a radio path are in the northern hemisphere mid-latitudes.



Wireless World Teletext decoder

8 — Modifications and lining up

by J. F. Daniels

Most constructors will probably want to use the decoder with a colour television receiver, but for those who use a black-and-white set, a few words on interfacing are needed.

Monochrome receivers

If a black-and-white receiver is to be modified then there are two options open to the constructor. The decoder may be wired in, in a similar manner to that described for the colour receiver, or a separate tuner and i.f. strip may be used, the output of the decoder being fed via a u.h.f. modulator into the receiver's aerial socket. This second method has the advantage that the decoder may be electrically isolated from the TV set. Whichever system is used, the best display will be obtained by mixing the red, green and blue outputs of the decoder together by means of variable resistors, the resistances of which may be varied to give the desired grey levels for different transmitted colours. Mixed syncs must also be added at this point to lock the scan circuits in the TV set. The problem most likely to be encountered with black and white sets, especially the older ones, is lack of bandwidth in the i.f. strip – a good reason for using the extra i.f. and modulator approach.

Character verticals

The following modification to the decoder circuitry has been found advantageous because it reduces the h.f. response requirements of the receiver video amplifier output stages. Fig. 1 shows the circuit, which uses existing "spare" i.c. gates. The extra gates are wired in series with the output of gate (57, 6). Gates (75, 8) and (75, 3) pass the signal through unchanged, but gate (75, 6) adds to the original signal a pulse derived from the trailing edge of the display character components. VR_3 can be adjusted to give the best character appearance, and the setting of this control will depend on the frequency response of the receiver video amplifiers. At zero resistance setting, the signal passes through this stage unchanged, but as the resistance is increased the width of the character verticals gradually increases until the appearance of the characters is obviously distorted. A suitable control setting should be found which gives the best character appearance.

Upper and lower-case characters

Texas Instruments have recently announced a new character generator i.c., the X887, which has been developed as part of their Tifax decoder module, and as the i.c. was specifically designed for Teletext decoders, it has a number of advantages over the 2513.

Firstly, it contains a complete set of upper and lower-case characters, which includes all those characters defined in the latest Teletext code table. Secondly it has provision for a four-bit row-select input code which means that all ten rows of the characters may be addressed independently, and no shifting of address codes is required for characters with "tails". Thirdly, it only requires a +5V supply, which means that the decoder power supply may be simplified as the −12V rail is now unnecessary.

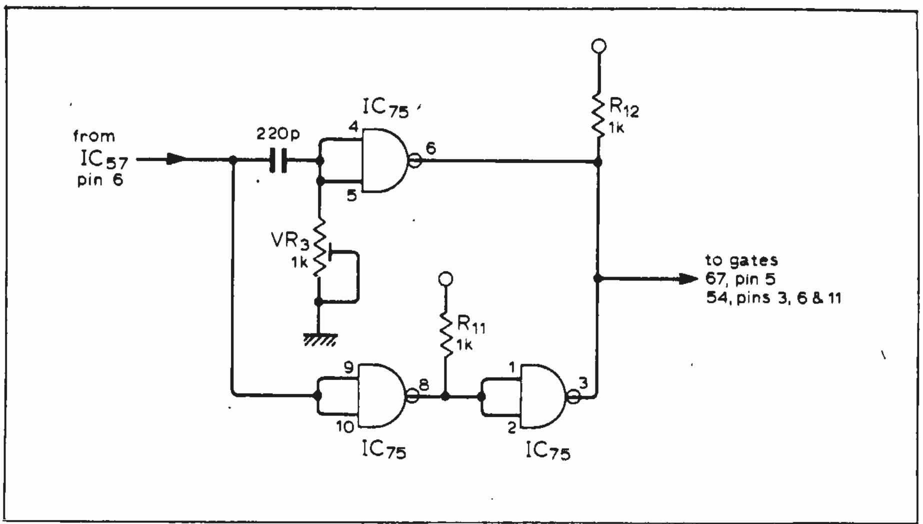
The circuit arrangement using the new i.c. is shown in Fig. 2 and is almost identical to the original circuit using the upper-case 2513. The differences are that all seven bits are now fed to the character-select inputs and the four-bit row-select inputs are fed from the Q_A, Q_B, Q_C and Q_D outputs of IC_5 directly. The Y_1-Y_5 outputs feed, as before, into the five open-collector gates, although the timing of the strobe pulses from IC_{42} has been changed slightly to allow for the faster access time of the X887.

The cost of the X887 is around £20, which makes it rather expensive compared with the 2513, but if a decoder with the lower-case facility is required, then the X887 is the obvious choice.

Line-up procedure

The following line-up procedure has been devised after lining up six decoders, but it does assume that the decoder has no faults and is being fed with a suitable video signal as described earlier. It would also be advisable to check that data is actually being transmitted on the selected TV channel, since the system is still in its experimental period and transmissions may be interrupted occasionally. To check the transmissions are present, reduce the height of the TV picture, or offset the vertical-hold control and look for lines of constantly-changing white dots and

Fig. 1. This modification reduces the degrading effect of poor video frequency / amplitude response in the television receiver. The effect is to broaden vertical components of characters.



dashes across the full width of the TV line in the field blanking interval.

The line-up procedure requires no test gear, but the power supply rails should be checked with a multimeter prior to following these instructions.

Set the six preset potentiometers (three on the analogue board, two on digital board 1 and one on digital board 2) to mid-position. A screen full of random characters will probably be obtained, because the flip-flops in the r.a.m.s take up random states at switch-on. Do not, however, push the clear-page button at this stage.

Adjust VR_3 on the analogue board (set sync separator) to give a display that is free from vertical jitter. Turning the potentiometer too far in one direction will cause the display to jitter vertically and move down the screen. Turning it too far the other way will make the display disappear altogether.

Adjust VR_1 on the upper digital board (horizontal shift), and VR_1 on the analogue board (display width) to give a correctly-centred and suitably proportioned display.

Connect a link between pins 13 and 14 of IC_9. This disables the "framing-code allow" monostable, and this is essential during the first part of the setting up procedure.

Switch the decoder to the "roll" mode and adjust L_1 to give the maximum amount of "movement" of the display. The characters should start changing at random and this may appear to be happening on consecutive rows from top to bottom of the screen, giving a "rolling-through" appearance. If so, adjust the coil for the most consistent rolling-through action. If the coil former being used is not the specified one, then the oscillation frequency can be checked as follows: – disconnect the uppermost wire link to the analogue board, (lines 11-21) and adjust L_1 to give a display of approximately the correct width. (Disconnecting this link inhibits the display oscillator and makes the data oscillator operate the whole time, so the characters will appear rather ragged). If this is outside the range of adjustment of L_1, adjust the value of C_2 until the width of the display is approximately correct. Reconnect the link to the analogue board.

Adjust VR_2 on the analogue board (slice level) to improve the rolling through action and some correct pages may now be observed changing very rapidly. Continue adjusting L_1 and VR_2 alternately to give the best rolling action. (N.b., when the roll mode is selected the decoder reads out each data row as it is transmitted, and this enables the effect of each adjustment to be observed, instantaneously, rather than having to wait for up to 15 seconds, which would be the case if pages were selected in the normal way.

Remove the link from IC_9, pins 13 and 14. The rolling-through action will probably cease. Adjust VR_2 on digital board 1 carefully, until the rolling-through action begins again. This control has an "on-off" action, unlike those previously adjusted, and is necessarily quite critical in its setting. The adjustment should be checked on different TV channels, since there may be slight differences in the position of the framing code between different channels.

Switch off the roll mode and select a clock-cracker page (at the time of writing page 899 on Oracle or page 140 on Ceefax). This page is used to accurately check the frequency of the data oscillator, and consists of 14 consecutive 1s followed by two 0s repeatedly across each row of the page. This means that the data oscillator gets the least possible amount of locking information on each line and so must free run at the correct frequency for almost two bytes of data. If L_1 is not quite correctly adjusted, a regular pattern will appear on the left-hand side of the screen which will gradually disappear or turn to "rubbish" on the right-hand side. L_1 should be adjusted a quarter of a turn at a time, until the page readout produces a pattern which is even over the whole screen. The two photographs in Fig. 3 show a correct and incorrect clock-cracker readout. These photographs were taken from the output of a decoder which had a lower-case character generator installed, and the characters displayed when an upper-case-only decoder is used are

Fig. 2. The revised character generator, which uses the Texas X887 to display both upper and lower-case characters, as well as the complete Teletext symbol set.

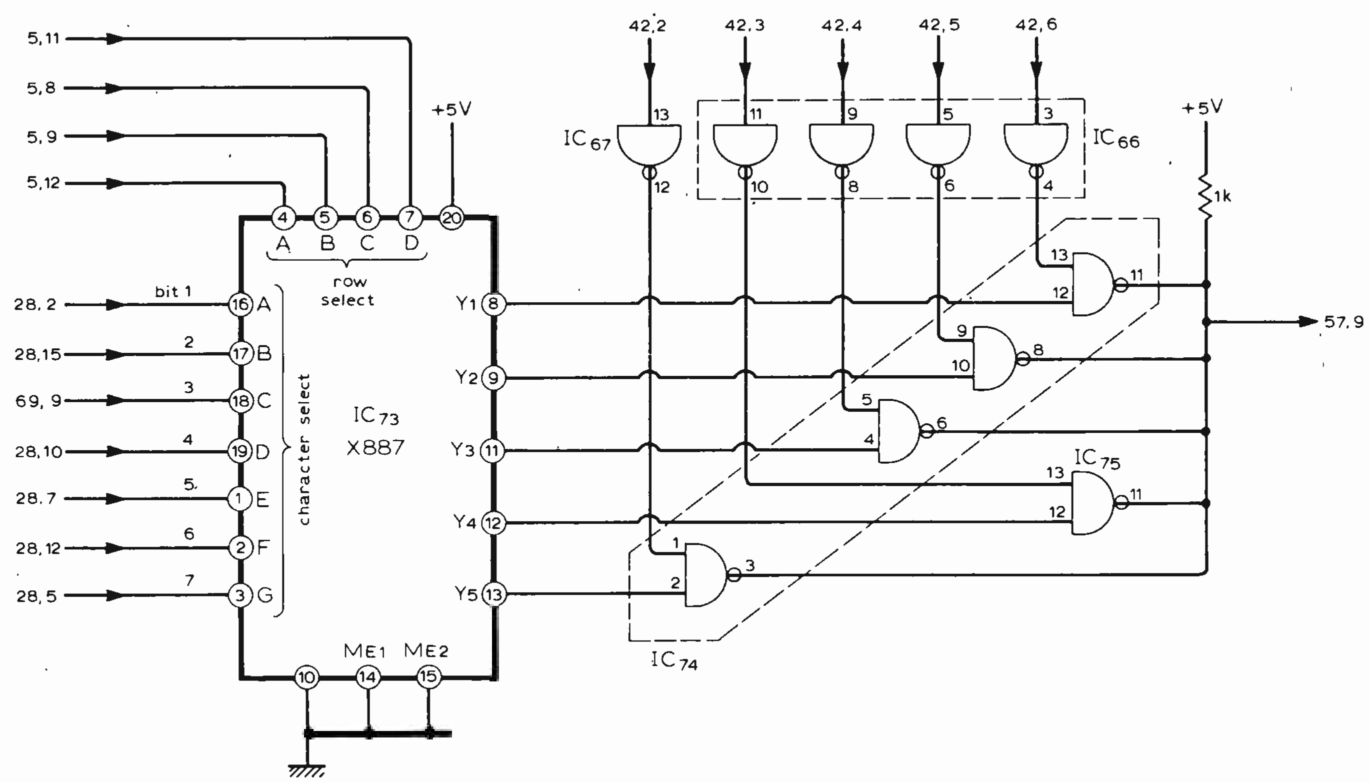
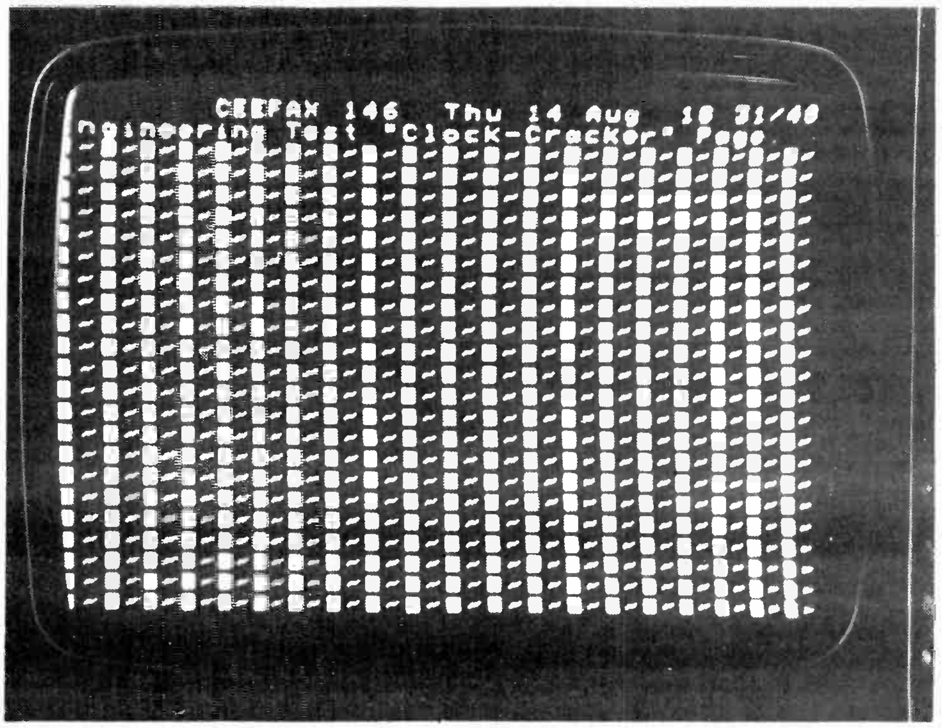
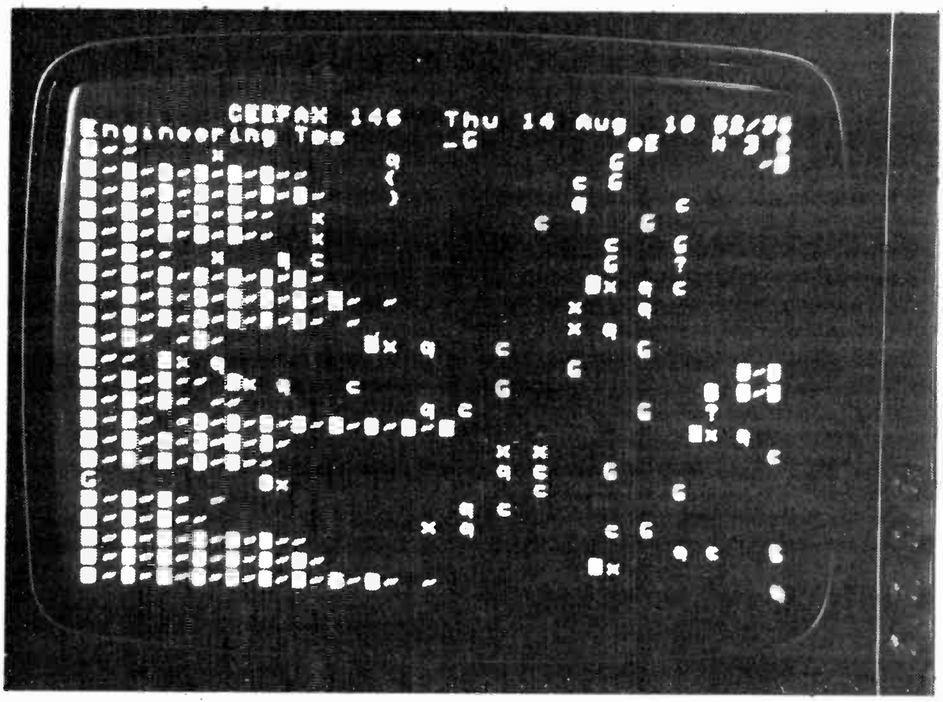


Fig. 3. The "clock-cracker" page, with L_1 (April issue, p.66) correctly adjusted is shown at (a), while the result of incorrect tuning is seen in (b).





different to those shown. The principle of adjustment is, of course, the same.

Finally adjust the slice level control (VR_2 on the analogue board) to give the most error-free page readouts, selecting pages in the normal manner. If the contrast control on the TV set alters the amplitude of the signal being fed to the decoder, check that both the sync separater and the data slicer work satisfactorily over the required range of the control.

Check that the decoder function switches operate correctly and adjust VR_3 on the lower digital board to give the most pleasing character appearance.

Fault finding

Experience with a number of decoders has shown that faults are almost invariably caused by i.c. pins being left unsoldered, especially on the top side of the p.c. boards, or missed connected-through holes, so it is best to check the boards very carefully before attempting the line-up procedure.

Faulty or suspect t.t.l. gates can be checked fairly easily by means of d.c. tests (remember that t.t.l. outputs can be shorted to the 0V rail for "in-circuit" testing of following gates, but must not be connected directly to the +5V rail.) If an oscilloscope is not available, suspect counters can only really be checked by substitution. Faulty r.a.ms can easily be detected by spotting an abnormally large number of spelling mistakes on each page and by consulting the code table, the bit which is common to all the incorrect letters can usually be located.

Installation

A few final hints on wiring the decoder into a domestic receiver may be of some use. Coaxial cable must be used for the video input feed to the decoder, and this should be kept as short as is practical. The other feeds to the decoder will be +5V, −5V, −12V and 0V. From the decoder to the receiver there will be red, green and blue output signals, the video switch control wire, and the clamp pulse feed. These last nine feeds may be combined in a single multicore type of screened cable. Screening is necessary to prevent pick-up of the high frequency display components of the output waveforms in the receiver sound or video stages.

Finally it must be stressed again that great care must be taken when connecting the decoder into the TV receiver, to ensure that every possible safety precaution is taken. The decoder box must be effectively **earthed,** not connected to the TV chassis, and there must be no exposed connections that are at anything other than earth potential. An isolating transformer (which allows the receiver chassis to be earthed) must be used while lining up the decoder, but if the above precautions are observed, this will not be necessary once the decoder is installed in its box.

Acknowledgments

I would like to thank Mullard Ltd for their help with character generator i.cs and also my colleagues, Dave Beavan, Norman Riggs and Arnie Tidder for their helpful suggestions and help with building the prototype decoders.

World of Amateur Radio

Is h.f. propagation getting worse?

The many months during which amateurs have struggled with low m.u.fs and early closing of the h.f. bands have underlined the recognised problems of the classic 11-year sunspot cycle. It is not so much that long-distance low-power signals disappear altogether but rather that activity becomes bunched on low frequencies, stations are heard more spasmodically and the resulting contacts go more and more to the elaborately equipped stations having effective aerials, leaving the less ambitious stations struggling after the occasional better "openings."

Such conditions this past winter came as no surprise to those radio amateurs whose memories stretch over several sunspot minima. But beyond this anticipated and transient deterioration there is another possibility that is attracting some attention: is there evidence to support a view that m.f.-h.f. radio propagation may be gradually changing – for the worse? That "average" propagation conditions today are less good than in the twenties or thirties?

Some people believe that a deterioration of conditions has been disguised by the gradual improvement in receivers and in the higher powers used by broadcasters and amateurs. Such a proposition would be extremely difficult to prove conclusively one way or the other; detailed information on signal path losses over many years is just not available, and it would be difficult to distinguish increased attenuation from the practical consequences of increasing mutual interference between stations.

Yet one does find a persistent belief among some old-timers that radio paths have gradually deteriorated or at least changed. One of the few tangible pointers in support of this view is the virtual disappearance of "long delay echoes" which, as recent correspondence has convinced me, were heard regularly and authentically in the period up to 1939.

If, in fact, ionospheric propagation has been subject to long-term changes this might be part of some as yet unidentified solar cycle or it might reflect the increasing effect of the vast increase in total radiated power, affecting electron temperatures in the ionosphere (as indicated for instance in the recent artificial radio aurora experiments in the United States).

On the bands

National Field Day, to be held this year on June 12-13, is to be run under new rules, including the dropping of the "double station" entries and the removal of power restrictions other than those imposed by the amateur licence. Instead new "open" and "restricted" sections have been created with those clubs entering the "restricted" section having to limit their amount of equipment and type of aerials that may be used. The original purpose of NFD, established by the RSGB in 1933, was to show that low power portable stations set up at short notice outdoors were capable of maintaining reliable communications with similar stations throughout the UK – a proposition that today would be accepted without question with the result that there has been some flagging of enthusiasm in recent years. It will be interesting to see if the new rules lead to a revival of interest.

Recent Australian microwave activities have included a 244km contact on 2304MHz between Mount Genini, near Canberra and Mount Canobalis, near Orange, New South Wales. This was made between Des Clift, VK2AHC and Bill Cox, VK2ZAC. These amateurs have also been investigating 6cm and 3cm paths, including super refraction over coastal paths.

A new headquarters station of the Royal Naval Amateur Radio Society has been inaugurated at the HMS Mercury training school.

The Home Office has agreed that amateurs holding slow-scan television permits may now use 256-line transmissions as an alternative to 128-line systems without further notification of the authorities.

To avoid interference from radio-teleprinter transmissions the RSGB is proposing to change the frequency of its Sunday morning GB2RS news-bulletin transmissions from 3600kHz to 3650kHz.

J. Michale Gale, G3JMG, a civilian instructional officer at the Fleet Air Arm's Air Engineering School, HMS Daedalus, Lee-on-Solent, Hampshire, has been instrumental in the setting up of a local amateur radio society. The society, using the call G3JMG, will be regularly active on 1.8MHz.

Some tips from a lecture by Lewis McCoy, W1ICP, at a recent amateur convention in the United States: "If you have confidence in your antenna it will work better than if you don't"; "If the antenna stays up it is too small"; and "If the confounded thing works, leave it alone." He is a strong advocate of the quad aerial as providing roughly 2dB more gain than comparable Yagi arrays.

For moonbounce operation, Peter Carey, ZE5JJ, is reported to be constructing a new 32ft dish aerial using some 500 metres of aluminium tubing. He also has a 128-element colinear array which gives 24-25dB gain on 432MHz. A 28ft diameter parabolic dish aerial with circularly polarized feed horn is used for moonbounce work on 1296MHz by Hans Lohmann Rasmussen, OZ9CR in Denmark.

25 years ago

25 years ago, following the imposition of unexpected operational conditions, the RSGB abandoned its original plans to equip and operate an amateur radio station in the Dome of Discovery at the 1951 Festival of Britain. However, special stations were established at Manchester, Leeds, Birmingham and Nottingham as part of the Land Travelling Exhibition, operating under the call GB3FB. A Festival amateur radio convention in London failed to attract anticipated support – and perhaps the most memorable feature from an amateur viewpoint of that Festival year turned out to be the publication of the first of the annual "RSGB Call Books", compiled by John Tyndall, G2QI.

In brief

The New Zealand Association of Radio Transmitters (NZART) celebrates its golden jubilee with a special convention from June 4 to June 7 at the North Shore Teachers' Training College, Auckland . . . The 1976 Welsh Amateur Radio Convention will be held on Sunday, September 26 at its usual venue: Oakdale Community College, Blackwood, Gwent. It is being organised by the Blackwood & District amateur radio society . . . A weekly bulletin of ARRL news is transmitted on 14,095kHz r.t.t.y. at 1730 GMT on Sundays by W2QFR, beamed on Europe and with 170Hz frequency shift. DL8VX transmits an r.t.t.y. information bulletin every 2nd and 4th Sunday of the month, except during contests (0900 GMT, 3585kHz) . . . The British Amateur Radio Teleprinter Group has warned its members that a number of Model 54 teleprinters appearing on the surplus market have non-standard keyboards and codes and that it might be difficult to convert them for amateur r.t.t.y. applications.

PAT HAWKER, G3VA

APRS 76

Exhibitors and details for the Association of Professional Recording Studios exhibition

The ninth international exhibition of professional recording equipment is to be held at The Connaught Rooms, Great Queen Street, London WC2 on Thursday, June 17 (09.00-19.00) and Friday, June 18 (09.00-18.00). Fire on February 5 this year at the Connaught Rooms had made the Grand Hall unusable for the time being so alternative arrangements have been made by the organizers within this venue. The exhibition is for professional users and is not open to the public. Tickets are available from E. L. Masek, 23 Chestnut Avenue, Chorleywood, Herts WD3 4HA.

APRS exhibitors

Acousmat
Acoustic Research
Agfa-Gevaert
AKG Equipment
Alice (Stancoil)
Allen & Heath
Allotrope
Amek
Amity Schroeder
Ampex International
Audio & Design Recording
Audio Developments
Audix

BASF United Kingdom
B & K Laboratories
Bauch, F. W. O.
Beat Instrumental
Beyer Dynamic (GB)
Bose (UK)
Brennell Engineering

Cadac (London)
Calrec Audio
Cetec Audio UK

Dolby Laboratories
Drake Electronics, Philip

EMI Tape

Feldon Audio
Ferrograph Professional Recorder
Fraser-Peacock Associates

H/H Electronic
Hammond, C. E.
Hampstead High Fidelity
Hayden Laboratories
Helios Electronics

Industrial Tape Applications
International Musician & Recording World

Jackson Recording Studios

Klark-Teknik

Lee Engineering
Leevers-Rich Equipment
Lennard Developments
Levy, Jacques
Lockwood & Co. (Woodworkers)

MCI (UK)
3M United Kingdom
Macinnes Laboratories
Magnetic Tapes
Midas Amplification
Millbank Electronics Group
Music Week

NTP Elektronik A/S
Neve, Rupert
North East Audio

Penny & Giles
Pyral Magnetics

Quad

Racal-Zonal Group Services
Radford Electronics
Raindirk
Richardson Electonics
Rockwool
Rola Celestion
Rugby Automation Consultants

Scenic Sounds Equipment
Shure Electronics
Sonaplan
Soundcraft Electronics
Studio Republic
Studio Sound
Surrey Electronics

Tannoy
Theatre Projects
Trad Sales & Service
Trident Audio Developments
Turner Electrical Industries
Tweed Audio

Uher (UK).

Veale & Associates, Edward
Vitavox

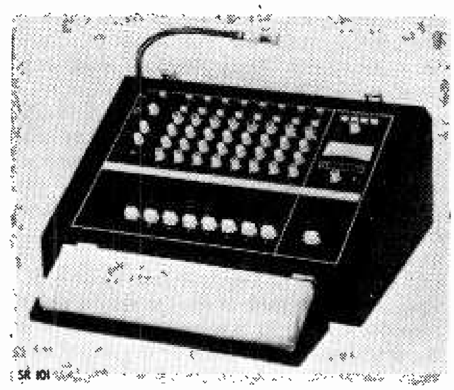
Webland Electronics

Zoot-Horn

Principle exhibit by Helios Electronics Ltd will be a music recording and re-mixing console designed and built for Release Records Ltd, Dublin. The console has 28 input channels, 16 main output groups and 24-track monitoring. The specification includes parametric equalization on all input channels and four echo sends with eight returns. Length of the console is less than 2m. New from Helios will be a rack mounting parametric equalizer. The unit has two independent channels, each with a four-section sweep equalizer, by-pass switch and overload indicator.

A range of acoustic screens will be exhibited by Sonaplan Ltd. Model A is designed for separating brass and woodwind from quieter sections of the orchestra. Model O has an observation window designed for vocalists, percussion and string sections where visual communication is desirable and Model S is a half size screen (1.05 × 1.00m) for rhythm sections.

Rupert Neve & Company Ltd who will be exhibiting at the show have released information about a new disc mastering system, the Neve/MSR 2000. This is the result of a joint venture between MSR Electronics Ltd and Rupert Neve to produce and market the mastering system on a worldwide basis. The lathe cuts monophonic and stereophonic production masters and direct replay acetates to the requirements of the recording industry and accommodates all standard record sizes. It has a range of four turntable speeds to facilitate half speed cutting of quadraphonic masters. The system offers such facilities as digital computer control of all functions, digital display readout of cutting suspension, a rumble-free servo-control turntable, turntable speed indication by electronic strobe and automatic groove compensation.



Focal point of the Shure display will be the recently introduced SR line of sound reinforcement equipment. The SR101 mixing console when used with the SR106 electronic crossover, SR105 power amplifier and SR108 two-way horn loaded speaker units forms a complete sound system.

Letters to the Editor

THE CONSULTANTS

As one of those interviewed last year by John Dwyer, I have read and followed with interest his article "The Consultants" published in the November 1975 issue, and the correspondence resulting from it. By and large, I found it a fairly well balanced commentary though, perhaps rightly, a little pointed. Not every conclusion he draws is accurate, and since others of your correspondents seem to have misinterpreted my views, perhaps I may be allowed to clarify them.

First of all, I know of no conscientious professional who is also a "26 hour a week" man. This time, as John Dwyer correctly quoted, is easily spent in the preparation and presentation of lecture and tutorial classes, but undergraduate students of engineering are not trained simply with a stick of chalk. Additional to this is the time necessarily spent on the development of a programme of laboratory experiments, projects and research, their supervision, examination and coursework assessment, the organisation and revision of these and other, new courses of conferences, my own registered research and participation in the Polytechnic's Faculty committees, in forming its long term academic plans. Those not qualified to teach might be forgiven for overlooking many of our responsibilities, but I hope they will at least take note of them.

I would have thought that James Moir and those of his calibre need have no fear of a little competition, whilst others have allowed this age-old reason for resentment to colour their judgment. Thus Gordon King (his letter, April 1976 issue) seems to think that an academically-based professional should not be paid for the work he does on commercial development or sponsored research projects. If that were the case, then some of the criticisms levelled at consultants in these columns recently, might eventually become more justified.

The same lack of judgment is evident in Mr King's interpretation of my comments about consultancy fees; it is because I do not wish the profit motive to dominate my work, as it must not, that I do not request high fees. There are other reasons why I want to see the excellent facilities in the PNL Acoustics Laboratory maintained and developed, which I thought were made clear in the article; not firstly to serve the hi-fi press, but to serve the best interests of my undergraduates. My consultancy work has assisted greatly in this; and it has created good will with certain sections of the engineering industry, and it has benefitted our laboratory facility. Recently, as a result of some such work, an instrument worth ten times the fee we received, was donated, at my request, to the Acoustics Laboratory at PNL. Private consultants are not unique in having professional integrity and responsibility.

Finally, I would like to echo the major point made by C. A. Henn-Collins (also April 1976 issue) about the crucial importance of the consultant's impartiality, especially when he must earn a living from both company development and consumer review work. Obviously, the two undertakings have contrasting purposes, one for the manufacturer, the other for the user, and must always be viewed accordingly. My position as an academically based consultant affords me the privilege of being able freely to observe this distinction.

Roger C. Driscoll,
The Polytechnic of North London.

CITIZENS' BAND IN THE UK?

The concensus of the various references to Citizens' Band radio in your March issue seems to suggest that if CB ever comes to Britain, it will come at 27MHz. Surely this is not necessary.

If we are to have a Citizens' Band, and I hope we are, we would be far better advised to have one operating at v.h.f. with narrow band f.m. This would have many advantages over 27 MHz a.m., including reduced t.v.i. and b.c.i., less chance of interference during sunspot maxima, and smaller antennas. Such v.h.f. transceivers would be somewhat more expensive than 27MHz ones, but if such firms as Yaesu Musen, Inoue, Standard and Trio can make v.h.f. transceivers (for the 2-metre amateur market) for well under £100, I am sure that they can do even better for the much larger CB market.

I know that there is considerable pressure on the v.h.f spectrum, but surely there must be six to ten channels somewhere between 60 and 300 MHz which could be allocated for this purpose — if e.r.p. is limited even this small number is unlikely to be too congested. A further refinement would be to incorporate a station identifying circuit which causes a tone sequence to be transmitted each time a transmitter is keyed. This could serve the dual purpose of uniquely identifying each transmitter and of acting as a selective call system — more sophisticated receivers could be set to unsquelch only on a call from a particular transmitter.

I feel that there will soon be a strong political demand for CB. I hope that when it comes, the Home Office will have plans ready — perhaps similar to those outlined above — and will not have an unsuitable 27 MHz system forced upon it from above for lack of a planned alternative.

James M. Bryant,
Cheltenham,
Glos.

Unlike Mr Webber I do feel that the introduction of Citizens' Band radio facilities in the UK would lead to abuse, caused by ignorance on the part of the user and commercial exploitation. If there is a need for a Citizens' Band in the UK then let it be introduced in the u.h.f. bands and not in the 27 MHz band.

I and many thousands share a few hundred kilohertz of the 27 MHz band for model radio control. We already suffer from having several hundred pounds' worth of aeroplane and radio equipment "shot down" by the illegal use of walkie-talkies. If CB radio is introduced we may all be grounded. As a professional engineer and a keen modeller I protest!

L. K. Anderson,
Braunton,
Devon

MICROPROCESSORS OVERSOLD?

Mr Hill has indeed made a number of valid points. Microprocessor technology is very new and by almost everyone's judgement, it has very great potential in the future. This therefore means that microprocessors have attracted considerable publicity in most of the media.

Mr Hill makes the point that the microprocessor chip cannot operate in isolation. This is, of course, true. The microprocessor only becomes a useful microcomputer when attached to memory devices and input/output interfaces, but already due to large-scale production these devices are very inexpensive for what they are. I think the semiconductor industry has proved that once a product goes into large scale production, costs fall dramatically. An example of this is the electronic calculator which, less than two years ago, would have cost £100 and is now available for less than £10. Significant microcomputer systems can be built now in only moderate volume for less than £40.

Mr Hill mentions the "shock situation" facing engineers wanting to use microprocessors in that they must learn some programming. I am sure that the majority of electronic engineers are well able to cope with learning a new technique and history proves that this is so, for every generation of engineers has had to learn to handle new technologies. In less than two decades, the industry has moved from the valve technology, through discrete semiconductors into the integrated circuit, with an aplomb that must have amazed some of the early experimenters and we are sure that the younger engineers will move into even higher levels of technology in the future without too much difficulty.

So, in answer to Mr Hill, I say yes, the engineers will have to learn programming but it is not that complex. The support hardware to help them to produce and debug programmes is available now and will be available in design centres all round the country in the future. Even if a company decides to buy some programme and system-proving hardware, it is no more expensive than a complex oscilloscope.

As Mr Hill says, the microprocessor is here to stay and indeed we are glad to see that he suggests an intelligent approach to dispel the image that it is the panacea for all iils, because, used intelligently, it can solve many problems of today and will obviously solve many problems in the future. We, as a company, are trying to educate the engineering fraternity and would be prepared to help Mr Hill in any way we can and I am sure this is true of all other semiconductor manufacturers concerned in the development of microprocessors.

Yes, we agree, let us get together so that the learning is made less difficult.

Vic Yates,
Motorola Ltd,
Wembley,
Middlesex.

When something important happens, like the introduction of the microcomputer, many claims are likely to be made as to the power and capability of the technology. Sometimes these claims are exaggerated and may, therefore, be misleading. You will sometimes find that such claims are made by individuals who have not yet acquired a full grasp of the subject or by companies who enter the new field late and are trying to establish themselves quickly.

However, I feel that Mr Hill's claim that much of the published material on microprocessors is misleading could also be construed to be an exaggeration in itself, since the bulk of this published information is in the form of technical data sheets and instruction manuals.

Now let us have a look at microcomputer systems to see if Mr Hill's other claims are justified. At the low end of the microcomputer spectrum it is possible to construct a powerful calculator-like system with just four chips: the 4040 c.p.u. the 4201 clock generator, a 4001 r.o.m. to hold the programme and a 4269 interface chip. This system will interface directly to encoded or non-encoded keyboards (up to 128 keys) and will drive a variety of multi-digit display devices. The display registers in the 4269 are used as read/write memory. If more r.a.m. is required, this can be provided by an additional chip. The system can be further expanded by adding a 4265 interface chip which will provide four four-bit ports, any of which can be inputs or outputs. These ports can be synchronous or asynchronous. The 4265 also incorporates all the logic necessary for 'handshaking' with a peripheral. These various options are selected by the software.

The important point here is that two chips provided a full keyboard and display interface, 16 programmable I/O lines and all the logic necessary to control a very wide variety of peripheral devices.

The same principles apply to 8-bit microcomputers. Interface chips are available that approach the c.p.u. in terms of internal complexity and which will provide serial, parallel, synchronous, asynchronous and bidirectional inputs and outputs. These chips also contain a great deal of sophisticated control logic, which relieves the c.p.u. from many of the repetitive and mundane tasks needed to service some peripherals.

A company which is about to use a microcomputer as the processing element in a piece of equipment that is being designed for production, will purchase a development system such as the MDS (see *Wireless World*, February 1976, page 40) which will provide the necessary teletype interface and interfaces for other peripheral equipment that might be needed for the project. In addition, the MDS will provide all the other aids required such as hardware and software development and diagnostic facilities. The cost of the MDS will be amortized over all the systems that are to be produced in this, and future, microprocessor projects.

The alternative to a microcomputer design is to use t.t.l. logic which, if the system is not a simple one, will involve a considerable amount of design effort. Once designed and in prototype form it is difficult, and expensive, to make changes since, amongst other things, circuit board artwork will have to be changed.

The microcomputer is controlled by a programme of instructions stored in read-only memory (r.o.m.). The more complex the task to be performed, the more r.o.m. will be needed. It can be said, therefore, that the r.o.m. in a microcomputer system is being used to replace the gates in a t.t.l. system. It takes between 8 and 16 bits of r.o.m. to form the equivalent of a gate. Since an average small or large-scale t.t.l. circuit contains an average of 10 gates, between 80 and 160 bits of r.o.m. are needed to replace each package. Memories are available with capacities of up to 16kbits and a r.o.m. of this size will replace between 100 and 200 gates.

It can be shown that a microcomputer replacement for a t.t.l. system requiring between 130 and 140 gates will take two circuit boards less, will consume about 14W less power and will save more than 130 cubic inches of space. This means real savings in production costs.

If we take a microprocessor equivalent of a 75-gate logic system of which 100 a year are going to be produced and include all component and production costs, it can be shown that the t.t.l. system will cost in the region of £56 and the microprocessor about £41.

A company starting on their first microcomputer design project can expect to spend around £5,000 on equipment and will take about six months to get an average system into production. This will add about another £5,000 to the cost of the project. On a second design project, using the same microcomputer family, the company will have zero capital expenditure (since they already have the equipment) and could expect to have a similar sized system in production in three to four months (since they have acquired the necessary expertise).

While writing, I would also like to comment on the statement made by J. O. Owen in the February issue, that "PL/M reduces the number of lines of programme by a factor of ten." This is somewhat misleading and, if I may beg a little more space, I would like to explain why.

What must be kept in mind is that when a microcomputer system is designed, it is usually intended that a fairly large number of identical systems are going to be produced. We know that a microcomputer is controlled by binary coded instructions stored in a read-only memory. These binary instructions are normally produced by a computer from a source programme which can either be written in the high-level compiler language PL/M or in assembly language. It is a fact of life that a *source* programme written in PL/M will be much shorter than an equivalent assembly language programme. The assembly language programme will, however, result in less machine code than the equivalent PL/M programme. Usually, therefore, the assembly language programme will make more efficient use of the programme store since fewer bytes will be needed, and the saving in memory capacity per system will be multiplied by the number of systems to be produced. In cash terms, the actual saving in memory cost will depend on the type of memory being used.

On the other side of the coin, it is much cheaper to write a programme in PL/M because it takes far less time. Therefore, the increased cost of writing an assembly language programme must be set against the likely savings on memory components.

As a general rule of thumb, it is more cost effective to use PL/M for systems which are not going to be produced in large quantities – say, below 1,000 systems if mask-programmed r.o.m. is used or below 100 systems if e.p.r.o.m. is used.

If the programme is very large or very complex, it is probably better to use PL/M regardless of the size of the envisaged production run since, in these circumstances, inefficiencies can be introduced by the programmer writing in assembly language.

Keith Chapple
U.K. Manager
Intel Corporation (UK) Ltd
Oxford

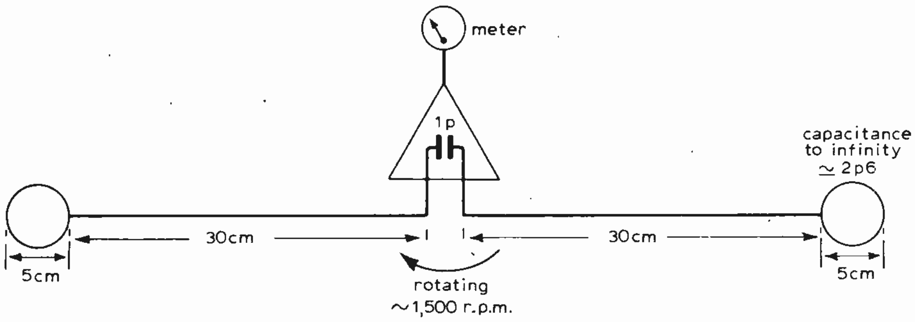
ELECTRODYNAMICALLY INDUCED E.M.F.

The opinions and proofs relating to this old problem as expressed by "Cathode Ray" and Messrs Smith and Masson all make good sense to me. It is clear that regardless of screening no e.m.f. will be measured. I personally do not need to look for proof as the following facts show.

An important measurement in oilwells is the spontaneous potential generated by telluric currents of various sources between a downhole electrode and a surface electrode. This is made by an insulated conductor screened with two layers of steel cable which is partially spooled on a winch drum. It is a fact that if the winch is mounted on a moving barge, the EMF induced in the coiled drum by the earth's field appears as a "noise" on the signal. It is effectively eliminated by mounting a small coil in series opposition in the same field. This coil need not be screened. Again, I would ask any doubting Thomases "Would electric motors, whose conductors are often totally surrounded by iron, work if the iron was effective in screening them?"

"Cathode Ray" (September 1975 Letters) suggests cutting the dipole and inserting a perfect field-effect device to measure the e.m.f. This raises a very interesting point. When he does this, will the capacitance across any real device destroy the effect? In school physics texts we read that a sphere has a capacitance to infinity, whatever that may mean, equal to its radius. If, then we put spheres on the ends of our dipole the theoretical measurement once again becomes practical, because the capacitance created will overide, the effect of capacitance across the amplifier. As "Cathode Ray" points out, the signal must be made into a.c. by rotating it. This will not change its magnitude. The experiment is not only feasible, it can be made with existing semiconductors as the signals, assuming reasonable dimensions of the apparatus, are well above the noise level. Furthermore I have obtained the necessary field-effect amplifier and would like to invite anyone with the time to spare to make the experiment.

What will we measure? Originally I was



attempting to devise an absolute speedometer for a sailing boat. I fear, though, that what we will actually measure will be the differential component of the changing earth's magnetic field.

I include a sketch of the apparatus as I designed it some years ago. There is no need for slip rings because if it is battery operated the whole thing can rotate. There exist a number of output displays which would be legible even if rotating at high speed.

R. Hunt-Grubbe,
University of Reading.

I was interested to read in your December 1975 issue Mr Gray's comments on my letter in the September issue, but I continue to maintain that the electric field perceived from the aircraft is real. Far from contradicting the principle of relativity, it is in fact a direct corollary. If the electric field were in any way unreal then the observer on the aircraft would be able to detect this and determine his state of motion without any external reference.

A correct description of the situation would be something like the following: Knowing the values of electric and magnetic fields measured in the aircraft, the navigator may calculate his velocity relative to the inertial frame in which the electric field is zero. Then, from the information that the electric field measured by a ground-based observer is zero, he is able to identify this calculated velocity with the speed of the aircraft relative to the earth.

I would also like to take issue with the other point raised in Mr Gray's letter. Unfortunately I have not been able to find a copy of his reference so I can only comment on his statement that "relative motion between a conductor and the system within which the conductor e.m.f. is to be detected is a basic requirement for electrodynamic induction of e.m.f. in the conductor". This may be refuted by a simple experiment in which a coil of wire is connected to the terminals of a meter. The insertion of a bar magnet into the coil causes an e.m.f. to be induced and the resulting current is indicated by the meter. Relative motion is, indeed, involved but not between the conductor and detector. Other examples may readily be adduced.

"Cathode Ray's" arrangement should work since, as the conductor is rotated, the electrons within it must be periodically redistributed to maintain an equipotential surface (as seen from the aircraft). The meter in the centre of the conductor will register an alternating current constituted by the flow of these electrons.

Colin Masson,
Cambridge.

Assuming that magnetic field uniformity is still conditional, in the continuing correspondence relating to Electrodynamically Induced E.M.F. (Cathode Ray's letter in your February issue), I retain my belief that Einstein's axiom is fundamental to the matter under consideration.

I cannot see that Cathode Ray's reference to "the measurement of relative velocity with reference to a field in another system" has any meaning; though I would agree to a condition of velocity of the field's source, relative to the conductor with which the observer is travelling, which returns one to my original argument. Detection of the field's velocity is another matter, for which I suggest that non-uniformity is a necessity.

Acceptance of the argument for "electrodynamic" detection of absolute conductor motion would require acceptance of induced e.m.fs in a multitude of superficial conductors, moving with the earth and within its magnetic field; and I am not aware that these have become manifest.

John Gray,
College of Technology,
Belfast.

WAS BAIRD FOOLING THE PUBLIC?

THE letter "Was Baird Fooling The Public?" from Mr H. F. Haynes in the April 76 issue, is, I think, likely to cause confusion among readers trying to follow the various articles about the Baird half-centenary. The original article by Messrs. Waddell, Smith and Sanderson, to which Mr Haynes refers, was purely concerned with the period 1925 to 1928 about which information is sparse and frequently contradictory, thanks partly to Baird's own passion for secrecy, a trait shared by many of his contemporary rivals.

But the 30-line story extends to *September 1935* (at least) and about these later years there is no shortage of information, since that august body, the BBC, was itself responsible for the regular programme of news and entertainment until December 1935. The "Televisor" referred to by Mr Haynes, in spite of many subsequent mechanical (and even electronic) rivals, continued to be the most popular type of receiver until the termination of the 30-line service, probably because of its basic simplicity, reliability and relative cheapness.

As for "synchronization over a distance" during these later years, the toothed wheel device, covered by a Baird patent, gave adequate results within the transmitter's reception limits, which were very extensive.

Whether the 30-line service gave acceptable standards for entertainment purposes, is perhaps a matter for debate. The recent practical demonstrations of the mechanical low-definition techniques by Mr E. W. Elliott at the University of Strathclyde and on the BBC programme "Blue Peter", and public shows by the Low Definition Television Association, have given a modern generation the chance to judge this issue in a direct and subjective way instead of by the largely sterile method of literary research.

Certainly, if one judges the techniques by the calibre of the artistes offering their services to the BBC for 30-line entertainments, one cannot fail to be impressed. A glance through the TV programmes of 1934 and 1935 resulted in a list of names that included some of the "top liners" of the period, all by courtesy of various kinds of "trundling mechanical image analyser" which remained supreme at both ends of the television process until the demise of the BBC service in September 35.

D. B. Pitt,
Chairman, Low Definition
Television Association,
Nottingham

Mr Haynes in a recent letter to the editor, *Wireless World*, April 1976, p.52, 'Was Baird fooling the public?' mentions an article written by myself and others, "John Logie Baird and the Falkirk Transmitter", *Wireless World*, January 1976, pp.43-46.

I feel it is Mr Haynes who is fooling the public, not John Baird. The statement in his letter that Radio Societies were amused is inaccurate. Over 600 people attended Baird's lecture, in November 1943, to the Institute of Radio Engineers in London, the lecture being on all-electronic, 3D colour television, a subject in which Baird could reliably be said to be leading the world. The Hankey Committee produced in 1945 a white paper on the future of British television. Up to 1,000 lines with 3D and colour were amongst the recommendations but, to that date, only Baird had demonstrated all three.

Mention is made of *Wireless World* remaining silent: this is grossly inaccurate. Following the E.M.I.-Marconi and Baird TV demonstrations at Alexandra Palace (November 1936 – Feb. 1937) Baird resumed cinema colour television, a world first. *Wireless World* reported this pioneering work and gave it much praise on February 17th, 1938, p.148, and August 17th, 1939.

Mr Haynes comments that Baird tried, in the late 1920's, to sell by pretence. This is inaccurate; newspaper articles by Baird in late 1928 stated that he was not yet prepared to sell television to the public on a production basis – keen amateurs could procure kits and check for reception.

I do not recollect in my article asking for "a serious study of the business and technical aspects of Baird's 30-line TV work." I asked simply for any photographic or written proof of what Baird used for TV equipment from late 1924 until early 1928. Mention is made by Mr Haynes of no synchronization: this is a strange comment, considering Baird's London-to-Glasgow demonstration in May 1927 and his transatlantic demonstration of February 1928!

Mr Haynes says that fibre optics were "well known" and not requiring synchronization. This is again inaccurate: Baird's patent (1927) on multi-fibre tube bundles was a world first, so how it could be well known to him beats me, he had to invent it first! Fibre optics still required synchronization; the fibres only eliminated a rotating lensed disc to dissect the transmitter image, but the receiver still had to be synchronized to the transmitter.

I have in my possession information on

John Baird which will, on publication, do much to redress the comments still being made against Baird. I am not ashamed to admit that I admire John Baird's many talents and to state that in my opinion the treatment he received in this country in the lack of scientific awards and credits is little short of a national disgrace.

Dr P. Wassell,
University of Strathclyde,
Glasgow

I feel I cannot let Mr Haynes' letter in your April issue pass without comment because in one respect at least, in his last sentence, it is factually incorrect.

The *Wireless World* did not remain silent. This may be checked by reference to your issue for 12 March, 1930. On page 277 you said in the first paragraph of an article . . . "At last a Baird television receiver built for sale to the public has arrived. As no commercial product can live that does not fulfil the purpose for which it is created, there is the obvious inference that this new apparatus functions in the way it should and that moving pictures can be received by the broadcast transmission. Without further preamble it can be stated that this receiver does give reception of images with sufficient definition to be readily intelligible." In the final paragraph of the article you said . . . "Such results will interest the enthusiast, and these have become possible since the adoption of the signal controlled toothed wheel method of synchronization first introduced towards the end of last year." The article also refers to an earlier article on p.282 of the issue for 18 September 1929 which reports the start of the 11-11.30 a.m. radio transmission from 2LO and illustrates the toothed wheel synchronizer. About this you said . . . "The aim is to provide for the rotation of a disc with a degree of constancy that after long periods of running must possess no cumulative error. In the Baird apparatus we find that this is accomplished by the phonic wheel method." You ended by saying . . . "a few facts as to the results may help others to appreciate clearly the degree of success at present obtainable. The image is viewed through a magnifier and possesses a slight, yet not tiring, flicker. Good brilliance is obtained, but with an excessive contrast between light and shade. A sitter at the transmitter is at once recognised, and his expressions considerably enhance his words which come from an adjoining loud speaker. With a little concentration one can note the time from a normal watch. Letters running past the transmitter in the manner of an advertising sign are clear and easily followed. These results, it is stated, will be obtainable on home equipment working on the broadcast service."

So, your impressions are clearly set down. But a quite different opinion was expressed in a third article in the issue for 18 December, 1929, on page 669. The author says . . . "Knowing that the real difficulty in television is that of synchronizing the revolving mechanism at transmitter and receiver, no inventor can claim success who does not first put forward a solution to this problem." He continues . . . "We know now that Baird had no important contribution to make in solving the synchronizing problem." The author of this article had applied considerable ingenuity in construction to improving the magnetic circuit of the synchronizer. It was unfortunate that he then coupled the light source and synchronizer to his output valve by a circuit different from that used by the Baird television receiver. He added four expensive and unnecessary components (a choke, two 4μF capacitors and a variable resistor (roughly the cost of 2 to 3 weeks' lunches for a student at that time) which altered completely the shape of the synchronizing pulses. That the pulses were distorted seriously is shown by his own statement in the article that, from the appearance of the pictures, it seemed that the synchronizing pulses lasted for about half the length of a line. This finding, that a method which was different in a number of significant respects from Baird's did not work, clearly does nothing but show that the author had made a mistake. The mistake was entirely justifiable in the technical milieu of that time, but it remains a mistake. The author's name? I nearly forgot; it was F. H. Haynes!

Some of us who later made the simplest possible equipment (this was dictated by cost, not insight) found that synchronization could be held over sufficiently long periods for the pictures to be interesting. Fading of the radio signal, which was then being received in Manchester from the late night transmissions, was the biggest problem. In the comparison with the cinema at that time I would agree that the results were not commercially viable. Entertainment, in anything like the modern sense, had to wait until high frequency transmission made possible a 300 times increase in the picture information. Even then, some years passed before TV became a serious threat to the cinema.

However, the results that could be obtained were just as fascinating as listening on a one or two valve short wave receiver, to snatches of intelligible messages from all over the world. That was not commercially viable as a method of communication either. If the pictures had not been worthwhile there would have been none of the drive that led to a mirror drum receiver projecting a 7× 3 in picture and using a polarizer, analyser and Kerr cell to modulate the light source.

Should we not give Baird full credit for what he did do? True, others might have done it equally well. Professional engineers might have done it better. But none of them, if they tried at all, tried long enough or hard enough. What Baird did do, on a shoestring budget, by prolonged and concentrated effort is made clear in your reports. This surely seems worth full recognition.

Prof. G. D. Dawson, McSc.,
Dept. of Physiology,
University College,
London.

I was very interested to read the letter in your April issue from F. H. Haynes on the claims made for Baird's contribution to the development of television. Those of your readers whose memories of *W.W.* go back to the 1920s may recall that Mr Haynes was its assistant editor. In that position he undoubtedly looked very closely into Baird's claims on behalf of *W.W.* and his conclusions should not therefore be dismissed out of hand.

Leslie Bailey in his "BBC Scrapbooks" (Vol 2: 1918-1939) reproduced the following advertisement which Baird inserted in the personal column of *The Times*. "SEEING by WIRELESS. – Inventor of apparatus wishes to hear from someone who will assist (not financially) in making working model. – Write Box . . . . ." Mr Bailey's comments are: "Baird was not a trained scientist. Indeed, it is astonishing to know that his knowledge of radio techniques at this period was so limited that he went to the staff of *The Wireless World* for help over the design of amplifiers. Mr Hugh S. Pocock, the then editor of that magazine, has written to Scrapbook: "I well remember Baird coming into the office and having a talk about his difficulties and particularly the problem of distortion which arose when he tried to amplify the shadow effects he was obtaining. We designed and built for him a suitable amplifier because at that time he had little knowledge of the correct design of distortionless amplifiers'."

P. P. Eckersley, whose ability to cut down to size anyone who made unjustifiable claims is well known to members of the I.E.E. where he so frequently entered into discussions after reading of papers, wrote in his 1941 book "The Power Behind The Microphone" that Baird possessed "that flair for picking about on the scrap-heap of unrelated discoveries and assembling the bits and pieces to make something work and so revealing possibilities if not finality."

I think it was Baird's obituary in 1948 that *W.W.* said he was the catalyst in the development of television.

H. W. Barnard,
Leigh-on-Sea,
Essex.

PHASE AND SOUND QUALITY

Reading all those contributions on "phase effects in loudspeakers," I cannot escape from the impression that many experts do not dare to be too certain and prefer referring to the opinions of others instead. What is everybody so worried about? Undo the tweeter from your loudspeaker cabinet so that it stands off, an inch or so nearer to the listener's ear. The result is a change in phase relationship between the high- and the low frequencies, right? An inch difference in path length corresponds with something in the order of a full wavelength for a tone of, say, 10 kHz. If this is not enought phase shift, move the tweeter further, a foot or so, so that the phase tumbles several times over and over before it reaches your ear. Better still, ask somebody to move the tweeter for- and backwards for you, so that there is a continuously varying phaseshift between the high- and low-frequency components.

Why not try that on a rainy Sunday afternoon?

I did. With sounds of harpsichords, pianos, plucked strings, whole orchestras, voices, rushing water, white noise, square waves. And I eat my hat if I hear phase effects.

Hans Evers,
Lammersdorf,
Germany.

Low-noise, low-cost cassette deck — 2

by J. L. Linsley Hood

Any convenient power supply circuit may be used for a.c. mains operation, provided that it can be set to give a stable, ripple-free output of 13.5-14V at output currents up to 250mA. A suitable design is shown in Fig. 8. The low-value resistor in the record amplifier supply line is to limit the supply line current surge through the changeover micro-switch when the large capacitor on this line is connected in parallel with the capacitor on the output of the power supply. To avoid noise originating from the pulsating current demand from the d.c. cassette-drive motor-control circuitry, the recorder supply is taken directly from the power supply reservoir capacitor through a 20Ω, 10W resistor, with the negative return line being also directly connected to the reservoir capacitor, rather than to a chassis return.

The chassis itself is only connected to the zero-volt line at the input to the replay amplifier.

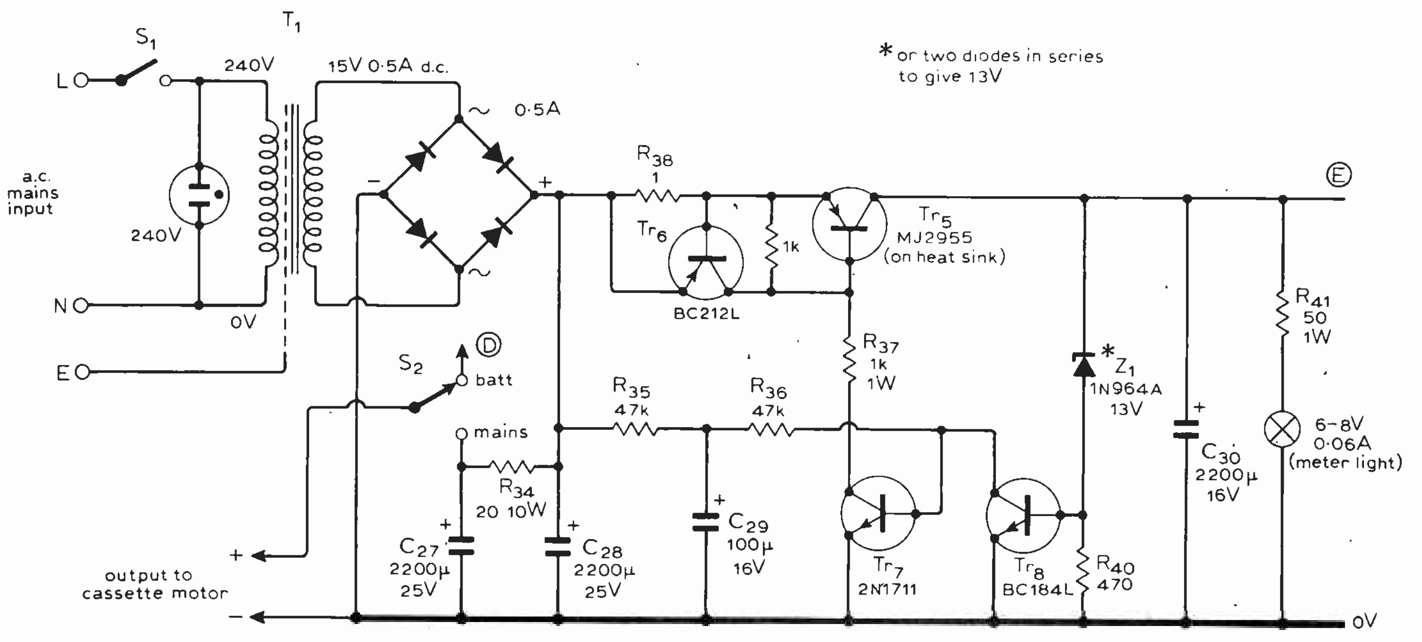
Recording and bias levels

One of the most obscure areas in the field of tape recording, in the eyes of the layman, is the interaction between tape types and biasing levels. While much information has been published on this subject, it is often discussed in obscure terms which make the argument difficult to comprehend. Since it is possible that the construction of a cassette recorder of this type may be of interest to those with no previous experience in this medium, an attempt has been made to provide a simple introduction to this topic.

In general, it is not practicable to obtain an adequate remanent magnetic flux in a magnetic tape, for the reproduction of signal waveforms of low harmonic distortion and good output level, unless a high frequency "bias" of suitable magnitude is superimposed on the signal at the time of recording. The effect upon the various signal parameters of variations in the bias level is shown in schematic form in Fig. 9. From this it will be seen that there is not a single biasing level which is optimum for all recorded frequencies, and that the optimum level for 1kHz is in excess of that which gives the highest output for, say, 10kHz. Also, the level which gives the lowest recorded noise level is less than that which gives the lowest t.h.d.

It is apparent from this that the setting of this parameter is one which demands some compromise, and the one which is chosen will depend upon the preferences of the user. In general, for cassette recorders, the chosen bias is that which gives the maximum output at 330Hz, or a slight excess of that optimum for 1kHz, and the reduction in output at higher frequencies is compensated by modifications to the record pre-emphasis curve. However, the required bias and compensation characteristics will be different from one make of tape to another, and from one design of record/replay head to another. In this design, the decision had been taken, partly in the interests of running costs, and partly in the interests of minimizing wear in the Permalloy heads, to optimize the design for "ferric" tapes rather than chrome types, and the Philips standard low noise C90 was taken as the reference. It was found, however, that the settings derived for this was also optimum for

Fig. 8. Power supply. The motor is fed with 3.5V by the stabilizer, but the solenoid is provided with the full 12-14V.



"super" tapes of the types exemplified by Memorex MRX_2, and BASF Super LH, although these gave an improved performance.

In general, there is very little difference in the background "bulk-erased" noise levels of most good-quality commercial cassette tapes, although there will be larger differences between the noise outputs of tapes passed through a recorder set to record at zero signal level. The greater the degree of homogeneity of the tape oxide layer, the lower the zero-recorded-level noise will be, down to a minimum which depends on the fundamental granularity of the oxide medium. The recently introduced "super" series tapes have a more uniform oxide coating, which can give a 1-2dB zero-signal background level improvement.

However, there are also improvements which have been made in the output level and harmonic distortion for a given output level, due to a more careful balance of grain shapes and sizes. The extra 2-3dB in output can lead, in total, to a small though audible improvement in overall signal-to-noise ratio (some typical results are shown in Fig. 11, and Table 1.) Useful though this is, a far greater capacity for improvement in overall performance lies in the hands of the user in a careful choice of the recording level setting. Ideally, one should record at as high a level as possible, so long as few signal peaks significantly exceed the DVU level. A 1-2dB excess is unlikely to be noticed in replay, especially with good tape, provided that the duration of overrun is brief, and the difference in s/n ratio from "correct" to over-cautious choice of record levels can readily exceed the difference between a cheap tape and an expensive one.

Probably the best way of choosing recording levels is to set the mechanism to Record but with the pause button pushed in, and in this condition to experiment with the gain settings until the optimum setting is found. when the recording can be started. In the case of a live performance, assuming one has the co-operation of the performers, it is usually possible to persuade them to execute a known fortissimo and set the record levels appropriately for this.

Noise characteristics of the system

During the development of this circuit, the sources of noise in the system were investigated at some length, since, although it was envisaged that some form of external noise-reduction system would be incorporated for use during replay, it seemed advisable to try to minimize noise in the design before taking additional palliative action. The reduction of noise in the replay circuit has already been described; if the unweighted noise level at this stage, without tape, is taken as the unit, the bulk-erased-tape noise level corresponds to about one and a half or two units, and the zero-record-level noise (with the circuit parameters arranged in accordance with normal practice) was then equivalent to some five or six units.

Obviously there was little that could be done about the noise level of the tape, as received, but it seemed that quite a lot could or should be done about the 14dB worsening of this during no-signal recording. Indeed, if it were possible to get down to the level of the original tape, the overall performance would have been beyond reproach, in spite of the low tape speed and narrow tape width. An additional piece of evidence which seemed of interest was that the replayed noise was "whiter" than would have been expected from an original white-noise source (i.e., the tape) when replayed through the type of equalizing characteristic employed in the replay amplifier. This seemed to be a common characteristic of commercial cassette recorders, which all sounded "whiter" on the replay noise tone than

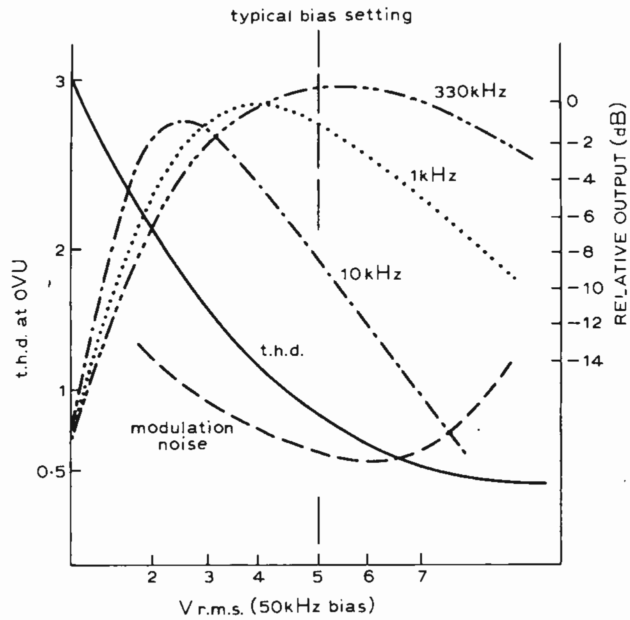


Fig. 9. The effects of changes in the h.f. bias level on output, t.h.d. and modulation noise.

Fig. 10. Record/replay frequency/amplitude curves for a variety of tapes, optimized for maximum flatness and for best square-wave reproduction

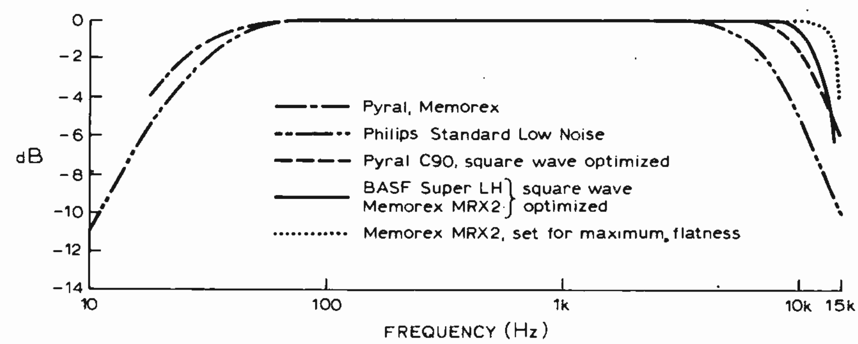


Table 1.

Relative output at 660Hz (OVU recording level)

Philips Standard C90	OVU (+0dB)
Pyral C90	+2dB
Memorex MRX_2 C90	+2dB
BASF Super LH C90	+3.5dB

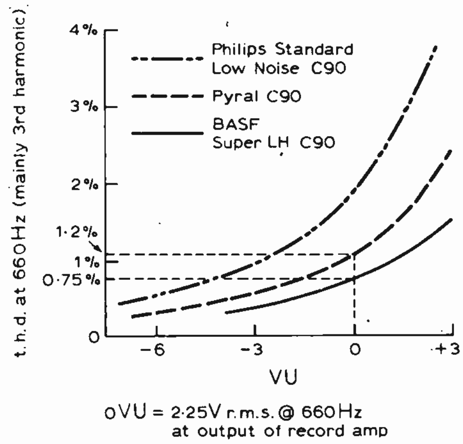


Fig. 11. Harmonic distortion (including noise) as a function of recording level for three types of tape.

seemed reasonable to expect. It was also observed that changes in the level, frequency or shape of the bias waveform made no difference to the result. The conclusion began to grow that the problem was due to generally-distributed noise, in the source and record amplifier, being selectively amplified in the 10-15 kHz band and applied to the tape at high levels through excessive signal pre-emphasis.

Having become convinced on this point, the attempt was made to determine the optimum compromise between flatness of frequency response and signal-to-noise ratio for a given record level. At this stage it was found that optimization of a recorded 1kHz square wave to reduce the initial overshoot and ringing found when more conventional magnitudes of pre-emphasis were applied gave also the best performance compromise on bandwidth against s/n ratio. The bias levels found during this exercise were compared to those obtained by more conventional setting-up procedures, and found to be substantially identical. However, the zero-signal-level recorded noise was found to have been reduced by about 10dB by the process of square-wave optimizing, as compared to that given by frequency response optimizing. The two curves are shown in Fig. 10, and it will be seen that the h.f. loss amounts to only 1dB at 10kHz and some 4dB at 14kHz, which can be remedied by the use of amplifier tone controls on replay with very little detriment to performance.

The final conclusion is that in general far more h.f. pre-emphasis is employed on recording, in the interests of maximum flatness of the published response curves, than is sensible in the light of the overall performance, and that with more prudence exercised in this respect, noticeable improvements could well be made. Interestingly, programme recordings made before and after optimizing of the square-wave performance of the recorder did not show the expected small loss of higher frequencies, with the upper register seeming both cleaner and more extended than before, possibly due to the lessening of the incidence of h.f. tape or head saturation.

One final recommendation in this respect is that for one's own use, even on ferric tapes, the 70µs characteristic should be used both on record and replay. However, this is a choice which can be assessed readily by individual experiment. Certainly, in the case of the author's prototype, the use of this equalizing time-constant, in association with an optimized square-wave characteristic, has given a system in which the tape noise, on a good quality tape, is sufficiently unobtrusive to render further noise reducing circuitry unnecessary.

Bias and equalization settings

It will be apparent from Fig. 9 that adjustment of the h.f. bias level of the recorder will have the effect of altering the whole response curve, by altering the effective recorded levels of the h.f. and l.f. components relative to one another, and it may therefore appear difficult to optimize either the bias or the equalization. The suggested method is therefore as follows:

- Set VR_2 so that the response curve on record is as curve A on Fig. 5., (approx. 85Ω) when measured at the output of IC_3.
- Set the bias level so that there is approximately a 1-2dB drop in output at 1kHz.
- Record a square wave at 660Hz, and make small adjustments to VR_2 until the cleanest leading edge is obtained on the replayed square wave, with only a small single overshoot.
- Finally, leaving VR_2 set at the chosen value, record a 660Hz square-wave at various bias levels and adopt the one which gives the best overall square-wave shape for the tape which it is desired to employ.

The technique of square-wave optimization is well known in the audio field as a means for setting tone-controls and filters to optimum flatness, because of the facility which it offers for a simultaneous examination of a wide range of frequencies. On exactly the same score it would appear to be an excellent method of optimizing bias levels.

While it is hoped that the performance given by the prototype will prove to be fairly typical of the results given by other models built to this design, it is appreciated that in a system in which

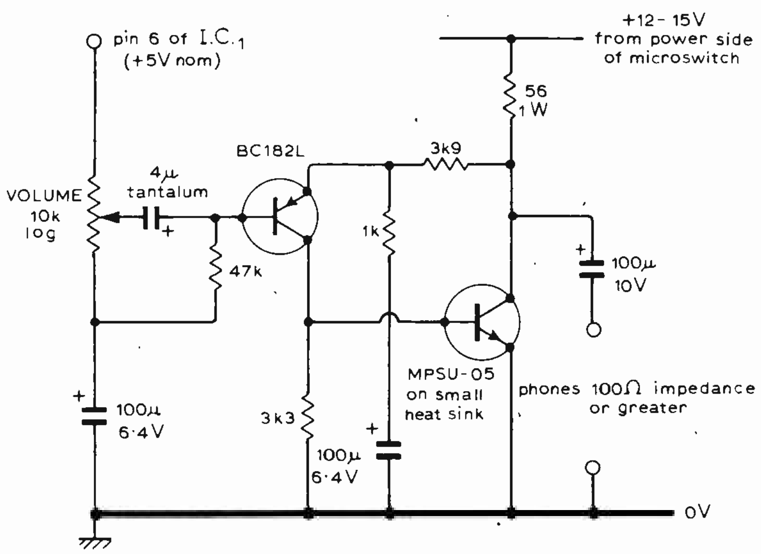


Fig. 12. Class A headphone amplifier, with a gain of 5.

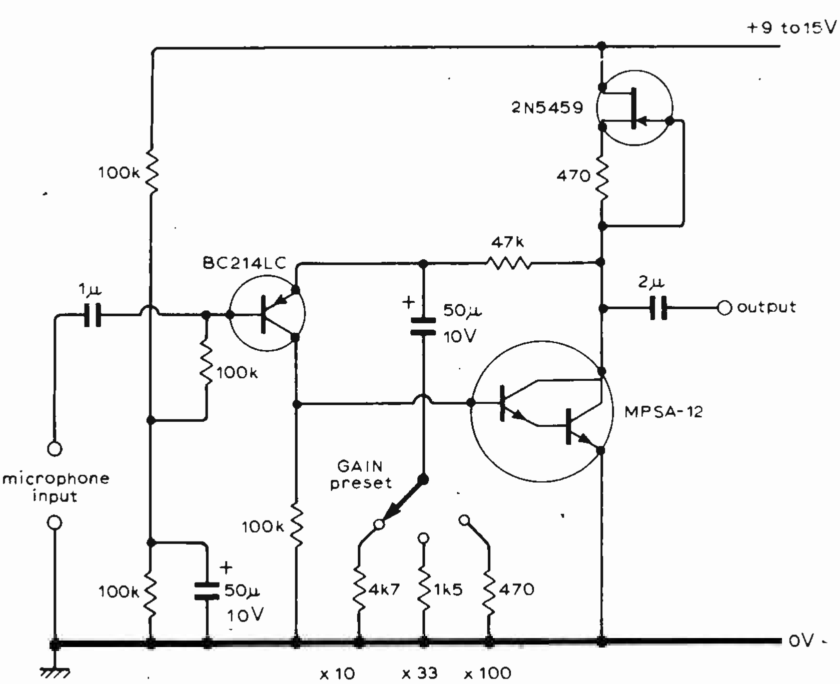


Fig. 13. Low-noise microphone pre-amplifier.

not only will components vary in types and tolerances, but also the tape transport mechanism and heads (which may be changed during the manufacturer's production run for reasons of commercial availablility) may differ from those used by the author, the scope for variability is considerable. Also, from personal experience, and measurements, there is a considerable variation in performance from one tape type to another, although the consistency of performance of the better-grade tapes from the better manufacturers appears to be fairly good. On the credit side may be set the fact that one does not have quality control problems in a unit that is one-off, and that one can optimize one's channel balance and h.f. performance for the tapes one prefers and the heads one happens to possess.

Headphone operation

Both the output level and the drive capability of the final 741s of the replay amplifier are adequate to give a satisfactory signal strength and quality into the 2kΩ load impedance of the author's headphones (Sennheiser HD414), so, for simplicity, this was the course adopted. However, for those with lower-impedance or less-sensitive headphones, a suitable circuit is shown in Fig. 12. This operates in class A, and is suitable for load impedances down to 100 ohms.

Direct microphone recording

The sensitivity of the record input is only intended to be sufficient for recording from an existing audio amplifier or radio tuner capable of delivering some 50-100mV output at a fairly low impedance, and it would not be suitable for microphone inputs. For this purpose a pre-amplifier can be used, of which a suitable circuit is shown in Fig. 13. Three preset gain positions are given, of 10, 33 and 100×, which should cope with the bulk of microphones likely to be found in practice. A typical gain suitable for a low-output cardioid capacitor electret microphone is of the order of 33, for a normal recording level at half-gain setting on the recorder.

Final details of the design will be in the final part, including information on the motor controller – lack of space prevents publication in this issue.

We are informed that components and metalwork for this design will be available from Hart Electronics, Penylan Mill, Oswestry.

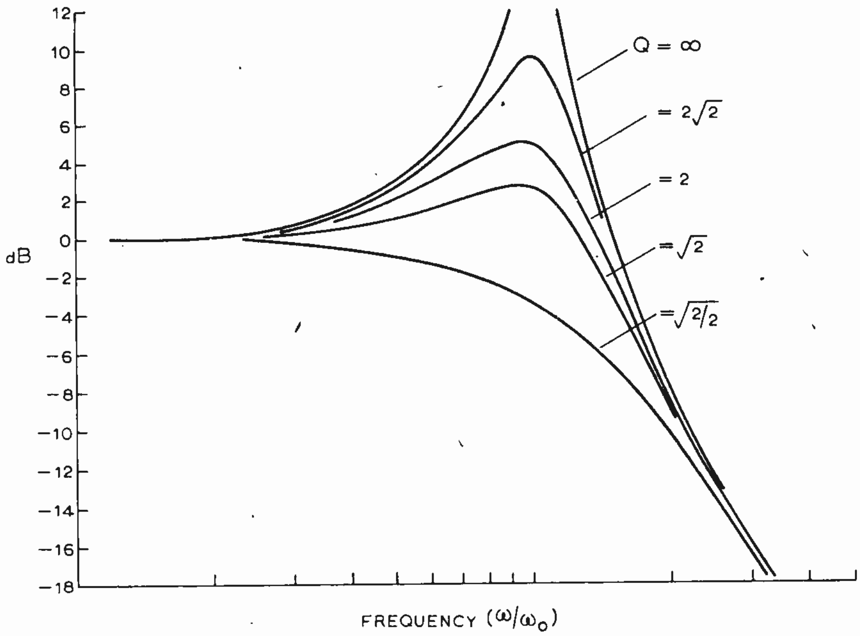


Fig. 15. Frequency/gain response of filter in Fig. 14.

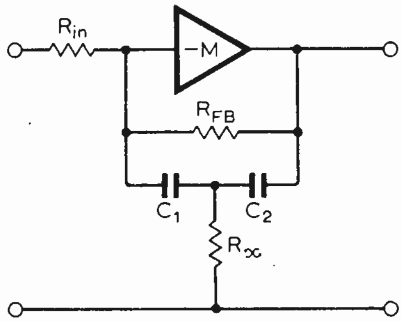


Fig. 14. Basic second-order active low-pass filter (as Reference 1).

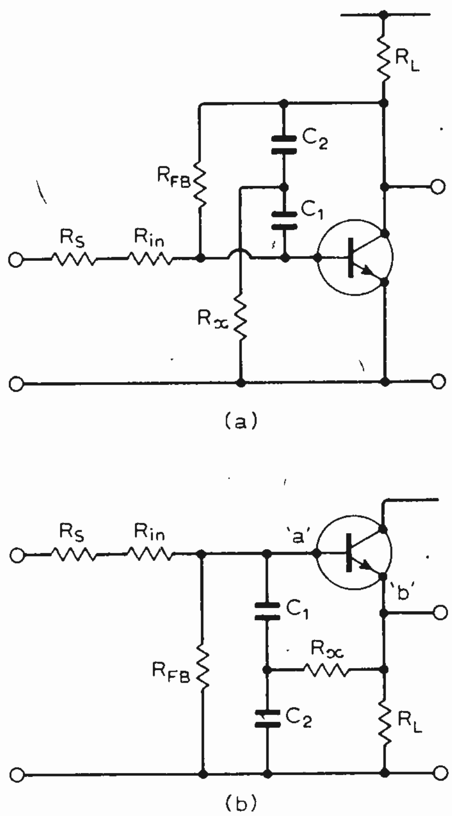


Fig. 16. Common-emitter (a) and common-collector (b) arrangements of basic circuit shown in Fig. 14.

Appendix

Derivation of record equalisation characteristics.

The generation of a recording pre-emphasis characteristic of the general form shown in Fig. 5 is normally done by incorporating a damped *LC* parallel resonant circuit in the feedback loop of an inverting amplifier stage. However, since it was desired, in the interests of simplicity, to avoid the use of inductors, and it was also required to avoid possible trouble due to the intrusion of 38kHz signals from multiplex stereo decoders, the decision was made to use the gain/frequency characteristics of an under-damped second-order active low-pass filter, such as that shown in Fig. 14.

This is one of the classic forms of active element, and was analysed by Girling and Good[1] in the first part of their survey of active filters in *Wireless World*. It has a gain/frequency response of the type shown in equation (1) and illustrated in Fig. 15 for various values of Q (1/α)

$$\frac{V_{out}}{V_{in}} = \frac{1 + j\alpha\frac{\omega}{\omega_c}}{1 + j\alpha\frac{\omega}{\omega_c} - \left(\frac{\omega}{\omega_c}\right)^2} \qquad (1)$$

If this is redrawn, ignoring biasing, in the form in which the amplifying element is a single, common-emitter-connected transistor, as shown in Fig. 16(a), it will clearly be seen that this can be rearranged into the common-collector form of Fig. 16(b) without significant alteration of the expression for the

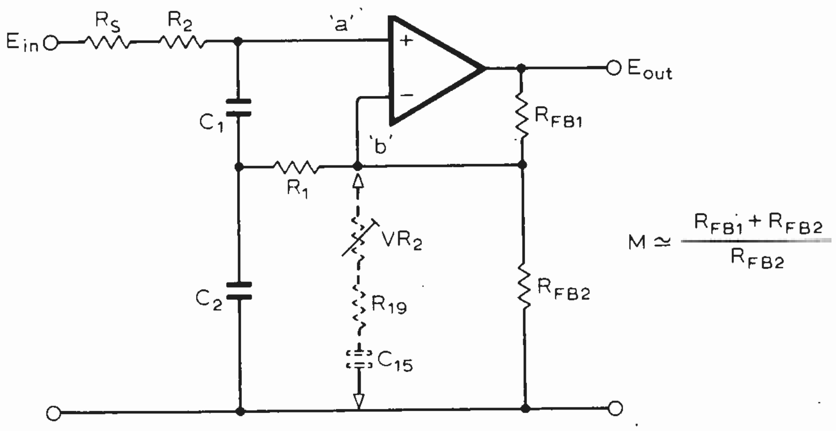


Fig. 17. Use of the active filter in a stage possessing gain, as in Fig. 4.

frequency response. (It was pointed out by Girling and Good that a similar rearrangement leads to the evolution of the filter circuit due to Sallen and Key[2] from the type based on a feedback loop containing an integrator and a lag, described earlier by Baxandall[3].)

Filters of the type shown in Fig. 14, and 16(b) were used in the authors "Modular preamplifier" design (*Wireless World* July 1969) and the subsequent postscript to this and the earlier class A amplifier, published in December 1970. The performance of the circuit shown in Fig. 16(b) referred to as a bootstrap or "H" filter, was analysed by the author in another place[4] and, in a different context, by Hemingway[5].

The operation of the filter circuit of Fig. 16(b), like that of the Sallen and Key configuration, can be realised by any active element in which there is approximately unity gain between points "a" and "b". This allows the use, for example, of a voltage-follower operational amplifier as the active circuit element, or even a non-inverting operational amplifier having more than unity gain, as shown in Fig. 17, provided that an adequate fed-back gain margin is available at the frequency of interest. The gain and frequency of maximum response of such a circuit is given by equations (3) and (4) where M is the normal gain of the stage with feedback.

$$f_c \approx \frac{1}{2\pi\sqrt{[C_3C_4R_1(R_2+R_5)]}} \qquad (3)$$

$$\left|\frac{E_{out}}{E_{in}}\right| = M\left(1 + \frac{(R_2+R_5)}{R_1}\,\frac{C_1C_2{}^{1/2}}{(C_1+C_2)^2}\right) \qquad (4)$$

While, basically, the Q of the system is determined by the ratios of $R_1 : R_2+R_s$, in a stage with a shunt network, such as that of VR_2, R_{19} and C_{15} in Fig. 4, the gain will change in the frequency region of the filter attenuation band. The associated phase shift due to this network also modifies the Q and allows adjustment of this by VR_2, which is a feature of some practical convenience.

References

1. Girling. F. E. J., and Good. E. F., *Wireless World*, vol. 75, No. 1406. pp 348-352.
2. Sallen. R. P., and Key, E. L., *Trans. IRE.*, vol. 2. No. 1., pp. 74-85.
3. Baxandall. P. J., *Wireless World*, vol. 61., No. 1., pp. 8-14.
4. Linsley Hood. J. L., *Hi-Fi News and Record Review*, vol. 18, No. 2., pp. 293-294.
5. Hemingway. T. K., Electronic Designers Handbook. pp. 283-288.

Component supplies

Goldring-Lenco CRV cassette mechanisms can be obtained from Goldring Ltd, 10 Bayford St, Hackney, London E8 3SE, or Hart Electronics, Penylan Mill, Oswestry, Salop. VU meters are available from J. E. T. Electronics, 90a Mawney Road, Romford, Essex.

Books Received

According to its sleeve note **Problems and Solutions in Logic Design** by Prof. D. Zissos, makes easy and reliable logic design techniques available to those with no specialist knowledge of mathematics or engineering. Even those who are not familiar with Boolean algebra will find an appendix giving sufficient foundation for the rest of the book. The emphasis throughout is on optimal rather than strictly minimal designs which have become less important with the availability of integrated circuits. In the case of sequential circuits, these allow hazard-free designs for the realistic engineering constraint of a maximum variation of 33⅓% in gate speed. A feature of the book is the comprehensive set of problems and solutions at the end of each chapter. These have been chosen to appeal to the student and include the design of logic circuits for traffic lights, a panel game, digital clocks and electronic dice. For the practising engineer solutions are given for commonly used circuits such as flat sorters, shaft encoders and counters. After an introduction to the basic concepts of logic design, the chapters deal with unclocked sequential circuits, clocked sequential circuits, counters and combinational circuits. The design pattern used throughout the book was developed by Prof. Zissos several years ago and is now gaining rapid acceptance. The technique involves the conversion of a design problem into a flow diagram which can be converted directly into the basic logic equations before the circuit is then drawn. The three stages are analogous to flow charting, writing the software statements and executing a computer programme. An important feature is that the documentation is inherent in the design. The use of state diagrams and sequential equations eliminates confusion in verbal statements. Price £1.75. Pp.146. Oxford University Press, 37 Dover Street, London W1X 4AH.

High Speed Pulse Techniques by J. A. Coebin describes the nature of pulse signals and the deliberate or inadvertent processing of them. The emphasis is on an appreciation of circuit and system behaviour at very high and ultra high speed. It is assumed that the reader is familiar with a.c. theory, use of the Laplace transform, small-signal transistor response, and the fundamentals of logic. Price £5.00 (£3.50 paperback). Pp. 219. Pergamon Press Ltd, Headington Hill Hall, Oxford, OX3 OBW.

Noise and Fluctuation in Electronic Devices and Circuits by F. Robinson. Noise to the physicist represents a phenomena described by statistical mechanics. To the engineer, noise is an obstacle in the realization of useful devices. This book attempts to interest the physicist and be sufficiently practical for the engineer. The emphasis is entirely on the physical origins of noise in electronic devices, and the way noise behaves in electronic circuits which are used as building blocks. Price £8.50. Pp. 246. Oxford Books, 37 Dover Street, London W1X 4AH.

Japanese Consumer Electronics — Schematic/Servicing Manual. This publication contains details and schematic diagrams for about 90 products manufactured by J.V.C., Lloyds, Midland, Panasonic, Sanyo, Sharp, Sony and Toshiba. Items covered are digital clock radios, a.m.-f.m. radios, monochrome television receivers, cassette recorders, eight-track tape players and receivers. Four chapters deal with radio principles, radio, recorder, and stereo servicing, transistor and i.c. cross references, and typical circuit diagrams. Foulsham-Tab Ltd, Yeovil Road, Slough, Bucks SL1 4JH.

Recent additions to the **Tab Books** range are Radio Astronomy for the Amateur by Dave Heiserman (No. 714, $5.95 paperback). Transistor Theory for Technicians and Engineers by A. Veronis (No. 717, $5.95 paperback). Computer Programming Handbook by P. A. Stark (No. 752, $8.95 paperback). Handbook of Multichannel Recording by A. Everest (No. 781, $7.95 paperback). Toshiba Colour TV Service Manual Vol. one (from 1970 to 1974, $5.95). Tab Books, Blue Ridge Summit, Pa.17214, U.S.A.

Balunamp design nomogram

Converting an unbalanced signal into a balanced one at low frequencies

by Andrew M. Stephenson

Plessey Telecommunications Research Ltd.

"Balunamp" is my portmanteau neologism for a device which converts a balanced electrical signal into an unbalanced one while providing a predetermined amount of amplification. That the gain may be less than one is irrelevant; the most important feature is that the input impedance is balanced about earth. In practice a balunamp is a special case of a differential amplifier incorporating an operational amplifier. What has been attempted is the design of a simple nomogram with which even a novice may construct a working balunamp with the minimum of fuss and false starts.

Fine. So what use is a balunamp?

Assuming that the reader is not interested in frequencies much above the audio spectrum, nor in the ultimate of performance, the device may be applied to almost any situation where it is desired to produce an unbalanced signal from a balanced one. Instances are microphone amplifiers and preamplifiers, floating a.c. to grounded d.c. converters, and line receivers.

The basic circuit is shown on page 68. This is a much simplified theoretical one; it has been left to the reader to decide what op-amp he will use and hence what other components are needed. The four resistors, R_1 to R_4 suffice to define the basic performance of the device.

The characteristics desired are

– an input impedance (R_{in}) balanced about earth or zero volts.

– an output impedance which is not balanced about earth.

– a certain voltage gain (G).

Few such amplifiers will be required to have a gain above 100. Thus if a good balance is to be preserved it is necessary to choose the values of R_1 to R_4 with care so as to take advantage of those commonly available, assuming that specials are to be avoided. This problem becomes particularly acute at lower values of G, such as 20 or below, and it is the peculiar virtue of this nomogram that it allows this choice to be made quickly and easily – more easily than by heuristic methods. Sceptics may prove this point to themselves if they wish.

As this is a practical article no attempt is made to derive the equations on which it is based; essentially they are straightforward derivations of standard amplifier design expressions. They are given next.

Knowing R_{in} and G (defined as the output voltage divided by the differential input voltage), then

$R_1 = R_{in}/2$, $R_2 = R_{in}G/2$, $R_3 = R_{in}/2(1+G)$, $R_4 = R_{in}G/2(1+G)$.

Two important assumptions must be pointed out: the op-amp is assumed to have an open-loop gain much greater than G, say, more than 20 times, and to have a negligible phase shift (other than 180° inversion) at the operating frequency.

From these equations one could derive values for R_1 to R_4 directly. In practice, however, some difficulty may be experienced in fitting them to real resistors; therefore their values have been calculated for G varying from 0.1 to 100, normalized to give $R_1 = 1.0$, and plotted on log-log graph paper, as in the nomogram.

Next, a substitute for a sliding scale has been drawn to the right of these curves, where three decades of the standard E24 series of resistors, commonly available in 2% tolerance, are marked.

Example 1

A balunamp having a G of 10 is required, the differential input impedance to be 300 ohms.

First draw a vertical line through G=10. This intersects the four resistor curves at $R_1 = 1.0$ (naturally), $R_2 = 10.0$, $R_3 = 0.0909$, and $R_4 = 0.9091$.

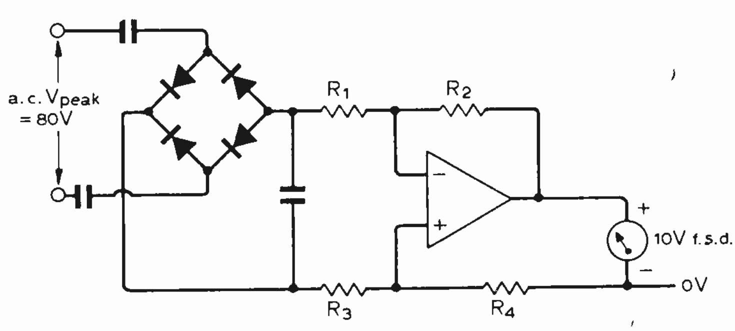
Now these values must be scaled to give $R_1 = 150$ ohms, this being half the desired input impedance. Sometimes it is not possible to perform this scaling and arrive at realistic values for the other resistors, as is the case here. Scaling gives $R_1 = 150$, $R_2 = 1500$, $R_3 = 13.635$, $R_4 = 136.35$. Therefore a compromise is necessary.

Often the impedance is not crucially important and may be altered slightly. Here, by extending the unscaled values of R_1 to R_4 across the E24 grid, we find that another suitable set of values is $R_1 = 180$, $R_2 = 1800$, $R_3 = 16$, $R_4 = 160$. This results in R_{in} being 356 ohms, there being an imbalance of only two ohms, or about 2.2%.

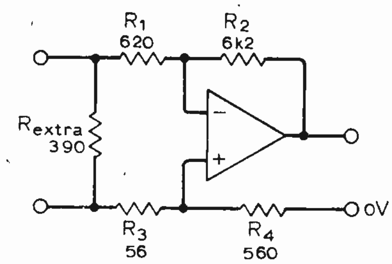
If the balance and the value of R_{in} *are* important, a modification must be made: an additional resistor across the input will adjust R_{in} to the right value while allowing greater flexibility in the choice of the other resistor values; thus $R_1 = 620$, $R_2 = 6200$, $R_3 = 56$, $R_4 = 560$ with an extra resistor of 390 ohms, as on p.68, gives $R_{in} = 296$ and an imbalance of about 0.65%. Naturally one may argue over the definition of imbalance, but for the applications in which the balunamp is likely to be used it is low by any measure.

Example 2

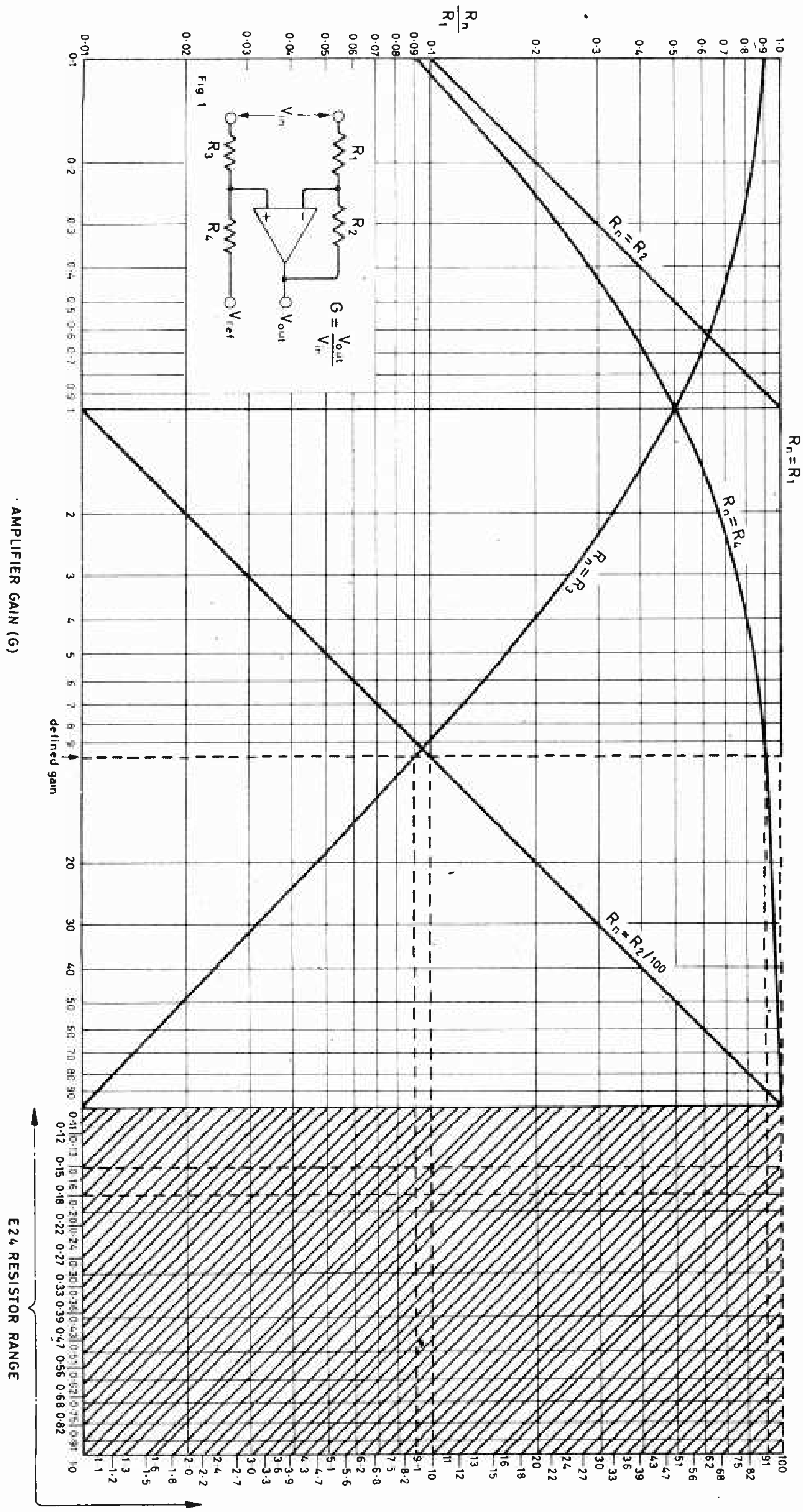
This simple case serves as an introduction. Consider another: a balanced a.c. to unbalanced d.c. converter such as



Application of nomogram to design of a.c. voltmeter – see Example 2.



Circuit to illustrate use of nomogram – see Example 1.



might be used in an a.c. voltmeter, as shown on page 67. The desired features are: a G of 0.125 and a very high input impedance, partly to make it a useful voltmeter but also to reduce the size of the various capacitors; assume for the moment that the capacitors are large enough to be ignored in these calculations.

Returning to the nomogram, the standardized values of R_1 to R_4 are $R_1 = 1.0$, $R_2 = 0.125$, $R_3 = 0.889$, $R_4 = 0.111$.

Now, there will be practical limitations such as the stability of high value resistors subjected to large voltages (up to 80V here); therefore set an upper bound on the largest resistor, R_1 in this case. Say R_1 to be equal to or less than 220 kohm.

Scaling with the aid of the E24 grid yields: $R_1 = 150k\Omega$, $R_2 = 18k\Omega$, $R_3 = 130k\Omega$, $R_4 = 16k\Omega$, G is about 0.1215, and the gain imbalance is only about 0.22dB with these values, while the input impedance is 296kΩ. At 50Hz, 1μF capacitors would be more than adequate.

These two examples should suffice to demonstrate the theory of the nomogram. It is left to the reader to recognize the applications which will help him personally.

One final point: at no time has any allowance been made for offset currents or voltages. It was felt that should this be important the designer should be able to devise some means of providing the necessary balance of resistance to ground while keeping the a.c. impedances at their correct values.

Acknowlegment: Thanks to Plessey Telecommunications Research Limited, for whom the early work leading to the construction of this nomogram was done, for permission to publish this article and the diagrams associated with it.

Generation of equal-tempered pitches

Robert M. Youngson

An adequate approximation to the equal-tempered musical scale can be derived from a fixed-frequency waveform by integer division. The realization of this process, by t.t.l. m.s.i. integrated circuits, is easy and reasonably economical.

Table 1 gives the frequencies of the 12 equal-tempered semitones in the octave from middle C upwards, based on the standard pitch A = 440Hz. A set of divisor integers is given with the resultant frequencies, for comparison with the standard pitches. In practice, the master oscillator frequency is selected as a convenient binary multiple of that given, so that the chromatic octave obtained by division by these integers lies above the frequency of the highest pitch required. All the necessary musical tones may then be obtained by successive binary division.

As the largest divisor in the set given is less than 256, the divisions may be implemented using 8-bit counters. Fig. 1 shows how pairs of SN 74193 counters may be connected to achieve division by the decimal number corresponding to any 8-bit binary number applied to the set of eight data inputs A,B,C,D,A′,B′,C′ and D′. Note that the A input is the least significant bit and that logical "1" inputs may be left unconnected.

A suitable crystal oscillator circuit is given in Fig. 2 and the connections for the binary division stages for the descending octaves of the chromatic intervals are shown in Fig. 3.

Variations in the frequency of the master oscillator do not, of course, have any effect on the accuracy of the relative tuning of the pitches, and if absolute accuracy is unimportant, almost any crystal can be used, extra division stages being inserted as required. In this event, a single SN 74193 would offer great flexibility in obtaining a suitable clock frequency for the set of 12 programmable dividers. Alternatively, a variable frequency oscillator, allowing immediate "one knob" tuning of the whole instrument may be preferred.

The set of divisors given offers a good compromise between relative tuning accuracy and economy and provides about the minimum of musically acceptable accuracy. The standard of precision may of course, be indefinitely improved by using even higher master oscillator frequencies with larger divisors. A sample set using 12-bit counters, and achieving a maximum inaccuracy of 0.013%, is given in Table 2.

This method of deriving musical tones is well suited to large scale integration, and implementation by l.s.i. has already been achieved.

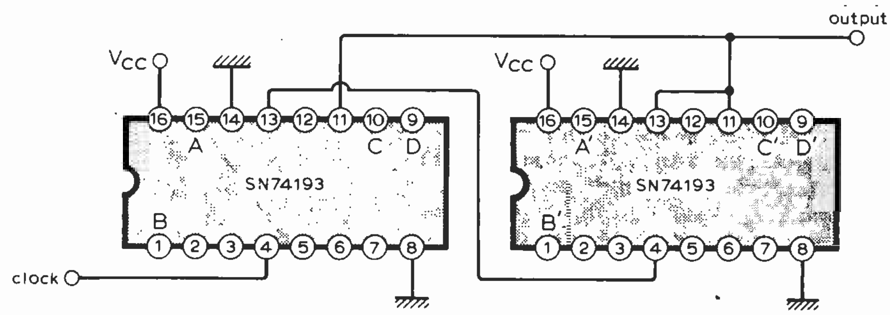
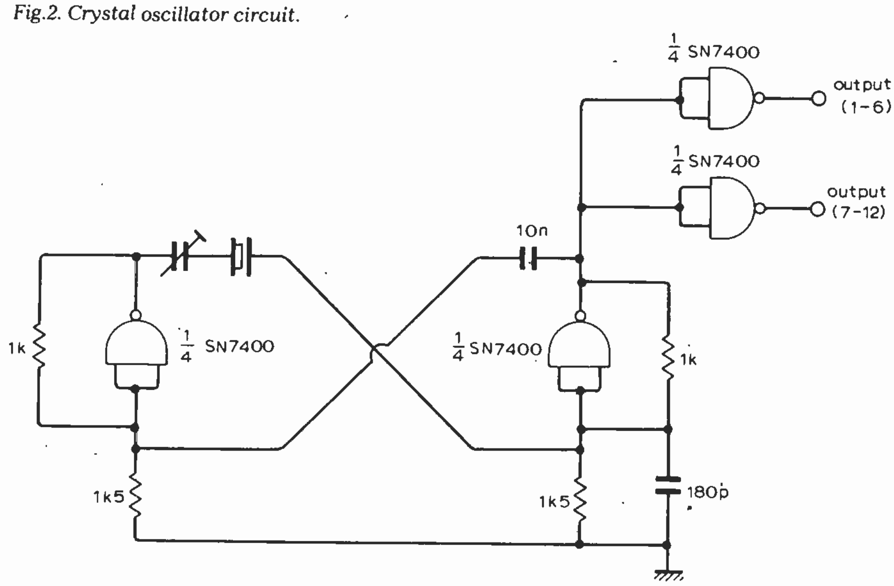


Fig.1. Binary counters connected to divide by the decimal number corresponding to an 8-bit binary number.

Fig.2. Crystal oscillator circuit.



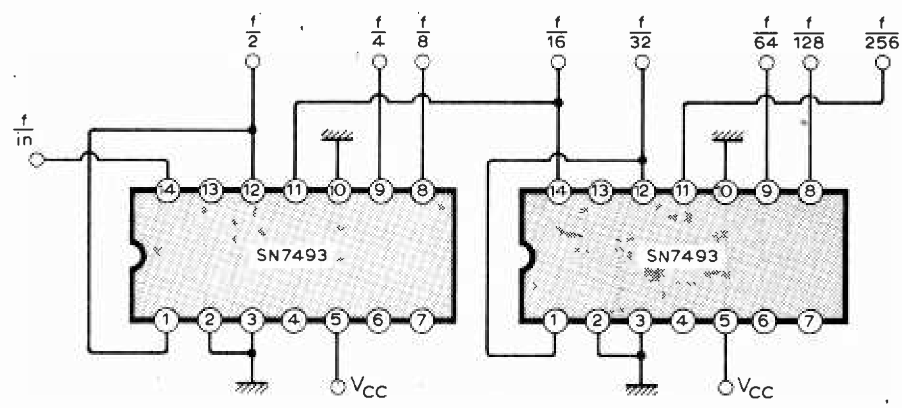


Fig.3. Binary division stages for descending octaves of the chromatic intervals.

TABLE 1
Master oscillator frequency = (4,8 or 16 ×) 57,290.5628Hz.

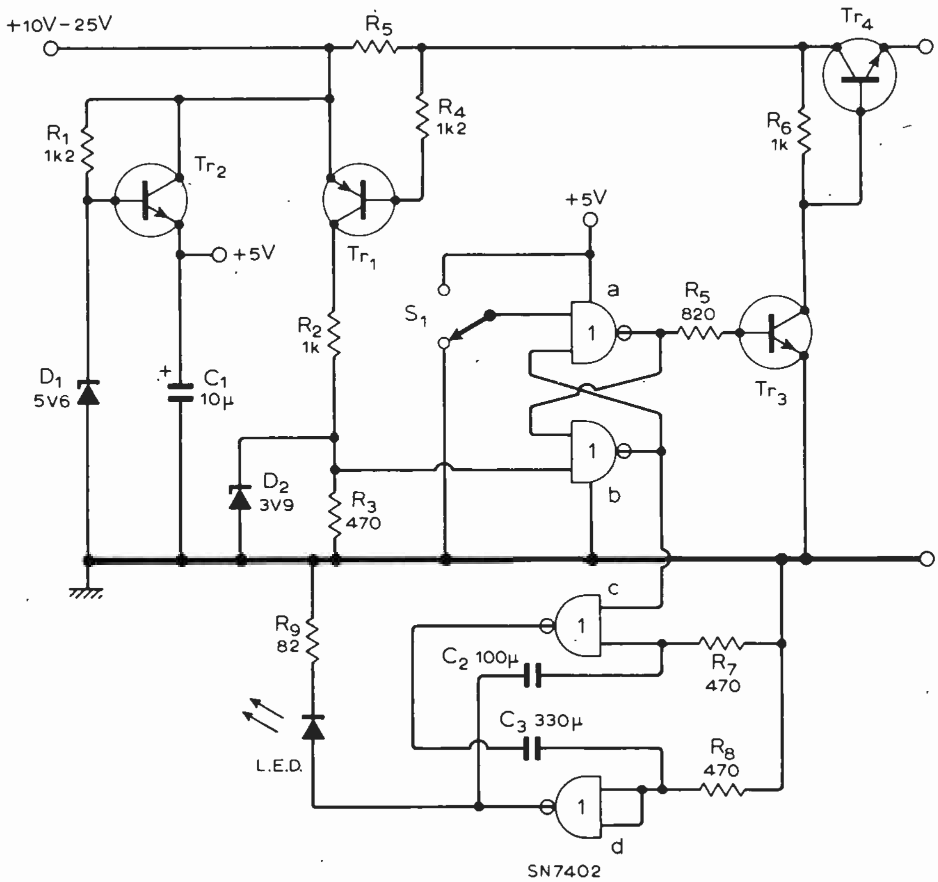
Pitch	Frequency	Divisor	Resultant Frequency	Percentage Error
B	493.8833	116	493.8833	–
A♯	466.1637	123	465.7758	−0.08
A	440.0000	130	440.6956	+0.15
G♯	415.3046	138	415.1480	−0.03
G	391.9954	146	392.4001	+0.10
F♯	369.9944	155	369.6156	−0.10
F	349.2282	164	349.3318	+0.02
E	329.6275	174	329.2553	−0.11
D♯	311.1270	184	311.3610	+0.07
D	293.6648	195	293.7970	+0.04
C♯	277.1826	207	276.7655	−0.15
C	261.6256	219	261.6001	−0.01

TABLE 2
Master oscillator frequency = (4, 8 or 16 ×) 963,600.00Hz.

Pitch	Divisor	Resultant Frequency	Percentage Error
B	1951	493.9004	+0.0034
A♯	2067	466.1828	+0.0040
A	2191	440.0000	–
G♯	2320	415.3448	+0.0096
G	2458	392.0260	+0.0078
F♯	2604	370.0460	+0.0139
F	2759	349.2569	+0.0082
E	2923	329.6613	+0.0102
D♯	3097	311.1398	+0.0041
D	3281	293.6909	+0.0088
C♯	3476	277.2151	+0.0117
C	3683	261.6345	+0.0034

Accuracy, with these divisors, can be improved further by lowering the oscillator frequency so as to distribute errors about zero.

Circuit Ideas



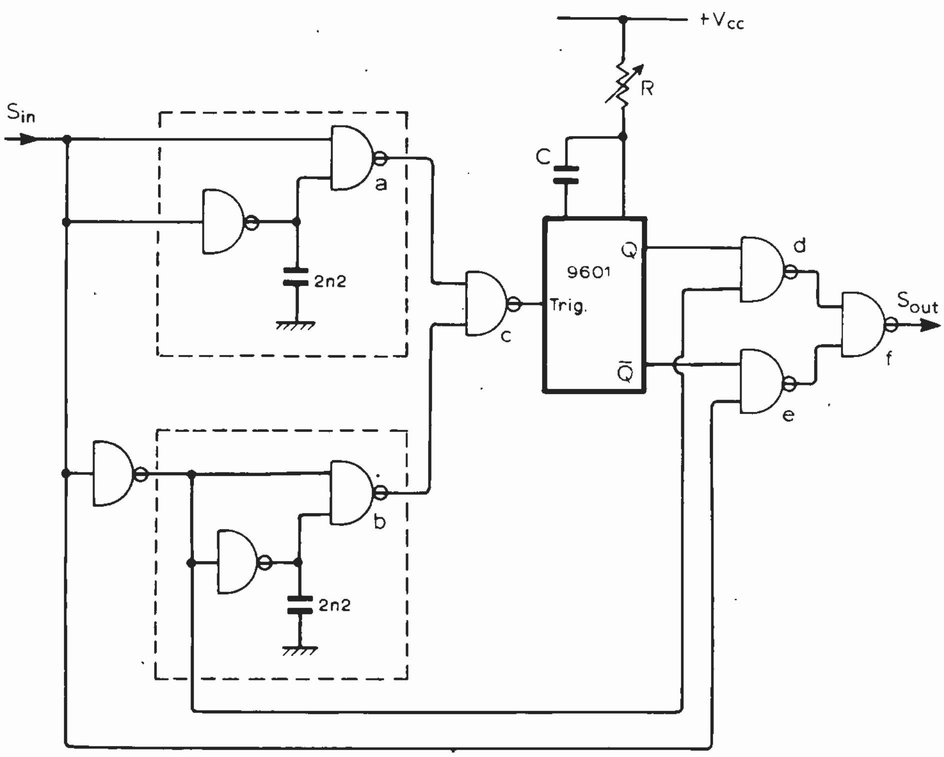
Electronic cut-out

The circuit shows a practical design used to protect experimental equipment against transients. Resistor R_1, D_1, Tr_2 and C_1 form a rudimentary 5V supply for the t.t.l. gates. Diode D_2 prevents overvoltage at gate b input. Transistors Tr_3 and Tr_4 provide the turn-off control. Note that Tr_4 needs no heat-sink because it is used as a switch. The two spare gates, c and d can be used as an indicator. They form an astable oscillator enabled by a 0 on gate c input. Thus the l.e.d. turns on when the power is applied, and flashes when the cut-out trips.

A variation of this circuit is a complementary version using 7400 gates and an n-p-n sensing transistor for negative rails. Bypassing R_5 with a capacitor reduces sensitivity to transients, or all a.c. signals, whereas adding a diode in Tr_1's collector as a reverse voltage protection allows one half-cycle of an a.c. circuit to be monitored. This arrangement is possible because the latch need not have the sensed line as its power supply.

The circuit is instantly reset by S_1 but, inexplicably, the circuit invariably resets when switched on. Any explanations would be welcome.

C. Woolf,
Swanland,
Yorks.



Variable phase delay for digital signals

In the diagram shown the monostable circuits generate a very narrow pulse on the leading and trailing edges of the input signal. These spikes are OR-ed together and used to trigger a 9601 monostable with a period dependent on C and R. Gate e NANDS the 9601 $\overline{Q}$ output with the input signal and causes a section of the input signal to be gated out. Gate d NANDS the 9601 Q output with the input signal thus generating a pulse at the trailing edge of S_{in}. These two outputs are effectively OR-ed by gate f to produce S_{out}, a delayed version of S_{in}.

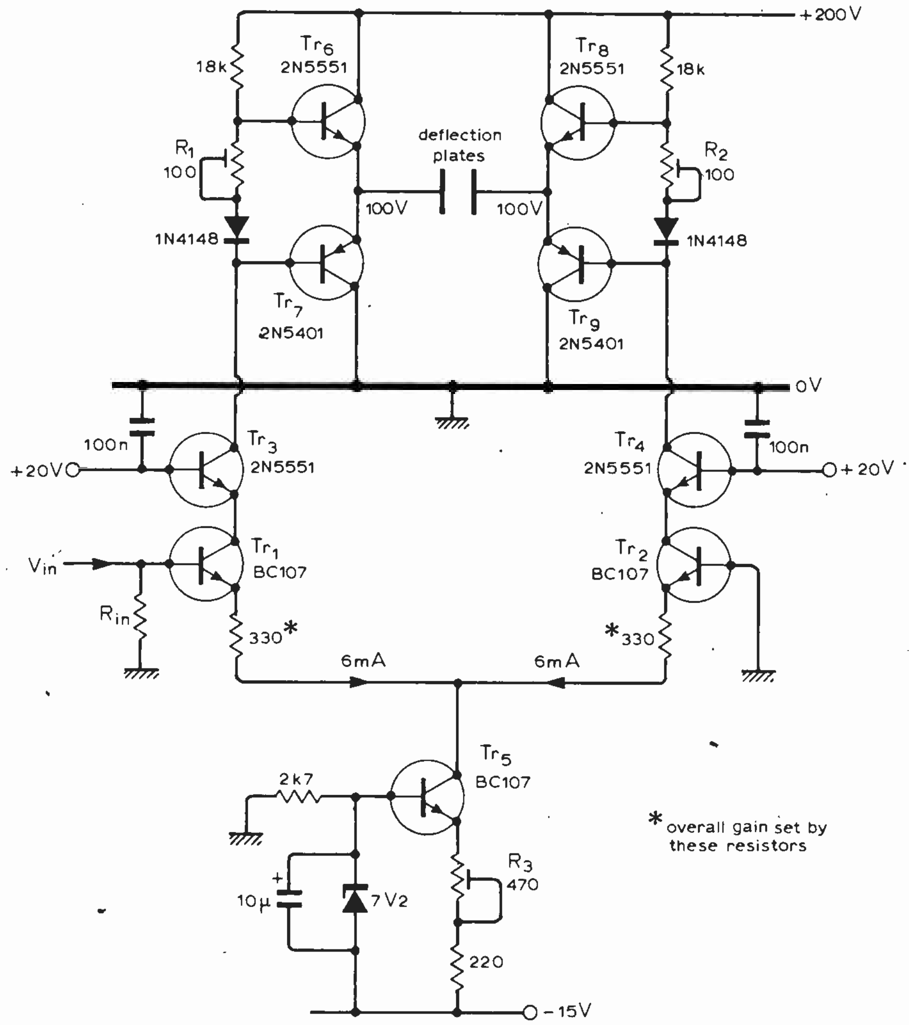
If the signal needs to be advanced and retarded with respect to a second signal, an identical delay unit can be incorporated in the other signal line. Delays between the two signals may then assume any desired phase relationship.

W. D. Gunn,
Glenrothes,
Fife.

Wideband Y amplifier for oscilloscope

Transistors Tr_1 to Tr_4 operate as a constant-current tail with Tr_5 added to improve linearity. This draws 6mA down each side of the amplifier and results in a voltage drop of nearly half the 200 volts across each 18kΩ collector resistor. Driven by this voltage, and with a slight forward bias provided by the 100-ohm preset potentiometers and diodes, Tr_6 and Tr_7 act as complementary emitter followers. They have their counterparts in Tr_8 and Tr_9 and both sets have a quiescent current of about 3mA. Bandwidth of this circuit seems independent of output capacitance loads up to 200pF and appears to be only limited by the 18kΩ resistors and the collector-base capacitance of the complementary pairs. Rise time of the circuit is 40ns, which improves to around 30ns with compensation. A bandwidth of 10MHz was easily obtained by driving the amplifier from a 50Ω source. An increase in the speed can probably be achieved by increasing the tail current and lowering the value of the 18kΩ resistors at the expense of increased dissipation. Any complementary small-signal transistors capable of withstanding above 200V can be used, but a supply current-limited at about 20mA is advisable.

B. J. Frost,
Paignton,
Devon.

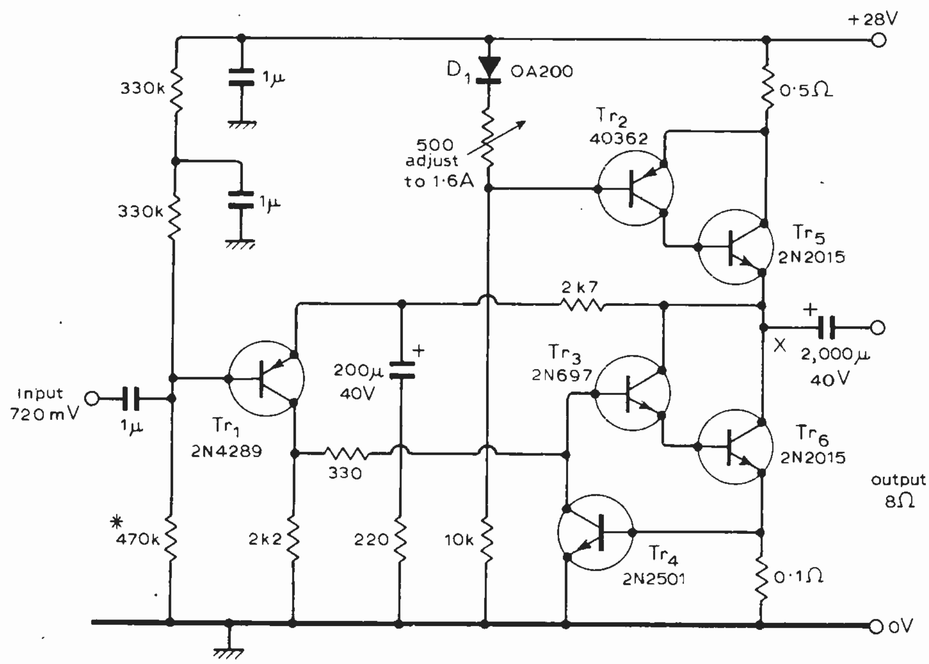


Class A power amplifier

This circuit was designed using easily available components. Its operating conditions are unconditionally stable, unaffected by individual transistor parameters and the transistor types are not critical. Short-circuit protection is provided by the constant-current source D_1, Tr_2, Tr_5 and Tr_4. Transistor Tr_4 may be omitted if short-circuit protection is not required. The amplifier may be altered for a different load impedance (R) or power output (W) by putting the output-stage current $I = 2W/R$, and supply voltage equal to $2 + 0.61 + 2\sqrt{2WR}$.

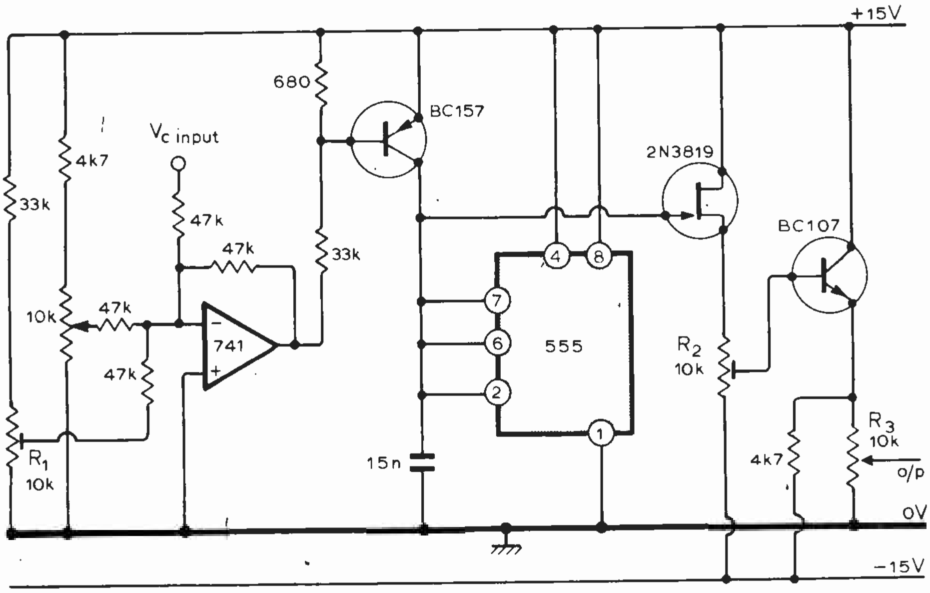
Dissipation in the output transistors is roughly $W \times 4$ watts, so the heat sinks need to be adequate. The amplifier shown will deliver 10W into an eight-ohm load. Diode D_1 and Tr_2 should be in thermal contact.

A. H. Calvert,
London NW1.



* adjust to make point X half the supply voltage (if necessary)

Voltage-controlled ramp generator



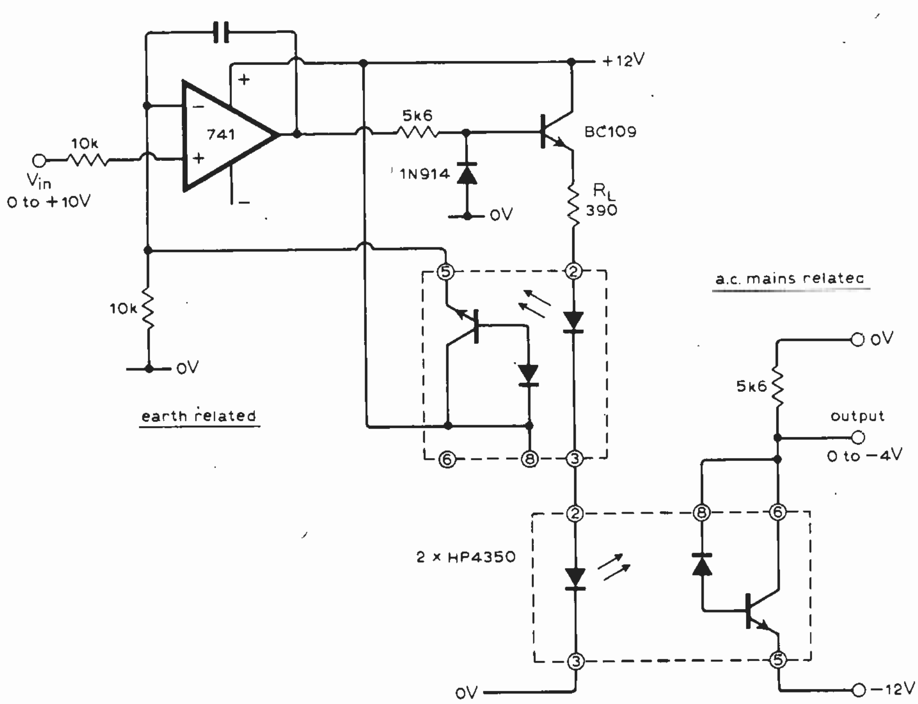
By using the 555 timer as an astable multivibrator with the charge current supplied by a transistor, a wide frequency range can be covered. With the values shown, the range is greater than 0.2Hz to 20kHz. Potentiometer R_1 sets the lowest frequency, R_2 sets the average output to zero volts, and R_3 sets the output level. The voltage/frequency relationship is logarithmic which makes the oscillator suitable for use in sound synthesizers.

J. L. Brice,
Fulwood,
Preston.

Linear d.c./d.c. opto isolator

The circuit shown was initially designed to provide input isolation for mains related thyristor converters. Diode turn-on voltage is rendered insignificant by the amplifier loop gain, and temperature effects are minimised by close tracking of the isolator characteristics. Linearity is within 2%. The circuit may be re-arranged to achieve alternative input/output polarities and operate with other power rails. Resistor R_L must, however, be chosen to limit diode current to 20mA, and the supply rail which provides the feedback current (positive in the circuit shown) must be at least V_{in} + 2 volts.

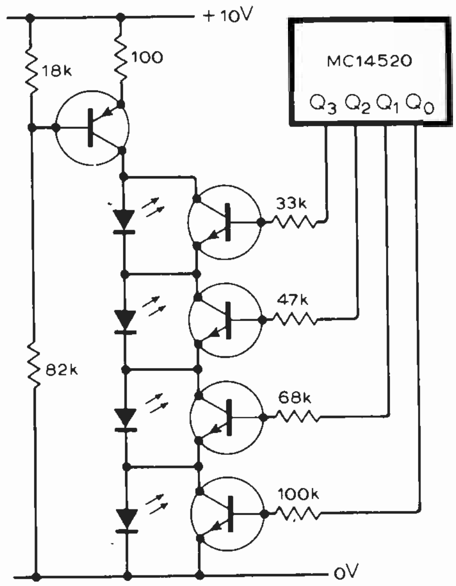
R. J. Haney,
Fletching, Sussex.



L.e.d. display

The low voltage and relatively high current requirement of l.e.ds means that when used in the normal way as digital indicators considerable power is wasted. In battery equipment with reasonably high voltages and where a number of indicators are required, it is advantageous to connect the l.e.ds in groups using a constant-current source for each group. The diagram shows a circuit to display a four-bit binary number from a c.m.o.s. counter.

T. R. E. Owen,
University of Cambridge.



Low-frequency triangle wave generator

In this generator circuit (Wireless World, May 1976), R_2 in parallel with R_3 is greater than 10kΩ and not R_2/R_3 as shown. Time t is $C_1R_1R_3/R_2$ and F is $1/T = R_2/4C_1R_1R_3$.

Contributors to Circuit Ideas are urged to say what is new or improved about their circuit early in the item, preferably in the first sentence.

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P8001	Monochrome Luminance + Chrominance channels	30mm diameter. Separate mesh construction.	P8131 *	Monochrome Luminance + Chrominance channels	Similar to P8130 series but with variable integral light bias.
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* Uses integral light bias but requires socket modification and bias supply.

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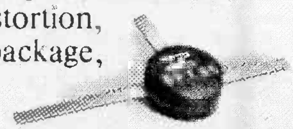

Low noise, high gain, minimum intermodulation distortion, low cost T-plastic package, make it ideal for wide band amplifiers and converters in the 1 GHz frequency range.

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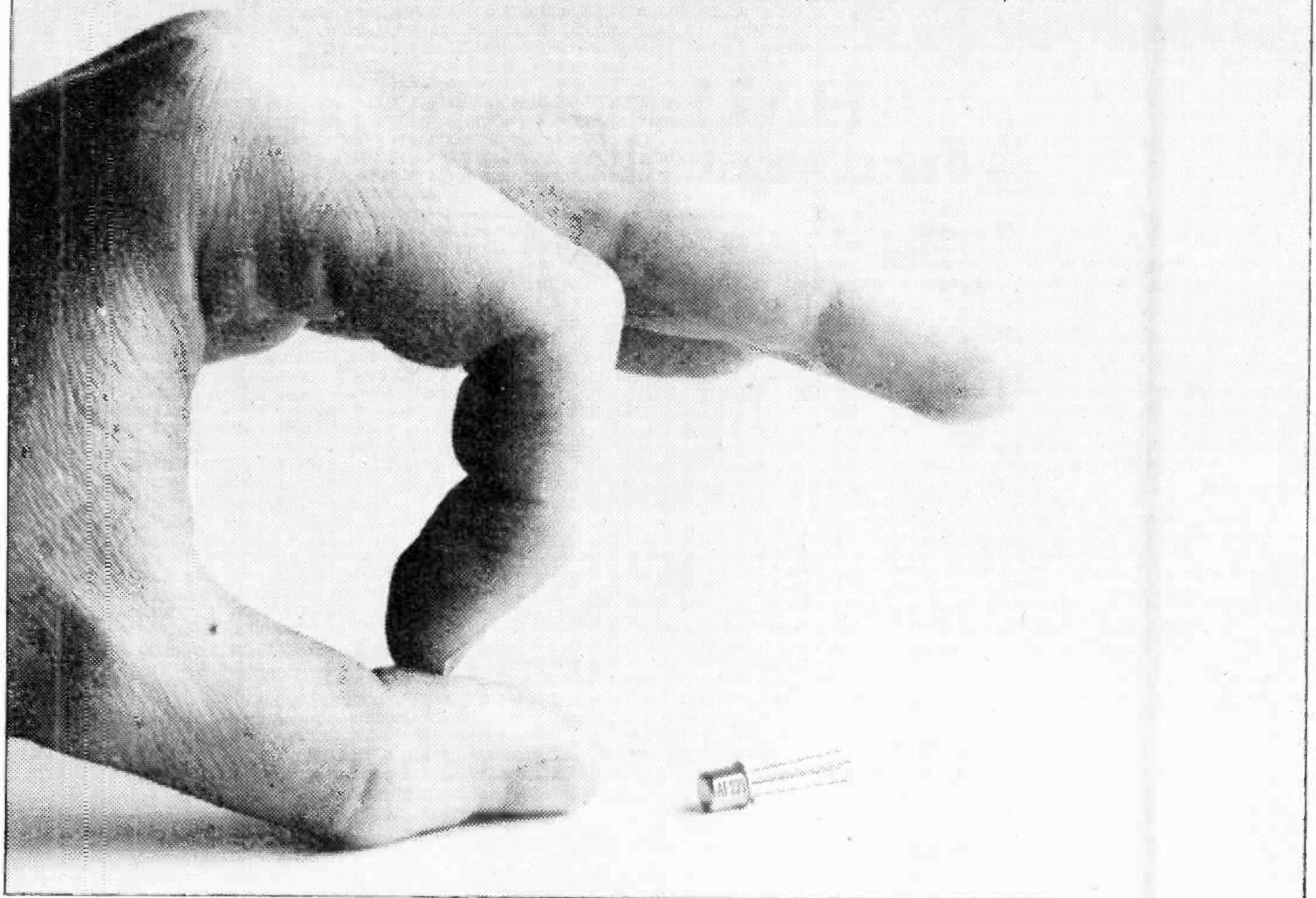


WW-064 FOR FURTHER DETAILS

Broadcasting's biggest

Highlights of the National Association of Broadcasters 1976 Convention reported by Pat Hawker

The NAB convention and exhibition returned this year to Chicago: by moving into the massive new McCormick Place exhibition centre on the shores of Lake Michigan, the 54th annual convention was able to reach new heights in size and scope. With well over 200 firms participating — including many from Europe — some 6,000 visitors and 4,000 industry representatives it reflected for those more used to Montreux and IBC in London the significant differences in broadcasting outlook and practice in North America and Europe.

At NAB broadcasting is an industry or trade; the attraction of any new equipment tends to be evaluated directly on whether it will increase the appeal of a station to its audience by jumping ahead of the competition or whether it will reduce operating costs or provide better coverage. Higher technical standards, if these are beyond those required to meet FCC regulations, or whose advantages will not accrue for some time to come — such matters are not for NAB unless as a means of securing commercial prestige. Montreux and IBC may give you a better idea of what broadcast engineering will be like in ten years' time — but NAB provides a wonderfully exciting and dynamic panorama of what the stations will be doing in the months ahead, provided that the new products stand up to the hard assessments that constitute the American form of Operational Research.

It is easy to say that the Americans do not have the same engineering dedication as Europeans to high standards of technical quality; that many of their television programmes would never make British screens. But when one considers what is available (for no licence fee) in metropolitan areas such as Chicago — where over many, many hours each day there are three network-affiliated stations (CBS, NBC and ABC); the local independent WGN; a public broadcasting/educational station on a v.h.f. channel (carrying much British and European programme material); a clutch of u.h.f. stations; and separate streams of m.f. and v.h.f. radio stations — it is difficult not to have at least a sneaking feeling that there is more to American broadcasting, as it is today, than is sometimes conceded over here.

Electronic journalism

News has become a major element in American programming and is still evolving rapidly. This is particularly true in the area known as "electronic news gathering" (e.n.g.). The use of electronic cameras as a replacement for film in news operations has made rapid progress in the past few years (ITN with a compact Range Rover unit have been active in this field). But the emphasis in the States is towards even smaller and lighter equipment, requiring less technical support, and even the complete elimination of news film by some stations.

E.n.g. fulfils the criteria for appeal to American broadcasters: it can provide more national and local news inserts, including 'live' and late news, making newscast more attractive to audiences; potentially it offers (at least debatably) economic advantages if film processing can be eliminated and tape is re-used and not stored for possible archival purposes. But against these must be set the proven reliability, low capital cost and ease of transportation of film, and film cameras.

The past 12 months have seen a number of North American stations convert to all-electronic news, many more to hybrid e.n.g./film working; and many sitting on the fence waiting to see what the competition will do.

All-electronic news became possible with the appearance of light-weight "portable" (though often heavy) back-pack cameras and more especially with the improvement in low-cost helical video recorders such as Sony U-matic or JVC units that became possible with digital time-base correctors. Now firms are rushing out new products specially designed for e.n.g. and to eliminate some of the reliability problems that do arise. Cables, cable connectors, head cleaning on recorders, batteries, "instant" interference-free microwave links and general maintenance all give more headaches than the early e.n.g.-advocates anticipated, but these problems are being tackled vigorously in the new designs.

E.n.g. cameras featured at NAB included the Thomson-CSF (CBS Laboratories) "Microcam" which sets a new record for an all-up weight of 13 lbs for a camera based on three 2/3-in. Plumbicons with built-in image enhancement. Camera head including lens weighs 8lb, a shoulder-slung hip pack weighs 3lb, and a typical battery belt weighs 1lb. Power consumption is 22 watts, including viewfinder. It is claimed the camera can be fully operational in 4 seconds from switch on. First production units are due to be delivered to CBS this summer. Size and weight reduction has been achieved largely by the use of l.s.i. circuits.

Other lightweight e.n.g. cameras include the RCA TK76 (shown at Montreux 1975) of about 28lb all-up weight; several Ikegami units including the HL77 with no back pack and weighing 6 kg (plus lens and viewfinder); the NEC MNC-61, again with no back pack, and weighing some 6.7 kg including viewfinder and hand grip; the Hitachi SK80 with a basic weight of 7.5kg. Many other portable cameras including those using 1-in lead oxide vidicons are being offered either for e.n.g. or as portable production or sports cameras, although some call for a strong cameraman rather than camera person. Many use 1-in lead oxide vidicons to give quality comparable with studio cameras.

Another area where considerable development can be seen is in microwave link equipment where it is not only required to set up links quickly and easily but where problems are being encountered in mutual interference between competing teams and those presented in such areas as New York due to high buildings. Trends include "quad polarization" for pick-up, allowing remote selection of right-hand or left-hand circular polarization or vertical or horizontal polarization, often also with remote selection of direction. The mobile units often use circularly polarized aerials.

Nurad have a new 2 GHz "Golden-rod" aerial for mobile use in the form of a 2-in diameter rod just under 4ft long which is claimed to provide circularly-polarized signals comparable with those from a 2 ft parabolic dish but with far less wind loading and easier to store and handle.

Video tape recording

For the past five years or so the "format controversy" of video tape recording has been waging, but most television broadcasts continue to be based on 2-in quadraplex machines — even ENG material is often transferred to 2-in cassettes for transmission. With the issue to RCA, Philips and IVC of licences for the manufacture and marketing of the Fernseh 1-in BCN series of helical scan recorders, and the introduction of a new Sony 1-in unit (BVH-1000), the stage is set for more general acceptance of 1-in tape.

The IVC-Cintel 9000, a 2-in super-band helical-scan studio machine, appeared at NAB in a new guise as the IVC 9000-4 half-track machine for archival purposes, where a 3 dB lower signal-to-noise performance (47 dB instead of 50 dB) can be tolerated.

Ampex introduced their new AVR 3 machine aimed at operators seeking modern replacements for the widely used VR2000-series. This uses the super high band plus pilot tone technique which Ampex first demonstrated on 625-line PAL. The pilot tone at 1.5 times colour subcarrier is claimed to provide superior autochroma and time base corrector performance, resulting in reduced head banding and reduced moirè patterning. The AVR3 is the first use of this system as an integral part of the design including automatic switching between normal high band and super high band pilot on playback. Ampex however has for this model abandoned the vacuum-buffered transport system that they introduced with the AVR1 to provide virtually instantaneous lock-up: in the AVR3 lock-up is achieved in 1-2 seconds.

Although the machine was not shown, J. Dierman of Ampex presented a detailed paper on the company's "electronic still store" the first delivery of which is due this summer to CBS. This is designed to replace the large collections of slides and graphics held by most broadcasters (it is suggested that the average broadcaster has a slide library of 3000 to 5000 items) by using computer disc drive techniques to store the material digitally. The system provides instant random access to 1472 stills and can store additional graphics off-line: still sequences can be assembled in advance. The basic storage medium is gamma ferrous oxide coated on to a thin aluminium disc.

A rather similar application was demonstrated by RCA with its optical disc recording system which can store up to 10,000 still pictures on a 12-inch disc. This is based on the original RCA video disc system and is distinct from the firm's later Selectavision technique with capacitance pick-up seen as having consumer applications. Although the optical system was shown working effectively on stills (it could be used for motion) no attempt was being made to indicate the appearance of an early production model, with final development put at 2 to 5 years away. RCA, however, are now offering a half-speed (7.5in/sec) version of their TR600 video tape recorder and also a modification kit including 6mm headwheel tip and use of super high-band f.m. for existing machines.

Other video memory systems include a 3M D8000 system and an Arvin/Echo "video frame-store" handling 400 stills.

As a lower cost arrangement to the massive video cartridge machines, Recortec have introduced a "video spot assembler" which is intended for use with two vacuum-buffered tape machines. The assembler itself is priced under $9000.

Apart from the IVC 9000-4 and the Fernseh BCN series, a number of new broadcast helical scan recorders have been introduced including a new 1-in Sony BVH-1000 with a tape speed (525-line) of 9.63 in/sec and claimed to be the only machine that eliminates head band flicker by recording in the vertical gap. It is being marketed with built-in time coding, and a 625-line version is expected in 1977.

Transmission

One of the problems which have faced u.h.f. stations using relatively low-efficiency multicavity klystrons has been the rising cost of electricity. This has often meant that with power amplifier efficiency less than 25 per cent the cost of maintaining a high power transmitter on the air has been significant. In recent years a number of klystron manufacturers have shown that efficiency can be increased to just over 40%; at NAB John Bullock of RCA and Robert Schmidt of Varian Associates presented a joint paper on a new approach to klystron operation that could further reduce power consumption by up to about 13%. This pulser or electronic switching system makes use of the fact that maximum output from the klystron is required only during the sync periods, representing on 525-lines just 8% of the total time. At other times the beam current can be significantly reduced, using radar techniques, by reducing the mod. anode voltage from —2000 to —4000 volts provided that greater linearity correction is applied. The bi-mode system has been developed for use with Varian "H" type klystrons and it has been estimated that for 16-hour per day operation annual savings of between about $3500 to $7000 are possible with high power u.h.f. transmitters.

Power saving is also seen as one of the attractions of all-solid-state m.f.-a.m. transmitters; Harris, Sparta and RCA were among the firms showing or announcing designs from 1 to 5 kW. RCA were also demonstrating their a.m.-f.m. m.f. stereo system — one of five m.f. stereo systems already proposed to the National AM Stereo Committee of the Electronic Industries Association. This committee is due to report in the Spring of 1977 but it will be some time before FCC is ready to accept a national system. The recent industry report on discrete quadraphonic systems has apparently left the matter up in the air since no direct inter-system comparisons are provided: meanwhile about 100 f.m. stations in the United States are using matrix quad encoders and several hundred are playing matrix encoded records. If a.m. stereo becomes established this could be a serious blow to the f.m. stations who still find it difficult to attract majority audiences— but undoubtedly would provide a boost for m.f..

Automation of radio stations continues to attract interest although the aim is now often to provide hybrid systems that have the appearance of being "live" stations. A new emergency broadcast system has just been introduced in the United States.

For many years the planning and operation of the m.f. band in the United States has been the envy of European broadcasters, with the effective use of directional aerials and day/night switching. However some U.S. operators are alarmed at the increasing number of extremely high power stations in the Caribbean not under FCC control.

Several firms have developed circularly-polarized v.h.f. and u.h.f. for television transmissions following field trials by RCA (v.h.f.) and Jampro (u.h.f.). To achieve true circular polarization — in terms of good axial and polarization ratios in all azimuth directions for broadband television transmissions — is by no means easy, and if, as seems likely, there is progressive utilization of this technique in North America it is likely to be an expensive undertaking (European use will probably be limited because of the use made of polarization discrimination). Certainly the field trials indicate that considerable reduction of ghosting is experienced by many viewers (especially those using bow-tie aerials). Harris have developed circular polarized v.h.f. aerials using a cavity-backed radiator. So far FCC have authorized only experimental use of circular polarization for television broadcasting.

Digital techniques

A year or two back, NEC introduced a series of large digital framestore synchronizers designed to allow any non-synchronous colour signal to be locked to the local station sync, and thus to be handled as a local source without special gen-lock techniques. This year Quantel (DFS 3000), and RCA (TFS 121) both show how it is now possible to provide these facilities in a compact unit. The DFS 3000 for instance is packaged complete with power supply and associated analogue circuitry into only 8.75-in of panel space. Prices of framestores are in the region of $50,000.

Apart from the time-based correctors and frame-store synchronizers, there were few signs that the Americans are thinking as seriously as Europeans of digital video throughout a studio or for transmission networks — although digital control and computer techniques are prominent. The convention papers and discussions on digital video were generally disappointing and undoubtedly the single most-sophisticated digital equipment on display was the first of the Marconi-built DICE (standards converters, to the IBA design.

The recent decision by FCC to permit much wider use of unattended operation of all classes of broadcast transmitters will undoubtedly be reflected in more use in North America of interval test signals and automatic measuring equipment of the type already in use in Europe, and several firms were showing sophisticated systems developed in Europe.

British and European firms were prominent. With the acquisition of CBS Laboratories, CSF-Thomson appear to have moved firmly into North America in a similar manner to Philips. Marconi had their largest display ever at NAB. Rank Cintel featured their new Mark 3 capstan-driven flying-spot colour telecine unit suitable for NTSC operation. Evershed Power-Optics, EEV, Marconi Instruments, Matthey Printed Products, Quantel, Racal, Amplivox, Rupert Neve, W. Vinten and several of the Rank companies were among those present at NAB.

Communications-systems of all types are proliferating, partly as a result of the emphasis on news gathering both television and radio. ABC in New York have been experimenting with extra sub-carriers on their television sound channel — similar to SCA f.m. radio techniques — to provide communications cueing and one-way communication with outside-broadcast units. A related development are more complex multi-channel radio microphone systems (Thomson-CSF are marketing a u.h.f. unit made by RF Technology suitable for up to 15 radio-microphone channels). A recently introduced "Optimod-FM" system by Urban is claimed to raise modulation levels by 2-3 dB with less than 0.25% distortion.

In brief, NAB 1976 was an exciting, rewarding reflection of broadcasting trends in North America; both for broadcast engineering and broadcast management.

Grateful acknowledgement is made to Mr Howard Steele, Director of Engineering, IBA, for permission to publish this report — the views expressed, however, are solely those of the author.

Electronics à Paris

New products at the Paris component show

The air of economic despondency of the previous Paris components show seemed to have disappeared this year although it was difficult to tell if this was a result of enthusiasm on the part of the organizers or of an increase in trade. The number of exhibitors this year (1013) was less than the previous year (more than 1100) mainly due to there being no section for test and measuring equipment. This aspect is to have its own venue in Paris at a later date.

Turnover in the French electronic component industry declined 6% in 1975. The semiconductor and capacitor branches were the hardest hit, their figures being down 24 and 15% respectively. Signs of a recovery appeared in the final quarter of 1975 in the consumer goods field which had been the worst affected early in the crisis along with data processing equipment. The French electronic components industry faces a less gloomy climate in 1976, a marked feature being the upturn in orders for consumer goods. Underlying trends in the international components market are a cause for reasonable optimism between now and 1980 even though competition is likely to be increasingly tough with new component manufacturers appearing particularly in the developing countries.

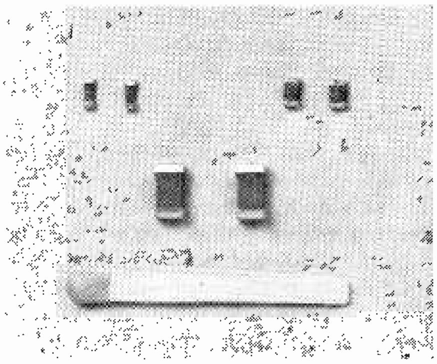
A single-chip, 8-bit, 40-pin c.m.o.s. microprocessor, the CDP1802, was launched by RCA. Also introduced by this company were several new memory and timekeeping devices using silicon-on-sapphire plus numerous additions to the range of c.m.o.s. and linear integrated circuits, power transistors and resistors. The CDP1802 microprocessor family is a development of the existing CDP1801 series, but with the two c.m.o.s. chips in the earlier microprocessor replaced by a single chip using self-aligned silicon-gate fabrication. Although compatible with the CDP1801 series, it is faster and is supplied with a wider range of instruction sets. Typical of the new range of RCA silicon-on-sapphire memories is the MWS 5001, a 1024 × 1-bit r.a.m. with an access time of 150ns for only 4mW of operating power. Operating

temperature range is −20 to +85°C and voltage range is +4.5 to 6V. A colour TV receiver featured by RCA contained several novel circuits. The horizontal deflection system for the 110° precision in-line tube combined a switched-mode power supply with a thyristor deflection circuit. The main point here was that no input inductor is required and the chassis is completely isolated. A similar system was also demonstrated by Videocolor S.A., a joint venture of Thomson and RCA.

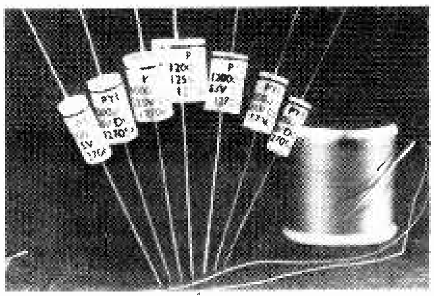
An array of new products was exhibited by Plessey. These included two new ranges of circular connectors now in production, together with an inter-rack wiring connector for telecommunications use. New capacitors exhibited included examples from the recently announced improvements to the 400V a.c. general purpose range which now has a reduction in physical size of up to 25% together with an extension of capacitor values so that values from 0.5 to 20μF are available. The Minican range of aluminium electrolytic capacitors has been extended to much larger capacitance values, up to 360,000μF. Being shown for the first time were smaller additions to the 1.60 Minibox series of low-cost miniature metallized polyester capacitors. The new values have radial leads at 5mm separation.

A new miniature chip tantalum capacitor to complement the use of ceramic capacitors on thick-film hybrid circuits was announced by Sprague. The type 194D Midget is available in eight chip sizes. Capacitance ratings at the lowest working voltage range up to 100μF while at the highest working voltage the maximum capacitance is 4.7μF. The new capacitor can be reflow solder-attached to substrates at temperatures up to 300°C for three minutes without damaging the electrical or mechanical characteristics of the capacitor.

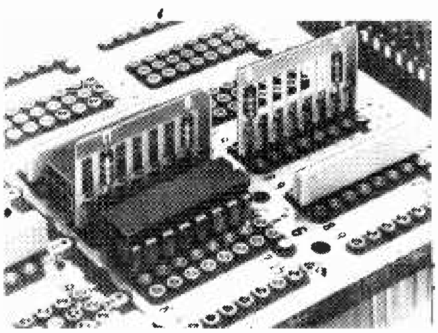
The SGS-Ates BFT95 is a new 5GHz silicon p-n-p transistor with low noise (2dB at 1GHz) intended for high-volume radio-frequency applications such as antenna amplifiers and cable TV. The device is constructed with the Planax silicon nitride technique and is mounted in the SGS-Ates T-plastic package using a copper alloy frame to withstand high currents and thus achieve an improved cross-modulation level. The device has a forward transmission gain of 10dB at 1GHz. The BFT95 will shortly be followed by another device able to handle even higher signal levels and designed for ultra-linear output stage applications. SGS-Ates has also developed three high-voltage, high-current Darlington transistor arrays each consisting of seven silicon n-p-n Darlingtons. The L201 array is suitable for d.t.l., t.t.l., p.m.o.s. and c.m.o.s. The L202 is designed for use with 14 to 25V p.m.o.s. elements and the L203 allows operation directly with t.t.l. or c.m.o.s. operating at a supply voltage of 5V. The three devices have an output sink capability



New tantalum miniature capacitor chip, the 194D Midget introduced by Sprague is available in eight sizes.



Pye has introduced a range of foil polystyrene capacitors encased in a newly developed plastic. They are claimed to have high reliability, low self inductance and low series resistance.



Augat's single-in-line terminating-resistor adaptor plug.

maximum of 500mA with a specified level of input current at 50μA.

One of the most interesting stands was that of Thomson-CSF on which several novel demonstrations took place. The TH7601 flat screen display was operated as part of an alphanumeric storage display terminal. The characters of the display could be generated either from an associated keyboard or read from a punched tape where they had been previously stored. Also demonstrated on the Thomson stand was an experimental system of video transmission by optical fibres and video image delay using a THX1105 charge transfer device. The monitor display consisted of two juxtaposed images one arriving directly, the other having been delayed by the charge-couple device. Each TV line was treated separately, the time lag being constant for each line but being adjustable by modifying the clock frequency of the THX1105 (number of elements: 256, distortion: 1%, dynamic range: 60dB, delay-bandwith product: 128 and clock frequency: 10kHz to 10MHz).

Siemens are investigating the use of optoelectronics in transistor car ignition units. Ignition units are already in existence in which the mechanical contact breaker points have been replaced by Hall effect generators or inductive type transducers – a light barrier provides an even simpler and longer lasting solution. The high operating temperature of the internal combustion engine to which the optoelectronic elements would be exposed presents difficulties but development work by Siemens has shown there are good prospects of being able to supply suitable light-emitting diodes and phototransistors with an adequate resistance to high temperatures. Siemens has a new m.o.s. device available for manufacturers of multimeters. The device incorporates a four-decade counter and automatically selects one of four possible current or voltage ranges in decade steps. This circuit, S190, has automatic polarity selection and a power dissipation of 50mW.

Several new additions to the Thorn Brimar range of cathode ray tubes were on view including a working demonstration of the smallest monitor tube yet produced by Brimar, the M8.100GX. Designed for avionic applications, the tube is also suitable for other alphanumeric applications where compact, low profile presentation is required. The Brimar TBK3 is a deflection component kit for use on 70°, 90° and 110° cathode ray tubes with 20mm diameter necks. This kit provides a typical final anode voltage of 11kV from an 11.5V d.c. supply and the various auxiliary voltages required by the circuit.

International Electronics S.A., a Greek TV tube manufacturing company were demonstrating a new TV tube whose screen was designed for operation in high incident light conditions. No detailed information is available yet but the tube has a dark raster and is used for both colour and black and white tubes.

News of a new processing technique was released by Isotronics who have begun production of a type of hermetic window which uses a new method of glass-to-metal hermetic sealing permitting high transmission of ultraviolet light for quick erasure of the programme material stored on erasable memory devices. The window can be sealed onto the package with a low leakage level. Windows presently used are made of quartz which also has high transmission of u.v. However, quartz requires time consuming and expensive finishing processes such as mechanical machining and lapping. The new window from Isotronics is claimed to be not only inexpensive to manufacture but easy to seal to the semiconductor packages. The first windows being manufactured are in a form suitable for solder sealing.

New Products

Deflection yoke

A colour deflection yoke, the type GI 1080-1, has been introduced by General Instrument (UK) Ltd. Intended for use with the Philips 26-inch 110° picture tubes type A66-500X (in for example the Philips 20AX system), it can be used in conjunction with an associated beam centering device type 1081 or similar assembly. The yoke housing is moulded from self-extinguishing plastic. Saddle coils of the pegged type are used for horizontal and vertical deflection whilst a toroidally-wound quadrapole winding on the ferrite core is used for convergence tolerance corrections. The yoke can be adjusted within the housing after fitting to the TV tube. General Instruments (UK) Ltd, Cock Lane, High Wycombe, Bucks.

WW 301 for further details

Capacitance meter

The ESP 200A linear capacitance meter from Electronic Services and Products Ltd is designed for fast, accurate measurements on a wide range of capacitors. Capacitances ranging from 1pF to 50µF may be measured simply by selecting the appropriate range and reading the value direct from the meter; no balancing is necessary. The instrument, which is housed in a robust metal case, has a stabilized supply and can be connected directly to a chart recorder for plotting capacitance changes. Short term stability is better than 1% of the meter reading. Electronic Services and Products Ltd, Cross Lane, Braunston, Nr. Daventry, Northants.

WW 302 for further details

Universal breadboard

Up to 36 14-pin d.i.ps can be fitted to a breadboard from GDS. The board, called the "All Circuit Evaluator," is intended for fast, solderless circuit building and testing, and consists of a matrix of 3,648 plug-in tie points consisting of 512 separate 5-point terminals, 32 vertical distribution buses and 4 horizontal buses. The vertical buses each have five connected 5-point terminals, and the horizontal buses each have eighteen 4-point types. Any combination of links may be made between buses to provide both unique and common circuit functions. Components are simply plugged into the breadboard terminals and interconnections are made easily using ordinary 22-gauge solid wire. No special patch cords are required. The tie-point material is a non-corrosive nickel-silver with acetal-copolymer dielectric, and the base, which serves as a ground plane, is made from anodized aluminium. Rubber feet are fitted to prevent sliding. The overall size of the breadboard is 10¼×9¼in. GDS Sales Ltd, Michaelmas House, Salt Hill, Bath Road, Slough, Bucks.

WW 303 for further details

Logic troubleshooter

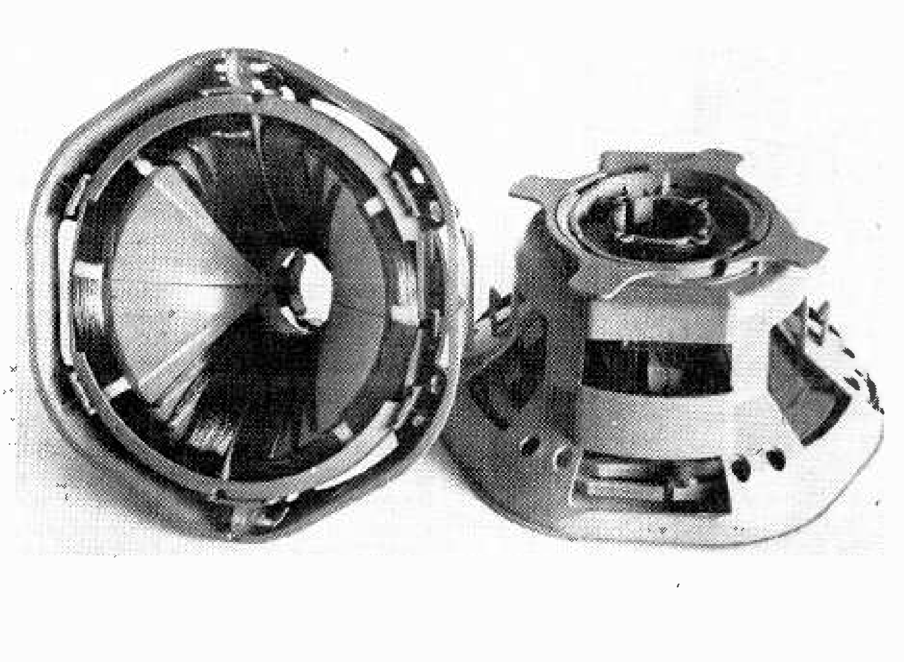
Hewlett-Packard have introduced a probe which can indicate digital states and the presence of pulses in both high-level c.m.o.s. and low-level t.t.l. The logic probe, designated as model 545A, has been designed for simplicity and speedy logic circuit testing. A single lamp displays high, low, unacceptable or open circuit conditions, and it is claimed that this probe enables almost all positive logic up to +18V d.c. to be sensed, including d.t.l., r.t.l., h.t.l., n.m.o.s., m.o.s. and high noise-immunity logic. The probe also features a pulse memory which controls the indicator lamp switching when logic changes occur. A pulse stretching facility allows the operator to see fast pulses – as short as 10ns – pulse trains up to 80MHz being detected in t.t.l. and up to 40MHz in c.m.o.s. logic. The hand-held probe, which requires a supply of up to 15V d.c. on t.t.l., and up to 18V d.c. on c.m.o.s., is protected against voltage overloads. Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.

WW 304 for further details

Low cost solenoids

N.S.F. have introduced the Ledex "D frame" range of solenoids, designed for simplicity, high performance and low cost. The solenoids, which have a dielectric strength of 1000V r.m.s., may be supplied for operating voltages ranging from 6 to 240V d.c. or 60Hz a.c. Design features include a plunger cavity as an integral part of the nylon/glass bobbin, a dichromate-treated cadmium-plated frame and multiple tapped mounting holes for easy installation and interchangeability. N.S.F. Ltd, Switches and Controls, Keighley, Yorkshire BD21 5EF.

WW 305 for further details



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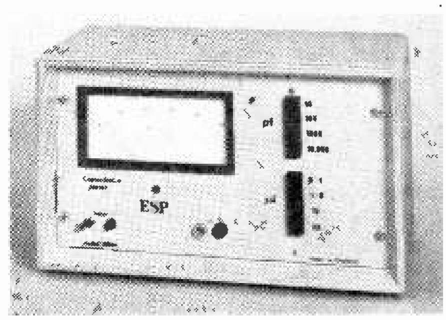

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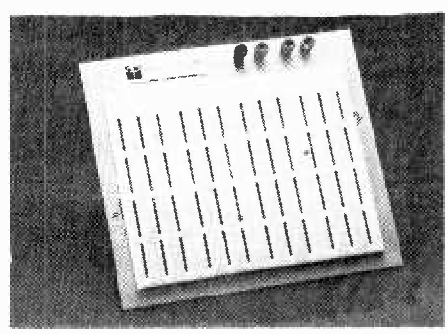

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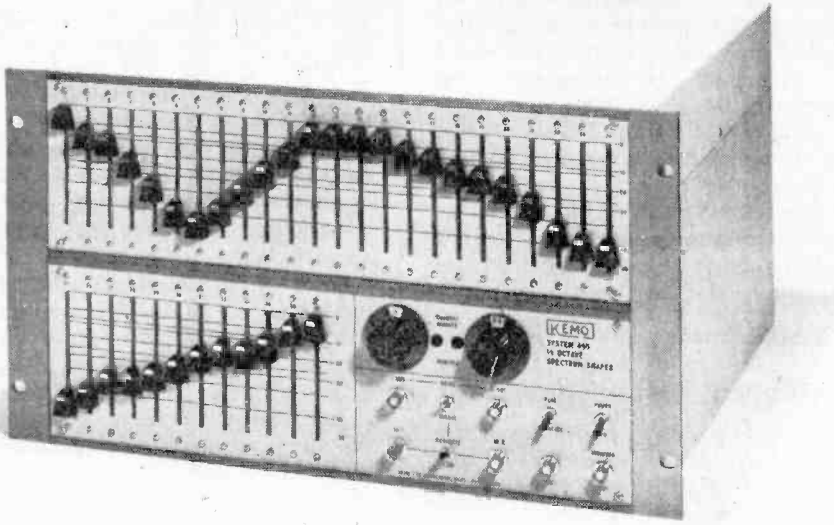

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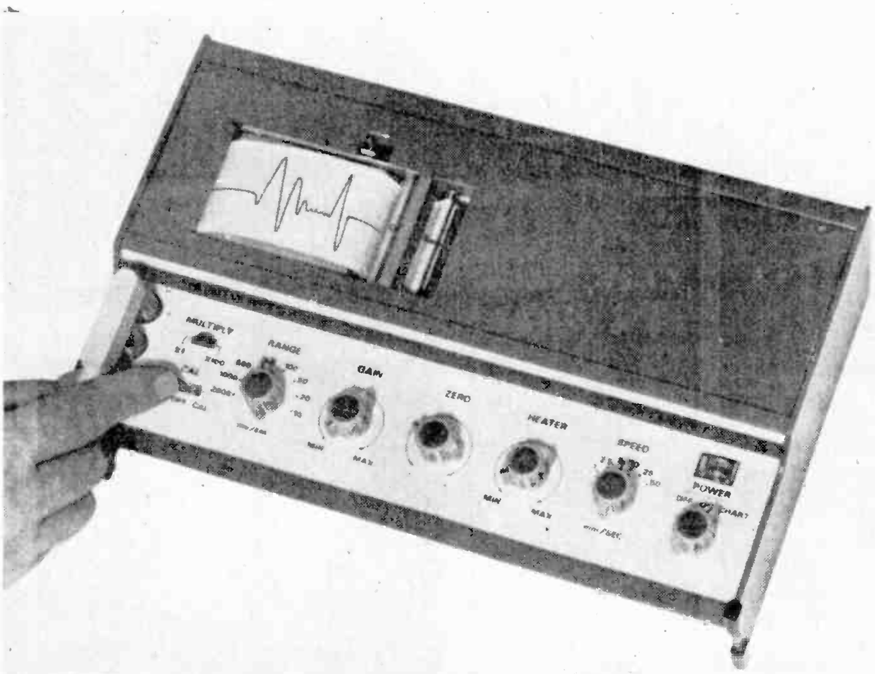
WW 307 for further details



WW 308 for further details

Spectrum shaper

The Kemo type 495 spectrum shaper has 36 channels, the input to each being adjusted by slide attenuators (patch panel optional). The outputs from each channel are summed and applied to an equalized output terminal. Each channel may also be selected by means of a rotary switch and applied to an output terminal. Provision is made within the system to fit two Kemo KA1193, n = 19, pseudo-random Gaussian noise sources which may be switched in at will. Main specifications are: frequency range 1Hz to 100kHz, filter accuracy ±2% of centre frequency, filter level accuracy ±0.5dB, maximum equalized output signal ±10V peak into 2kΩ, output impedance 51Ω. Kemo Ltd, 9-12 Goodwood Parade, Elmers End, Beckenham, Kent BR3 3QZ.

WW 306 for further details

Portable oscilloscope

Small size, light weight and simplicity of controls are the features of the S22 single-beam portable oscilloscope. The Telequipment instrument can be operated from its internal rechargeable batteries, or direct from the mains supply. Although the instrument is small enough to pack into an attache case or tool box, it contains a relatively large screen size of about 6×3.6cm. Normal bandwidth of the oscilloscope is 5MHz at 10mV sensitivity, but a gain switch enables the sensitivity to be increased to 1mV for a bandwidth of 1MHz. Tektronix UK Ltd, Beaverton House, P.O. Box 69, Harpenden, Herts.

WW 307 for further details

Fast response recorder

The WTR771 portable Miniwriter, made by Environmental Equipments Ltd, is a single-channel fast-response recorder having a 40mm chart width and a frequency response from 0 to 60Hz. This model, which supersedes the WTR711 Miniwriter, features a thermal writing system incorporating an automatic heat control which, it is claimed, improves the record obtained. The WTR771, which has a higher sensitivity and improved chart speed accuracy, has 14 switched input ranges, having a maximum sensitivity of 10mV/cm on the standard version, and 0.5mV/cm on the high-sensitivity version. Chart speeds range from 1 to 50mm/s in 6 switchable steps. The recorder weighs only 5.5kg and can be operated from the mains supply or from a 12V battery. Optional extras include a solenoid-operated event marker, a 1/10 speed gearbox, and a rechargeable battery pack. Environmental Equipments Ltd, Eastheath Avenue, Wokingham, Berkshire, RG11 2PP.

WW 308 for further details

Data selecting system

Fenscan 3 is a versatile data scanning and logging system designed for demanding process system applications such as multipoint digital temperature indication, alarm scanning and logging, and intrinsically-safe multiplexing in computer systems. The system, which was launched at the "All Electronics Show" by Fenlow Electronics Ltd, features up to 200 low-level analogue inputs, two 16-segment linearization programmes, manual point selection by a calculator-style keyboard, and a high-accuracy dual-ramp digital voltmeter which uses a strobe-locking technique to reduce series mode mains interference by ensuring that integration is performed over one complete cycle. Optional extras include alarms to aid the automatic point scanning and a trend recording facility. The units are designed to give freedom of location for the scanner, keyboard and display. Fenlow Electronics Ltd, Whittots Eyot, Weybridge, Surrey.
WW 309 for further details

Coaxial attenuators

Fixed 50Ω 'axial-attenuators, for use from d.c. to 4GHz, are available in six values between 3 and 40dB from Aspen Electronics Ltd. The LDV 5033 series offers an attenuator accuracy of between ±0.5dB and ±1.0dB, depending on the model, a maximum v.s.w.r. of 1.2, and has a power handling capability of 15W continuous and 13kW peak. Each attenuator unit consists of an internal resistor and black anodized-metal fins on a rugged substrate. The unit has a distributed structure designed for uniform power distribution and low skin temperature. Aspen Electronics Ltd, 18a High Street, Northwood, Middlesex HA6 1BN.
WW 310 for further details

Instrumentation amplifier

A compact differential d.c. amplifier has been produced by Fylde Electronic Laboratories Ltd, for instrumentation applications in transducer and recording systems. This modular amplifier, designated as FE-351-UA, has a bandwidth greater than 50kHz and exhibits less than 8μV pk-pk noise. The gain is variable between 0.2 and 10000 from two outputs, one being matched for galvanometers up to 20mA, with less than 0.02% non-linearity and a typical stability of 1μV/°C. The amplifier, which can be powered by either an isolated d.c. supply or the integral mains circuit, has both input and output protection, and greater than 100dB common-mode rejection. A wide range of compatible analogue conditioning modules are available and fourteen of the amplifiers can be packed into a 19in two unit high crate. Fylde Electronic Laboratories Ltd, 49 Fylde Road, Preston PR1 2XQ.
WW 311 for further details

Solid State Devices

Names of suppliers of devices in this section are given in abbreviation after each entry and in full at the end of the section.

High frequency transistors

Motorola have added two more n.p.n silicon transistors to their range of radio frequency products. The transistors, BFR90 and BFR91, are designed primarily for use in high gain, low noise, small signal amplifiers, but are also claimed to be suitable for applications requiring fast switching times. The devices are in Macro-T plastic packages and have radially arranged leads.
Motorola

Amplifier transistors

BCX38 is a family of 60V, 800mA 1W n.p.n Darlington amplifier transistors introduced by Ferranti's Electronic Components Division. The transistors, produced in E-line plastic encapsulations and available in gain bands, offer high gains and input impedances and are claimed to be suitable for use in driver and output stages of audio amplifiers and also for interfacing with integrated circuits. **Ferranti**

High current transistors

Two high current transistors, designated as 2N4276 and 2N4283, have been introduced by the Germanium Power Devices Corporation. The devices, available in copper TO-3 and TO-41 hermetically sealed packages, have high gain and low voltage saturation and are suitable for inverter and computer power supply applications.
GPD

Transistor package

Thirty-four different transistors in the Durawatt 92-Plus package are offered by National Semiconductors. This is a modified TO-92 package containing a small heat sink. The 34 transistor types are n-p-n and p-n-p general purpose devices, n-p-n Darlington pairs and high-voltage transistors (300V V_{CEO}). A square inch of copper p.c. board is required to reach at least 1.2W power dissipation at an ambient temperature of 25°C.
National

Op-amps

The CA301AG, CA307G, and CA748G general-purpose operational amplifiers, CA1458G dual operational amplifiers, CA3401G quad operational amplifier and CA3119 voltage comparator are additions to the Gold Chip linear i.c. ranges produced by RCA Solid State. All of the circuits are hermetically packaged and are available in industrial and military temperature range options.
RCA

High performance r.a.m.

The MK4027 is a 4kbit r.a.m. which has a claimed 200ns access time and a 10% tolerance on all supplies. The 16-pin d.i.p. memory system offers a performance matching the 160ns obtainable from a 22-pin 4-kbit r.a.m. by eliminating the 40ns delay of the 12V clock driver. Features include direct interfacing capability with Schottky-t.t.l., two methods of chip selection, and a cycling operation, called page-mode, which allows an increased access speed of 135ns at decreased power for successive memory operations within the same row address. **Mostek**

Multipurpose p.m.o.s. dividers

A range of G.I.M. frequency dividers can be driven by both square and sine wave inputs up to 1MHz, and require —13-volt and —27-volt supplies. All outputs are changed on the negative-going clock edges. In particular, the AY-1-5050 divider, supplied in a 14-lead dual in-line plastic package, can divide by 1, 2, 3, 4, 5, 6 and 7 by appropriate selection of divider elements. **SCS**

Silicon power rectifiers

A series of high current silicon rectifiers, SCSF05-SCSM6, has been introduced by Semtech specifically for high frequency, high power industrial, military and space applications. The rectifiers, known as "Cupac 150", have fast recovery characteristics and allow heat sinking from both the anode and the cathode. Peak inverse ratings extend from 50 to 600 volts. **Bourns**

Bourns (Trimpot) Ltd, Hodford House, 17/27 High Street, Hounslow, Middlesex TW3 1TE.
Ferranti Ltd, Electronic Components Division, Gem Mill, Chadderton, Oldham, Lancs.
Germanium Power Devices Corp, P.O. Box 65, Shawsheen Village Station, Andover, Ma. 01810, U.S.A.
Motorola Ltd, Semiconductor Products Division, York House, Empire Way, Wembley, Middlesex HA9 0PR.
Mostek UK Ltd, 240 Upper Street, London N.1.
National Semiconductor U.K. Ltd, 19 Goldington Road, Bedford MK40 3LF.
RCA Ltd, Solid State— Europe, Sunbury-on-Thames, Middlesex.
SCS Components, Northfield Industrial Estate, Beresford Avenue, Wembley, Middlesex HAO 1SD.

Real and Imaginary

by "Vector"

"COME IN, REYNARD 51, YOUR TIME IS UP"

I see that the Min of Ag., Fish and Food has been advertising for an electronics engineer. Not any old run-of-the-mill electronics engineer, you understand, but one (and I quote)

"To work in a biological laboratory concerned with control of vertebrate pests. Development of radio-telemetry systems for tracking movements of foxes, badgers, rats, coypu, polecats and other species in a variety of habitats. Considerable scope for research and development."

That first sentence — control of vertebrate pests — is perfectly straightforward and will, I'm sure, meet with the full approval of every thinking electronics engineer. I mean, we could all, at the drop of a microcircuit, provide a long list of vertebrate pests we would like to control; vacillating marketing managers; all group leaders; H.M. Collector of Taxes; that anonymous Scrooge in Accounts Dept who is constantly ringing to reduce our latest expense account presentation by an order of magnitude, *et al.* By the time this piece gets into print the onerous post at the Ministry will doubtless have been filled and I'm sure the best wishes of all go to the successful candidate. It's a comforting thought to know that one of our fraternity has infiltrated into a Government laboratory and (one earnestly hopes) is actively working on our behalf.

So far, so good, and if only the Ministry man who compiled the advertisement had downed his ball-point at this juncture and gone home to his fish and chips, he would have left me a happy man. But no. I can only suppose that he felt that his story so far didn't constitute a fair week's work and so, after a painful gestation period and a w.p.b. full of rejected copy, he at length gave birth to the foxes, badgers and rats bit and caught the 4.15 back to Pinner, thoroughly exhausted.

I think it's a tribute to the restraint with which affairs in the animal kingdom are conducted that the author of that piece of copy hasn't been torn to pieces by the savage carnivores with which our country is infested. Foxes, in particular, must be feeling grossly ill-used. As is well-known, foxes relish being chased over the terrain by well-bred huntspersons and aristocratic hounds. It is their express reason for being, and, no doubt, as they are being torn to pieces, their last thoughts are of intense satisfaction at having fulfilled their destiny, particularly if the MFH is an Old Etonian. But to be tracked across country by a miscellany of microcircuits is quite another matter. It is devoid of dignity; the babel of binary code will never be an adequate substitute for the resounding "Tally-Ho!" from the throats of the elite and the impetuous "There goes the little brown **!*?!!" from the less erudite followers.

In a Gallup poll taken on the 8.27 a.m. from Woking, commuters were asked whether they considered polecats to be a pest. Of those questioned, 247 thought they were extinct, 123 said "don't know" and one said he preferred the Military Two-Step. It subsequently transpired that his hearing-aid was defective.

But what particularly intrigues me is this; exactly how does one go about selecting a radio-telemetry coypu-tracker? It's worried me to the point where I have a recurring nightmare about it . . . The scene is the Ministry office where the Comptroller of Pest Infestation is interviewing a candidate, a gangling six-footer with red hair and a wild look in his eyes. The Comptroller glances down at the application form

"Good morning, Mr Shakespeare –"

"Not Shakespeare, sir – Napoleon."

"But it says Shakespeare on your application," says the Comptroller, peering through his gold-rimmed spectacles.

"Ah, yes, sir. That was last week when I sent it in. This week it's Napoleon."

"Good gracious me! Do you change your name every week?"

"No sir, of course not. That would be silly, wouldn't it? No – just every other week."

"H'm. Now, Mr – er – Napoleon; I presume you have had previous experience in a biological laboratory. Which one?"

"Broadmoor, sir. It's the invisible ink."

"The what?"

"The invisible ink, sir, why the form is apparently incomplete. I had to do it that way. You see, THEY are after me."

"They?"

"No sir. – THEY, in capitals; or, to put it another way, in upper case. THEY. The ones with snow on their boots. They want to know how I do it."

"Do what?"

"Why, how I track the movements of foxes, badgers, rats, coypu, polecats and other species in a variety of habitats of course. What else?"

At this the Comptroller leans forward excitedly.

"You mean that you're already doing this? By radio-telemetry?"

"Well, not exactly, sir. It's more what you might call audio than radio."

"Audio? I don't follow."

"Well, sir, I'm not supposed to tell you this – Official Secrets Act, and all that rubbish. But this is how I do it. First, I concrete over their variety of habitats, and then I fit the animal pests with littble hobnailed boots. They make such a noise coming and going that I can keep track of them over quite long distances. Bang, bang, bang they go, all night long; sometimes it makes me go quite funny in the head. But that's the price of science, I always say. What do you always say, sir?"

"But –"

"Funny you should say that sir, because it reminds me of my latest development. I don't need concrete or hobnails any more. It works a treat with my experimental goat. I call him 'Nearly'."

" 'Nearly'? That's an odd name for a goat. Why do you call him 'Nearly?"

"I was hoping you'd ask that, sir. I call him 'Nearly' because he's all but. D'you get it, sir? All butt – see? Why aren't you laughing, sir? I wish you would. I get funny pains in the head and things swim around in a red mist when people don't laugh at my little jokes."

"I do not wish to know that! Now, Mr Napoleon – let us stick to the matter in hand. You say you have dispensed with your earlier – er – apparatus and you can still track this goat of yours?"

"Yes, sir, and foxes, and polecats in a variety of habitats."

"Ah. Now we are getting somewhere. Radio-telemetry this time, I presume?"

"No sir. I sniff them out. Did you ever smell a polecat, sir?"

"Most certainly not. Now, Mr – er – Napoleon; you seem to be under a certain misapprehension as to our *modus operandi.* Our approach is to catch the pests, implant a miniscule telemetry transmitter in each and then turn the animals loose again."

"Why, sir?"

"Perfectly odvious, I would have thought. By applying modified mine-detector techniques we can then track down these pests and destroy them. Ingenious – what?"

"But – sir! If that's what you wanted, why didn't you kill them in the first place? Why bother with implants?"

At this the Comptroller sits bolt upright, his face a mixture of incredulity and joy.

"By jove! A lateral thinker at last! Mr Napoleon — my congratulations, my boy. You've provided us with the breakthrough we've been looking for! When can you start?"

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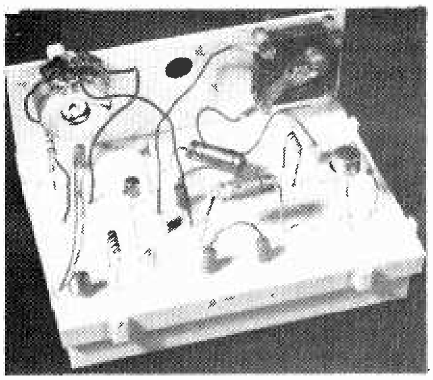

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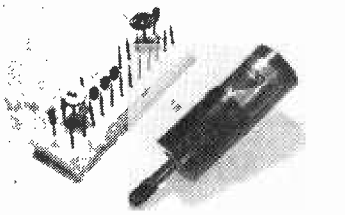

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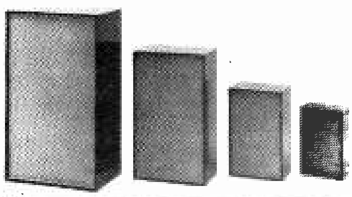

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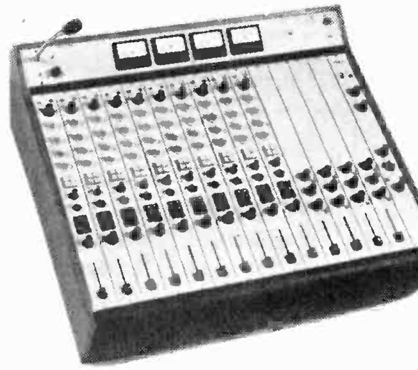

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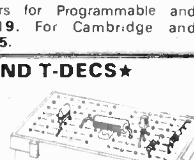

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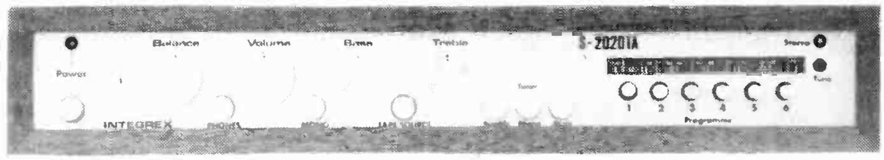

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Brief Spec. Amplifier: Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc), THD less than 0.1% at 20W into 8 ohms. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section: uses Mullard LP1186 module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88—104MHz. 30dB mono S/N @ 1.8μV THD typ. 0.4%

PRICE: £48.95+VAT

NELSON-JONES STEREO FM TUNER KIT

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Sens. 30dB S/N mono @ 1.8μV
THD typically 0.4%
Tuning range 88—104MHz
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orchard electronics

TRANSISTORS

	p		p		p		p		p		p		p
AC125	20	ASY26	30	BC132'	11	BC178B	18	BC261A	16	BC559'	9	BF166	38
AC126	20	ASY27	34	BC135'	12	BC179B	19	BC262A	15	BCY70	15	BF167	21
AC127	20	ASY28	30	BC136'	16	BC182B'	10	BC266A	18	BCY71	18	BF173	20
AC128	20	ASY29	34	BC137'	16	BC182L'	11	BC267A	14	BCY72	14	BF178	24
AC132	35	ASY67	70	BC138	15	BC183B'	10	BC268B	13	BD115	60	BF179	25
AC141	20	BA145'	15	BC139	35	BC183L'	10	BC269	13	BD121	90	BF180	30
AC142	17	BA154	10	BC142	22	BC184B'	12	BC287	20	BD123	90	BF181	30
AC151	24	BA155	12	BC143	24	BC184L'	11	BC300	27	BD124	68	BF183	34
AC153	27	BAX12	10	BC147A'	9	BC186	25	BC301	26	BD131	36	BF184	25
AC176	20	BAX13	4	BC147B'	10	BC187	26	BC302	24	BD132	38	BF185	28
AC188	20	BAX16	6	BC148'	9	BC204A'	16	BC303	30	BD133	65	BF194'	10
AD161	42	BC107	11	BC149B'	11	BC205A'	15	BC304	27	BD135'	37	BF195'	10
AD162	42	BC107A	12	BC149C'	11	BC206A'	15	BC307A'	16	BD136'	39	BF196'	12
AF114	24	BC108	10	BC153'	18	BC207A'	11	BC308A'	14	BD137'	44	BF197'	12
AF115	24	BC108B	11	BC154'	18	BC208A'	11	BC309B'	16	BD138'	47	BF200	38
AF116	24	BC109	11	BC157B'	12	BC209B'	13	BC317A'	12	BD139'	54	BF257	30
AF117	24	BC109B	12	BC158A'	12	BC212A'	13	BC319B'	12	BD155'	75	BF258	50
AF118	47	BC109C	13	BC159A'	12	BC212L'	15	BC322B'	15	BD165'	34	BF259	52
AF124	30	BC115'	15	BC167A	11	BC213B'	12	BC327'	20	BD232'	70	BF271	50
AF125	30	BC116'	15	BC168B'	14	BC213L'	14	BC328'	18	BDY20	80	BF336	28
AF126	28	BC117'	18	BC171A'	14	BC214'	15	BC337'	18	BF115	22	BF337	30
AF139	34	BC118'	10	BC172A'	15	BC214L'	17	BC338'	16	BF154'	20	BF338	34
AF186	50	BC119	28	BC173B'	16	BC237A'	16	BC461	35	BF158'	20	BFW10	68
AF239	37	[illegible]	14	BC177	17	BC238A'	15	BC557'	9	BF159'	26	BFW11	68
						[illegible]	15	BC558'	9	BF160'	20	BFX13	55

SILICON RECTIFIERS
50V 3A 13p
100V 3A 15p
200V 3A 16p

THYRISTORS
60V 1A 20p
100V 1A 30p
200V 4A 40p
600V 1A 60p
BT106 120p

RESISTORS
(E 12) 1½p *
½W 1Ω
-10mΩ

DIODES
OA 47 5p
OA202 7p
1N 914 5p
1N4001 5p
4002 6p
4006 10p
4148 5p

I.C.s TTL Dig
7400 18p
7401 20p
7402 18p
7403 18p
7404 23p
7405 23p
7406 40p
7407 40p
7408 24p
7409 23p
7410 18p

BRIDGE REC
100V 1A 24p
200V 1A 25p
400V 1A 26p
200V 2A 78p
600V 2A 97p

DIL SOCKETS
8 pin 13p
14 pin 15p
16 pin 17p

C MOS, CAPACITORS POTS & PRESETS
POTS, PRESETS, PLUGS & SOCKETS

I.C.s LINEAR
709 (8 PIN DIL) .40p*
741 (8 PIN DIL) .33p*
LM 380 1.29*
NE 555 .60p*
SN76013N 1.57p*
SN76023N 1.57p*
TBA 800 1.35p*
ZN 414 1.35p*

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BZX83 BZY88
3V3 3V6 3V9
4V3 4V7 5V1
5V6 6V2 6V5
7V5 8V2 9V1
10V 12V 13V
15V 18V 30V
All at **12p** each

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(TO3)
5V ½A 1.35
12V ½A 1.35
15V ½A 1.35
5V 1A 175p
12V 1A 175p
15V 1A 175p

LED (like TIL 209)
Small 0.125"
125 Red 20p
125 Green 27p
125 Yellow 27p
Large 0.2"
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MAINS ISOLATING

PRI 120/240V sec 120/240V
Centre Tapped and Screened

No.	VA (Watts)	£	P&P p
07*	20	£3.10	58
149	60	4.69	72
150	100	5.33	85
151	200	8.54	1.12
152	250	10.32	1.41
153	350	12.47	1.41
154	500	14.33	1.61
155	750	21.94	BRS
156	1000	30.51	BRS
157	1500	34.89	BRS
158	2000	38.92	BRS
159	3000	61.48	BRS

*115 or 240 sec only

12 and/or 24-VOLT

Primary 220-240 Volts

Ref. No.	AMPS 12v	24v	£	P&P p
111	0.5	0.25	1.54	28
213	1.0	0.5	1.86	58
71	2	1	2.41	58
18	4	2	2.97	72
70	6	3	4.43	72
108	8	4	5.09	85
72	10	5	5.50	85
116	12	6	5.80	97
17	16	8	7.48	97
115	20	10	10.91	1.61
187	30	15	14.20	1.41
226	60	30	17.67	BRS

50 VOLT RANGE

SEC. TAPS 0-19-25-33-40-50V

Ref. No.	Amps.	£	P&P p
102	0.5	2.71	58
103	1.0	3.55	72
104	2.0	4.95	85
105	3.0	6.10	97
106	4.0	7.98	1.12
107	6.0	12.71	1.25
118	8.0	13.63	1.61
119	10.0	17.75	BRS

30 VOLT RANGE

SEC. TAPS 0-12-15-20-25-30V

Ref. No.	Amps	£	P&P p
112	0.5	1.90	58
79	1.0	2.52	72
3	2.0	3.77	72
20	3.0	4.70	85
21	4.0	5.56	85
51	5.0	6.73	97
117	6.0	7.52	1.12
88	8.0	10.20	1.25
89	10.0	10.36	1.41

60 VOLT RANGE

SEC. TAPS 0-24-30-40-48-60V

Ref. No.	Amps	£	P&P p
124	0.5	2.48	72
126	1.0	3.68	72
127	2.0	5.33	85
125	3.0	7.90	97
123	4.0	9.19	1.41
40	5.0	10.24	1.25
120	6.0	12.07	1.41
121	8.0	15.75	BRS
122	10.0	19.40	BRS
189	12.0	20.25	BRS

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	AUTO TAPS		P&P p
113	20	0-115-210-240V	1.75	51
64	75	0-115-210-240V	3.05	72
4	150	0-115-210-220-240V	4.33	72
66	300		6.11	85
67	500	" "	9.36	1.25
84	1000	" "	14.36	1.61
93	1500	" "	19.02	BRS
95	2000	" "	25.41	BRS
73	3000	" "	36.84	BRS

HIGH VOLTAGE

MAINS ISOLATING
PRI 200/220 OR 400/440
SEC 100/120 OR 200/240

VA	Ref.	£	P&P p
60	243	4.37	97
350	247	10.93	1.41
1000	250	26.31	BRS
2000	252	44.12	BRS

SCREENED MINIATURES

Ref.	mA	Volts	£	P&P p
238	200	3-0-3	1.62	39
212	1A 1A	0-6, 0-6	1.93	46
13	100	9-0-9	1.56	25
235	330.330	0-9, 0-9	1.64	25
207	500.500	0-8-9, 0-8-9	2.02	51
208	1A 1A	0-8-9, 0-8-9	3.07	58
236	200, 200	0-15, 0-15	1.56	25
214	300, 300	0.20, 0.20	2.03	58
221	700 (DC)	20-12-0-12-20	2.38	58
206	1A 1A	0-15-20, 0-15-20	3.63	72
203	500, 500	0-15-27, 0-15-27	3.15	72
204	1A 1A	0-15-27, 0-15-27	4.14	72
S112	500	12, 15, 20, 24, 30	1.97	58

ON-SITE TOOL ISOLATORS

240v to 110v (To BS3535)

Ref.	VA	£
277	500	29.96
278	750	34.47
279	1000	37.63
280	1500	41.55

P&P BRS. Send for details

CASED AUTO. TRANSFORMERS

240v mains lead input and USA 2-pin outlets
20VA **£3.29**. P&P 72p. Ref. 113W
150VA **£6.37**, P&P 85p. Ref. 4W
500VA **£10.97**, P&P £1.25p. Ref. 67W
1000VA **£18.39** BRS. Ref. 84W
2000VA **£28.71** BRS. Ref. 95W

BRIDGE RECTIFIERS

50v	2A	35p
100v	2A	40p
100v	6A	70p
200v	1A	35p
200v	2A	45p
400v	2A	50p
400v	4A	65p
600v	2A	55p
500v	10A	PM7A6 £2.35

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HIGH QUALITY MODULES

3 watt RMS Amplifier	£2.30
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10 watt RMS Amplifier	£2.95
25 watt RMS Amplifier	£3.95
Pre-Amp for 3-5-10w (new)	£6.50
Pre-Amp for 25w	£13.87
Power Supplies for 3-5-10w	£1.20
Power Supplies for 25w	£3.00
Transformer for 3w	£1.90
Transformer for 5-10w	£2.30
Transformer for 25w	£2.60
P&P Amps/Pre-Amps/Power Supplies	18p
P&P Transformers	37p

VAT 12½%

METERS

AVO8 **£61.09**
AVO72 **£24.07**
AVOMM5 **£20.94**
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Complete chassis, inc. 7+7w rms amps, pre-amp, power supply, front panel, knobs (needs mains trans.) **£15.75**. Mains trans. **£2.45**. Teak veneered cab. **£3.65**. P&P 88p. VAT 12½%.

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15W **£2.90**. 18W **£2.75**. 25W **£2.45**
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Stand for above **£1.13**. P&P 25p VAT 8%

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4-speed autochanger **£6.00.**

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15—240 Watts!

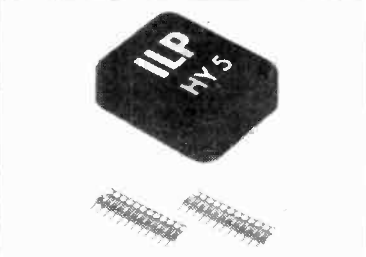
HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag. Cartridge, tuner, etc) are catered for internally, the desired function is achieved either by a multi way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack — Multi function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo

APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address

SPECIFICATIONS:
INPUTS Magnetic Pick-up 3mV Ceramic Pick-up 30mV Tuner 100mV Microphone 10mV Auxiliary 3-100mV input impedance 47kΩ at 1kHz
OUTPUTS Tape 100mV Main output 500mV R.M.S.
ACTIVE TONE CONTROLS Treble ±12dB at 10kHz Bass ± at 100Hz
DISTORTION 0.1% at 1kHz Signal/Noise Ratio 68dB
OVERLOAD 38dB on Magnetic Pick-up SUPPLY VOLTAGE ±16-50V
Price £4.75 + 59p VAT P&P free.



HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build

APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — audio oscillator

SPECIFICATIONS
OUTPUT POWER 15W R.M.S. into 8Ω DISTORTION 0.1% at 15W
INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz -3dB
SUPPLY VOLTAGE ±18V
Price £4.75 + 59p VAT P&P free.

Available June '76

HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components

APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz -3dB
SUPPLY VOLTAGE ±25V SIZE 105.50.25mm
Price £6.20 + 77p VAT P&P free.

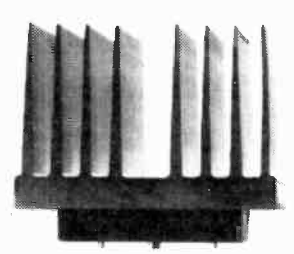
HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion — Integral heatsink — Load line protection — Thermal protection — Five connections — No external components

APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz -3dB SUPPLY VOLTAGE ±35V
SIZE 114.50.85mm
Price £14.40 + £1.16 VAT P&P free.



HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral heatsink — No external components

APPLICATIONS: Hi-Fi — Disco — Monitor — Power slave — Industrial — Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz
SIGNAL/NOISE RATIO 96 dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ±45V
SIZE 114.100.85mm
Price £21.20 + £1.70 VAT P&P free.

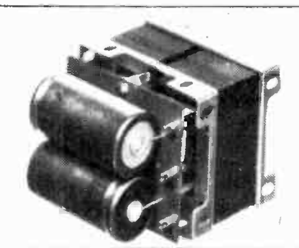
HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω. It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components

APPLICATIONS: Public address — Disco — Power slave — Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1kHz
SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114x100x85mm
Price £29.25 + £2.34 VAT P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£4.75** plus 59p VAT P/P free
PSU50 suitable for two HY50's **£6.20** plus 77p VAT P/P free
PSU70 suitable for two HY120's **£12.50** plus £1.00 VAT P/P free
PSU90 suitable for one HY200 **£11.50** plus £0.92 VAT P/P free
PSU180 suitable for two HY200's or one HY400 **£21.00** plus £1.68 VAT P/P free

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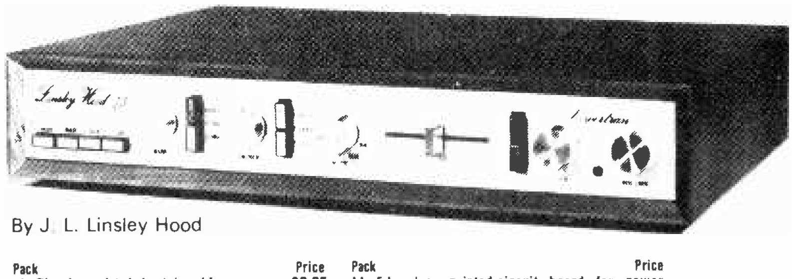
HI-FI NEWS 75W/CHANNEL AMPLIFIER



By J. L. Linsley Hood

In Hi-Fi News there was published by Mr Linsley-Hood a series of four articles (November, 1972-February, 1973) and a subsequent follow-up article (April, 1974) on a design for an amplifier of exceptional performance which has as its principal feature an ability to supply from a direct coupled fully protected output stage, power in excess of 75 watts whilst maintaining distortion at less than 0.01% even at very low power levels. The power amplifier is complemented by a pre-amplifier based on a discrete component operational amplifier referred to as the Liniac which is employed in the two most critical points of the system namely the equalization stage and tone control stage, positions where most conventional designs run out of gain at the extremes of the frequency spectrum. Unusual features of the design are the variable transition frequencies of the tone controls and the variable slope of the scratch filter. There is a choice of four inputs, two equalized and two linear, each having independently adjustable signal level. The attractive slimline unit pictured has been made practical by highly compact PCBs and a specially designed Toroidal transformer

Pack	Price
1. Fibreglass printed-circuit board for power amp	£0.85
2. Set of resistors, capacitors, pre-sets for power amp	£1.70
3. Set of semiconductors for power amp	£6.50
4. Pair of 2 drilled, tinned heat sinks	£0.80
5. Fibreglass printed-circuit board for pre-amp.	£1.30
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£2.70
7. Set of low noise, high gain semiconductors for pre-amp	£2.40
8. Set of potentiometers (including mains switch)	£2.05
9. Set of 4 push-button switches, rotary mode switch	£3.70
10. Toroidal transformer complete with magnetic screen/housing primary: 0 117-234 V: secondaries: 33-0-33 V, 25-0-25 V	£9.15
11. Fibreglass printed-circuit board for power supply	£0.65
12. Set of resistors, capacitors, secondary fuses, semi-conductors for power supply	£3.50
13. Set of miscellaneous parts including DIN skts, mains input skt, fuse holder, inter-connecting cable, control knobs	£4.25
14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£6.30
15. Handbook	£0.30
16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

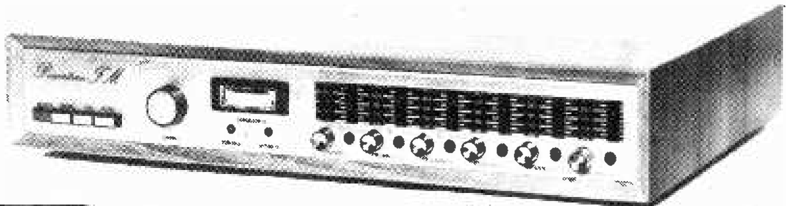
2 each of packs 1-7 inclusive are required for complete stereo system. Total cost of individually purchased packs £72.25

FREE TEAK CASE WITH FULL KITS

KIT PRICE ONLY **£62.40**

WIRELESS WORLD FM TUNER

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley Hood 75W Amplifier, this kit provides the perfect match. The Wireless World published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module, excellent a.m. rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push button pre-selection. Frequencies are indicated by a frequency meter and sliding LED indicators attached to each channel selector pre-set. The PLL stereo decoder incorporates active filters for birdy suppression and power is supplied via a toroidal transformer and integrated regulator. For long term stability metal oxide resistors are used throughout



Pack	Price
1. Fibreglass printed board for front end IF strip, demodulator, AFC and mute circuits	£2.15
2. Set of metal oxide resistors, thermistor, capacitors, cermet preset for mounting on pack 1	£4.80
3. Set of transistors, diodes, LED, integrated circuits for mounting on pack 1	£6.25
4. Pre-aligned front end module, coil assembly, three section ceramic filter	£8.80
5. Fibreglass printed circuit board for stereo decoder	£1.10
6. Set of metal oxide resistors, capacitors, cermet preset for decoder	£2.60
7. Set of transistors LED, integrated circuit for decoder	£3.45
8. Set of components for channel selector switch, module including fibreglass printed circuit board, push-button switches, knobs, LEDs, preset adjusters, etc.	£8.30
9. Function switch, 10 turn tuning potentiometer, knobs	£5.30
10. Frequency meter, meter drive components, fibreglass printed circuit board	£8.60
11. Toroidal transformer with electrostatic screen. Primary: 0—117V—234V	£4.45
12. Set of capacitors, rectifiers, voltage regulator for power supply	£2.95
13. Set of miscellaneous parts, including sockets, fuse holder, fuses, inter-connecting wire, etc.	£1.50
14. Set of metal work parts including silk screen printed facia panel, acrylic silk screen printed tuning indicator panel insert, internal screen, fixing parts, etc.	£6.50
15. Construction notes (free with complete kit)	£0.25
16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

One each of packs 1-16 inclusive are required for complete stereo FM tuner. Total cost of individually purchased packs £76.85

FREE TEAK CASE WITH FULL KITS

KIT PRICE only **£66.75**

STOP PRESS!

LINSLEY-HOOD CASSETTE DECK

Goldring-Lenco mechanism, as specified **£19.10**

PCB, Components — Please send for details

Wireless World Amplifier Designs

Full kits are not available for these projects but component packs and PCBs are stocked for the highly regarded Bailey and 20W class AB Linsley Hood designs, together with an efficient regulated power supply of our own design. Suitable for driving these amplifiers is the Bailey Burrows pre-amplifier and our circuit board for the stereo version of it features 6 inputs, scratch and rumble filters and wide range tone controls which may be either rotary or slider operating.

For those intending to get the best out of their speakers we also offer an active filter system described by D. C. Read which splits the output of each channel from the pre-amplifier into three channels each of which is fed to the appropriate speaker by its own power amplifier. The Read/Texas 20W or any of our other kits are suitable for these. For tape systems a set of three PCBs have been prepared for the integrated circuit based high performance stereo Stuart design. Details of component packs are in our free list

30W Bailey Amplifier	
BAIL Pk 1 F/Glass PCB	£1.00
BAIL Pk 2 Resistors, Capacitors Potentiometer set	£2.35
BAIL Pk 3 Semiconductor set	£4.70
20W Linsley Hood Class AB	
LHAB Pk 1 F/Glass PCB	£1.05
LHAB Pk 2 Resistor, Capacitor Potentiometer set	£3.20
LHAB Pk 3 Semiconductor set	£3.35
Regulated Power Supply	
60VS Pk 1 F/Glass PCB	£0.85
60VS Pk 2 Resistor, Capacitor set	£1.95
60VS Pk 3 Semiconductor set	£3.10
60VS Pk 6A Toroidal transformer (for use with Bailey)	£7.95
60VS Pk 6B Toroidal transformer (for use with 20W LH)	£7.25
Bailey Burrows Stereo Pre-Amp	
BBPA Pk 1 F/Glass PCB	£2.35
BBPA Pk 2 Resistor, capacitor semiconductor set	£6.10
BBPA Pk 3R Rotary Potentiometer set	£2.40
BBPA Pk 3S Slider Potentiometer set with knobs	£2.70

PRICE STABILITY!

Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement for two months from issue date provided that this advertisement is quoted with your order. E&OE. VAT rate changes excluded.

All components are brand new first grade full specification devices. All resistors (except where stated) are low noise carbon film types. All printed circuit boards are fibre-glass, drilled, roller tinned and supplied with circuit diagrams and construction layouts.

U.K. Orders. Subject to 12½%* Surcharge for VAT. Carriage free MAIL ORDER ONLY (*or at current rate if changed)

Securicor Delivery. For this optional service (Mainland only) add £2.50 VAT inc per kit

Overseas Orders. No VAT. Postage charged at actual cost plus 50p packing and handling

Further details of above and additional packs given in our FREE LIST

DEPT. WW06

POWERTRAN ELECTRONICS

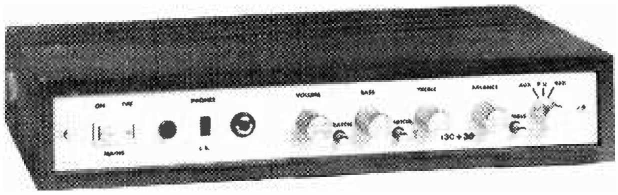
PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NN

Switzerland Angola Cyprus Eire Hungary Muscat & Oman Norway United States Guernsey South West Africa Turkey Ghana Zambia Yugoslavia

Portugal Mozambique Belgium Sumatra

Hong Kong Jersey Australia St. Lucia India Barbados Antigua Jordan Spain Israel Mauritius St. Vincent Uganda Ascension Island Malta Sierra Leone Somalia New Guinea Italy Kuwait Netherlands Canada Trinidad Malaya Austria

AUDIO KIT SUPPLIERS TO THE WORLD



T20+20 and our new T30+30 20W, 30W AMPLIFIERS

Designed by Texas engineers and described in Practical Wireless the Texan was an immediate success Now developed further in our laboratories to include a Toroidal transformer and additional improvements, the slimline T20 + 20 delivers 20W per channel of true Hi-Fi at exceptionally low cost The design is based on a single F/Glass PCB and features all the normal facilities found on quality amplifiers, including scratch and rumble filters, adaptable input selector and head phones socket In a follow up article in Practical Wireless further modifications were suggested and these have been incorporated into the T30 + 30 These include RF interference filters and a tape monitor facility Power output of this new model is 30W per channel

Pack	T20	T30
1 Set of low noise resistors	0.95	1.05
2. Set of small capacitors	1.50	2.10
3. Set of power supply capacitors	1.40	2.05
4. Set of miscellaneous parts	1.90	1.90
5. Set of slide, mains, P.B. switches	1.20	1.20
6. Set of pots, selector switch	2.00	2.00
7. Set of semiconductors, ICs, skts.	7.25	7.75
8. Toroidal transformer — 240V prim. e.s. screen	4.95	6.80
9. Fibreglass PCB	2.50	2.90
10. Set of metalwork, fixing parts	4.20	4.80
11. Set of cables, mains lead	0.40	0.40
12. Handbook (free with complete kit)	0.25	0.25
13 Teak cabinet 15.4" x 6.7" x 2.8"	4.50	4.50

FREE TEAK CASE WITH FULL KITS

T20+20 KIT PRICE only **£28.25**

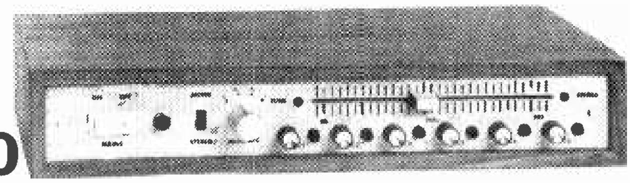
T30+30 KIT PRICE only **£32.95**

2 NEW TUNERS!

WW SFMT II

Following the success of our Wireless World FM Tuner kit we are now pleased to introduce our new cost reduced model designed to complement the T20 and T30 amplifiers The frequency meter of the more advanced model has been omitted and the mechanics simplified however the circuitry is identical and this new kit offers most exceptional value for money Facilities included are switchable afc, adjustable, switchable muting channel selection by slider or readily adjustable pre-set push-button controls and LED tuning indication Individual pack prices in our free list

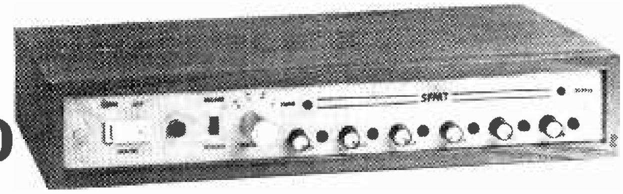
KIT PRICE **£47.40**



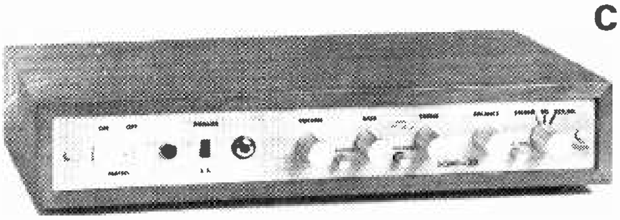
POWERTRAN SFMT

This easy to construct tuner using our own circuit design includes a pre-aligned front end module PLL stereo decoder adjustable, switchable muting switchable afc and push-button channel selection As with all our full kits, all components down to the last nut and bolt are supplied together with full constructional details

KIT PRICE **£32.60**



CONVERT NOW TO QUADRAPHONICS!



SQM1 — 30 KIT PRICE **£37.15**

With 100s of titles now available no longer is there any problem over suitable software No problems with hardware either Our new unit the SQM1-30 simply plugs into the tape monitor socket of your existing amplifier and drives two additional speakers at 30W per channel A full complement of controls including volume bass, treble and balance are provided as are comprehensive switching facilities enabling the unit to be used for either front or rear channels, by-passing the decoder for stereo-only use and exchanging left and right channels The SQ matrix decoder is based upon a single integrated circuit and was designed by CBS whilst the power and tone control sections are identical to those used in our T30 + 30 amplifier which the SQM1-30 matches perfectly Kit price includes CBS licence fee

Special offer to T20 + 20 and Texan owners!

Owners of T20 + 20 and Texan amplifiers, which have no tape monitor outlet, purchasing an SQM1-30 will be supplied, on request, a free conversion kit to fit a tape monitoring facility to the existing amplifier This makes simple the connection to the highly adaptable SQM1-30 quadraphonic decoder/rear channel amplifier

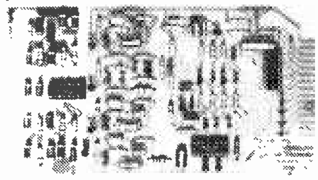
SQ is a trade mark of CBS Inc.

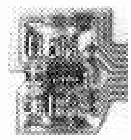
SEMICONDUCTORS

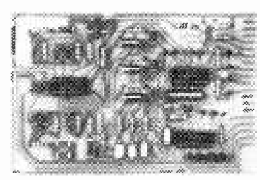
as used in our range of quality audio equipment.

2N699	£0.20	BC212K	£0.12	MPSA65	£0.35
2N1613	£0.20	BC182L	£0.10	MPSA66	£0.40
2N1711	£0.25	BC184L	£0.11	MPSU05	£0.60
2N2926G	£0.10	BC212L	£0.12	MPSU55	£0.70
2N3055	£0.45	BC214L	£0.14	SBA750A	£2.50
2N3442	£1.20	BCY72	£0.13	SL301	£1.30
2N3711	£0.09	BD529	£0.85	SL3045	£1.60
2N3904	£0.17	BD530	£0.85	SN72741P	£0.40
2N3906	£0.20	BDY56	£1.60	SN72748P	£0.40
2N4062	£0.11	BF257	£0.40	TIL209	£0.30
2N4302	£0.60	BF259	£0.47	TIP29A	£0.50
2N5087	£0.42	BFR39	£0.25	TIP30A	£0.60
2N5210	£0.54	BFR79	£0.25	TIP29C	£0.71
2N5457	£0.45	BFY51	£0.20	TIP30C	£0.78
2N5459	£0.45	BFY52	£0.20	TIP41A	£0.74
2N5461	£0.50	CA3046	£0.70	TIP42A	£0.90
2N5830	£0.35	LP1186	£5.50	TIP41B	£0.82
40361	£0.40	MC1310	£2.90	TIP42B	£0.98
40362	£0.45	MC1351	£1.05	1N914	£0.07
BC107	£0.10	MFC4010	£0.95	1N916	£0.07
BC108	£0.10	MJ481	£1.20	1S920	£0.10
BC109	£0.10	MJ491	£1.30	5805	£1.20
BC109C	£0.12	MJE521	£0.60		
BC125	£0.15	MPSA05	£0.25	**FILTERS**	
BC126	£0.15	MPSA12	£0.55	FM4	£0.80
BC182	£0.10	MPSA14	£0.35	SFG10 7MA	£2.80
BC212	£0.12	MPSA55	£0.25		
BC182K	£0.10				

SQ QUADRAPHONIC DECODERS







Feed 2 channels (200-1000mV as obtainable from most pre-amplifiers or amplifier tape monitor outlets) into any one of our 3 decoders and take 4 channels out with no overall signal level reduction On the logic enhanced decoders Volume, Front-Back LF-RF balance LB-RB balance and Dimension controls can all be implemented by simple single gang potentiometers

These state-of-the-art circuits used under licence from CBS are offered in kits of superior quality with close tolerance capacitors metal oxide resistors and fibre-glass PCBs designed for edge connector insertion All kit prices include CBS licence fee

M1 Basic matrix decoder with fixed 10-40 blend All components, PCB **£5.90**

L1 Full logic controlled decoder with 'wave matching' and 'front back logic' for enhanced channel separation All components PCB **£17.20**

L2A More advanced full logic decoder with variable blend extended frequency response, increased front back separation All components, PCB **£24.60**

EXPORT NO PROBLEM

Our Export Department will be pleased to advise on postal costs to any country in the world. Some of the countries to which we sent kits in 1975 are shown surrounding this advertisement.

Finland

Kenya France St. Martin, Java New Zealand Borneo South Africa Denmark Nigeria Anguilla

BI-PRE-PAK

Bargains in Semi-Conductors, components, modules & equipment.

B·P·P Packs

Originated in 1959 by the Company's managing director, his were the first semi-conductor and component packs to be marketed in this country, and indeed, the company's name grew out of "British Industrial Pre-Packed Components". Today, Bi-Pre-Pak continues to occupy a position of pre-eminence in the supply of packs as well as a vastly extended range of products detailed in our latest 24-page A.4 size free catalogue. Send 10p stamped large addressed envelope for your copy by return.

IT'S ALL IN OUR FREE CATALOGUE

Component Packs

CP1	150	Capacitors mixed bag of paper, silver mica, electrolytics, etc Approx quantity, counted by weight	60p
CP2	200	Resistors mixed bag of different types, values, wattages, etc Approx quantity counted by weight	60p
CP3	40	Wirewound resistors, mixed types, values and wattages	60p'
CP4	12	Potentiometers, pre-sets, w/wound, carbon, etc Mixed types and values	60p
CP5	5	Earphones, single low impedance for transistor radios, cassettes, etc. Less plugs, for suitable plugs see PAKs CP9 and CP10	60p
CP6	50	TO-5 mounting pads, fits between transistor and board, for that pro finish	60p
CP8	500	Cable clips for G P O ⅛" dia cable Nylon with hardened steel pin (probably tungsten) per sealed box of 500	60p'
CP9	5	3 5mm plugs, miniature jack, to fit earphones in PAK CP5	60p'
CP10	5	2 5mm sub miniature jack plugs, to fit earphones in PAK CP5	60p'
CP11	6	Screwdrivers, 1 x mains neon tester, 5 x grub screwdrivers	60p'
CP12	10	Reed relay inserts, 1" long ⅛" dia. These will operate from an external magnet or coil For magnets see PAK CP13	60p'
CP13	10	Magnets of various sizes for operating reed switches on PAK CP12 Ideal for burglar alarms on doors and windows, etc	60p'
CP14	40	Potentiometers, presets, wirewounds, carbons, dual gangs, with and without switches, etc Mixed values and wattages	£1.20
CP15	12	Standard crocodile clips, screw fixing, good quality	60p'
CP16	5	P C boards each containing a BF180 UHF amplifier transistor A good basis for building a T V aerial pre-amp as various parts inc	60p
CP17	25	Electrolytic Capacitors, various values and voltages, many useful types, from T V to transistor radio and Hi-Fi	
CP18	1	Light activated SCR 50 volts 1 6 amps type L9F Ready mounted on PC board with gate resistor and leads fitted Full data and circuit diagrams for 14 projects includes slave photo flash unit, burglar alarm, etc	
CP19	3	Micro switches 1 pole change over, standard model 1⅛" x ⅛"	60p'
CP20	10	Relays assorted types, Ex-G P O and others mixed voltages	£1.20'
CP21	200	Square inches of copper laminate P C board, in approx 8 pieces	60p'
CP22	3	Fibreglass plain printed circuit boards, approx 2½" x 14"	60p'
CP23	4	Switches miniature push to make, single pole	60p

YOUR SUPPLIERS FOR:
Semi-conductors — all popular types. Opto-electronic devices inc. Nixie Tubes, Solder Tools, Terminals, Switches, Knobs, Ex-G.P.O. items, Aluminium Boxes, Triacs, Thyristors, Zener Diodes and much more in our catalogue and shop.

Semi-Conductors

● TESTED AND GUARANTEED PACKS

TP4	3	SN7490 integrated circuits. 14 pin dual in line TTL type Decade counter Get one FREE, these are 60p each in singles	£1.20p'

ALL THE FOLLOWING ARE AT 60p EACH PACK

TP9'	5	SN7400 integrated circuits, 14 pin dual in line TTL type Quad 2-input NAND gate Get one FREE, these are 15p each
TP10	2	Light dependant resistors, 400 ohms light, 1 megohm dark, ¼" dia
TP11	10	Transistors XB102 and XB112 equivalent to AC126, AC156, OC81/2, OC72 etc
TP12'	4	BY127 Silicon rectifiers 1000 piv 1 amp Plastic T V rectifier
TP13'	5	OCP71 Light sensitive transistors
TP14	20	OC71 germanium PNP audio pre amp transistor, black glass type
TP15	20	OC81 Germanium PNP audio output transistor, white glass type
TP16	20	OC200/1/2/3 transistors, PNP silicon TO-5, unmarked
TP17	20	1 watt zener diodes mixed voltages 6.8 to 43 volts
TP18	20	2N3707/8/9/10 transistors, NPN silicon plastic, unmarked
TP19	100	Diodes, mixture of germanium, gold bonded, silicon, etc., a useful selection of many types, marked and unmarked
TP20	10	Mullard OC45 transistors, I.F amp, PNP germanium
TP23	20	BFY50/1/2, 2N696/7, 2N1613, etc NPN silicon TO-5 uncoded. COMPLEMENTARY TO PAK TP24
TP24	20	BFY64,2N2904/5, etc., PNP silicon TO-5 uncoded COMPLEMENTARY to PAK TP23
TP30	20	NPN silicon planar transistors, TO-18 similar to BC108, etc., uncoded
TP31	20	PNP silicon planar transistors, TO-18 similar to BC178, etc., uncoded
TP32	20	2N2926 silicon plastic transistors, uncoded and ungraded for colours

● UNTESTED PACKS — 60p each
Specially for keen bargain hunters

UT1	50	PNP germanium transistors, AF and RF Very good yield
UT2	150	Germanium diodes miniature glass type
UT5	40	Zener diodes, 250 mW OAZ240 range average 50% good
UT6	25	Zener diodes, 1-1½ watt top hat type, mixed voltages.
UT9	40	NPN silicon planar transistors, of the 2N3707-11 range, low noise amp
UT10	15	Power transistors, PNP germanium and NPN silicon, mostly TO-3 but some plastic and some marked.
UT13	15	Integrated circuits, experimenters pak, dual in line, TO-5, TTL, DTL, marked and unmarked, some definitely good but old types

FOR FULL RANGES — SEE CATALOGUE

● Singles
BRIDGE RECTIFIERS Plastic encapsulated

P.I.V	50v	100v	400v
1 amp	25p'	35p'	45p'
2 amp	35p'	45p'	55p'
4 amp	45p	50p'	80p'
6 amp	50p'	60p'	90p'

BY164 equiv SKB2/02 400v 1.5 amp **45p'**.

FETs

2N3919	18p
2N4416	20p
MOS F.E.T.s	
3N141/MEM616	50p

UNI-JUNCTION TRANSISTORS

2N2160	65p'
2N2646	48p'
TIS43	31p'

PUTs

2N26027	50p

Also Power Diodes, Thyristors, Triacs, Diacs-Zener Diodes, Opto-Electronics, etc.

LEDs

TIL209—Red	18p'
TIL211—Green	33p'

X-44 POCKET SIZE R.F. CROSS HATCH GENERATOR
Improved version of our famous Mk 2 model, of which thousands are in regular use Size 150 x 75 x 50mm, strong plastic case with handle/stand, 4 push button operation, 4 patterns. Self-contained line and frame generator and synchro pulse. Pre-set adjust for R F output and line/frame synch Uses 4 alkaline type 1600 batts. Blank raster facility. **FOR COLOUR AND MONO.** (P/P add 35p)

£27.50● Built & tested

VAT ADD 12½%

EXCEPT ITEMS MARKED ● WHICH CARRY ONLY 8%

POWER TRANSISTORS

	Vce	Watts	IcAmps	Price
40P1	15	20	3	30p'
40N2	40	40	4	30p'
40P2	40	40	4	30p'
90N1	15	45	4	25p'
90P1	15	45	4	25p'
90N2	40	90	8	35p'
90P2	40	90	8	35p'

Many other types available from 3 to 115 watts

INTEGRATED CIRCUITS

MM5314 Dual in line clock chip	£3'
LMS380/SL60745 Dual in line 2w audio amp with data., etc	75p

Dual in line I.C sockets 8 pin **14p**; 14 pin **15p'**; 16 pin **16p'**.

Sundry

SIGNAL GENERATOR
For MW and IF Covers 550 KHz to 1 6 MHz for MW and 400 to 550KHz for IF Fully portable Invaluable in AM repair and alignment jobs (p/p 40p) **£4.25'**

POCKET SIGNAL INJECTOR
Fountain-pen type. Invaluable for fault tracing in radio sets, amplifiers, TVs tape recorders, etc. Takes one HP7 battery **£2.00'**

EX-G.P.O. 5in SIDECUTTERS
Not new but in perfect order per pair **50p'**

EX-G.P.O. 6" LONG NOSE PLIERS
Not new, but in perfect order, per pair **60p'**

MAINS TRANSFORMERS

MT6	6v 0 6v 100mA	£1.22'
MT12	12v 0 12v 50mA	£1.22'
SST9/1	9v 1amp	£1.67'
SST12/1	12v 1amp	£2.05'
SST18/1	18v lamp	£2.50'
SST25/2	25v 2amp	£3.00'
SST30/2	30v 2amp	£4.25'
SST35/4	35v 4amp	£5.50'

(P/P 50p any one)

PC EDGE CONNECTORS

Type	Sizes	Pitch	
SSEC 6-way	1⅛"	156"	32p
SSEC 10	1¼"	156"	50p
SSEC 12	2"	156"	60p
SSEC 16	2½"	156"	75p
SSEC 18	3"	156"	85p
SSEC 22	3½"	156"	1.00

UHF TUNER UNITS
Brand new, by famous manufacturer 625 lines. Channels 21-65. Ideal for use as TV sound receiver With data **£2.50**

BOOKS
All free of VAT. We carry very large stocks of technical books by Babani & Bernard Publishers, by Newnes and Butterworth as well as reference books from the Common Market in English/German/Italian. All detailed in our catalogue

MONEY SAVER FOR CAR OWNERS
The "Super Spark" Capacity Discharge Ignition Unit developed out of our original model (of which we have sold well over 9,000) enables you to enjoy this system at a truly economic price Facilities include simple adaption to pos or neg earth immediate switch back to conventional ignition, anti-burglar immobilisation with all parts in totally enclosed strong metal case Very easy to fit and install With full instructions (P/P add 50p)

KIT £7.95● READY-BUILT £10.50●

● B-P-P SECURITY CHECK POINT

- **Write your own name and address clearly in block capital letters.**
- *Check that your order is correct for description, quantity and price*
- *Don't forget VAT at 25% of total value of order unless otherwise marked' or (8%).*
- **MAKE SURE YOU GET OUR NAME AND ADDRESS RIGHT WHEN ORDERING.**
- *Cash (cheque, money or postal order) with your order please Made out to Bi-Pre-Pak Ltd*
- *Mention this journal when ordering if you don't want to cut out the coupon*

TERMS OF BUSINESS: *VAT rates subject to alteration if decreed by Government*
VAT at 12½% must be added to total value of order, except for items marked ' or (8%), when **VAT** is to be added at 8%. No **VAT** on overseas orders **POST & PACKING** Add 30p for UK orders except where shown otherwise Minimum mail order acceptable — £1 Overseas orders add £1 for postage And difference will be credited or charged **PRICES** Subject to alteration without notice **AVAILABILITY** All items available at time of going to press when every effort is made to ensure correctness of information

To: BI-PRE-PAK, 220/222 WEST RD. WESTCLIFF-ON-SEA, ESSEX SS0 9DF

Please send ....

for which I enclose .... inc. VAT

NAME ....

ADDRESS ....

WW6A

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● FIRST IN U.K. WITH PACKS FOR ELECTRONICS USERS

DESIGNED BY TEXAS

Texan Amplifier as featured by PRACTICAL WIRELESS

SOLE U.K. DISTRIBUTORS – HENRY'S

Build it yourself for only

£32 KIT PRICE INC. VAT + £1.00 p&p
Built and tested £42.00 inc. VAT + £1.00 p&p

★ Can be built Stage by stage *Ask for leaflets 5.*
★ Everything necessary supplied. Full after sales service and guarantees.

Build the Texan stereo amplifier, then you can be doubly proud! For a start, you'll own a superb home entertainment unit. And have had all the pleasure of doing it yourself, with the Henry's kit.

Look at the Texan specification

Incorporating fully integrated stereo preamp and power amp. with 6 IC's, 10 transistors, 6 rectifiers and zener diodes. Plus stabilised, protected circuitry, glass fib pcb, Gardeners low-field low-line mains transformer, all facilities and controls. Slim design, chassis 14½" x 6" x 2" overall. 20 watts per channel RMS, less than 0.1% distortion at 1 kHz.

TEXAN FM TUNER KIT £23.50 inc. VAT + 50p p&p

Built and tested £28.50 inc. VAT + 50p p&p

Build the matching Texan stereo tuner! Features advanced varicap tuning. Phase lock loop decoder. Professionally designed circuit. Everything you need is in the kit. From the glass fibre pcb to the cabinet itself. Excellent spec. 2.5 uV aerial sensitivity. 500 mV output (adjustable). Tuning range 87–102 MHz. Mains powered.

THE NATURAL FOLLOW-ON

VIDEO SPORT

An up-to-the minute game. Plugs into your own TV aerial socket. Switch on. And you're away! Choose your game – football, tennis or hole in the wall. Absolutely safe. For you. Your children. And your TV. Mains powered. List Price £42.50

HENRY'S PRICE £25.00 inc. VAT + 50p p&p

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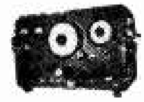

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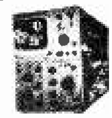

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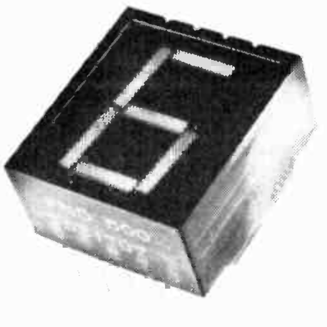

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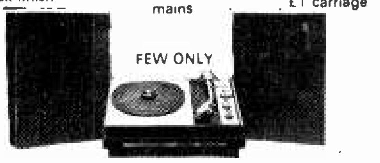

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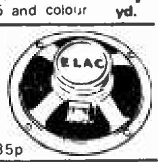
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd **£3;** 60 yd **£4.50** FRINGE LOW LOSS Ideal 625 and colour **15p** yd.

ELAC HI-FI SPEAKER
8in. or 10 x 6in.



Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 c/s Bass resonance 55 c/s 8 ohm impedance. 10 watts. music power. **£4.35** Post 35p

E.M.I. 13½ x 8in. SPEAKER SALE!
With tweeter and crossover 10 watt State 3 or 8 ohm As illustrated **£5.25** Post 35p
Bass Wooter, 15 watts, 8 or 15 ohm. **£6.60** Post 45p

With flared tweeter cone and ceramic magnet 10 watt Bass res 45-60 c/s Flux 10 000 gauss 8 ohm 40 to 11,000 c/s. **£3.45** Post 35p

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Teak finish 16 x 10 x 9in For EMI 13 x 8 speakers **£6.95** Post 75p

THE "INSTANT" BULK TAPE ERASER AND HEAD DEMAGNETISER. Suitable for cassettes and all sizes of tape reels A.C mains 200/250V Leaflet S A E Will also demagnetise small tools **£4.35** Post 30p

BLANK ALUMINIUM CHASSIS. 6 x 4—**70p;** 8 x 6—**90p;** 10 x 7—**£1.15;** 12 x 8—**£1.35;** 14 x 9—**£1.50;** 16x6—**£1.45;** 16 x 10—**£1.70.**
ALUMINIUM PANELS. 6 x 4—**17p;** 8 x 6—**24p;** 14 x 3—**25p;** 10 x 7—**35p;** 12 x 8—**43p;** 12 x 5—**30p;** 16 x 6—**43p;** 14 x 9—**52p;** 12 x 12—**68p;** 16 x 10—**75p.**

ELAC 9 x 5in HI-FI SPEAKER TYPE 59RM
This famous unit now available, 10 watts, 8 ohm
£3.45 Post 35p

RCS LOW VOLTAGE STABILISED POWER PACK KITS
All parts and instructions with Zener diode, printed circuit rectifiers and double wound mains transformer Input 200/240V a c Output voltages available. 6 or 7.5 or 9 or 12V d c up to 100mA or less Size 3 x 2½ x 1½ in Please state voltage required. **£2.95** Post 45p

RCS POWER PACK KIT 12 VOLT 750mA Complete with printed circuit board and assembly instructions. **£3.35** Post 30p
12 VOLT 300mA KIT. **£3.15.** 9 VOLT 1 AMP KIT. **£3.35.**

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Ideal for Mike, Tape, P U , Guitar, etc Can be used with Battery 9-12V or H.T. line 200-300V d c. operation. Size, 1¾ x 1¼ x ¾in Response 25 c/s to 25 kc/s. 26 dB gain For use with valve or transistor equipment Full instructions supplied. Details S.A.E. **£1.45** Post 30p

ELECTRO MAGNETIC PENDULUM MECHANISM
1.5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed Ideal displays, teaching electro magnetism or for metronome, strobe, etc **95p** Post 30p

R.C.S. "MINOR" 10 watt AMPLIFIER KIT
This kit is suitable for record players, guitars, tape playback, electronic instruments or small P A. systems Two versions available Mono, **£12.50;** Stereo, **£20.** Post 45p Specification 10W per channel, input 100mV; size 9½ x 3 x 2in. approx S.A.E. details. Full instructions supplied. AC mains powered

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ALL POST 50p

250-0-250V 70mA, 6.5V, 2A	£3.45
250-0-250 80mA 6 3V 3 5A, 6 3V 1A or 5V 2A	£4.60
350-0-350 80mA, 6 3V 3 5A, 6 3V 1A or 5V 2A	£5.80
300-0-300V 120mA, 6 3V 4A C T , 6 3V 2A	£7.00
MIDGET 220V 45mA, 6.3V 2A	£1.40
HEATED TRANS 6 3V ½ amp **£1;** 3 amp	£1.40

GENERAL PURPOSE LOW VOLTAGE Tapped outputs at 2 amp 3, 4, 5, 6, 8, 9, 10 12 15, 18, 25 and 30V **£4.60.** 1 amp 6, 8, 10 12, 16, 18, 20 24, 30 36, 40, 48, 60 **£4.60.** 2 amp 6, 8 10, 12, 16, 18 20, 24, 30, 36, 40, 48, 60 **£7.00.** 3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36 40, 48, 60 **£8.70.** 5 amp 6 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 **£11.25.** 6.06V 500mA **£1,** 9V 1 amp **£1,** 12V 300mA, **£1,** 12V 500mA, **£1,** 12V 750mA, **£1,** 10V, 30V, 40V, 2 amp **£2.75,** 20V, 3 amp , **£2.45,** 40V 2 amp., **£2.95,** 22-0-22V, 4 amp d c , **£3.45,** 16V, ½ amp, **£1,** 16V, 2 amp , **£2.20,** D, 5, 8, 10 16V, ½ amp., **£1.95,** 20V ½ amp., **£1.75,** 20V, 1 amp , **£2.20.**
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CHARGER TRANSFORMERS 1½ amp **£2.75;** 4 amp **£4.60.**
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8 ohm 10W Large ceramic magnet Special Rubber cone surround. Frequency response. 30-8000 c/s Ideal HI-FI Enclosure Systems. **£6.75**

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2/350V	20p	250/25V	20p	50+50/300V	50p
4/350V	20p	500/25V	25p	900/350V	95p
8/350V	28p	100+100/275V	65p	32+32/250V	20p
16/350V	35p	150+200/275V	70p	32+32/450V	80p
32/500V	60p	8+8/350V	50p	350+50/325V	85p
25/25V	15p	8+16/350V	50p	100+50+50/350V	85p
50/50V	15p	16+16/350V	60p	32+32+32/350V	65p
100/25V	15p	32+32/350V	60p	4700/63V	95p

LOW VOLTAGE ELECTROLYTICS
1, 2, 4 5 8 16, 25, 30, 50, 100, 200mF 15V **10p.**
500mF 12V **15p;** 25V **20p;** 50V **30p.**
1000mF 12V **17p;** 25V **35p;** 50V **47p;** 100V **70p.**
2000mF 6V **25p;** 25V **42p;** 50V **57p.**
2500mF 50V **62p;** 3000mF 25V **47p;** 50V **65p.**
5000mF 6V **25p;** 12V **42p;** 25V **75p;** 35V **85p;** 50V **95p.**

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PAPER 350V-0 1 **7p;** 0 5 **13p;** 1mF 150V **15p;** 2mF 150V **15p;** 500V-0 001 to 0 05 **5p;** 0 1 **10p;** 0 25 **13p;** 0 47 **25p.**
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SUB-MIN MICRO SWITCH, 25p. Single pole change over
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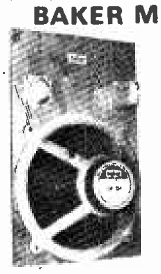
NEON PANEL INDICATORS 250V AC/DC. Amber or red. **30p.**
RESISTORS. ¼W ½W, 1W 20% **2p;** 2W **10p;** 10Ω to 10M
HIGH STABILITY. ½W 2% 10 ohms to 6 meg **12p.**
Ditto 5% Preferred values 10 ohms to 10 meg **5p.**
WIRE-WOUND RESISTORS 5 watt, 10 watt 15 watt 10 ohms to 100K **12p** each
TAPE OSCILLATOR COIL Valve type **35p.**
BRIDGE RECTIFIER 200V PIV ½ amp **50p.**

BAKER MAJOR 12" £11.50



30-14,500 c/s, 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30-17,000 c/s with tweeter, crossover, baffle and instructions **£14.50** Post 60p each
Please state 3 or 8 or 15 ohms.

BAKER "BIG-SOUND" SPEAKERS. Post 50p each.

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NEW MODEL **BAKER LOUDSPEAKER,** 12-inch 60 WATT GROUP 50/12, 8 OR 15 OHM HIGH POWER FULL RANGE PROFESSIONAL QUALITY 30-16,000 CPS MASSIVE CERAMIC MAGNET ALUMINIUM PRESENCE CENTRE DOME. **£14.50** Post 80p

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For 12in or 10in speaker 20x13x12in **£12.50** Post 95p
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LOUDSPEAKER CABINET WADDING 18in wide **20p** ft.

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Four inputs Four way mixing, master volume, treble and bass controls Suits all speakers This professional quality amplifier chassis is suitable for all groups, disco, P A , where high quality power is required 5 speaker outputs A/C mains operated Slave output. Produced by demand for a quality **valve** amplifier
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SPECIAL OFFER: 80 ohm 2¼in 2¾in , 35 ohm, 2in , 3in , 25 ohm, 2½in dia , 3in dia , 5in dia , 8 ohm, 2½in , 3in , 3½in 15 ohm, 3¼in dia, 6x4in , 7x4in , 8x5in 3 ohm , 2½in , 2⅝in , 3½in., 5in dia. **£1.25 each.**
PHILIPS LOUDSPEAKER, 8in , 4 ohms, 4 watts, ceramic magnet **£1.95**
RICHARD ALLAN TWIN CONE LOUDSPEAKERS
8in diameter 4W **£2.50.** 10in. diameter 5W **£2.95;** 12in diameter 6W **£3.50.** 3/8/15 ohms, please state
VALVE OUTPUT TRANS. 40p; MIKE TRANS, 50 1, **40p.** Mike trans, mu metal 100 1 **£1.25.**

Loudspeaker Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting. ¼in. spindle. **65p**

BAKER 100 WATT ALL PURPOSE AMPLIFIER

All purpose transistorised Ideal for Groups, Disco and P A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm, a.c Mains Separate treble and bass controls Guaranteed Details S A E. **£65** Carr £1.00 each
NEW MODEL MAJOR—50 watt, 4 input, 2 vol Treble and bass Ideal disco amplifier **£49.95**

100 WATT DISCO AMPLIFIER CHASSIS
volume, treble, bass controls 500 M V input Four loudspeaker outputs 4 to 16 ohm **£52**

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Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output 9V **£5.20**
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DIN SOCKETS FREE 3-pin 25p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p. VALVE HOLDERS, 10p; CANS, 10p.

R.C.S. SOUND TO LIGHT KIT
Kit of parts to build a 3 channel sound to light unit 1,000 watts per channel **£12.50.** Post 35p Easy to build Full instructions supplied, cabinet **£3.** As featured in December Practical Wireless

E.M.I. TAPE MOTORS. 240V a c 1 200 r p m 4 pole 185mA Spindle 0 187x0 75in Size 3¼ x 2½ x 2¼in **£2.** Post 40p
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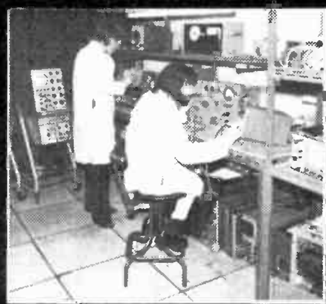

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626A Signal Generator
8552B Spectrum Analyser — IF Section
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211A Crystal Monitored Sig. Gen.
355D Attenuator
6920B Meter Calibrator
5326B Univ. Timer/Counter/D.V.M.
435A Power Meter
1707B

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TF 1066B/6 FM Signal Generator

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8100B Digital Multimeter
8300A Digital Voltmeter
332B Voltage Calibrator
341A D.V.M. Calibrator

TEKTRONIX
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465/05/07 TV Scope
475 200MHz D.T. Scope
422 15MHz D.T. Scope
549 Storage Scope
1L40 Spectrum Analyser Plug in.

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Phase A M Signal Generator TF 2003 0 4-12MHz **£150**
A M Signal Generator TF 801B 3S 12 485MHz 0 1uV 1V **£195.00**
R C Oscillator TF1101 Frequency range 20HZ-200KHz Output Direct into 600Ω 0-20V variable Attenuator 0-6dB in 10dB steps Impedance 600Ω Distortion Via 1KHz Filter less than 0 1% Direct or via Attenuator Less than 0 5% 50Hz-20KHz Less than 1% 20Hz 200KHz Superb condition **£175**
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50MHz single channel 1751A Time Mark Gen 1783 Aux Plug In 1780A Display Scanner 1782A Sweep Delay Gen 1781B Dual Trace Vert Amp 1750A Delay Gen 1781A

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Transistorised compact single beam portable scope bandwidth of 8MHz Compensated Y — attenuator 12 ranges 50mV/cm to 30V/cm Timebase sweep range of 10Hz to 500kHz and can be triggered from +Ve or —Ve externally or internally. Y input can be AC or DC coupled. Display area 6cm × 4cm. Rise time 44ns Dimensions 203mm × 160mm × 240mm. Wt 5Kg BRAND NEW Type No HM207 **£85.00**

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TELEQUIPMENT

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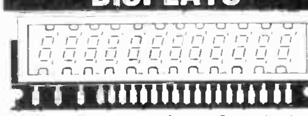
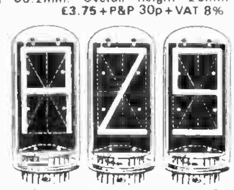
DISPLAYS



Segmented Multiple Cold Cathode Gasfilled Indicator Tube Type ZM1500/12 made by Mullard — unused. 12 Decades Character height 7 6mm Striking voltage 160. Ideal for Display Applications requiring a large No. of digits to be displayed, e.g Desk Top Calculators Overall width 86.2mm. Overall height 26mm **£3.75 + P&P 30p + VAT 8%**



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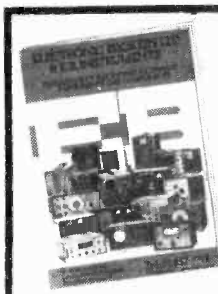
Type 315—0505928G 12V—25A £40



ELECTRONIC BROKERS TEST EQUIPMENT CATALOGUE

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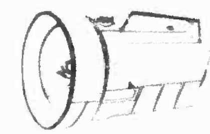

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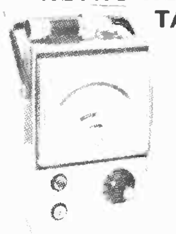

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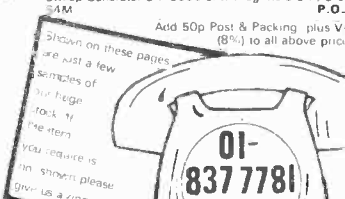

ELECTRONIC BROKERS LTD

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COMPONENTS

CARBON RESISTOR PAKS
These Paks contain a range of Carbon Resistors, assorted into the following groups:—

R.1	50 Mixed 100 ohms — 820 ohms ⅛th W	0.60
R2.	50 Mixed 1K ohms — 8.2K ohms ⅛th W	0.60
R3.	50 Mixed 10K ohms — 82K ohms ⅛th W	0.60
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R5.	30 Mixed 100 ohms — 820 ohms ½ W	0.60
R6.	30 Mixed 1K ohms — 8.2K ohms ½ W	0.60
R7.	30 Mixed 10K ohms — 82K ohms ½ W	0.60
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These are unbeatable prices.

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500 µF 50V Elect 0.09 each
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	CH3	7.5mH	0.29
	CH5	1.5mH	0.26
	CH2	5.0mH	0.28
	CH4	10mH	0.31
COILS	DRX1 Crystal set		0.29
	DRR2 Dual range		0.42

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VC 1	Single Less Switch	0.20
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VC 4	1K Lin Less Switch	0.20
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0.1 Watt 0.09 each
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240V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 40V, 50V and 25V-0-25V.

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Etch resistant printed circuit marker pen. Full instructions supplied with each pen *0.92p

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Takes 6 H.P. 7's complete with terminal clip and lead *0.31p each

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BV3	6"	x 4¾"	x 1½"	*£0.92
BV4	9"	x 5¼"	x 2½"	*£1.39

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No.	Length	Width	Height	Price
BA1	5¼"	x 2¼"	x 1½"	*0.45
BA2	4"	x 4"	x 1½"	*0.45
BA3	4"	x 2¼"	x 1½"	*0.45
BA4	5¼"	x 4"	x 1½"	*0.54
BA5	4"	x 2½"	x 2"	*0.45
BA6	3"	x 2"	x 1"	*0.39
BA7	7"	x 5"	x 2½"	*0.79
BA8	8"	x 6"	x 3"	*£1.02
BA9	6"	x 4"	x 2"	*0.65

(Each complete with ½" deep lids & screws)
PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX

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Pak No.	Qty	Description	Price
C1	200	Resistors mixed values approx. count by weight	.60
C2	150	Capacitors mixed values approx. count by weight	.60
C3	50	Precision Resistors mixed values	.60
C4	75	⅛th W Resistors mixed preferred values	.60
C5	5	Pieces assorted Ferrite Rods	.60
C6	2	Tuning Gangs. MW/LW VHF	.60
C7	1	Pak Wire 50 metres assorted colours	*.60
C8	10	Reed Switches	*.60
C9	3	Micro Switches	*.60
C10	15	Assorted Pots & Pre-Sets	.60
C11	5	Jack Sockets 3 x 3.5m, 2 x standard Switch Type	.60
C12	30	Paper Condensers preferred types mixed values	.60
C13	20	Electrolytics Trans. types	.60
C14	1	Pack assorted Hardware-Nuts/Bolts,Grommets, etc.	*.60
C15	5	Mains Slide Switches, 2 Amp	.60
C16	20	Assorted Tag Strips Panels	.60
C17	10	Assorted Control Knobs	.60
C18	4	Rotary Wave Change Switches	.60
C19	2	Relays 6-24V Operating	*.60
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CP 7	Three Core Mains Cable	*0.11
CP 8	Twin Oval Mains Cable	*0.08
CP 9	Speaker Cable	*0.06
CP 10	Low Loss Co-Axial	*0.14

Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.00

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SK2.Soldering Kit	*£4.60

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Bit No.			
102	for model CN240	3/32"	*42p
104	for model CN240	3/16"	*46p
1100	for model CCN240	3/32"	*46p
1101	for model CCN240	3/8"	*46p
1102	for model CCN240	¼"	*46p
1020	for model G240	3/32"	*46p
1021	for model G240	1/8"	*46p
1022	for model G240	3/16"	*46p
50	for model X25	3/32"	*46p
51	for model X25	1/8"	*46p
52	for model X25	3/16"	*46p

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Model ECN	*£1.25
Model EG 240	*£1.60
Model ECCN 240	*£1.60
Model EX 25	*£1.40

SOLDERING IRON STAND
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Antex heat shunt *11p

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PS 2	D.I.N. 3 Pin	0.11
PS 3	D.I.N. 4 Pin	0.14
PS 4	D.I.N. 5 Pin 180°	0.15
PS 5	D.I.N. 5 Pin 240°	0.15
PS 6	D.I.N. 6 Pin	0.16
PS 7	D.I.N. 7 Pin	0.17
PS 8	Jack 2.5mm Screened	0.17
PS 9	Jack 3.5mm Plastic	0.11
PS 10	Jack 3.5mm Screened	0.17
PS 11	Jack ¼" Plastic	0.14
PS 12	Jack ¼" Screened	0.20
PS 13	Jack Stereo Screened	0.33
PS 14	Phono	0.09
PS 15	Car Aerial	0.14
PS 16	Co-Axial	0.14
INLINE SOCKETS		
PS 21	D.I.N. 2 Pin (Speaker)	0.13
PS 22	D.I.N. 3 Pin	0.19
PS 23	D.I.N. 5 Pin 180°	0.19
PS 24	D.I.N. 5 Pin 240°	0.19
PS 25	Jack 2.5mm Plastic	0.15
PS 26	Jack 3.5mm Plastic	0.15
PS 27	Jack ¼" Plastic	0.28
PS 28	Jack ¼" Screened	0.32
PS 29	Jack Stereo Plastic	0.28
PS 30	Jack Stereo Screened	0.35
PS 31	Phono Screened	0.17
PS 32	Car Aerial	0.20
PS 33	Co-Axial	0.20
SOCKETS		
PS 35	D.I.N. 2 Pin (Speaker)	0.07
PS 36	D.I.N. 3 Pin	0.09
PS 37	D.I.N. 5 Pin 180°	0.09
PS 38	D.I.N. 5 Pin 240°	0.10
PS 39	Jack 2.5mm Switched	0.11
PS 40	Jack 3.5mm Switched	0.11
PS 41	Jack ¼" Switched	0.19
PS 42	Jack Stereo Switched	0.28
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PS 47	Co-Axial Flush	0.19

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PROFESSIONAL D.I.Y. PRINTED CIRCUIT KIT
Containing 6 sheets of 6" x 4" single sided laminate, a generous supply of etchant powder, etching dish, etchant measure, tweezers, etch resistant marking pen, high quality pump drill with spares, cutting knife with spare blades, 6" metal ruler, plus full easy to follow instructions. *£7.80 per kit
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125 watts R.M.S.

POWER AMPLIFIER
Specially designed for use in—Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems

The module has a sensitivity of 450mV and frequency response extending from 25Hz to 20KHz whilst distortion levels are typically below 1%. The use of 4, 115w transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.

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SPECIFICATION
Output Power: 125 watt RMS Continuous
Operating voltage: 50-80
Loads: 4-16 ohms
Frequency response: 25Hz-20kHz *Measured at 100 watts*
Sensitivity for 100 watts output at 1kHz: 450mV
Input impedance: 33K ohms
Total harmonic distortion 50 watts into 4 ohms: 01 1% 50 watts into 8 ohms: 0.06%
S/N ratio: better than 80dBs
Damping factor, 8 ohms: 65
Semiconductor complement: 13 transistors, 5 diodes
Overall size: Heatsink width 190mm, length 205mm, height 40mm

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'J'	Tape Head Cleaning Kit	72p
'P'	Hi-Fi Cleaner	*30p
Model 9	Wire Stripper	*£1.00
23	¼" Tape Editing Kit	*£1.80
24	⅛" Cassette Editing Kit	*£1.84
29A	Salvage Cassette	*44p
32A	Stylus Balance	£1.28
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S222	5 pin DIN plug to 5 pin DIN socket length 1.5m	.68p
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S270	2 pin DIN plug to 2 pin DIN socket length 10m	.80p
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S318	5 pin DIN socket to 2 phono plugs connected to pin 3 & 5 length 23cm	.68p
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S219	5 pin DIN plug to 5 pin DIN plug length 1.5m	.80p
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S600	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5 length 1.5m	.80p
S700	5 pin DIN plug to 3.5 jack connected to pins 1 & 4 length 1.5m	.80p

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High quality modules for stereo, mono and other audio equipment.

NEW

PUSH-BUTTON STEREO FM TUNER

OUR PRICE ONLY **£19.95** Fitted with Phase Lock-loop Decoder

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461**.
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection. Full instructions supplied. **£2.65**

VAT ADD 12½%

POSTAGE & PACKING
Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER PA 100

OUR PRICE **£13.50**

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

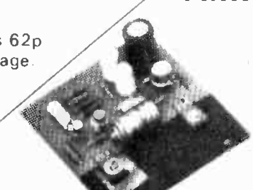
Frequency Response + 1dB 20Hz 20KHz Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz
Supply — 20-35V at 20mA.
Dimensions — 299mm x 89mm x 35mm

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27.55.** plus 62p postage.

TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9.20** plus 62p postage.

AL10-20-30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home.

SPECIFICATION:
- **Harmonic Distortion Po=3 watts f=1KHz 02.5%**
- **Load Impedance 8-16ohm**
- **Size: 75mm x 63mm x 25mm**
- **Frequency response ±3dB Po=2 watts 50Hz-25Hz**
- **Sensitivity for Rated O/P — Vs=25v. RL=8ohm f=1KHz 75mV.RMS**

AL10 3w R.M.S. **£2.30** **AL20** 5w R.M.S. **£2.65** **AL30** 10w R.M.S. **£2.95**

STEREO 30

COMPLETE AUDIO CHASSIS
7+7 WATTS R.M.S.

P & P 45p **£15.75**

The Stereo 30, comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £3.65 plus 62p p & p.

AL 60 25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast. **£3.95**

NEW PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL10/20/30 Amplifier Modules. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (−3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V 5mA. Size 152mm x 84mm x 33mm. **£6.50**

PS12

Power supply for **AL10/20/30, PA12, SA450** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C. Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.20

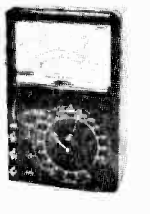
Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.
Transformer BMT80
£2.60 + 62p postage

£3.00

BI-PAK
P.O. BOX 6, WARE, HERTS.

K.30. THD



The **Model K-30 THD** has thermal scales provided which directly read temperature. Along with a thermometer probe attached, the meter checks temperature of from −50°C up to 200°C.

1. The midget bead thermistor is used as its thermal element accelerates temperatures response, and time lag is minimized compared with conventional thermometers.
2. By simply replacing the probe with usual test leads, the meter performs as a circuit tester.
3. As a circuit tester the 18-position rotary system range selector switch and individual jacks cover practically all measurement requirements.
4. The collapsible stand angles the meter to facilitate use of the meter.

Technical Data
DC volts 0.25 ~ 1000V in 6 ranges (10k Ω/V).
AC volts 10 ~ 1000V in 5 ranges (5k Ω/V)
DC milliamperes 0.25 ~ 250ma in 4 ranges.
DC ohms Rx1 ~ Rx1000 in 4 ranges (min. 2Ω & max. 10mg Ω).
Decibels −20 ~ +62 db
Temperature −50°C ~ 100°C & 0 ~ 200°C −50 ~ 200°F & 30 ~ 400°F
Accuracy: DC ±3% AC ±4%. **Weight:** 590g.
Size: 144 x 96 x 45mm Old price £26.14
Meter **£23.98** (B) Meter available with case **£27.47**(B)
Old price £32.13 **HIGH VOLTAGE PROBE AVAILABLE**

K-30D

This is a pocket-size circuit tester of versatile performance equipped with a 70µA meter movement. The combination of an 18-position rotary range switch and separate jacks covers practically all measurement needs.
The diode circuit automatically safeguards the movement against inadvertent overload. For easy reading and convenience operation, the meter can be positioned tilted by snapping open the collapsible stand fitted on the back. High voltage probes of 10kV and 25kV ratings are separately available for alignment of colour as well as black-and-white television circuits.

Measurement Ranges Available
DC voltage 0.25V, 2.5V, 10V, 50V, 250V, 500V, 1000V
AC voltage 10V, 50V, 250V, 500V, 1000V
DC Current 0.1mA, 2.5mA, 25mA, 500mA
Resistance Range — RX1, RX10, RX100, RX1K. Midscale — 96Ω, 960Ω, 9.6kΩ 96kΩ Maximum — 10kΩ, 100kΩ, 1MΩ, 10MΩ
Volume level −20 ~ +62dB
Capacity 0.0001 ~ 0.6uF } Use external power
Megohm 0.1 ~ 200MΩ
Accuracy: Within ±3% f.s. for DC ranges.
Within ±4% f.s. for AC ranges
Within ±3% of the scale length for ohm ranges.
Internal Resistance: 10,000 o.p.v. for DC. 5,000 o.p.v. for AC
Size: 144 x 96 x 46mm Meter **£18.41** (A)
Meter with case **£28.08**

EM-800

A new type of circuit tester of super-high sensitivity using FET devices ● The internal impedance for each DC voltage range is maintained at 12 meg ohms and at 1 meg ohm for each AC voltage range ● The frequency coverage extends to 5MHz ● The instrument can be used as a galvanometer by adjusting the pointer for centre-zero reading.

±DCV 0.3(3MΩ) 1.2 3 12 30 120 300 1.2k; (12MΩ) ±4% 30kV (w/HV probe).
±DCA 0.1uA 1.2mA 12mA 300mA (300mV) — ±4%.
ACV: 1.2 3 12 30 120 300 1.2k (1MΩ) — ±4%; Freq. — 30Hz ~ 5MHz at 1.2V.
Ω X1 X100 X1k X100k (max. 1000M).
dB −20 ~ +63.
225 x 150 x 84mm. 1.1kg.
Price **£55.78.** (C)
Old price £80.46.

HIGH VOLTAGE PROBE AVAILABLE

YX-360TR

Comparable with high-grade meters in performance. Universally accepted as a most versatile standard tester and used extensively by electrical and radio engineers. Accurately checks transistor circuits on the low DC voltage ranges for their high internal resistance.
Apart from its function as a wide range circuit tester, the SANWA model **YX-360TR** also serves as a simplified semi conductor checker. Provided with LI and LV scales, the meter tests the characteristics of practically all types by semi conductors, diodes, thermistors, etc.

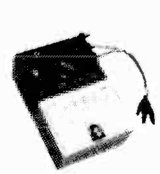
Measurement ranges available:
DCV 100mV, 0.5, 2.5, 10, 50, 250, 1KV (20KV Ω/V). (25KV with HV Probe)
ACV 10, 50, 250, 1KV (8K Ω/V)
DCA 50uA, 2.5mA, 25mA, 0.25A (250mV, 100mV for 50uA)
Ω Range x1, x10, x1K, x10K. Maximum 2K, 20K, 2M, 20M. Mid-scale 20, 200, 20K, 200K.
dB −10 ~ +22 (for 10V AC
hFE 0 ~ 1000
ICEO 0 ~ 150uA (x1KΩ), 0 ~ 15mA (x10Ω) 0 ~ 150mA (x1Ω)
Accuracy:
± 3% f.s.d. for DC ranges ± 4% f.s.d. for AC ranges ± 3% of scale length for Ω ranges ± 3% of scale length for hFE ± 5% of scale length for ICEO
Meter **£16.09** (A) Meter with case **£21.76** (A)
Size and weight: 100 x 150 x 57mm and 420g.

P2B

DC voltage 10V, 50V, 250V, 500V, 1000V (2K Ω/V)
AC voltage 10V, 50V, 250V, 500V, 1000V (2K Ω/V)
DC current 0.5mA, 10mA, 250mA
Resistance Range 0 ~ 5K Ω 0 ~ 500K Ω
Midscale 50Ω 5KΩ
Minimum 1Ω 100Ω
dB −20 ~ +22dB & +20 ~ +36dB
Megohm 0.1 ~ 50M Ω } Externally Powered
Capacity 0.0002 ~ 0.3uF & 0.01 ~ 0.6uF
Accuracy: DC ± 3% FSD AC ± 4% FSD.
Resistance: ± 3% of scale length.
Battery: 1 x 1.5V
Size: 120 x 88 x 40mm **Weight:** 365g.

The P-2B is a general purpose testmeter. Ruggedly built connections are made by Pinjacks. Clear easy-to-read scale.
Meter **£12.69** (A)
Meter with case **£17.28** (A)

AT-45

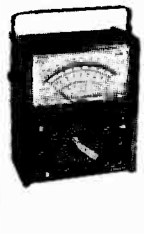


The **AT-45** is a transistor tester capable of checking readily and efficiently not only the leakage current of all types of transistors, but also their DC current amplification factor.

SPECIFICATIONS
Measurement Ranges:
Reverse leakage current (on ICEO scale)
0 ~ 5mA (X100uA
0 ~ 50mA (X1mA)
Accuracy Within ±5%
DC current amplification factor (on hFE scale)
0 ~ 250 (X5)
0 ~ 1000 (X20)
Accuracy Within ± 1 scale division.
Meter Moving-coil (Sensitivity-55uA)

Size and Weight: 180 x 120 x 39mm, 670g.
Accessories: Test lead pair and 3 clipped cords.
SCR check. The ON/OFF test of an SCR is available by connecting it to the instrument.
FET check. The activity and impedance conversion capacity of an FET can be measured on the instrument.
Meter **£20.61.** (B) Old price £25.00
Meter with case
£23.64. (B) Old price £31.00

N-401



The **N-401** MULTITESTER has two outstanding advantages. Firstly, a taut-band meter movement of 5uA is introduced. In sensitivity, it is close to that of a galvanometer. Secondly, an original automatic cut-out device provides exceptional safeguard.

SPECIFICATIONS:
Ranges Available
DCV (±) 0.16 0.4 1.6 4 8 16 40 160 400 800 1.6kV Input impedance 200kΩ/V for 40V & below. 16MΩ for 160V: 40MΩ for 1.6kV. 20MΩ for 400V & 800V
DCA (±) 8uA 40uA 400uA, 1.6mA 4mA 16mA 40mA 160mA 1.6A 16A. Voltage drop 400mV (500mV for 160mA)
ACV 4V 8V 16V 40V 160V 400V 1.6kV Input impedance 5kΩ/V for 16V & above at 50Hz
ACA 1.6A 16A Voltage drop 400mV
Ω Range x1 x10 x100 x1k x10k Maximum 5kΩ 50kΩ 500kΩ 5.50mΩ
Accuracy: Within ± 2% f.s.d. for DC ranges. Within ± 3% f.s.d. for AC ranges
Within ± 2% of scale length for Ω ranges
Frequency error: Within ± 1dB - 50Hz ~ 250kHz (4V & 8V AC) 50Hz ~ 5kHz (other ranges).
Size and Weight: 252 x 191 x 107mm & 1.95 Kg.
Meter **£39.87** (C). Old price £57.40

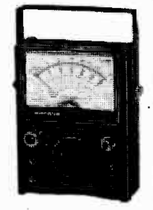
SP-10D

A small pocket instrument of robust construction with meter movement protection, rugged shockproof resin rear case, low ohms range minimum 0.2Ω, 20Ω midscale.

SPECIFICATIONS:
Measurement ranges:
DCV 0.25, 10, 50, 250, 500, 1000 (4kΩ/V)
DCmA 0.25, 25, 500 (250mV drop)
ACV 10, 50, 250, 500, 1000 (4kΩ/V)
Ω Range — x1, x10, x/kΩ
Midscale — 20, 200, 10k
Maximum — 500, 5k, 1M
Battery — 1.5V x 1
dB −20 ~ +22 +20 ~ +36
MΩ 0.1 ~ 50 } Using external power
uF 0.0001 ~ 0.02 0.01 ~ 0.3

Accuracy:
Within ± 2.5% fs for DCV & DCmA
Within ± 3.5% fs for ACV & dB
Within ± 3% of arc for Ω
Size and Weight: 140H x 95W x 440 mm, 310 gr.
Meter **£14.36** (A)
Meter with case **£19.49**

N-201



The **N-201** incorporates a transistor amplifier circuit which provides a high input impedance of 200k ohms per volt for 0.3V to 120V and 20k ohms-per-volt for 600V and upwards for DC measurements.
High Sensitivity and Ruggedness. A Solid-state amplifier circuit permits the use of an 80uA meter movement. In ruggedness, therefore, it surpasses usual high sensitivity meter movement.
Fast response is another advantage. **Wide, Mirror Scale.** The scale has a wide angle operation of nearly 100° which is not usual with conventional meters.

SPECIFICATIONS:
Ranges Available:
DCV 0.3 1.2 3 12 120 (200k Ω/V), 600, 1200, 3000 (20k Ω/V)
ACV 3 12 120 300 600 (10k Ω/V)
DCmA 0.006 0.12 3 30 600 (300mV)
DCA 3 (300mV)
Ω Range — x0.1, x10, x100, x1K. Midscale — 1Ω, 100Ω, 1kΩ, 10kΩ. Maximum — 5kΩ, 500kn, 5MΩ, 50MΩ.
LI 30mA 0.3mA 0.03mA
LV 1.5V 1.5V 1.5V
dB −20 ~ +57
Size and Weight: 60 x 118 x 157mm and 740g.
Accuracy: DCV & DCA Within ± 3% f.s.d.
ACV & dB Within ± 4% f.s.d. (± 6% for 25V)
Ω Within ± 3% of arc
Meter **£27.65.** (C) Old price £38.50

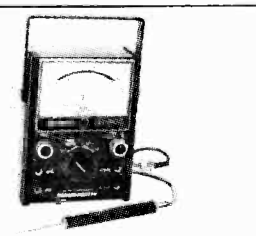
460-ED

This is a circuit tester of the highest sensitivity with a 10 microampere meter movement of 100 K ohm/volt internal resistance, meeting the ever demanding needs of electronic industry ● Double protection of the meter movement against overload and shock ● Minimum measurement loss ● Unique AC current range ● Polarity Switch — This not only converts polarity but determines if the voltage measured is positive or negative. This is a factor indispensable for aligning electronic circuits.

Measurement Ranges:
DC voltage 0.3V 3V 12V 30V 120V 300V (100k Ω/V), 1.2kV 6kV 30kV (with probe) 16.6k Ω/V).
DC current: 12uA 0.3mA 3mA 30mA 300mA 1.2A 12A (300mv).
AC voltage 3V 12V 30V 120V 300V 1.2kV (5kΩ/V)
AC current 1.2A 12A
Resistance Range — X1 X10 X100 X10K Midscale — 40Ω 400Ω 4kΩ 400kΩ Maximum — 5k Ω 50k Ω 500k Ω 50M Ω.
Volume level. 20 ~ +63dB

Accuracy: ± 2% DC ranges ± 3% AC ranges
Frequency coverage:
50Hz — 100kHz for AC 30V and below (± 3%)
10kHz for other AC voltage ranges
Size: 184 x 134 x 88mm Meter **£30.93** (B) Old price £40.69
Weight: 1.3kg. Meter with Case
High Voltage Probe
Current £37.94 & £49.93 **£12.41.** Old price £15.23

TH-500



The temperature probe thermistor quickly responds to change of temperature. It is readily indicated on the easy to read double LO/HI mirror scale. The instrument also performs as a two range voltmeter reading 150V and 300V AC at full scale. The ohms range provided measures resistance up to 100kΩ.

SPECIFICATIONS
Measurement Ranges
Temperature (°F) (LO) −50 ~ 230° (HI) 215 ~ 570°
AC voltage (V) 0 ~ 150V 0 ~ 300V (4k Ω/V)
Resistance (Ω) 0Ω100k (midscale-abt. 2.5k)
Batteries: 1.5V (UM-3) x 2 & 9V (PP3) x 1
Accuracy: Within ± 2% of arc for temperature
Within ± 4% f.s.d. for AC voltage Within ± 3% of arc for resistance
Size & Weight: 157 x 118 x 45mm & 830gr w/accessories
Price **£56.00.** (C) Old price £81.86

PDM-500 SERIES

The **SANWA DM** and **PDM** instruments are automatic battery operated Insulation Resistance Testers. Solid state circuitry provides marked advantage over conventional automatic and hand-driven insulation meters.
The dial is designed for easy and accurate reading.
Size and weight 174 x 122 x 73mm & 960gr.

Models available

Type	Price	Rated Voltage & Resistance	Effective Scale Range
PDM-100	£41.22 (C)	100V/20 mΩ	0.02 ~ 20 ~ 50 mΩ
PDM-250	£41.22 (C)	250V/50 mΩ	0.05 ~ 50 ~ 100 mΩ
PDM-500	£41.22 (C)	500V/100 mΩ	0.1 ~ 100 ~ 200 mΩ
DM-500	£39.31 (C)	500V/1000 mΩ	1 ~ 1000 mΩ
DM-1000	£45.65 (C)	1000V/2000 mΩ	2 ~ 2000 mΩ

Old price PDM 100-500 **£59.18.** DM 500 **£56.36.** DM 1000 **£66.04**

To celebrate the transfer of ownership of the Company, its move to new premises, we have decided to offer a selection from the range of **SANWA** meters at **REDUCED PRICES.** We have achieved this by arranging to supply those items marked (C) after the price only direct from **QUALITY ELECTRONICS LTD.,** while those marked (B) are available from selected wholesale/retail outlets only. Instruments marked (A) are widely available through normal wholesale/retail channels. Details of new **QUANTITY DISCOUNTS** are available on application. All prices include VAT at 8%. **Postage and Packing** on this introductory offer is **free.** Full Sanwa catalogue and price list available on receipt of S.A.E.

Sole U.K. Importers:

QUALITY ELECTRONICS LTD.

24 HIGH STREET, LYDD, KENT TN29 9AJ
(FORMERLY OF KINGSTON, SURREY). TELEPHONE: LYDD 20252. TELEX: 965265 (A/B Servolydd)
In association with SERVO & ELECTRONICS SALES LTD. at the same address
Specialist suppliers of Alps Panel Meters, Synchros, Servomotors, Electrical Connectors Test Equipment and Computer Peripherals.

WW—062 FOR FURTHER DETAILS

Wilmslow Audio

THE firm for speakers!

Baker Group 25, 3, 8, or 15 ohm	£8.64
Baker Group 35, 3, 8 or 15 ohm	£10.25
Baker Deluxe, 8 or 15 ohm	£12.38
Baker Major, 3, 8 or 15 ohm	£10.69
Baker Regent, 8 or 15 ohm	£9.00
Baker Superb, 8 or 15 ohm	£16.31
Celestion HF1300 8 or 15 ohm	£6.98
Celestion MH 1000 horn, 8 or 15 ohm	£13.50
Decca London and X over	£36.25
Decca DK30 and X over	£24.00
EMI 5" Mid range	£3.15
EMI 6½" d/cone roll surr. 8 ohm	£3.93
EMI 8 × 5, 10 watt, d/c, roll/s 8 ohm	£3.56
EMI 14" x 9" Bass 8 ohm	£11.92
Elac 59RM 109 15 ohm, 59RM 1148 ohm	£3.38
Elac 6½" d/c roll/s 8 ohm	£3.83
Fane Pop 15 watt 12"	£5.25
Fane Pop 33T 33 watt 12"	£9.25
Fane Pop 50 watt, 12"	£12.50
Fane Pop 55, 12" 60 watt	£15.50
Fane Pop 60 watt, 15"	£17.95
Fane Pop 70 watt 15"	£18.75
Fane Pop 100 watt, 18"	£27.95
Fane Crescendo 12A or B, 8 or 15 ohm	£37.95
Fane Crescendo 15, 8 or 15 ohm	£49.95
Fane Crescendo 18, 8 or 15 ohm	£67.95
Fane 807T 8" d/c, rolls/s, 8 or 15 ohm	£5.18
Fane 801T 8" d/c roll/s 8 ohm	£8.96
Goodmans 8P 8 or 15 ohm	£5.95
Goodmans 10P 8 or 15 ohm	£6.25
Goodmans 12P 8 or 15 ohm	£14.95
Goodmans 12P-D 8 or 15 ohms	£16.95
Goodmans 12P-G 8 or 15 ohms	£16.50
Goodmans Audiom 200 8 ohm	£13.46
Goodmans Axent 100 8 ohm	£7.60
Goodmans Axiom 402 8 or 15 ohm	£19.80
Goodmans Twinaxiom 8" 8 or 15 ohm	£9.50
Goodmans Twinaxiom 10" 8 or 15 ohm	£9.86
Kef T27	£5.18
Kef T15	£6.25
Kef B110	£6.75
Kef B200	£7.85
Kef B139	£15.08
Kef DN8	£2.08
Kef DN12	£5.39
Kef DN13	£4.05
Richard Allan HP8B 8" 45 watt	£11.93
Richard Allan CG8T 8" d/c roll/s	£7.65
STC 400 1 G super tweeter	£5.90
STC 400 1 K super tweeter	£5.90
Baker Major Module, each	£13.28
Goodmans Mezzo Twinkit, pair	£42.47
Goodmans DIN 20, 4 ohm, each	£13.28
Helme XLK35, pair	£26.75
Helme XLK40, pair	£38.50
Helme XLK30, pair	£21.95
Helme XLK50, pair	£55.50
Kefkit 1, pair	£44.10
Kefkit III, each	£39.38
Richard Allan Twinkit, each	£13.46
Richard Allan Triple 8, each	£20.25
Richard Allan Triple, each	£25.16
Richard Allan Super Triple, each	£29.25
Richard Allan RA8 kit, pair	£37.80
Richard Allan RA82 kit, pair	£59.40
Wharfedale Linton 2 kit (pair)	£20.81
Wharfedale Glendale 3 XP kit, pair	£47.70
Wharfedale Dovedale 3 kit, pair	£59.40

All Radford, Gauss, Castle, Jordan Watts, Eagle, Lowther, Peerless Tannoy units in stock

Prices correct at 26.4.76

ALL PRICES INCLUDE VAT

Cabinets wadding, Vynair, Crossovers etc.
Send stamp for free booklet "Choosing a Speaker"
FREE with all orders over £10 — HiFi Loudspeaker Enclosures Book
All units are guaranteed new and perfect
Prompt despatch
Carriage. Speakers 50p each, 12" and up 75p each, tweeters and crossovers 30p each, kits 80p each (£1.60 pair).

WILMSLOW AUDIO

Dept. WW

Loudspeakers & Export Dept: Swan Works, Bank Square, Wilmslow, Cheshire SK9 1HF. Discount HiFi, PA etc: 10 Swan Street, Wilmslow. Radio, Hi-Fi, TV: Swift of Wilmslow, 5 Swan Street, Wilmslow. Tel. (Loudspeakers) Wilmslow 29599, (HiFi, etc.) Wilmslow 26213.

WW — 017 FOR FURTHER DETAILS

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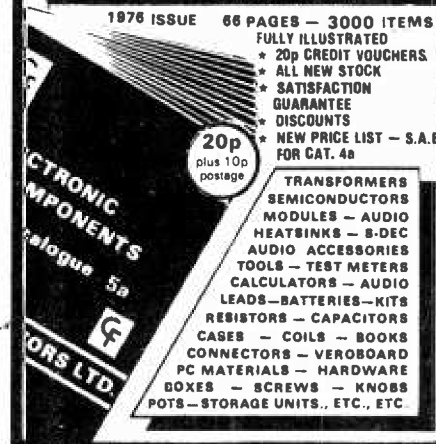

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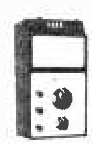

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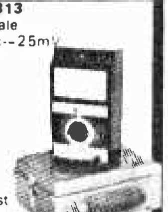

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OSCILLATOR—1 KHz and 465 KHz (A M) at approx 1 Volt Size —160 x 97 x 40mm
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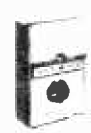

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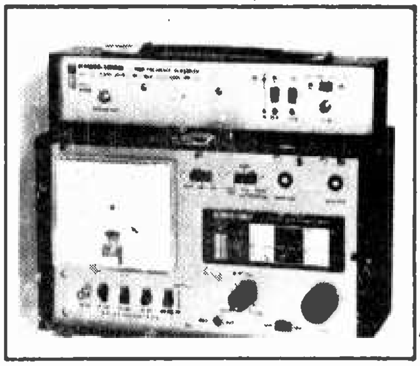

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PHONE: Owen Bailey on 01-261 8508 or 01-261 8423.
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

TEST AND LIAISON ENGINEERS

Ferranti in Edinburgh have a number of Ministry of Defence contracts involving the design and development of advanced avionic equipment for military aircraft in an international market.

We have vacancies for test and liaison engineers who will probably be qualified to HND level in electronic engineering with some years' experience in design, test or support of modern avionic equipment. A knowledge of digital and analogue techniques is essential.

Close liaison with design/development teams currently engaged on inertial navigation and display systems will be necessary and the work will entail factory acceptance testing, fault diagnosis and system commissioning on a variety of sophisticated equipment.

There will be opportunities for some of these engineers after a period of in-house training to be selected for technical liaison duties at locations in the U.K., Europe, Middle and Far East.

The Company offers an attractive employment package which includes 22 days holiday and membership of a life assurance and pension scheme. Incoming personnel will qualify for housing under the Scottish Special Housing Association scheme and realistic assistance will be given with relocation expenses where applicable.

Apply in writing giving details of age, experience and qualifications to:
THE STAFF APPOINTMENTS OFFICER
FERRANTI LIMITED
FERRY ROAD
EDINBURGH EH5 2XS

FERRANTI

UNIVERSITY OF STRATHCLYDE
AUDIO VISUAL UNIT

TELEVISION ENGINEER

Grade 6

required with experience in the maintenance of television and sound equipment. In addition to supervision of staff, the work includes the running of an electronic workshop and operational duties as a Senior member of the studio crew for television recordings. Candidates should have experience in a television studio, preferably as vision control engineer or sound mixer and should hold an H.N.C., City & Guilds or R.T.E.B. Certificate.

Salary Scale £3156 - £3762 per annum

Applications in writing, QUOTING REFERENCE AV.4, giving details of age and qualifications, should be made to The Personnel Officer, University of Strathclyde, Royal College Building, 204 George Street, Glasgow G1 1XW (5397)

SENIOR TEST ENGINEER

To fault find on interesting and varied circuits for a range of equipments. Produced in small batches. Experience of digital and analogue circuits is essential. Above average salary and good promotional prospects. The Company is rapidly expanding with positive management. We have a full order book, mainly for export World Wide.

Please contact in confidence Mr. D. Hemsley
DIGITAL ELECTRONICS LTD.
Holywell Industrial Estate
Watford, Herts
Tel: 45991

(5519)

ema

Opportunities in the ELECTRONICS FIELD

We have selected from many vacancies those which offer exceptional career prospects and job interest. If you have experience in design, test, sales or service and wish to progress your career, please telephone Mike Gernat B.Sc. who is advising on these opportunities.

E.M.A. Management Personnel L'td.
Burne House, 88/89 High Holborn
London WC1V 6LR
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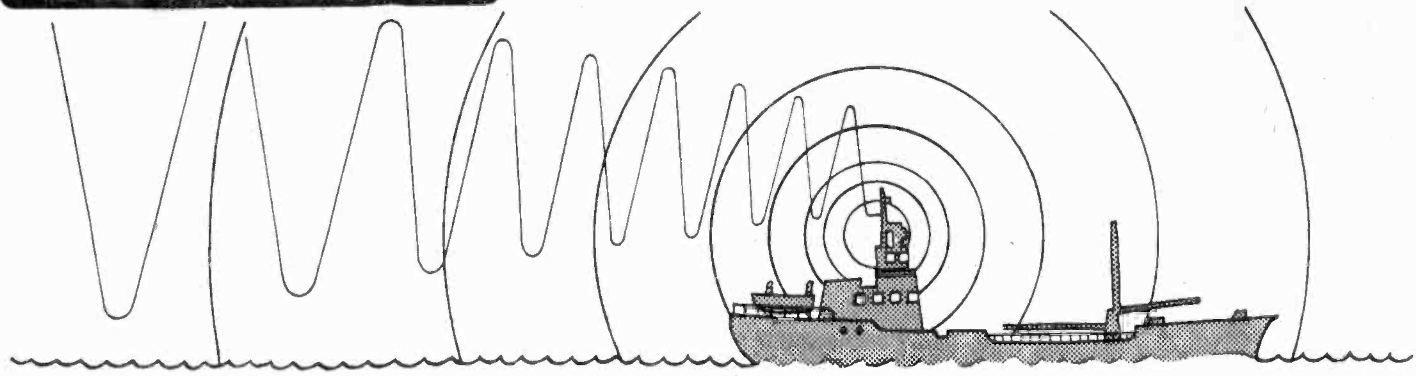

Radio Officers–now you can enjoy the comforts of home.

Working for the Post Office Maritime Services really makes sense. You still do the work that interests you, but with all the advantages of a shore-based job: more time to enjoy home life, job security and good money. To qualify, you need a United Kingdom Maritime Radiocommunication Operator's General Certificate or First Class Certificate of competence in Radiotelegraphy, or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic.

Starting salaries, at 25 or over, are £2905 rising to £3704 after three years service. Between 19 and 24, the starting salary varies from £2234 to £2627 according to age. You'll also receive an allowance for shift duties which at the maximum of the scale averages £900 a year and there are opportunities to earn overtime. There's a good pension scheme, sick pay benefits and prospects of promotion to senior management.

Right now we have vacancies at some of our coastal radio stations, so if you're 19 or over, write to: ETE Maritime Radio Services Division (L687), ET 17.1.1.2., Room 643, Union House, St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

93

Engineer Technicians

EMI have all kinds of future for you at Hayes

With several different EMI industries concentrated at Hayes, Middlesex, the Company offers you work on a wide variety of equipments – plus opportunities to win promotions in one direction or another without ever having to move out of the Hayes area.

And, since the entire EMI Group is constantly expanding – and, indeed, looks likely to continue to expand for years to come – these opportunities may be expected to come up frequently.

Recent practical electronics experience associated with maintenance, commissioning, fault finding, testing or calibration, either in industry or with HM forces is essential.

Ideally, it will have involved work on advanced and complex electronic devices.

Certainly you'll need a good technical background with knowledge equivalent to ONC.

Given these minimum conditions, Engineer Technicians of all levels are required – and you're starting salary will faithfully reflect the experience you have accumulated to date.

Terms and conditions of employment at EMI are everything you would expect of a major international organisation, and assistance towards relocation expenses will be considered where necessary.

To apply, please write to Bill Clark, Personnel Department EMI Limited, 135 Blyth Road, Hayes, Middlesex.

Or telephone him on 01-573 3888 extension 639 or Record-a-call anytime on 01-573 5524.

EMI

The international music, electronics and leisure Group. (5381)

UNIVERSITY LABORATORY OF PHYSIOLOGY OXFORD

ELECTRONICS TECHNICIAN

PHGY 3770

Opportunity to join a small team providing an electronics service to a number of research and teaching groups. The work involves the full range of activities from initial discussion, through design, construction, installation, modifications and maintenance.

Candidates must have at least 5 years' experience in the construction and application of electronic equipment, including analogue and digital techniques. H.N.C. standard is required and the ability to work with a minimum of supervision is essential. Familiarity with medical electronics would be advantageous.

Salary on University Technical Scale Grade 5, £2751 x 5 - £3207.

Letters of application stating age, qualifications, experience and the names of 2 referees to:

Administrator
University Laboratory of Physiology
Parks Road, Oxford OX1 3PT

Further details from Wilf Laycock, Supervisor, Electronics Group, Oxford 57451 (5367)

ELECTRONIC TECHNICIAN

DEPARTMENT OF CHEMISTRY

ELECTRONIC TECHNICIAN GRADE 5 required to join a team concerned with the development and maintenance of a wide range of electronic equipment encountered in chemical research. Experience of electronic equipment maintenance and development an advantage. Salary in range £2.751 to £3.207 + £465 London Weighting. Application form from Personnel Officer (Technical Staff CE5), University College London, Gower Street, WC1E 6BT. Closing date 28 May 1976. (5520)

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M.E.L., part of the Philips Organisation, has recently achieved outstanding success in gaining new markets for its highly successful range of medical Linear Accelerators - used in the fight against cancer.

This expansion has created new opportunities for skilled engineers to install these highly sophisticated equipments in all parts of the world. As a member of a specialist team, you will be required to carry out installation projects (of up to three months' duration), service equipment and trouble-shoot - wherever your skills are needed.

You must be adaptable and self-reliant, qualified to at least ONC level or equivalent and have a good knowledge of semi-conductor circuitry. Preferably, you will also have worked on such equipment as modern high-power radar systems.

We offer a progressive salary, bonus and pension scheme, generous expenses and twenty three days' holiday. If appropriate, assistance will be given in moving to this attractive part of Sussex, situated mid-way between Brighton and London.

Please write or telephone for an application form to Diana Hill, Personnel Officer, M.E.L. Equipment Company Limited, Manor Royal, Crawley, Sussex. Tel: 0293 28787.

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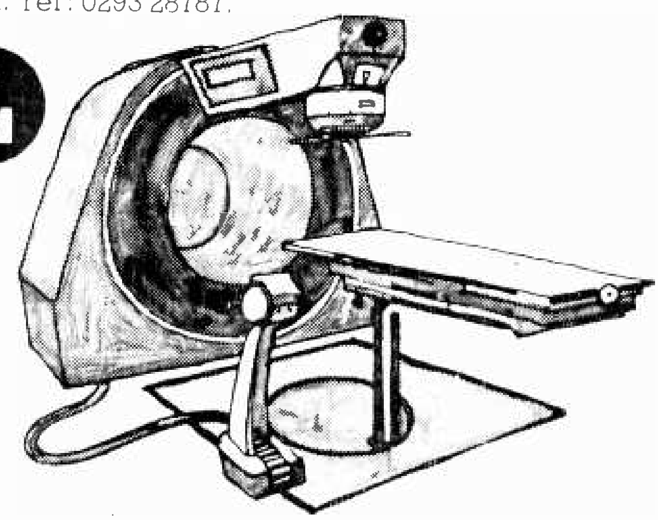

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- Hard work is necessary

We are recruiting on renewable one year contracts and have vacancies for the following and other positions:

PROGRAMME STAFF

— Production Direction
— News
— Film Editing
— Transmission Controller

OPERATIONS STAFF

— Telecine
— V.T.R.
— Sound Dubbing and Mixing
— Film Processing

ENGINEERS

— Studio
— Transmitters
— Microwave
— O/B Van

PLUS

— Aerial Rigger
— Electricians

Let us discuss with you your abilities for these interesting and important positions.

Phone: Tony Towers, 01-573 8333 for more information

PERSONNEL & ELECTRONICS LTD.

(5509)

Radio Technology

TELECOMMUNICATIONS OFFICERS

... for a Radio Station in Hertfordshire. The work is mainly concerned with the installation and maintenance of electronic equipment such as radio receivers, spectrum analysers and direction-finding equipment and involves the use of a wide range of test equipment.

Candidates (aged at least 23) must have ONC in Engineering (with a pass in Electrical Engineering 'A) or in Applied Physics, or an equivalent qualification. In addition, they should have had experience in the operation of radio receiving equipment and have a knowledge of current operational systems of radio communications.

Salary starting between £3,145 and £3,790 (according to age) and rising to £4,090. A shift system is worked and a shift disturbance allowance is payable. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 14 June 1976) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours) or London 01-839 1992 (24-hour answering service). Please quote T/9292/3.

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30/75 Watt Amplifier	Kit £12.00	Made £15.95
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Frequency meter. Price to be announced

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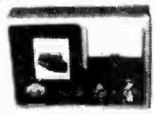

325 Fore St., Edmonton, London N.9
01-807 3719 Closed Thursdays (5210)

Electronics Engineers

VOL is the worlds largest operator of commercial work submersibles. A number of these units are involved in underwater surveying, primarily for the off-shore oil industry.

As a part of our continuing expansion we have vacancies for Electronics Engineers to operate and maintain the computers, data logging and underwater acoustic systems, used in this developing technology.

Past experience should include either underwater navigation, surveying systems or data recording and computer maintenance. Familiarity with DEC PDP11 machines would be particularly useful.

Applicants should be of HNC standard and be able to work on their own initiative in a challenging environment. Off-shore and base training will be provided for suitable applicants. These positions are based at VOL's Leith Base and would involve periods of work at sea, usually not exceeding 3 weeks.

Please write for an application form to the:-

**Personnel Officer,
Vickers Oceanics Ltd.,
P.O. Box 215
East Old Dock,
Leith Docks,
Edinburgh EH6 6PH**

Tel: 031/554/0676

(5387)

International Broadcast Sales Engineers

RCA Broadcast Division has openings for Sales Engineers to assume responsibility for the marketing and sale of our range of professional television and radio studio and transmitter equipment in areas of Europe, Africa and the Middle East.

The positions will be based either in Sunbury on Thames, England, or if appropriate on the continent of Europe, and each salesman/woman will have direct responsibility for the aggressive promotion and sale of our products.

As a considerable amount of time has to be spent in the countries concerned, applications are invited only from persons willing to spend up to 50% of their time in their sales territory.

Ideally, we seek people with past experience of selling broadcast or associated products, preferably internationally. However, we will also consider for training, candidates with experience in the operation and maintenance of broadcast equipment who are interested and keen to enter commercial and selling activity.

We are looking for people who are interested in overseas travel and who have the initiative, dedication and personality to operate effectively in the challenging environment of international sales. A knowledge of French and/or German would be an asset for some posts.

Salaries are negotiable but will certainly be in keeping with the responsibilities and demands of these posts. Competitive Company fringe benefits etc., exist.

Applications outlining past experience, age etc., should be sent as early as possible to:

**Pam Torma, RCA International Ltd.,
50 Curzon Street,
London, W.1,
England.**

RCA

(5528)

THE BRITISH COUNCIL

SAUDI ARABIA AUDIO-VISUAL SPECIALISTS

The British Council will require extra staff from July or August, 1976, for established Projects in Communication Skills in English at universities in Saudi Arabia.

The Projects, which are designed to teach English to students of Engineering, science, architecture and medicine, are supported by extensive audio-visual facilities. Vacancies will exist for suitably qualified Specialists in Audio-Visual Techniques and for Electronic Engineers with experience of cctv.

Contracts will be for 12 months in the first instance. Total emoluments will be within the range £6,000 - £9,000 p.a. depending on the post and the circumstances of the candidate. They will be free of Saudi income tax. Free furnished accommodation will be provided.

Further particulars and forms of application are obtainable from Overseas Educational Appointments Department, The British Council, 65 Davies Street, London W1Y 2AA. Please quote reference 76 AU 30-60.

(5379)

CCTV Engineer

EMI Service require an experienced CCTV Engineer to supervise a team engaged in the servicing and commissioning of CCTV systems and equipment. For this position, which offers varied and interesting work, applicants should have at least 5 years' practical experience in CCTV.

There's an attractive starting salary, subsidised lunches, 4 weeks holiday and excellent sick pay and pension schemes. For further details telephone or write to M. Ford on 01-573 3888 ext. 2167. EMI Service, 254 Blyth Road, Hayes, Middlesex.

EMI

The international music, electronics and leisure Group.

TWO INSTRUCTORS IN MARINE RADIO

are required by

COLLEGE OF I.M.R. COMMUNICATIONS
160-176 CHORLTON ROAD, MANCHESTER M16 7WT

One will be required to instruct morse sending and receiving to trainee radio officers, and the other will teach the theoretical syllabus for the Home Office General Certificate course.

Qualifications and experience will determine the position on a salary scale £2,112 to £3,945.

(5524)

LEEDS CITY COUNCIL
Department of Education
Leeds Polytechnic — Education Technology Unit

T.V. ENGINEER (Temporary)

(Ref. 13/23)
T3 £2922 - £3282

The holder of this post works with the media production team in the operation of the colour television studio and related recording facilities and assists in the maintenance of equipment.

Application forms (quoting ref. no.) together with further details, should be obtained from the Administration Officer, Leeds Polytechnic, Calverley Street, Leeds LS1 3HE. Please enclose S.A.E.

(5378)

SCOTTISH HOME AND HEALTH DEPARTMENT

WIRELESS TECHNICIAN

Applications are invited for a post of Wireless Technician in Scottish Home and Health Department.

Location:
Montreathmont Moor (near Montrose)

Qualifications:
HNC in Electrical or Electronic Engineering or City and Guilds Certificate desirable.

Experience:
3 years' appropriate experience.

Starting Salary:
£2,010 (age 17) to £2,905 (age 25 or over) scale maximum £3,385. In addition a supplement of £313.20 per annum is payable for staff aged 18 or over (£261.00 per annum for staff aged 17). Applicants should have sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean current driving licence and ability to drive private and commercial vehicles are essential.

Appointment is unestablished initially but there is prospect of an established (ie permanent) appointment after 1 year's satisfactory service.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 105, 22/25 Queen Street, Edinburgh EH2 1LY (quote ref: PM(PTS)2/5/76 (031-556 9222, ext. 727).

Closing date for receipt of completed application forms is 27 May, 1976.

(5389)

Anglian Water Authority

ELECTRICAL AND MECHANICAL ASSISTANT

Ref: W1032 Grade 7 £4,650-£5,016

Applications are invited for the above post based at Milton Keynes Office, Old Stratford.

The successful candidate will be reponsible for the operation, maintenance and installation of all electrical, electronic and mechanical equipment in the area, including modern processor operated telemetry.

Relocation expenses payable in appropriate cases and an essential car users allowance will be attached to the post.

NJC for Water Service Staffs Conditions of Service apply.

Further details available from: The Area Manager, Cosgrove Road, Old Stratford. Telephone: Stony Stratford 2481.

Applications in writing to: The Divisional Manager, by May 30th 1976.

BEDFORD WATER DIVISION
Cambridge Road, Harrowden, Bedford, MK42 011

Looking for a new job?

Perhaps we can help!

We have regular contact with hundreds of electronics and electrical companies needing qualified electronics engineers and technicians and TV service engineers.

We can, therefore, help you to find an interesting and well paid job. All you need to do is to return the coupon below or give us a ring. Our service is confidential and costs you nothing.

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Tunbridge Wells (0892) 39388

TJB

TJB Electrotechnical Personnel Services is a division of Technical & Executive Personnel Ltd. and is solely concerned with job placement in the Electronics and Electrical Industries

Please note that this service is available only for engineers who are (or will be) available in the U.K. for interview.

Please send me an "Application for Registration" form

NAME ....

ADDRESS ....

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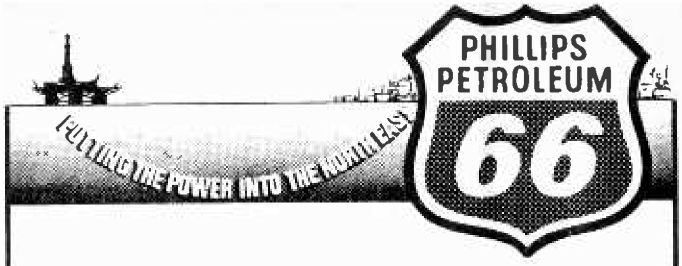

Phillips Petroleum Company, operator for the Phillips Norway Group of companies, is establishing a major crude oil processing; natural gas liquid fractionating and terminalling project at Seal Sands, Cleveland, which will create employment opportunities for high calibre personnel

TECHNICIANS

(WW/1/76)

An integral and important part of our operations capability at our oil stabilisation and NGL fractionating plant presently under construction will be sophisticated computer and communications controls

Daniels, Kent, AAI computers will be used extensively to optimise plant control functions with the metering and loading of products into sea going tankers

Communications equipment centres around at Tropospheric scatter shore station and micro wave link with the Ekofisk oil field in the North Sea. In plant radio and telephone systems will also be in operation

We now wish to establish a small group of technicians to maintain and repair this wide range of equipment and invite applications from candidates who can offer relevant practical experience with preferably a H.N.C qualification

These appointments offer competitive commencing salaries, and conditions of service are those one would expect from a major organisation such as Phillips Petroleum Company

If you are interested in these vacancies, please write for an application form (quoting job reference No.), to: Mr. A. Jackson Personnel Officer

(5395)

PHILLIPS PETROLEUM COMPANY
Teesside Operations, Seal Sands, Middlesbrough, Cleveland TS2 1HD Tel: 0642 546411

WEST BIRMINGHAM HEALTH DISTRICT

TECHNICIAN

For the Electronics and Bio-Medical Engineering Section

The successful applicant must have sound knowledge and experience of maintenance and development of electro medical respirators; ventilators, laboratory and other electro-mechanical equipment

Salary. Technician III £2931-£3834 (increase pending)
Technician II £3558-£4581 (increase pending)
Starting salary dependent on qualifications and previous experience

Application form and job description from District Works Officer, Dudley Road Hospital, Birmingham B18 7QH
Telephone 021-554 3801, Ext. 4838

Please quote ref. 840/WW

(5506)

SENIOR TECHNICIAN

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