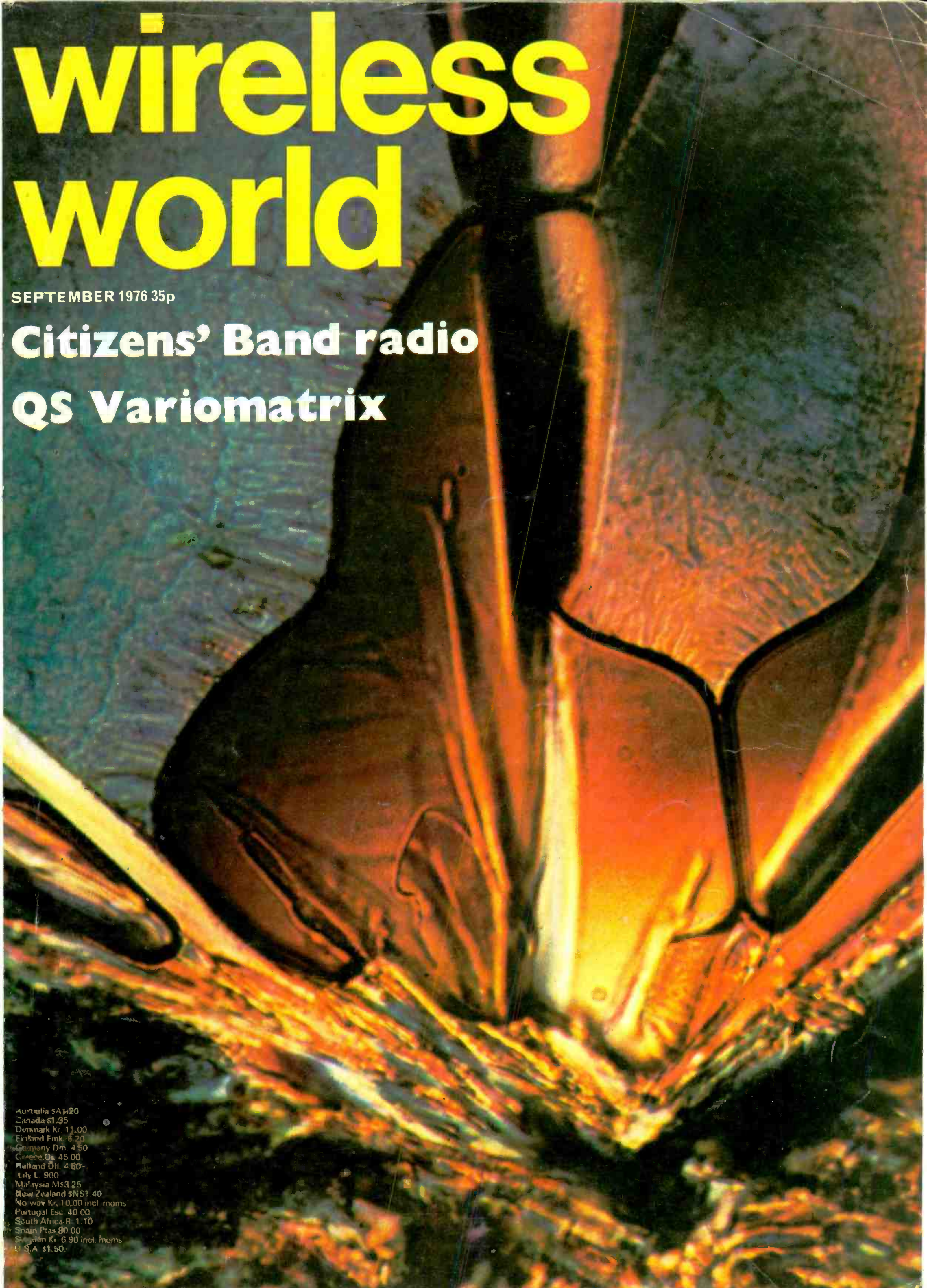

wireless world

SEPTEMBER 1976 35p

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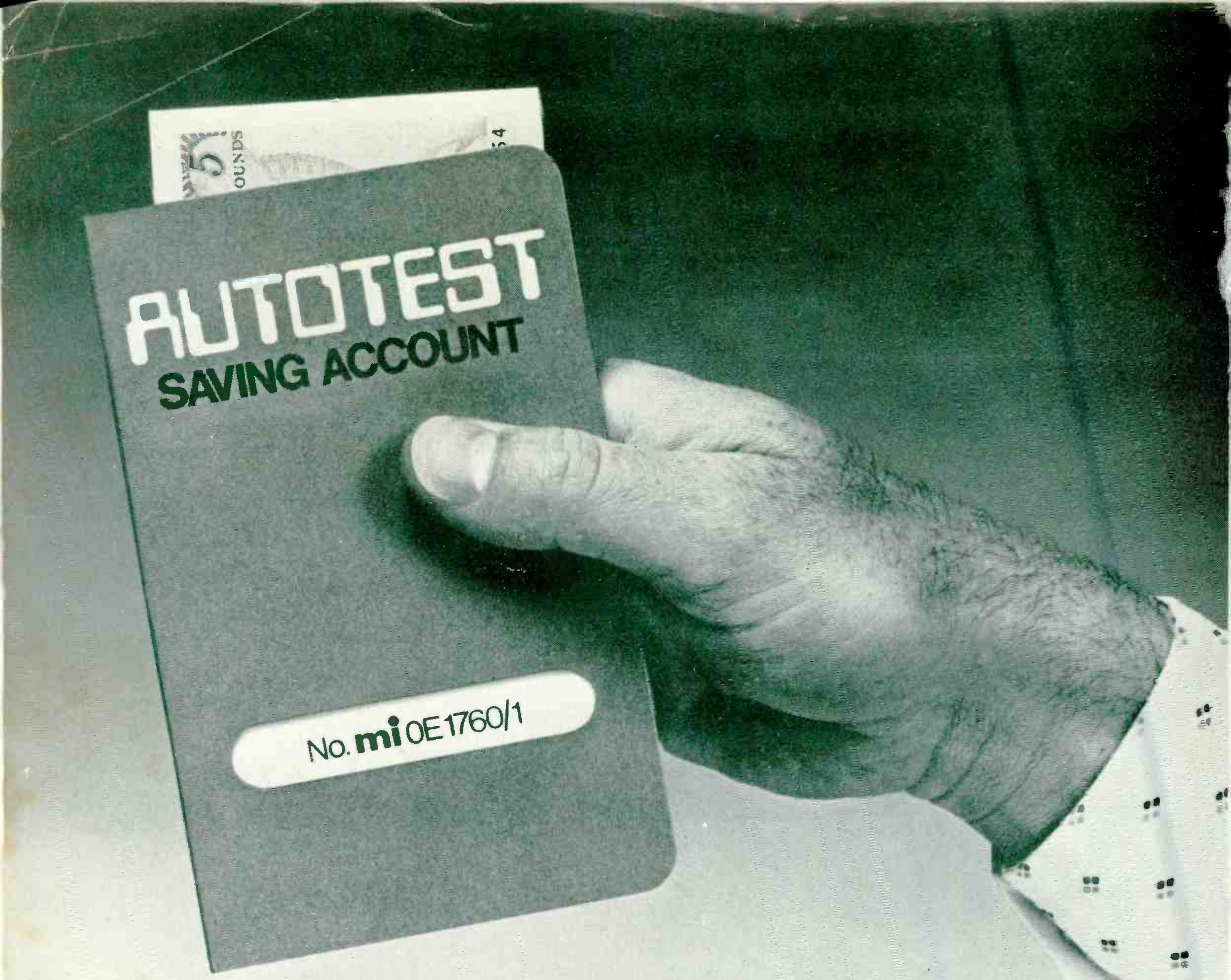

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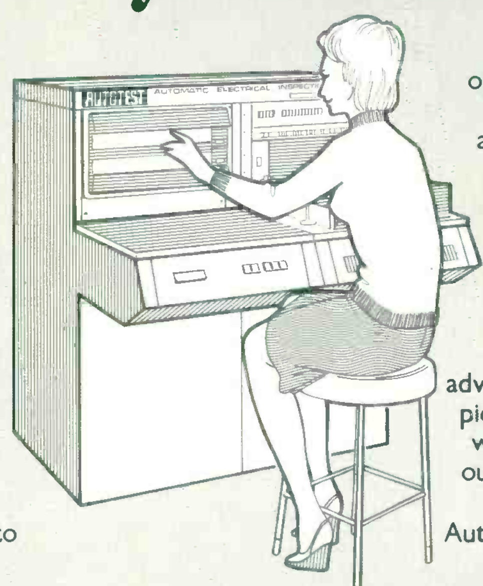

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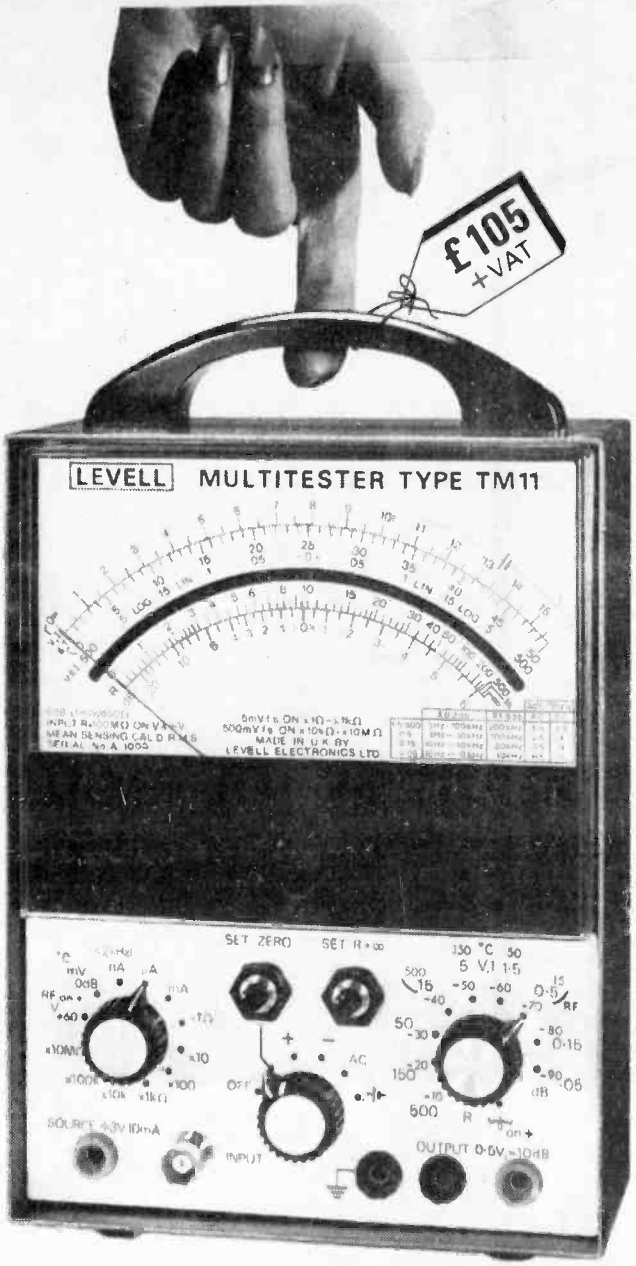

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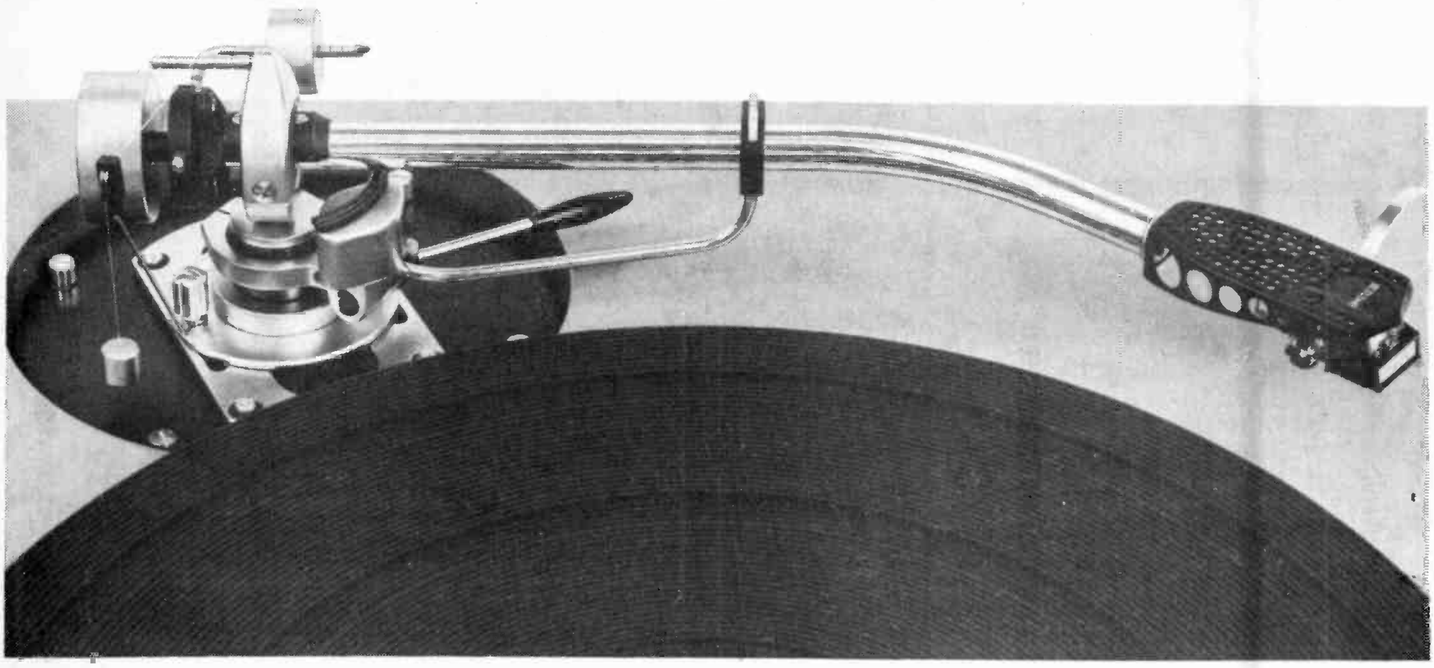

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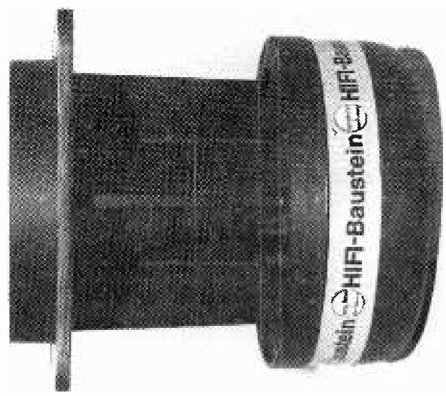

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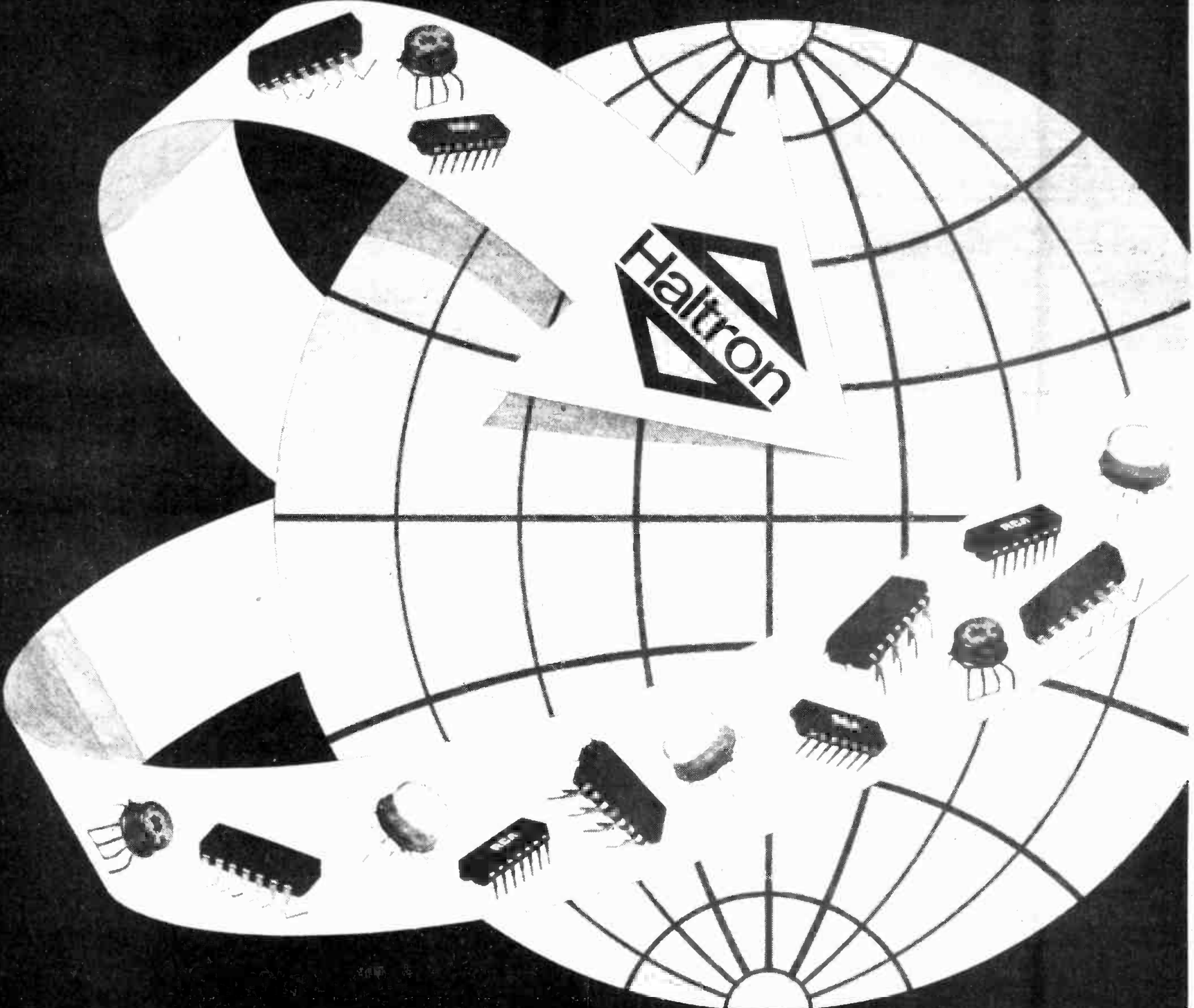

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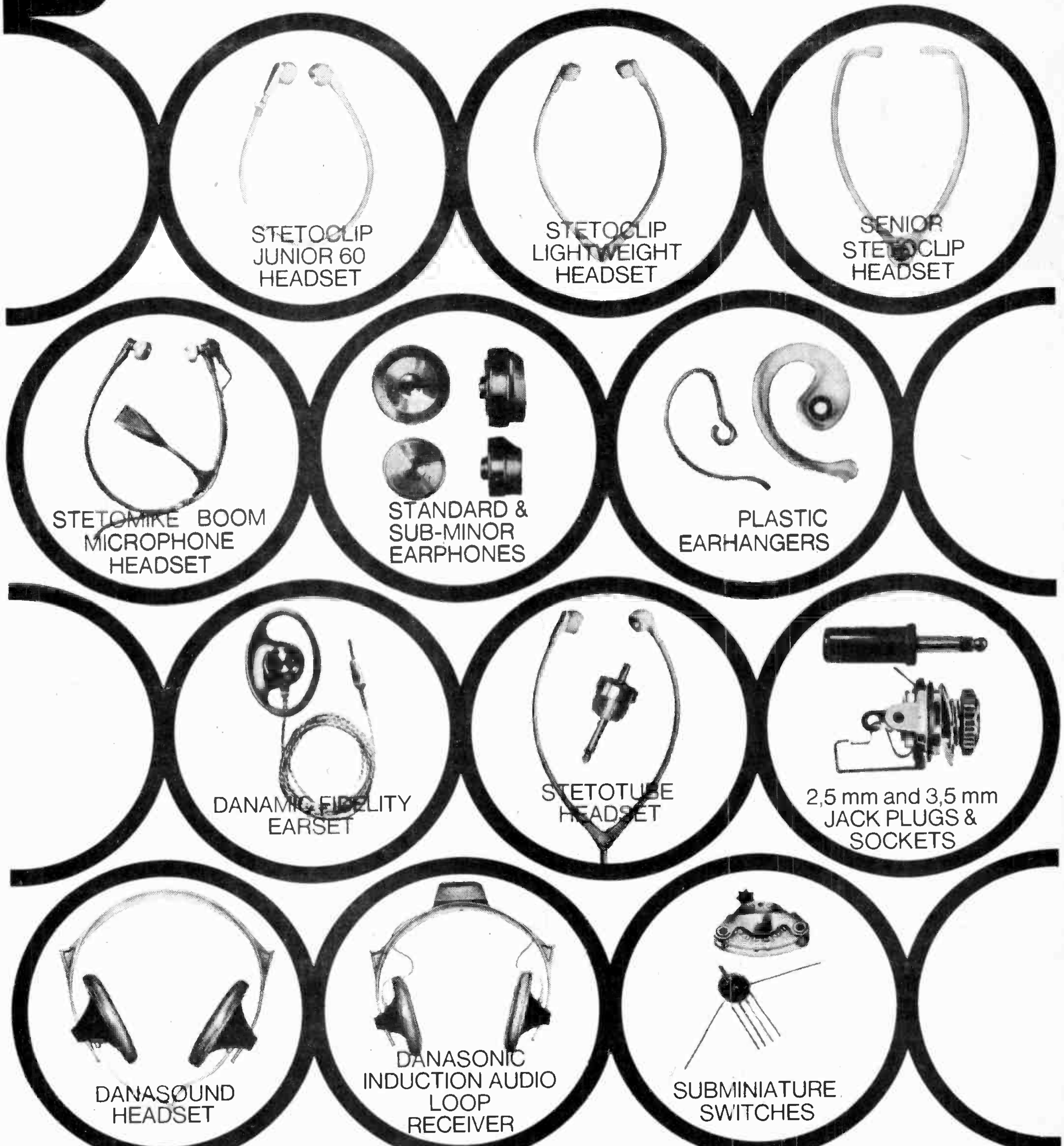

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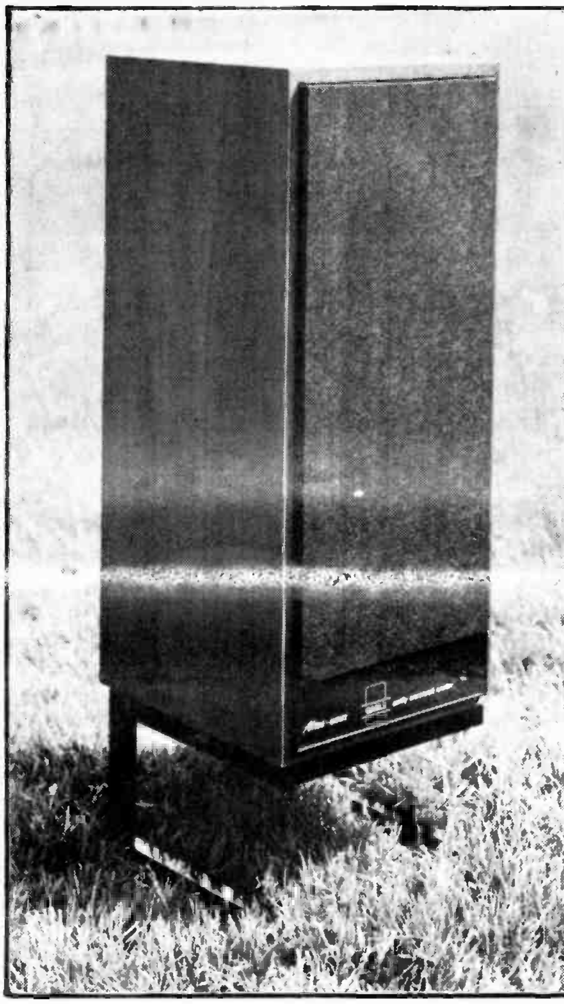

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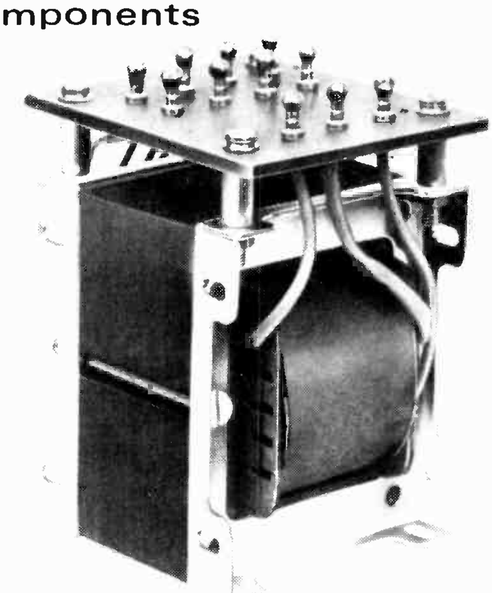

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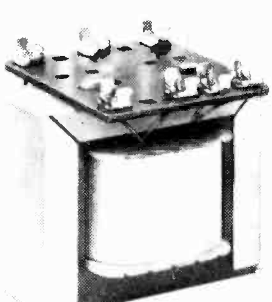

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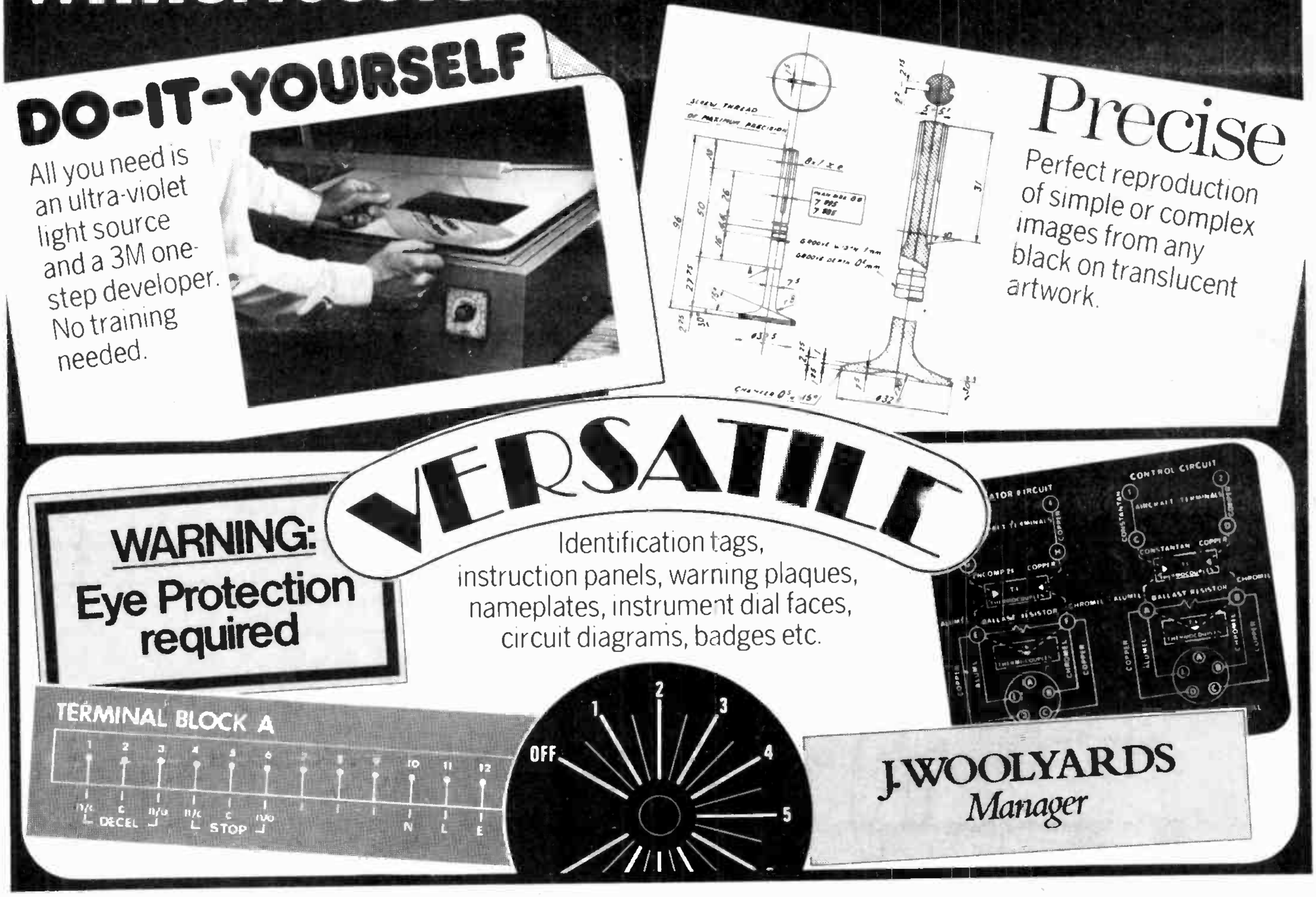

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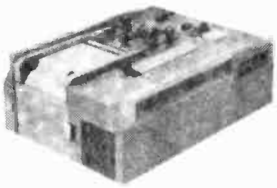
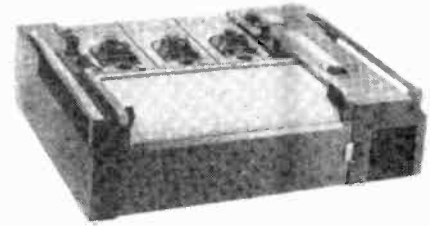


Type H3020-1
Single pen

Type H3020-3
Three-pen



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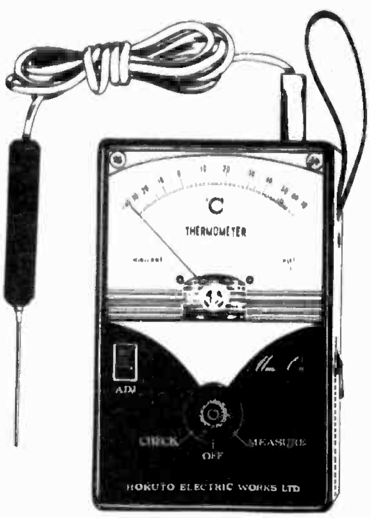

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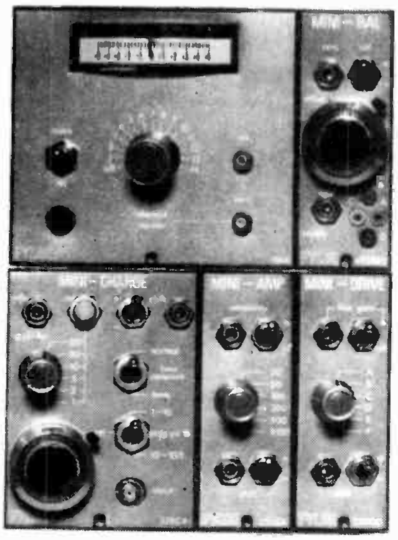

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NV7308	5	180	0.05	2.5	2.5
NV7312	12	5	1.00	005	.024
NV7314	12	2x 5	1.00	005	.024
NV7317	12	6	1.00	.009	021
NV7319	12	2x 6	1.00	009	.023
NV7323	12	2x12	0.50	014	.011
NV7328	12	2x15	0.50	019	.011
NV7336	12	24	0.5	07	09
NV7342	24	5	1.00	004	.024
NV7344	24	2x 5	1.00	.004	024
NV7349	24	2x 6	1.00	008	023
NV7353	24	2x12	0.50	010	012
NV7357	24	15	1.00	024	.021
NV7358	24	2x15	0.50	015	.012
*NV7366	24	24	0.5	07	09
NV7368	24	50	0.25	.3	2
NV7372	50	5	1.00	002	.024
NV7383	50	2x12	0.50	.007	.011
NV7388	50	2x15	0.50	.010	.012
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PU02	5	1.0	770	0.5
PU03	15.0.15	0.10	37	0.1
PU04	15.0.15	0.20	84	0.1
PU05	12.0.12	0.12	45	0.1
PU06	12.0.12	0.24	120	0.2
PU11	18.0.18	0.15	50	0.1
PU10	15	0.10	37	0.1
PU12	12	0.10	45	0.1
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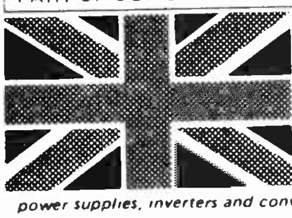

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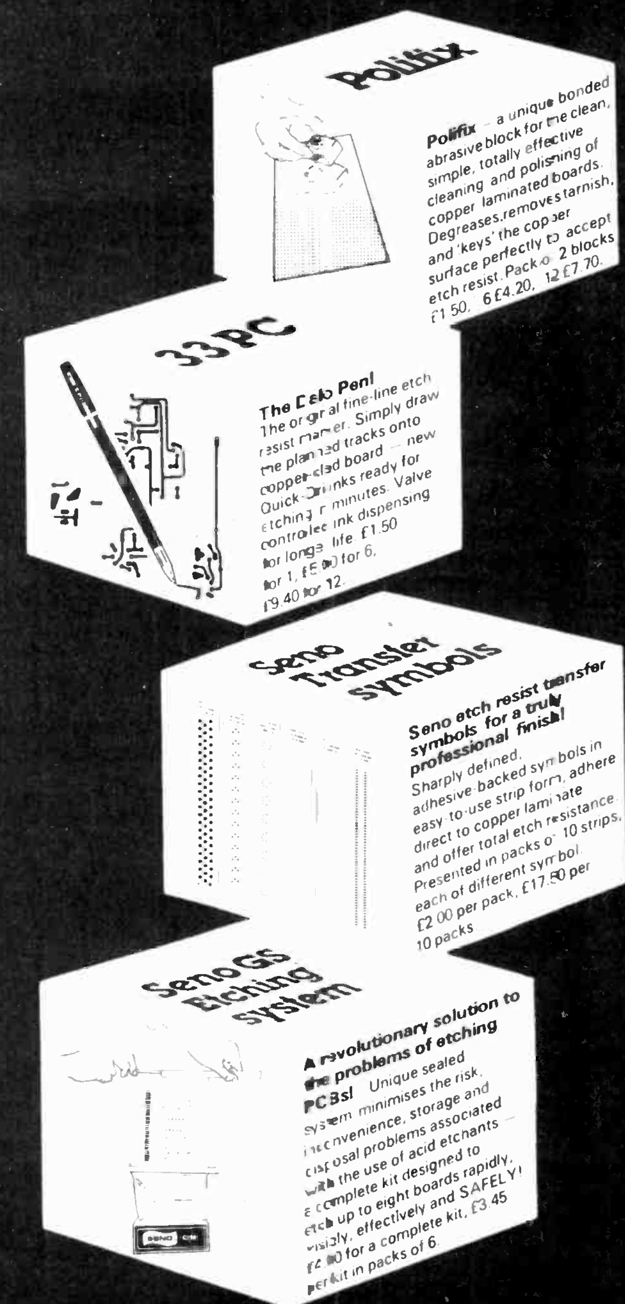

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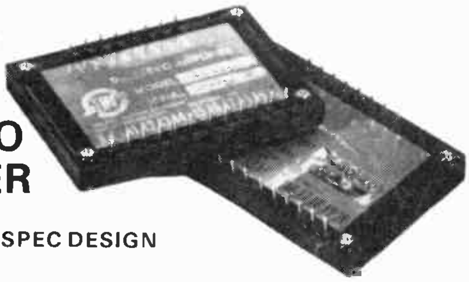

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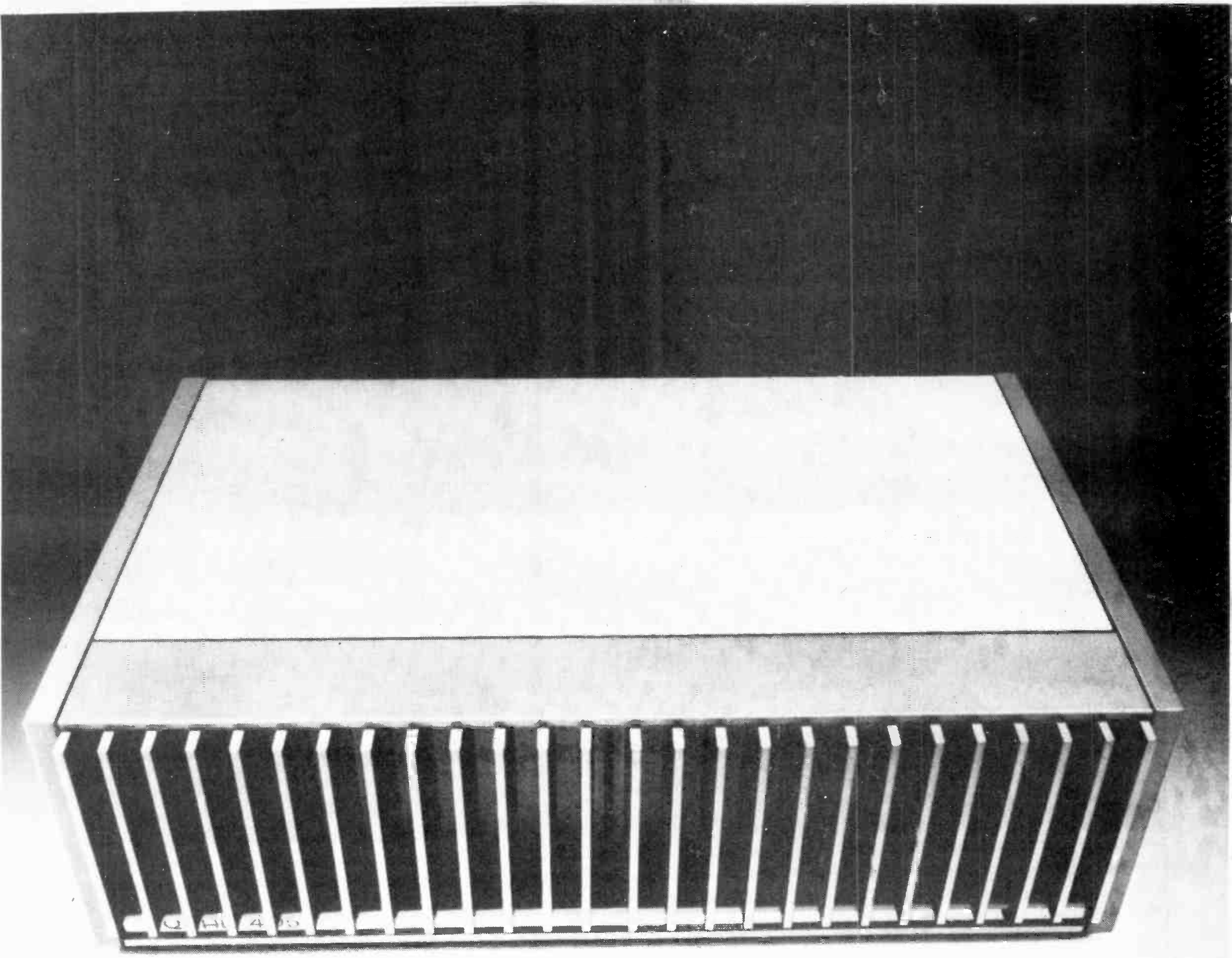

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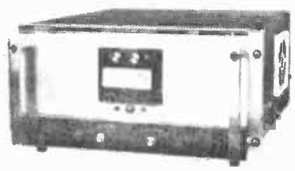
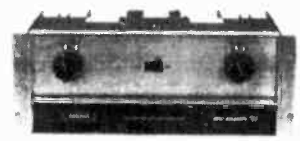


	M600	DC 300A	D150A
RMS power out	750 watts into 8 ohms 1,350 watts into 4 ohms	500 watts rms into 2.5 ohms (1 chan)	200 watts into 2.5 ohms (1 chan)
Power bandwidth	DC to 20 kHz + 1 db — 0 db	DC-20kHz + 1 db — 0 db	DC-20 kHz + 1 db, — 0 db
Phase response	+ 0' — 15' DC — 20 kHz	+0, — 15' DC to 20kHz	+ 0', — 15' DC to 20 kHz
Slew rate	16 V/μsecond	8 volts per microsecond	6 volts per microsecond
Hum & noise	120 db below 600 Watts	At least 110db below 150 watts	At least 1'5 db below 90 watts
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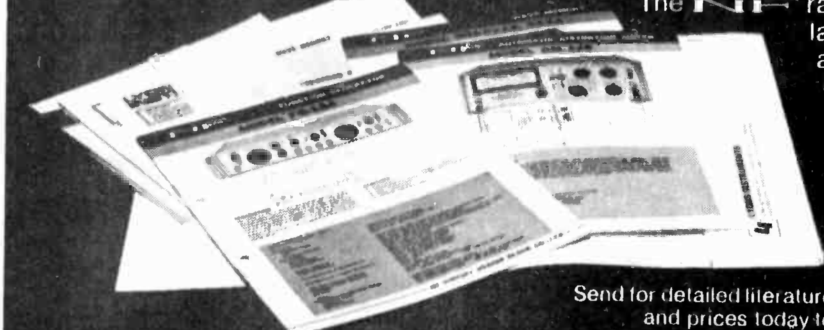

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Result? The customer is reassured, confident he is getting value for money. So you sell more, more easily.

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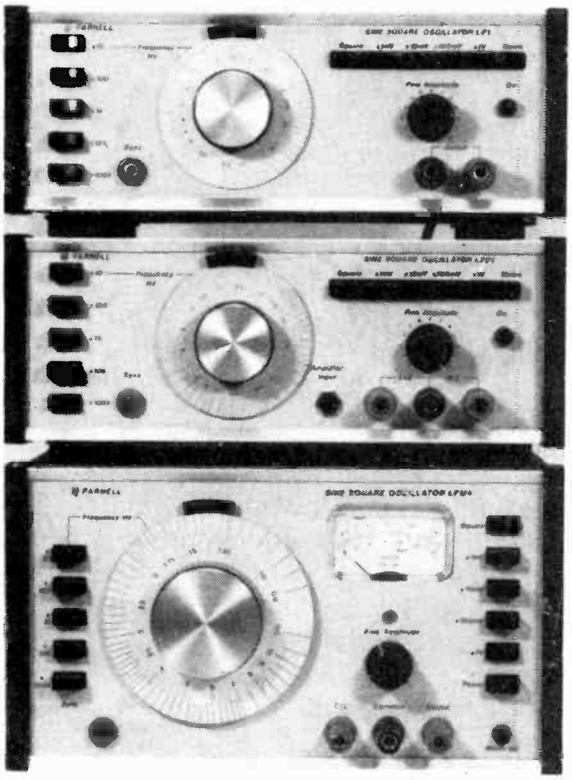

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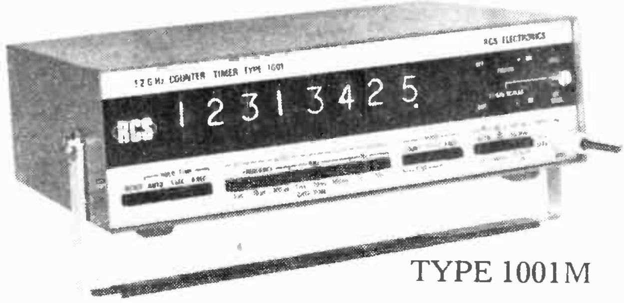

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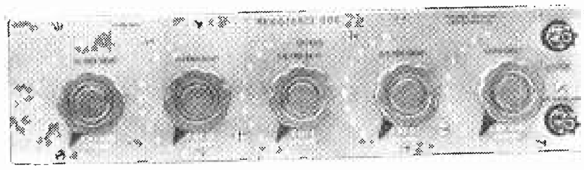

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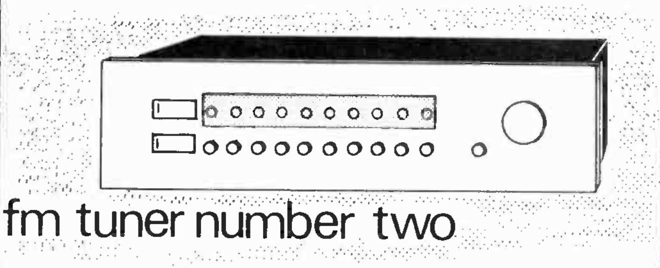

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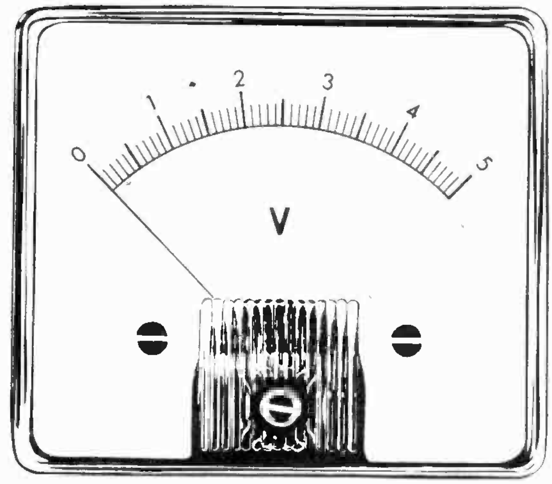

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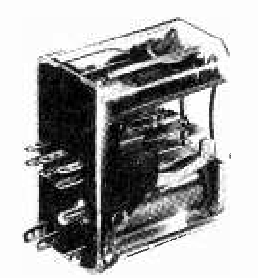

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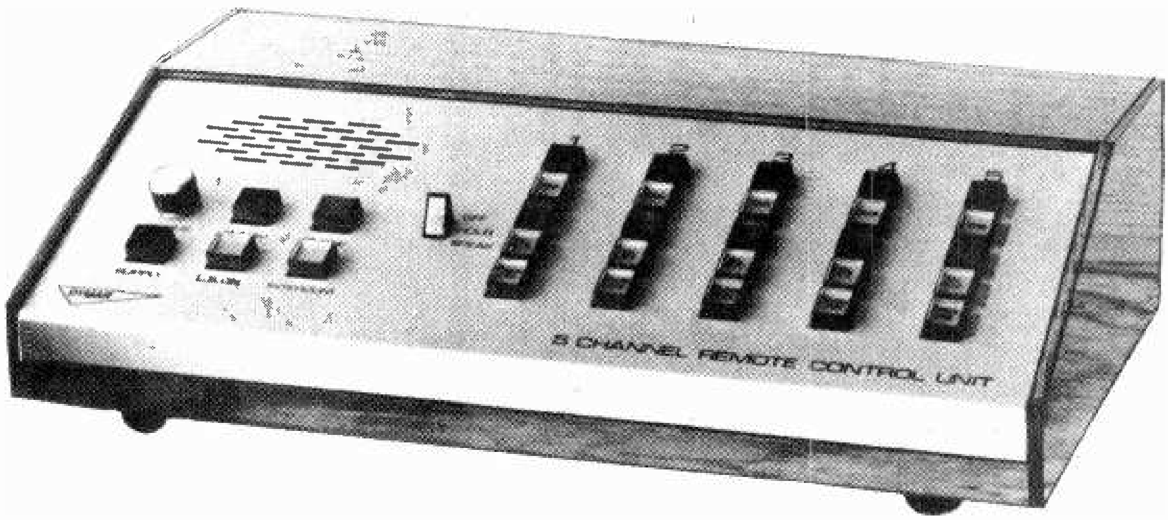

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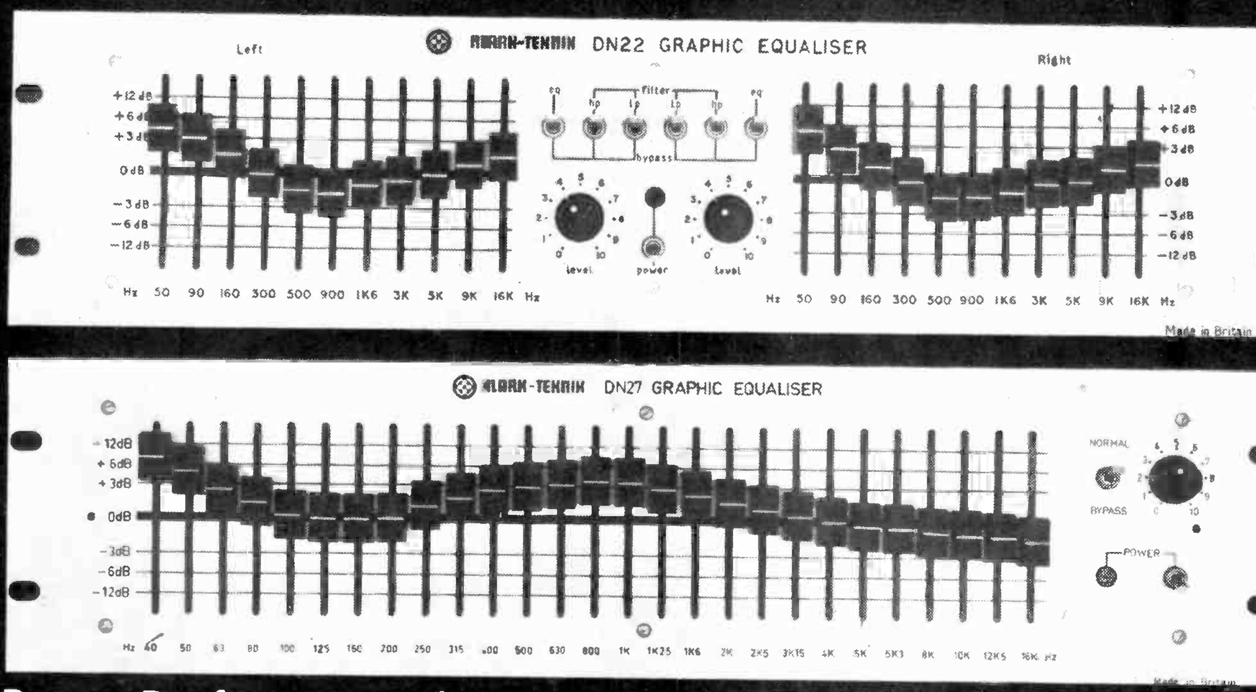

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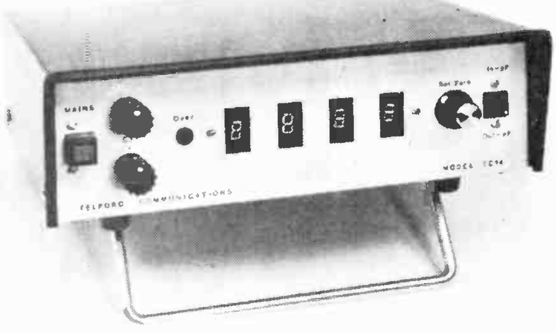

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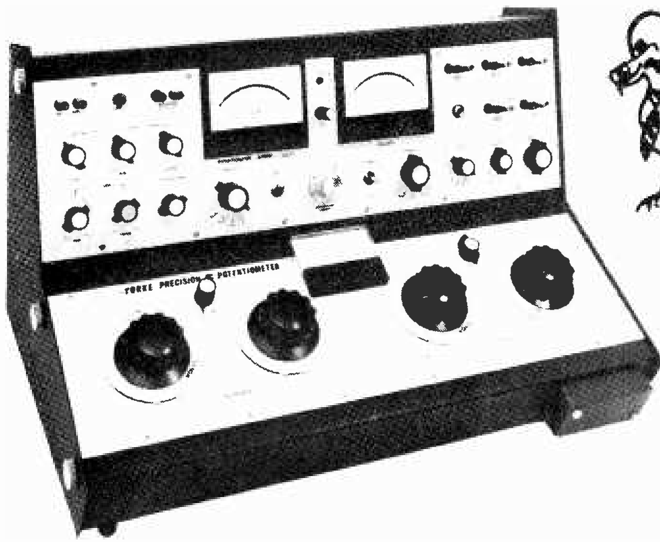

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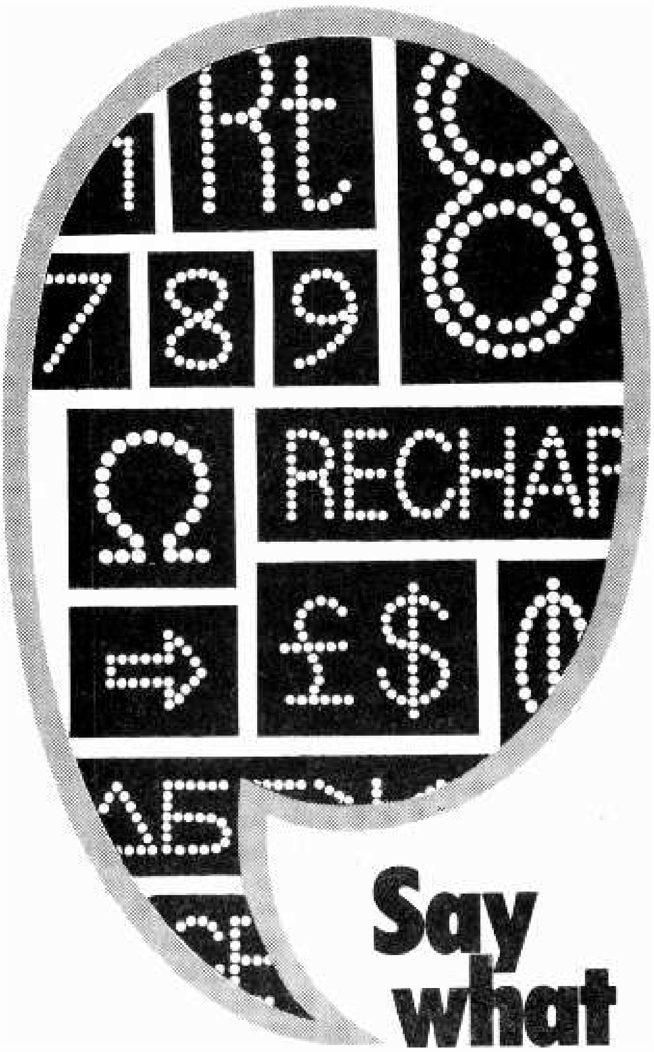

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A common weakness of the present-day popular transistor amplifier is its inability to maintain its rated output voltage into loads much below 8 ohms and supply current to a reactive load. Loudspeakers present a complex load to an amplifier and some nominal 8 ohm systems have an impedance of less than 4 ohms at some frequencies together with a stressing phase characteristic. This combination produces listening fatigue and a sense of unease, due to transients produced by the switching operation of the protection circuits, and the crossover switching of the quasi-complementary output stages when driving practical dynamic loudspeakers near the rated level. Published tests have shown that some transistor power amplifiers rated at 100 watts output cannot provide as high an ***effective*** sound pressure level as a good valve amplifier rated as 25 watts output.

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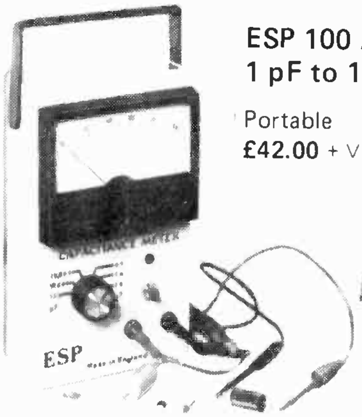

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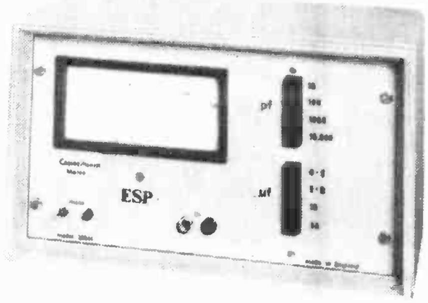

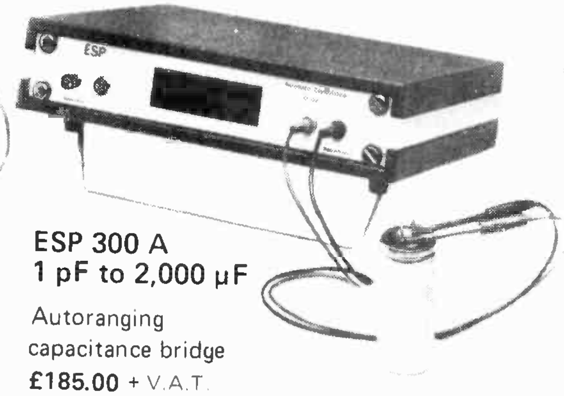

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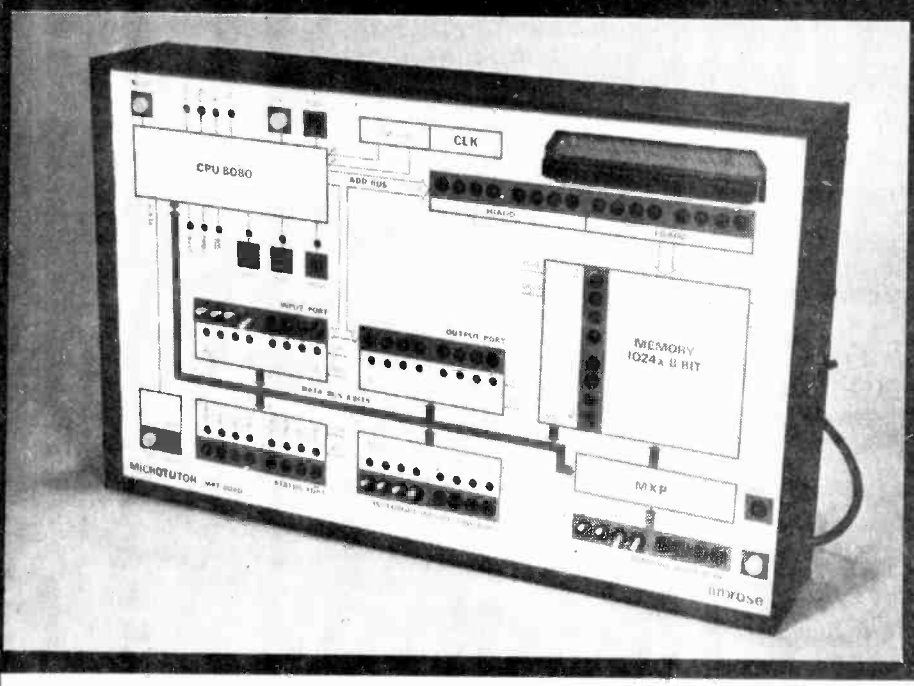

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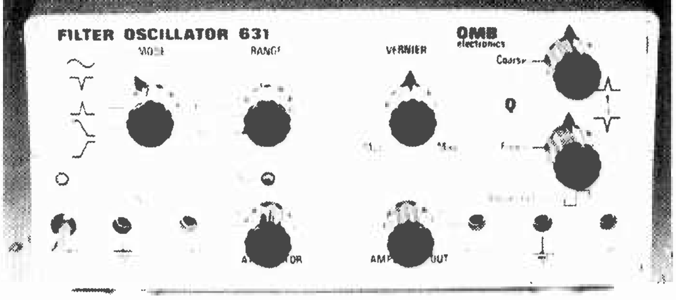

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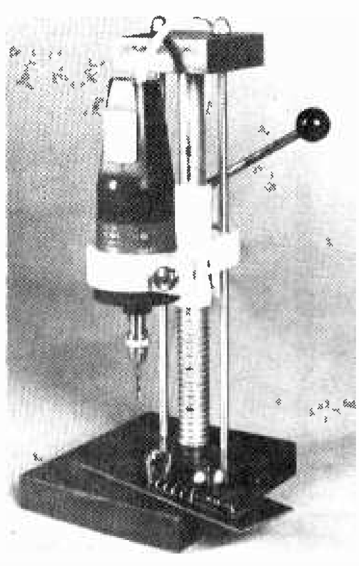

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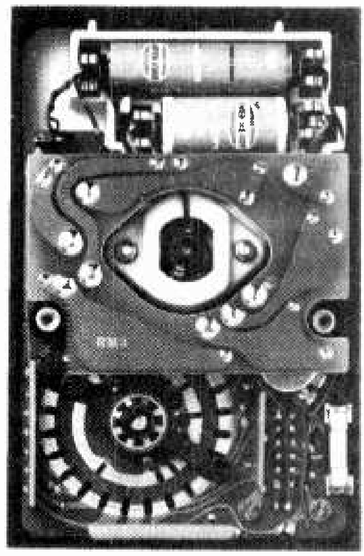

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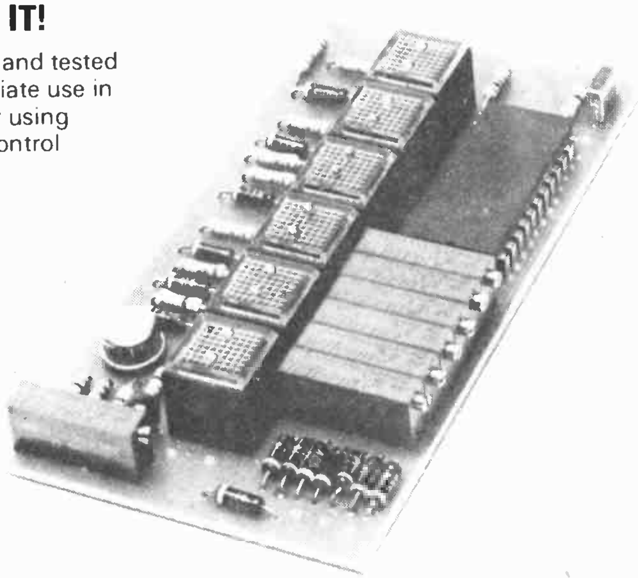

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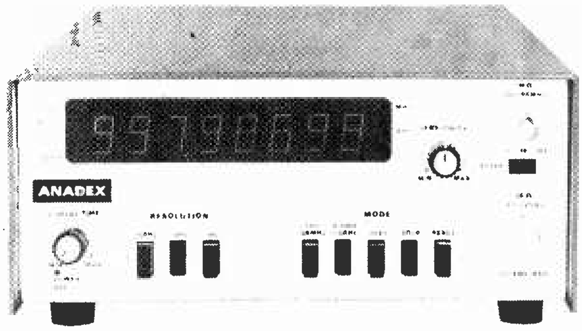

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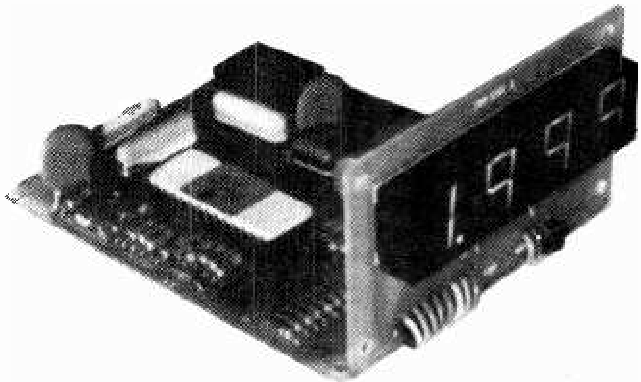

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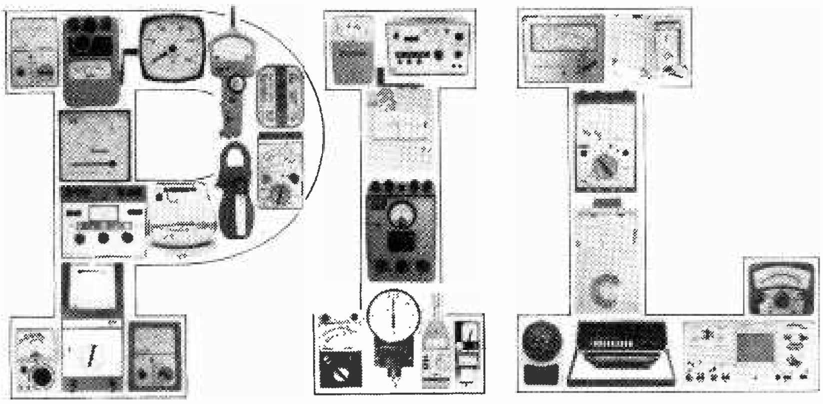

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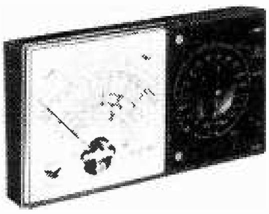

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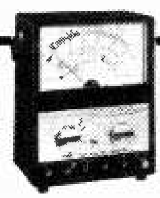

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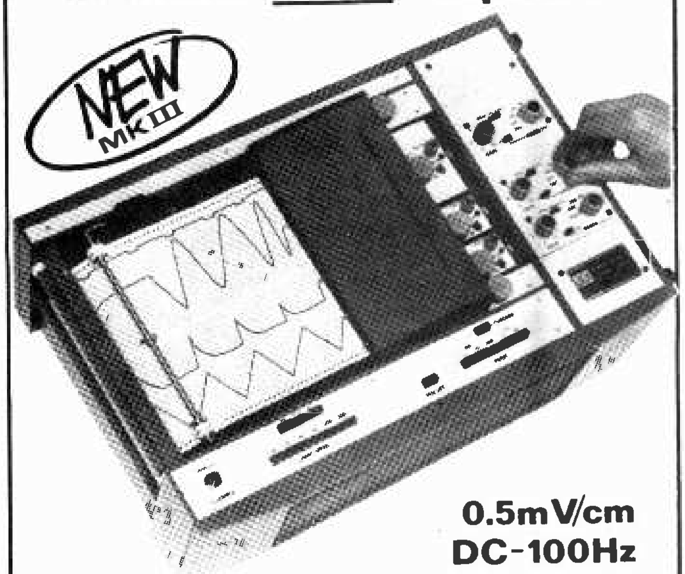

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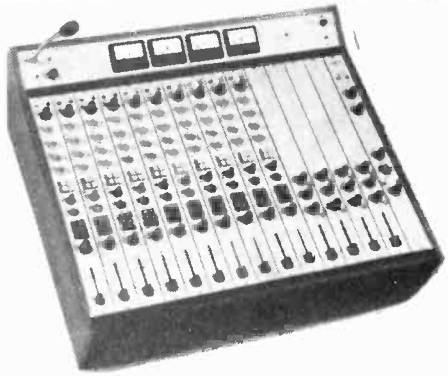

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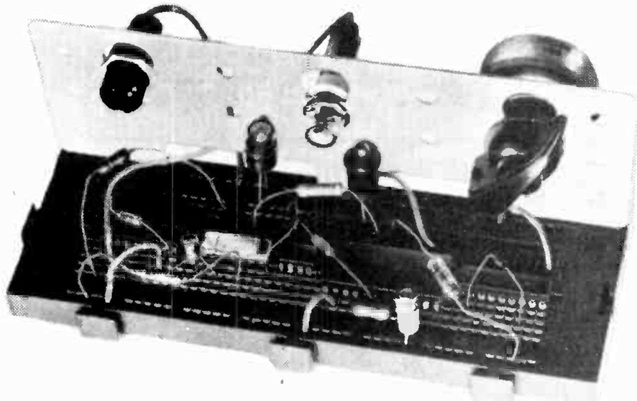

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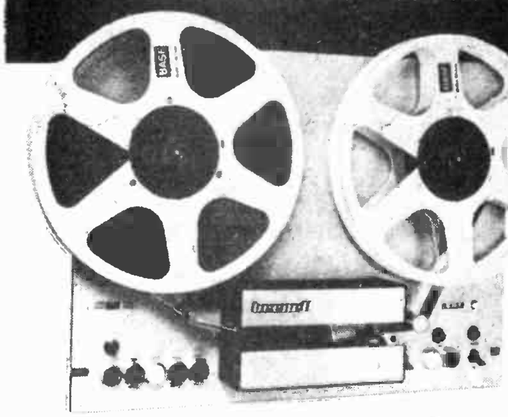

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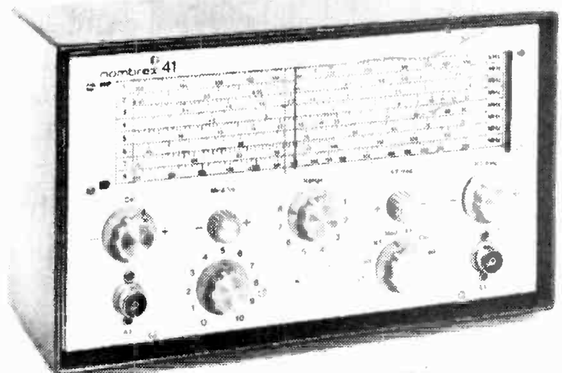

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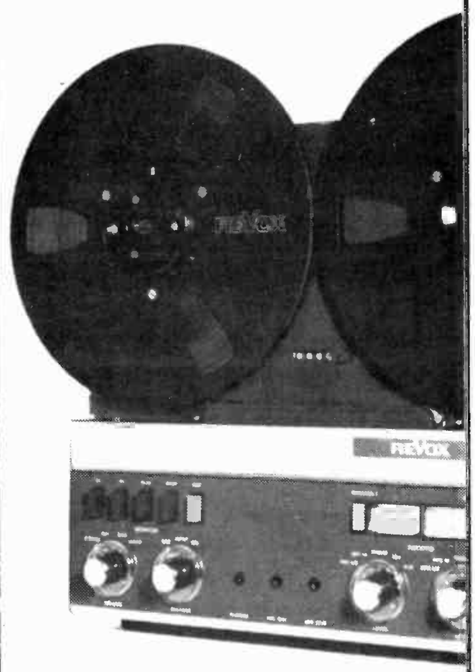

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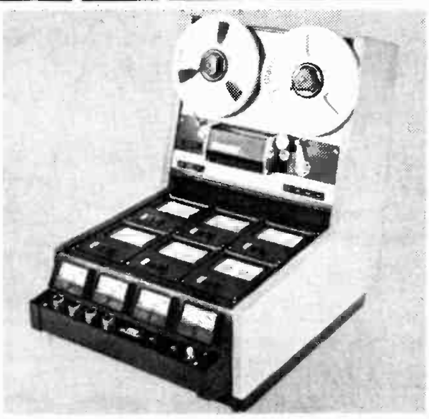

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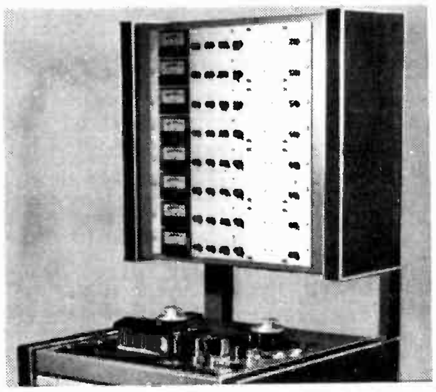

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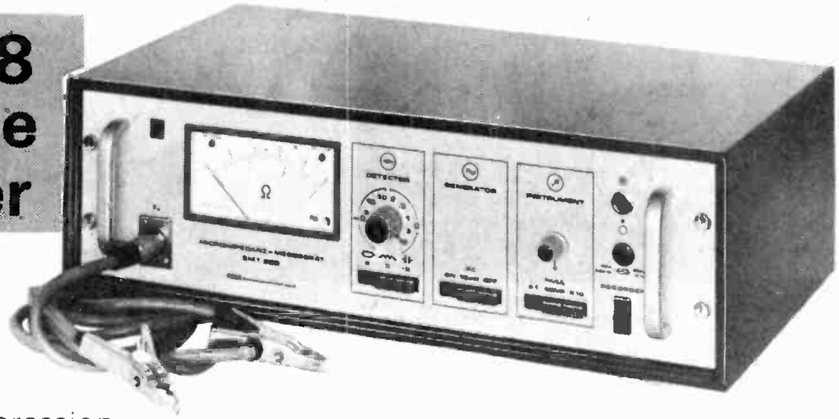

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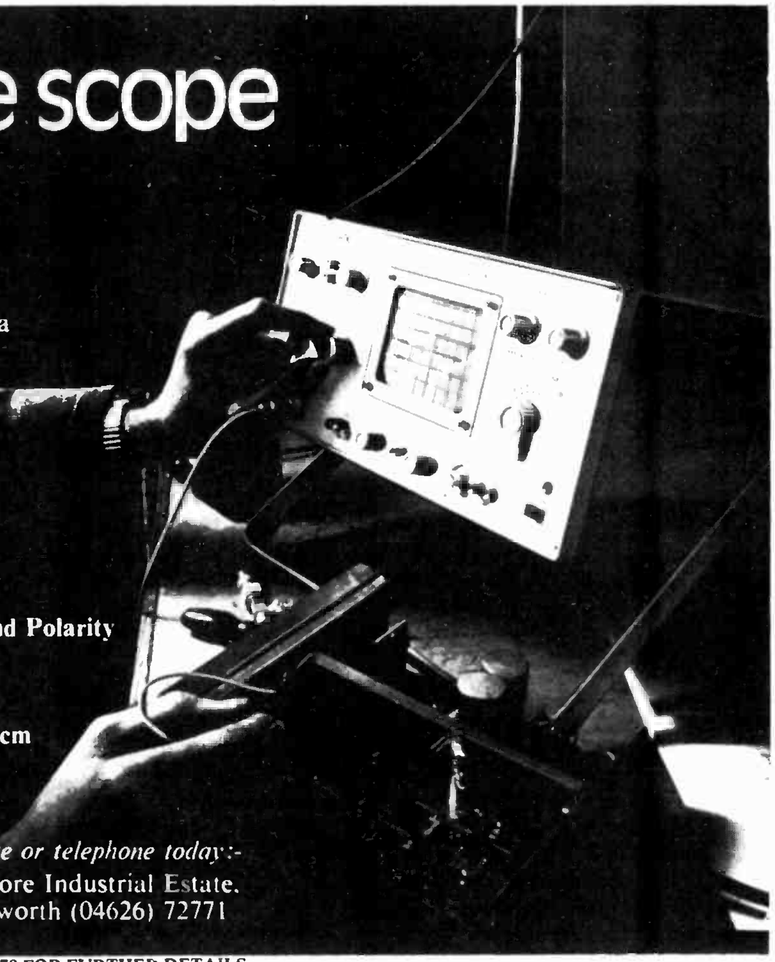

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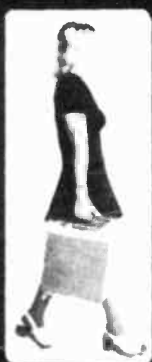

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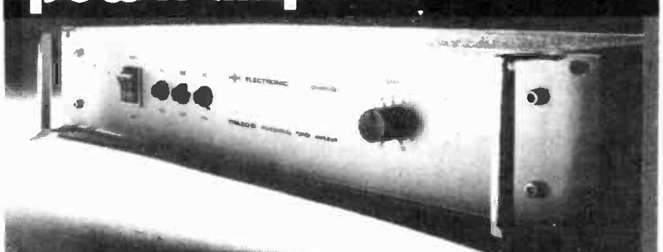

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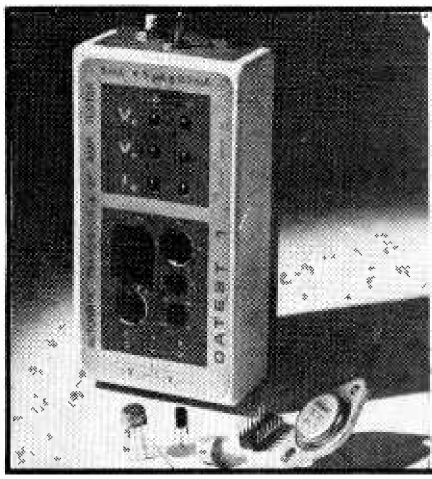

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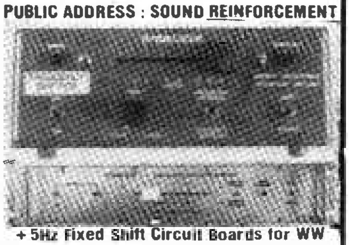

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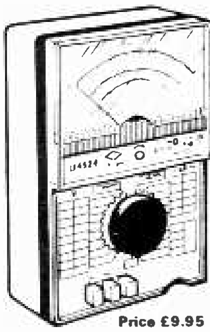

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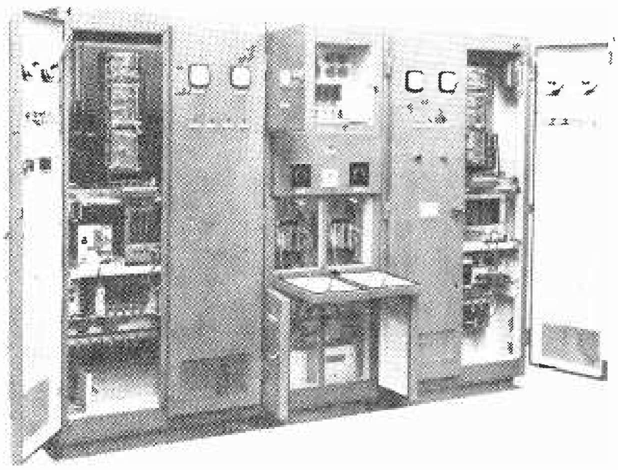

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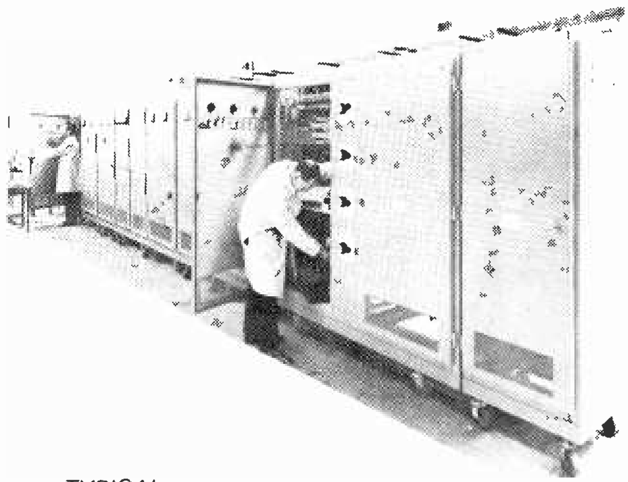

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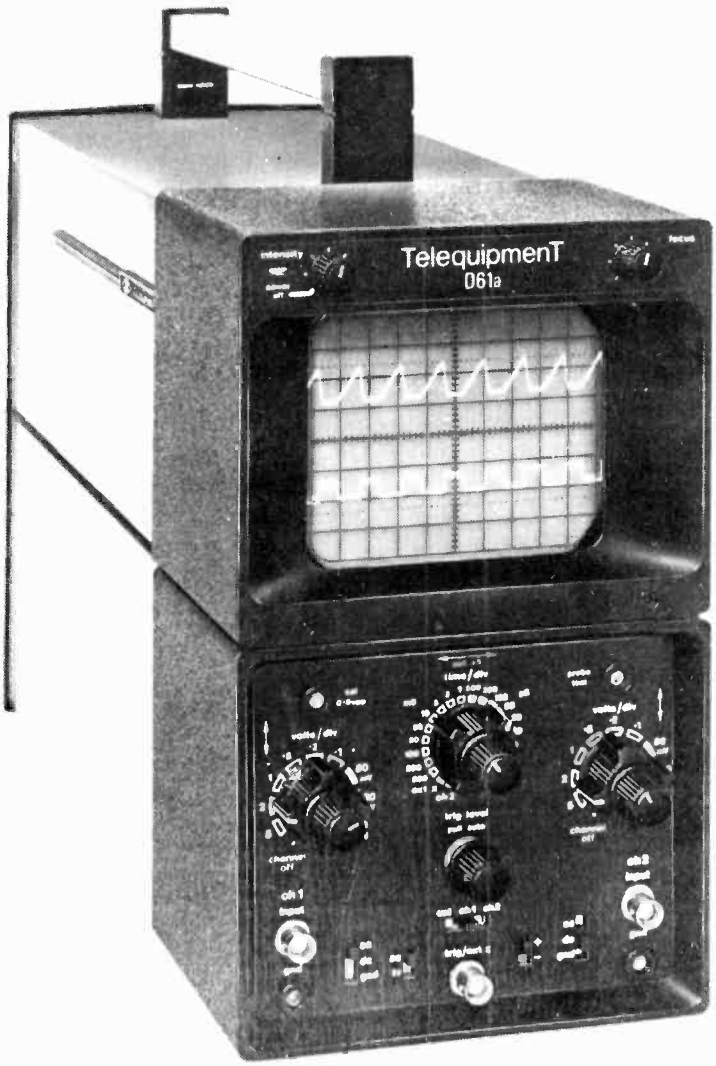

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SEPTEMBER 1976 Vol 82 No 1489

Contents

Front cover shows liquid crystal molecular textures photographed by John Varney, Paisley College of Technology, in polarized light with analyzer and polarizer crossed.

IN OUR NEXT ISSUE

Digital wristwatch. Constructional design for low cost watch using liquid crystal display and only one integrated circuit and one p.c. board.

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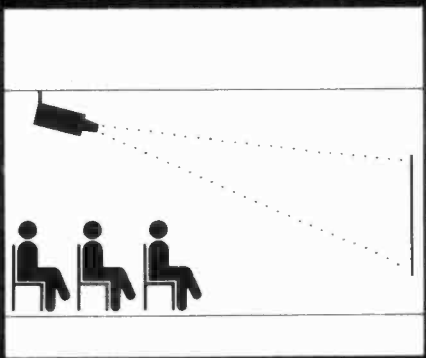

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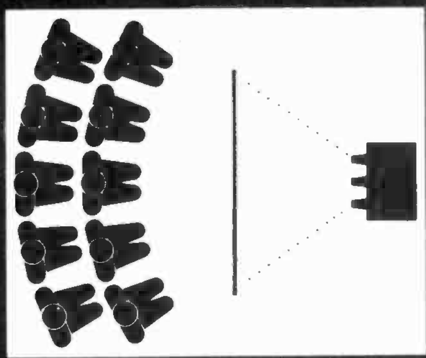

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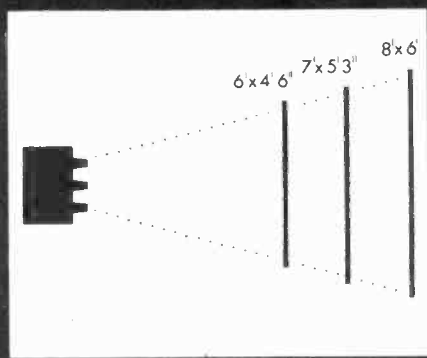

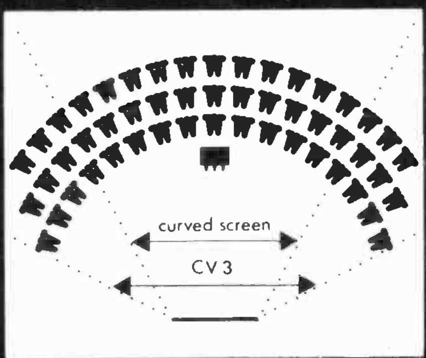

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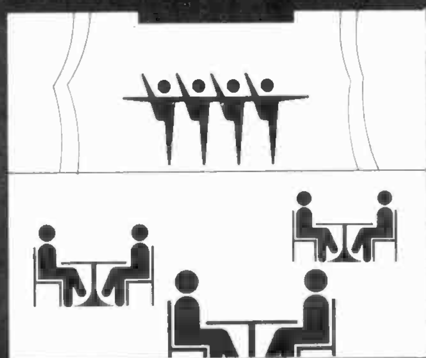

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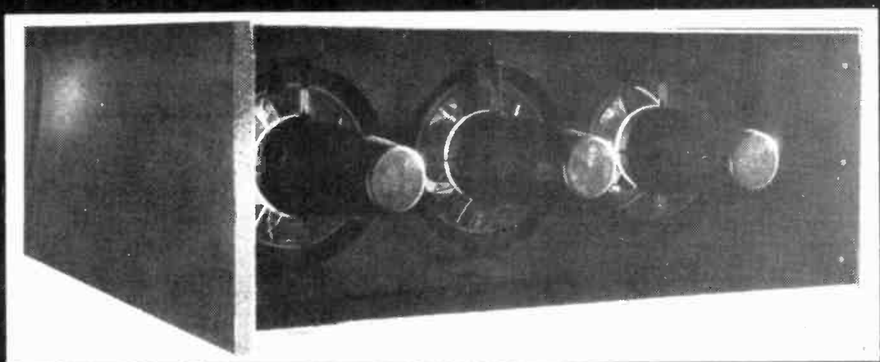

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Man and machine

According to Alan Godfrey, general manager of Plessey Resistors, the British components industry must adopt more automation, to achieve economies of scale, if it is to survive against foreign competition. His own firm provides a good example: an automated production system which turns out potentiometers for consumer electronics at a rate of 1000 per hour, to sell at approximately 8p per unit. Apparently production costs have been halved in relation to traditional manual assembly methods. This is good news. But what does automation mean to the production workers themselves? How does it affect the attempts to increase "job satisfaction" that are being made in the more enlightened parts of industry nowadays?

In the first place automation means fewer workers. Those that remain are enmeshed even more tightly in the process of mechanization that has been going on since the Industrial Revolution. The alienation of people from their work first noted by Karl Marx in the 19th century was the result of the division of labour. Each person performed a repetitive, highly specialized operation and became isolated from the final product and from human contact with the customer. Later, the rate at which he performed his work was paced by machines — conveyor belts and the like. The relationship between the person and the machine was such that he saw himself as part of the machine, as a thing rather than a human being. Inevitably the psychological effects on the worker were that he felt his job to be meaningless, trivial and monotonous; it required no skill or responsibility. And we all know the results: absenteeism, strikes and general demoralisation.

Attempts to increase job satisfaction have concentrated on making the worker more involved with and responsible for the final product. In some electronics factories, such as at Bang & Olufsen's television set plant at Struer, Denmark, small autonomous groups of people are made responsible for producing particular modules and are identified with them by means of a marking system. The members of a group sit close together, to aid communication about faults to be rectified and so on. Then each B & O television set is assembled complete from the modules by a single worker. This is certainly getting back towards the ideal of pride in individual craftmanship, but the method applies essentially to the assembly of electronic equipment, not to the manufacture of components.

With automatic production machinery, at least the worker has the opportunity to become more of a supervisor, to be challenged by the unexpected rather than bear the misery of the totally predictable. A small reward, but perhaps the best that can be expected until man is taken out of the machine completely, in the computer controlled factories of the future.

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Citizens' Band in America

Growth of the newest and potentially most democratic development in radio communications so far

by W. R. Stone and Harry G. Samuels *E. F. Johnson Company, Waseca, Minnesota*

In early March as I (WRS) was driving down the road in the flat land of north-central Kansas, I was looking forward to a visit with my friend, George Stein. George owns a farmstead of about 1500 acres in Smith Center, located in north-central Kansas. It was a warm sunny day when I started out, and the frozen dirt road in the country soon turned into a slippery quagmire. Then, as I was rounding a corner near my destination, the heavily loaded station wagon suddenly slipped off the road into a ditch, and was irrevocably stuck.

Two years ago I would have struck out through the mud to the nearest farmhouse. But today I reached for my Citizens' Band radio microphone.

"Breaker 11 for a Smith Center base station."

"You got one buddy, come on."

"This is the Jayhawker, KHT0538. I've got a four-wheeler stuck up to the axle in this Kansas mud, and I need help."

"What's your 10-20, Jayhawker?"

"Just north of the cemetery and two miles west. Do you know George Stein?"

"10-4, I sure do."

"Since he's expecting me, will you give him a jingle and tell him my location. Also tell him to bring a four-wheel drive to drag this wagon out of the mud."

"10-4 Jayhawker. You got the Inkblot here. I'm glad to be of help."

The preceding CB radio jargon could be translated into an approximation of the Queen's English as follows:

"Calling for a Smith Center CB radio base station monitoring channel 11."

"I hear you friend, go ahead with your message."

"This is the Jayhawker (CB radio

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nickname), KHT0538 (CB radio call sign issued by the Federal Communications Commission). I've got a four-wheeler (a passenger vehicle) stuck up to the axle in this Kansas mud and I need help."

"What's your 10-20 (designated as location using the CB 10 code) Jayhawker?"

"Just north of the cemetery and two miles west. Do you know George Stein?"

"10-4 (yes), I sure do."

"Since he's expecting me, will you give him a jingle (call him on the telephone) and tell him my location. Also tell him to bring a four-wheel drive to drag this wagon out of the mud."

"10-4 (I will honour your request) Jayhawker. You got the Inkblot (CB radio nickname) here. I'm glad to be of help."

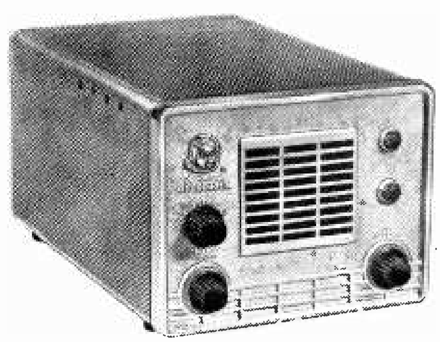
Within fifteen minutes, help arrived and the four-wheel drive truck quickly jerked the station wagon out of the mud and set it on the solid road.

In that particular part of the United States, the population is about six and one-half people per square mile, and this makes Citizens' Band radio communication especially valuable. Without a doubt, CB radio is an electronic marvel for the American consumer, and it's entertaining as well as useful. With a variety of English accents ranging from the Texas drawl to the Maine and Vermont twang, it's entertaining to chat with the truckers, the drivers of the big 18-wheelers operating coast-to-coast, to Canada and Mexico. It is also entertaining and informative to exchange the latest information concerning good fishing lakes or the facilities of a nearby campground with passing recreational vehicles. When searching for a particular spot, a quick request for information will bring an equally quick answer from someone knowledgeable about streets, business and industry locations. In most of the cities across America, there is a vast number of CB radio operators ready to provide information to each trucker (lorry driver) or traveller who is seeking a good restaurant, a reasonable place to sleep for the night, or the location of a particular facility.

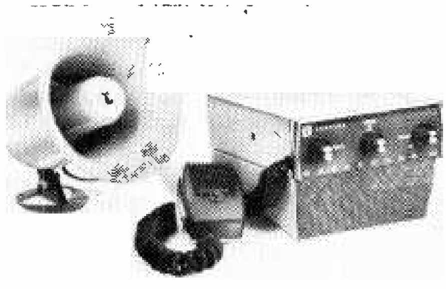
A prime example of CB's value is the Midwest blizzard in February of 1975, still described as the blizzard of the century. During this potentially disastrous period, CB radio played an important role in communicating road conditions and latest advice from the state highway patrol to the travellers and truckers.

But CB radio has also proved attractive to vandals and thieves. The Dallas, Texas, Police Department recently estimated that more than 10,000 CB radios are reported stolen each month, more than half as many again as the number last year.

Just how important is this social phenomenon? What has it cost us and where is it likely to lead? There will soon be as many sociological theories explaining why people buy CB radios as

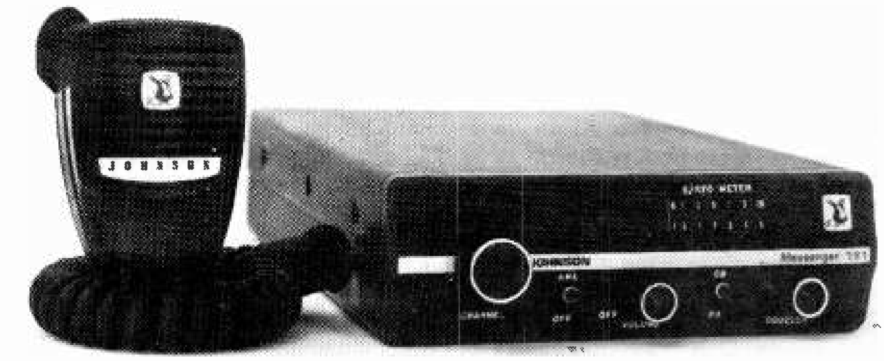


The 1958 Johnson Viking Messenger, a five channel valve CB radio transceiver.



The Johnson Messenger III, shown with power supply and external speaker.

Johnson Messenger 191 23 channel transceiver.



there are sociologists and, generally speaking, they can be summed up by saying that man desires to communicate with man, especially if he can do so while still retaining an element of privacy. Hence the handle or nickname which is his identity when using CB radio. He reveals some of himself in his choice of handle and in the content of his conversation with total strangers, but he retains a certain private personal image of himself.

From a technical perspective, CB could lead to a much more sophisticated nationwide communications network. Since the giants of the communications industry such as American Telephone and Telegraph, General Telephone and Electronics, and Motorola have the capability of introducing state-of-the-art CB transceivers, a major radio network of sophisticated equipment could overlay the American highway system. Such a radio network is possible with mobile radio transceivers operating full duplex and using digital control as they move between different communication zones. The technology is available, but technological advances become a reality only with the allocation of economic resources. Although statistics show that a trucker is willing to pay between \$350 to \$400 for a sophisticated single-sideband CB radio transceiver with a range of 7 to 10 miles, will he be willing to pay \$800 to \$1,000 for a unit enabling him to communicate nationwide? Perhaps if the product employed frequency rather than amplitude modulation, operated at 220MHz where the effects of the sunspot cycle are not felt, then the value to the user would justify the price differential.

On the other hand, it's conceivable that, given the realities of our political system, the Federal Communications Commission could decide that the interest of the public is best served with a form of service other than personal mobile communications. Under those circumstances, probably only a small group of CB hobbyists would survive as users of the service. Making predictions on political economic matters is risky enough for the politician – more so for the businessman. Yet common sense (if it can be applied to politics) indicates that the wishes of so many consumers who have a direct interest in decisions from Washington can hardly be ignored by their elected representatives. When consumer desires and technological possibilities come together as they seem to do for CB radios, they can create an extremely bright future for an industry.

CB radio background

The original Citizens' Radio Service (Class A, B and C) was established in 1945, but owing to a lack of low cost equipment, only about 40,000 licences were granted up to 1958.

Then, Class D of the citizens' radio service (commonly referred to as Citizens' Band or CB radio) was established by the Federal Communications Commission (FCC) in 1958 to fill the communication needs of private citi-

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zens. As a result, any citizen of the United States over 18 years of age may hold a citizens' radio licence. (A four dollar licence fee along with a properly filled-out licence application form is all that is required — no test is necessary and the licence is good for five years.)

With the exception of setting aside channel 9 exclusively for emergency calls in 1970, the rules and regulations covering the Class D citizens' radio service remained relatively unchanged until September 1975. At that time, several significant changes included the following:

- Hobby restrictions were removed. (The only restricted traffic is profanity, playing music, transmissions pertaining to illegal activities, and selling merchandise. The discussion of equipment, radio checks and idle conversation is now permissible.)
- Omnidirectional antennas can be mounted 60 feet above ground on an antenna support. Originally, the tip of the antenna could not exceed 20 feet above the supporting structure. (Tripling the antenna height produces the same effect as multiplying the transmitter power by a factor of six.)
- Channel 11 was established as the national calling channel. (This allows an operator to make contact and then switch to an unused channel to complete the communication.)
- The silence period between station calls was changed from five minutes to one minute. (The maximum communication period of five minutes remains the same.)
- An operator is required only to identify his station by call sign and it is not necessary to use the call sign of the party contacted. ("Handles" or names can be used in addition to giving call signs.)
- The elimination of the distinction between intra and inter-station calling channels. (Now, any licensee can call any other licensee on any channel other than 9.)

"It took 16 years, 1958 to 1974, for us to get the first million licensees in Class D," said Richard Everett, assistant chief of the FCC's amateur and citizens' division. "Then it took eight months to get the second million, and three months to get the third."

1976: 2,000,000 (first two months only)
1975: 2,300,000
1974: 475,759
1973: 246,002
1972: 183,593
1971: 200,388
1970: 234,074

yearly totals*

* *Editor's note:* Reports from the Chicago Consumer Electronics Show indicate that sales of CB units are running at around half a million a month. It would perhaps be fair to assume that licence applications are running at a similar rate.

The Hy-Gain Hy-Range III transceiver.

Motorola's 2020 CB transceiver. The top of a range of four models, it has digital phase lock loop synthesiser, dual gate FET front end dimmable l.e.d. digital channel readout.

Undoubtedly, the reduced fee, coupled with increased enforcement efforts by the FCC on illegal operators, resulted in a surge of new applications during the early months of 1975. (The licence fee was reduced from $20 to $4, effective March 1, 1975.)

In January 1976, more than half a million licence applications were received by the FCC. Today, more than five million licensed operators (it is estimated that at least another million operators are operating without a licence) crowd the 23 channels allocated by the FCC.

With all the operators who own more than one unit, an estimated 13 to 15 million CB radios are in use. This explosive growth in CB radio is so great that the manufacturers are unable to meet the demand.

In April 1976, the FCC introduced a temporary permit at point of sale to alleviate the backlog of applications. These permits are good for 60 days. Yet the demand continues. It is estimated that half the trucks (lorries) in the United States are equipped with CB units, as well as 1 of every 7 recreational vehicles and 1 of 20 automobiles. Also, many thousands of homes are equipped with Citizens' Band radio to chat with family members, neighbours and highway traffic.

The beginning of the boom coincided with the petrol shortage of 1973-1974, when long-haul truck drivers bought units to keep each other informed of the whereabouts of gas supplies. Then when the highway speed limit was nationally cut to 55 miles per hour, CB radio was used to warn about speed traps manned by highway troopers.

During the truckers' strike against the high price (50c per US gallon) of diesel fuel and the lowered speed limit, truckers appeared on television and demonstrated how they used CB radios to communicate and organize their forces. For the first time in its history, the citizens' radio service received mass public exposure.

Although the long-haul trucking market (estimated to be 65% of CB sales) is nearly saturated, automobile and light truck drivers are only beginning to contribute to sales. The Electronics Industries Association predicts there will be more than 20 million CB radios in use in the United States by the end of the year. The FCC estimates that as many as six million licence applications may be processed in 1976 (nearly three times the number in 1975). This would bring the number of licensed stations to over nine million.

Frequency spectrum management

Class D citizens' band occupies the portion of the radio frequency spectrum between 26.96 and 27.26 MHz, which is divided into 23 channels. Transmitter output power is limited to 4 watts for amplitude-modulation and 12 watts peak envelope power for single-sideband transmission. Transmitted frequency must be within 0.005% of nominal channel frequency and modulation must not exceed 100 per cent.

With the recent explosion in CB radio interest, a critical problem for the FCC (besides dealing with the hundreds of thousands of licence applications) has been to find a way to relieve channel congestion. Several proposals at present being considered are listed as follows.

FCC docket 20120 proposes an expansion of the allocated channels from 23 to 70, with emphasis on s.s.b. and eventual elimination of amplitude-modulation. Single-sideband (s.s.b.) transceivers at present use 23 lower sideband channels and 23 upper sideband channels. Since most s.s.b. transceivers transmit standard amplitude-modulation as well, this makes a total of 69 channels on which to communicate.

However, s.s.b. does have two drawbacks compared with a.m. First, it contains more complex circuitry, which increases the cost. Secondly, s.s.b. requires the use of an added fine tuning control, commonly called a clarifier, which makes it slightly more difficult to operate.

Although an announcement of channel expansion was expected to coincide with the Personal Communications show of the Electronic Industries Association on March 30, 1976, a snag was encountered and the announcement has been delayed. Just two weeks

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before authorization of 50-channel usage FCC engineers discovered a serious technical problem. The proposed extra channels were to be added onto the present 23 channels in the 27 MHz range. However, the engineers discovered that strong CB stations transmitting on the proposed channels 1 to 10 and 41 to 50 produced intermodulation distortion. This occurs when two signals of different frequencies mix to create an interference signal. Charles Higginbotham, Chief of the FCC's safety and special services bureau, reports that FCC officials expect to find a solution in a few months.

FCC docket 19759 proposes the creation of a new CB radio service in the 220MHz f.m. region, designated as Class E. Owing to strong opposition from the armed forces (which uses this frequency band for radar installations) and the Amateur Radio Relay League (this proposed frequency range is currently shared by amateurs), no commission action is expected before 1977.

FCC docket 20351 proposes that all CB transmitters have a digitally coded identification system, designated as the automatic transmitter identification system (ATIS). ATIS could be designed so that encoded transmissions would only activate similarly equipped receivers. At the moment, it seems that this proposal will not be acted on for some time.

A major concern of the FCC is interference, whether both man-made or natural. Examples are noise from cars caused by high efficiency alternator diodes and electronic systems, noise caused by adjacent channel signals, and by solar storms. Sunspot cycles peak every 11 years. These peaks cause CB radio transmissions at 27MHz to "skip" thousands of miles with little attenuation. Many manufacturers believe that the resulting signal-to-noise degradation contributed to a decline in CB radio popularity during the last sunspot cycle peak in 1969. Transmissions in the 220MHz region proposed in docket 19759 would not be subject to "skip" as a result of solar storm activity.

Product technology

CB radio design has changed considerably since the valve transceiver was first introduced in 1958. An important step was taken when the E. F. Johnson Company introduced the first 5W solid state CB radio transceiver, the Messenger III, in early 1963. Since then, high-performance transistors, printed circuits, integrated circuits and mass production techniques have become commonplace in the CB radio industry.

Early CB radios used a separate receive and transmit crystal for each of the 23 allocated channels. Later, 14 crystal frequency synthesizer circuitry, with six in a common bank and four each for receive and transmit, was used to generate the 23 channel frequencies. Today, with the acute shortage of the necessary crystals and the proposed increase in the number of allocated channels, digital frequency synthesizer circuitry using phase locked-loop techniques appears to be the answer. This scheme uses only one to three crystals and has an added advantage in not requiring additional crystals to generate 50 to 70 channel frequencies; the 14 crystal heterodyne frequency synthesizer circuitry can generate 24 channels, but would require additional crystals for a 50 channel capability.

Since several manufacturers have been busy developing phase-locked-loop technology, a one-chip LSI with all necessary functions, such as channel programming, and a diode converter which directly drives a digital readout is now possible.

Single conversion was used on earlier receivers. Later, more expensive models began to use double conversion for improved image-frequency rejection. However, the trend is back to single-conversion with a higher i.f. which allows effective noise blanking. It is very difficult to achieve the required coincidence between noise pulses and series gate noise blanking pulse at the lower frequencies.

A US semiconductor manufacturer, Signetics, recently developed a monolithic i.c. for CB applications which included an r.f. amplifier with a.g.c., a balanced mixer, separate oscillator, and i.f. amplifier with a.g.c.

As CB radio moves into the largely untapped automobile market, more units will be designed for the dashboard. In fact, some manufacturers offer dashboard units which include a 23 channel transceiver, cassette stereo player and an a.m./f.m. broadcast receiver.

New channel selection techniques are also being explored. The standard 23 position rotary switch is presently used, but complete rotation is time consuming. A continuous automatic incrementing with channel selection memory is being evaluated. Another possibility is keyboard entry, similar to touchtone telephone keyboards. As a general rule, product technology in the next few years will depend on how the FCC decides to relieve channel crowding.

References

1. FCC Part 95 Citizens Radio Service Rules and Regulations (as amended 9-15-75).
2. CB Yearbook (1976) published annually by Davis Publications, Inc.

VINTAGE CRYSTAL SETS

Crystal sets, with their polished mahogany cases, brass terminals and general aura of the "hand-made" are very collectable pieces. The difficulty, of course, has been the identification of these old receivers, since references to them appeared in advertisements from long-defunct companies which are often not bound in volumes of old magazines. This 128-page book is intended, therefore, as an aid to collectors and contains lists of 400 tradenames, 600 companies and 200 receivers, with brief descriptions. One suspects that it will also be read by many people whose first contact with radio was in the twenties and who may even want to build a receiver to re-live the experience. If so, the circuit diagrams in the book will be of assistance, although the lack of selectivity will probably be disappointing. "Vintage Crystal Sets 1922-1927" by G. J. Bussey is on sale in bookshops at £2.50 or from General Sales Department, Room 11, Dorset House, Stamford Street, London SE1 9LU at £2.80, inc. postage and packing.

Books Received

Data books have published the second edition of **Opto Electronics.** Entries are listed in sections called emitters, sensors, photocouplers, and opto-isolators, displays and special devices. Supplementary sections deal with U.S. military specifications, schematic drawings, outline drawings, and manufacturers local offices. Other Data books in the series include linear integrated circuits and discontinued thyristors. London Information (Rowse Muir) Ltd, Index House, Ascot SL5 7EU.

Tab Books have recently published the following paperbacks; Built-It Book of Miniature Test and Measurement Instruments (No. 792), Mosfet Circuits Guidebook (No. 796), Microprocessor/microprogramming Handbook (No. 785), Digital/Logic Electronics Handbook (No. 774), Aviation Electronics Handbook (No. 631), Introduction to Medical Electronics (No. 830), Switching Regulators & Power Supplies (No. 828), and Modern Applications of Linear i.c.s (No. 708). Tab Books, Blue Ridge Summit, Pa.17214, U.S.A.

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News of the Month

New l.e.d. ten times better than any other, say authors

A paper published in the *IEEE Journal of Quantum Electronics* on June 6 describes an l.e.d. with a radiance of 1000W/cm^2, an order of magnitude higher than any previous l.e.d. According to the abstract, "the l.e.d. is an (AlGa) As double-heterojunction edge-emitting structure. This structure acts as a waveguide for the internally generated light, and with appropriate Al concentration difference at the heterojunctions ($\Delta x \approx 0.3$) and active region width ($\sim$50nm), the radiation pattern perpendicular to the junction can be less than 30° (FWHM). For fibre optic communications this l.e.d. is capable of coupling 850μW, at a coupling loss of only −10 dB into a 0.14 numerical aperture (NA), 90μm diameter low-loss fibre. The l.e.d. is capable of being directly modulated at 250MHz and has a spectral width of less than 30nm."

The paper was written by Michael Ettenberg, Henry Kressel, and James Wittke of RCA.

Components crisis?

The Massachusetts headquarters of the Sprague Electric Company has issued a newsletter warning that some components, particularly tantalum capacitors, are in increasingly short supply. The tantalum shortage will arise because demand in 1977 will be about a third above this year's level and over half as much again as the 1975 figure, and because supplies of tantalite ore will be restricted for reasons outside their control. Thailand supplies 28% of the world's tantalite ore, which is a by-product of tin mining, but world demand for tin has dropped and for the past four months the production of tin has declined. The supply of tantalite ore has also dropped. Zaire produces 24% of the world's tantalite ore, Canada 18%, Mozambique 12% and Malaysia 9%, the rest coming from other African and South American countries. "In a normal year, "says Sprague, "the free world uses two million pounds of pure tantalum powder. In 1975 utilization was down to about 1.1 million pounds . . ." a result, they say, of multiple ordering and the recession. The capacitor industry can supply the forseeable need this year, they say, but by early 1977 demand will rise and total needs during that year will exceed those of the previous peak year, 1974.

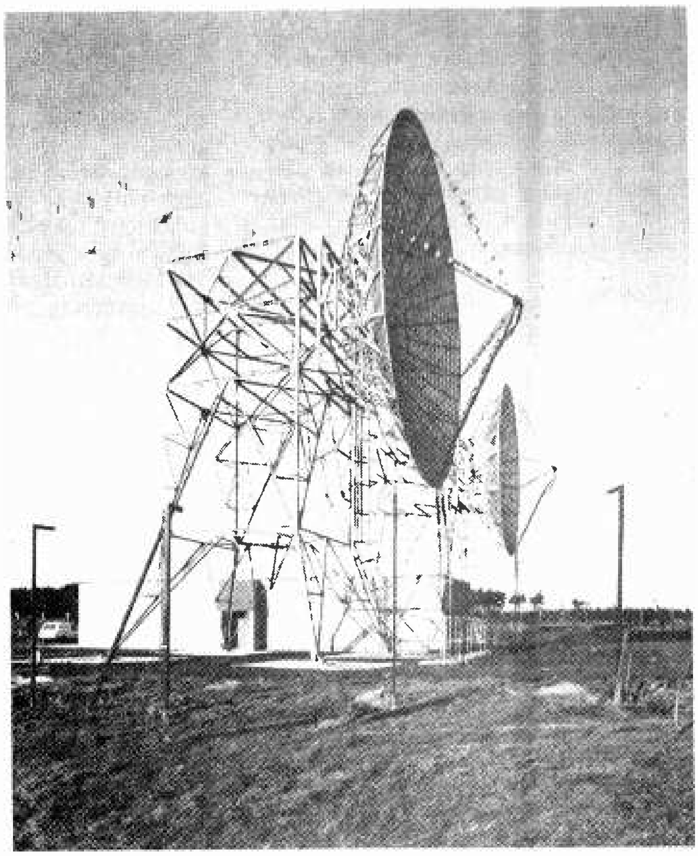
● "Later this year we face a shortage of some critical components," Mr Akiya Imura, managing director of National Panasonic (UK) said at a recent press launch. This was a sign, he said, that industry, and particularly the electronics industry, was recovering from the recession. The hi-fi market had remained at £45 million in the UK since 1974, and would probably be the same this year, he said. "That means the market has got a lot smaller. £45 million buys a lot less hi-fi than it did in 1974."

Norsat link opened

Since July 7, the Ekofisk oil field has been connected to voice, teletype and computer services in Norway via the Intelsat IV satellite; previously, the only communications were by single-sideband radio and helicopter mail services. According to Phillips petroleum, which is operating the field, this is the first time that satellite communication services have been available to offshore operations in the Norwegian sector. The satellite system is operated by the Norwegian government's Telecommunications Administration, from whom Phillips has leased five of the 130 available communications channels, one of them an emergency-only line. The ground station for the communications is at Eik, Norway, which is connected via leased lines with Phillips operations headquarters in Stavanger and their computer installation in Oslo, which will process daily production data.

The company's communications system will eventually cover more of the North Sea and petroleum installations. It says it expects to spend $1 million of its total communications investment of $16 million on the satellite system. It has already spent $12 million on communication links, all of which are private networks not connected with public 'phone systems in Britain or Norway. Work is expected to finish soon on the tropospheric-scatter radio links between Ekofisk, the pipeline terminals at Emden and Teesside, the four pipeline booster stations, and the Cod field, 50 miles to the north-east of Ekofisk. A station has been erected on Eston Nab, five miles from the Teesside terminal, where a 40 foot dish aerial transmits to Ekofisk in one hop. This, the first link, became operational two months ago. Three hops are needed between Ekofisk and Emden and Phillips says the link will be finished in October.

The signals reaching Eston Nab are in the 2,000 to 2,500 MHz range. They are re-transmitted in the 1,500 MHz range



Eston Nab tropospheric scatter station's two 40ft aerials linking the Teesside oil terminal with the Ekofisk field.

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to a microwave receiver at the Teesside terminal. Links between platforms are by line of sight microwave.

● Radio teleprinter links worth £100,000 are being used in the search for oil in the Celtic sea. The Post Office has provided extra equipment at its coast radio station near Ilfracombe, Devon, to provide these facilities for oil rigs and the first to use the service was a semi-submersible exploration rig which is drilling for Amoco about 40 miles south-west of Milford Haven. The rig has its own links to the base office in Pembroke Dock and a shared radio telephone service connects it with the public telephone network. The Post Office say up to 15 rigs will be able to have their own exclusive radio teleprinter links with the mainland.

The Miranda mobile microwave interception and analysis system. The signals intercepted are the pulsed radar control signals to foreign, possibly hostile guided missiles.

Tannoy leave West Norwood

As has been expected for some time, Tannoy is to close its West Norwood factory. Both it and the offices at Knight's Hill are on short term leases and will be shut by the end of the year. The Tannoy premises at Canterbury Grove, of which Tannoy own the freehold, will carry on some specialist manufacturing and administration. The main manufacturing plant will be in Harman's new Scottish factory, and the headquarters will be at High Wycombe.

Mr Norman Crocker, managing director, said that Tannoy had applied for permission to build a three-storey block in Canterbury Grove in 1963 but had been turned down, preventing any further expansion in West Norwood. In 1970 the company's fortunes turned down, he said, and by the time Harman took them over they were bankrupt and "could not have gone on another week".

"Since they took over," he told the South London Press, "we invested £50,000 between Scotland and here between 1974 and 1975. Between 1975 and 1976 we invested £180,000 and by the end of September next year we shall have invested £300,000."

A.m. stereo proposal

Leonard Kahn, president of Kahan Communications of New York, has filed a petition with the FCC to change the rules which prevent a.m. broadcasters from transmitting in stereo. Kahn has patented a system which he says took 16 years to develop and which is "completely compatible with standard a.m. broadcasting . . . and will allow radio listeners to enjoy stereophonic reception with little or no additional investment in receiving equipment." Two stations had used the system experimentally. Two conventional sets are used, Mr Kahn told *Wireless World*, one tuned above and the other below the nominal tuning point. Although dependent to some extent on the selectivity of the set, the slight off-tune caused little or no deterioration in the sound quality. Mr Kahn explained that the system he had devised using ordinary receivers was one of two systems, the other requiring a specially built set, but which gave better results, notably a 30dB stereo separation with single tuning. The stereo adapter could be installed in a conventional a.m. transmitter in a few hours.

Viewdata trial

The post Office says that more than 70 organisations are now taking part in the pilot trial of the Viewdata system which started at the beginning of the year. All four branches of the Post Office are taking part as well as television firms, news organisations, consumer groups, travel organisations and educational establishments. Post Office Telecommunications, as well as providing the technical requirements of the service, is also supplying telephone, telex and data transmission information.

The tv manufacturers, GEC, ITT, Mullard, Philips Electrical, Pye, Rank Radio International and Thorn, are participating to see if viewdata receiver terminals can be made relatively easily on existing production lines at reasonable cost. By the beginning of the year most of them were able to produce prototype decoders for both viewdata and teletext, much of the circuitry for which is common to both systems. The information providers also have to assess the costs of and the return on providing the service and whether or not it will be necessary to charge customers for it.

Although decoders are available, editing terminals are not, and information providers, who include the Financial Times, Reuter, Extel, British Publishing Corporation, the International Publishing Corporation, the Consumers' Association, the Department of Prices and Consumer Protection, the English Tourist Board, British Rail, London Transport, the Road Research Laboratory, the University Central Council for Admissions, the Open University, the Careers and Occupational Information Office, the Central Office of Information, the Central Statistical Office and Aslib, have to give the information to the Post Office who put it into the "data base" on their behalf. Towards the end of July there were still only two editing terminals, both in the possession of the Post Office, but the Post Office expected delivery of 40 before long. Editing terminals would be rented to users, who would then be able to insert their information without the intercession of the Post Office.

Only a few of the 70 organisations listed by the Post Office are now contributing to the service, the rest are

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preparing to do so. If the service starts, as it could do within three years, the Post Office says, subscribers will have access to a number of computer centres all over the country. For the pilot trial, all the Viewdata information is stored at the Post Office research centre near Ipswich.

Surround-sound broadcast

After Radio Clyde's experimental surround-sound broadcasts, believed to be the first live surround broadcasts in Europe, chief engineer John Lumsden told *Wireless World* that the mono compatibility had been "better than the compatibility with normal stereo broadcasts." The reasons for this remained unclear, he said, but his view had been endorsed by independent consultant Angus McKenzie, who had heard tapes of the broadcasts.

Clyde had broadcast two concerts on June 26 and July 2 from a series of promenade concerts given by the Scottish National Orchestra at the Kelvin Hall, Glasgow. Engineers used a cluster of four AKG 414 microphones whose signals went into an Alice mixer in the outside broadcast caravan, through a Post Office line to Clyde's main music studio control room to another Alice desk and thence to the transmitter. This arrangement was used, Lumsden said, because the OB van was stereo and they wanted to get the best listening environment they could, so it was best to monitor the encode and decode signal and the off-air signal at the studio. Commentary was from a lip microphone at Kelvin Hall via an auxiliary line.

The experiment differs from that carried out by Piccadilly radio in April in that Piccadilly had encoded all their output using the Sansui QS system, which was mostly from two-channel sources apart from some QS-encoded records. Clyde were providing live material from four microphones which were then matrixed down to two, again using the Sansui system.

ITV stereo experiment

On July 16 London Weekend and Capital Radio collaborated in the first "simulcast" on commercial television. LWT's pictures were matched by stereo sound broadcast by Capital. The programme, transmitted at 23.30h, featured Jethro Tull performing their latest album, "Too old to Rock 'n' Roll, too young to die." Although the BBC have broadcast many simultaneous television and stereo radio programmes, the difficulty for the commercial companies has always been that they are wholly independent of one another financially and organisationally, and the co-ordination of advertising slots has seemed the biggest stumbling block. In this case the co-ordination seems to have been taken over by Television International, Ltd who provided the technical facilities and co-ordinated the production of the final tape. According to TVI, a TVI OB unit with three LDK5 colour cameras and a hand-held camera recorded the "concert" in mono sound. Other microphone feeds were recorded separately on one-inch, eight-track tape. EBU time code was recorded synchronously on v.t.r. and audio tape, after which the videotape was edited. The master eight-track tapes were then mixed down to stereo and a separate eight-track master was used to synchronize sound and picture. LWT transmitted both sound and vision, sending stereo sound by PO lines to Capital for their stereo f.m. service.

Alternative to microstrip

Microwave Associates are now using an air dielectric alternative to microstrip called suspended substrate, which they say is less bulky for some applications than microstrip. Although microstrip assemblies taken by themselves are smaller, by the time the interconnections between strips and coaxial links or waveguides have been made any advantage in size reduction on the strip itself has been lost.

The dielectric is formed by mirror-image channels in two metal plates, between which is fixed a glass-loaded substrate with copper tracks on each side. The two copper tracks are so close that, at r.f., the gap between them is negligible. The transmission mode is TEM.

Connections to suspended-substrate microwave assemblies are simple, say Microwave Associates, and the technique is also less lossy than microstrip enabling a smaller magnetron to be used. Microwave systems division manager Ian Williamson said in a statement: "For ferrite isolators we can achieve a 0.2dB loss per pass compared with 0.7dB minimum with the garnet used in microstrip. Functions such as switches and limiters can be made from packaged 50ohm structures and tested prior to assembly, in contrast to microstrip, which needs unpackaged diodes, testable only when positioned in the final circuit." Because of their greater size, airstrip circuits were easy to manufacture and test. Ferrite pucks and other modules could be introduced into the holes in the plates and were easily exchanged when faulty. Another advantage was the strength of the assembly.

Microwave Associates first developed the system for an airborne X-band transponder for the Navy Lynx helicopter and Maritime Harrier. The U.S. parent company had already developed suspended-substrate technology and, although they had not made the fact public, they had built up a library of designs for different suspended substrate components.

The transponder gives two power levels from one of two transmit and receive antennae, and is self testing. Even with a large number of isolators in the design, say Microwave, the unit measures only 6 by 7 by 3 inches.

Having found an application that might use the technique to advantage, the assistant manager of the British semiconductor division went to the United States to learn more about it. Two teams at Dunstable then built transponder r.f. units, one using conventional microstrip techniques and the other using suspended substrate. Ian Williamson told *Wireless World*: "We evaluated the two systems in all sorts of respects. Losses, weight, size and so on, and suspended substrate was the more suitable for this application. Other companies may have used these techniques but as far as I know they do not have an extensive library of building blocks."

● Using an air dielectric in microwave devices, particularly directional couplers, has been widely known since the 'fifties. But the use of the technique has usually been confined to a small number of devices, and the size of the devices that did exist was somewhat greater.

Voice controlled computer terminal.

EMI are using microprocessors in a new data terminal, the Threshold 500, which can recognize at least 32 words or short phrases spoken into it in any language irrespective of vocabulary, accent, dialect, speech impediment, or background noise. Although EMI have already developed a voice recognition for their VIP 100 general purpose minicomputer system, the Threshold 500 is half the size and, at £6,500, half the price of its predecessor.

The selected vocabulary is put into the machine and users of the system then "train" the equipment to understand their individual pronunciation of the words by repeating each five or ten times into a noise cancelling microphone. The terminal then averages the voice patterns out for each word and stores it with the others in an r.o.m. memory. When the terminal is used, the operator calls up his own voice pattern, which is identified by a reference number on the control unit used for speaker selection and voice training. If the operator's voice alters for any reason he can call words up for retraining.

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Projection television

A review of current practice in large-screen projectors

by Angus Robertson

Although projection television has been around since television was originally developed, it is only in recent years that considerable research has been directed towards developing new techniques for producing large-screen television projectors. Several TV projectors have been produced specifically for the consumer market, although at present their prices are far higher than direct-viewing receivers.

In the early days of television, it was not easy to manufacture cathode-ray tubes larger than 30cm diameter. To obtain larger pictures, manufacturers used a lens in front of a small, high-intensity c.r.t. and projected the raster onto a screen contained within the cabinet. Mirrors were usually used to fold the light path and enable smaller cabinets to be used. During the fifties, larger and brighter c.r.ts were manufactured and projection TV faded out. Although larger tubes have been produced for special applications, sizes have levelled off with diagonals of 66cm: larger pictures require special techniques.

The first large-screen television projector was invented by Professor Fischer at the Swiss Federal Institute of Technology in 1939. At that time, Prof. Fischer thought that the growth of television would come from the development of networks of neighbourhood "television theatres" and he invented the Eidophor with the capability of projecting TV pictures onto cinema-sized screens. The earliest Eidophors were cumbersone machines, which could project only black and white pictures in a darkened or semi-darkened room. They were not the most reliable of machines and for a number of years the Eidophor system was little known or used.

Later the American space programme called for a reliable, high-performance, large-screen projection system capable of working for long periods of time, to provide data displays in NASA flight control centres. Gretag AG, Zurich, a subsidiary of Ciba Geigy and patent holders and manufacturers of the Eidophor, successfully developed the projector's capability to meet NASA specifications. The latest Eidophors are able to project full-colour television pictures onto screens 18m wide. The Eidophor is still the only commercially-available projector able to project cinema-sized pictures, but colour versions cost over £100,000. Cheaper techniques have therefore been developed to provide projectors for industry, education and the home.

Three basic projection techniques are used. Eidophor, General Electric, Hughes, Westinghouse, IBM and Titus (Philips) use light-valve projectors, in which varied techniques are employed to modulate a light source, which is then projected onto the screen. The second method is to use Schmidt optics (like the telescopes) to magnify and project the image from a small, high-intensity c.r.t. Advent, Pye (Mullard/Philips), Image Magnification, Ikegami, Kalart Victor and Pro-

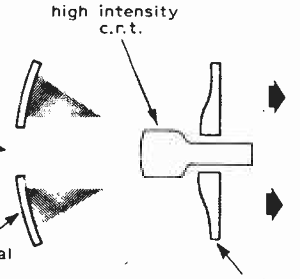

Fig. 1. Light path in Schmidt optical system.

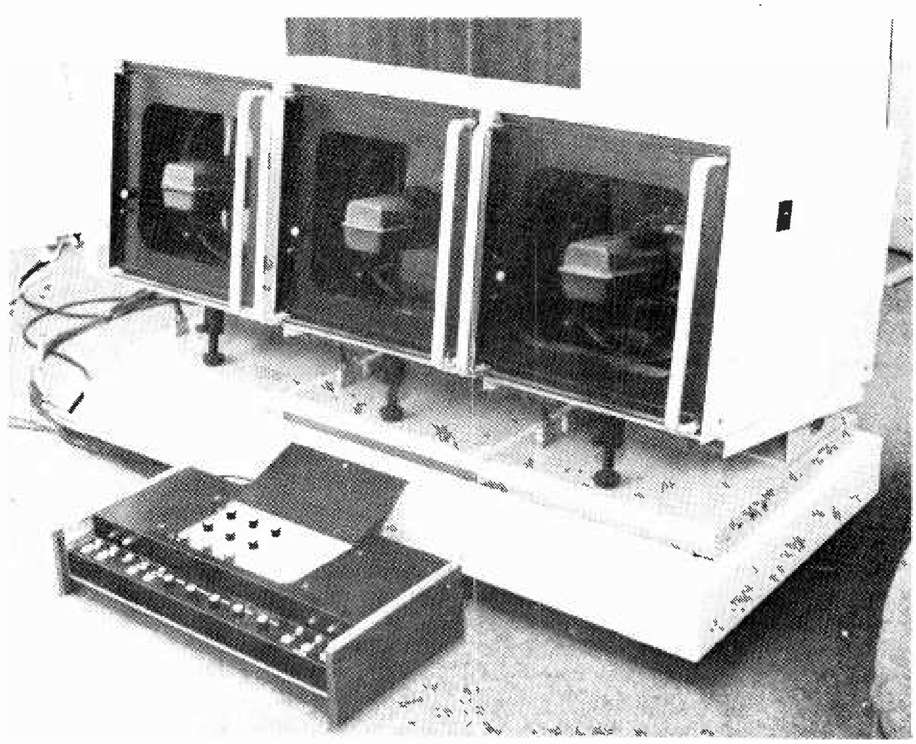

Fig. 2. Magna Image 111H colour Schmidt projector.

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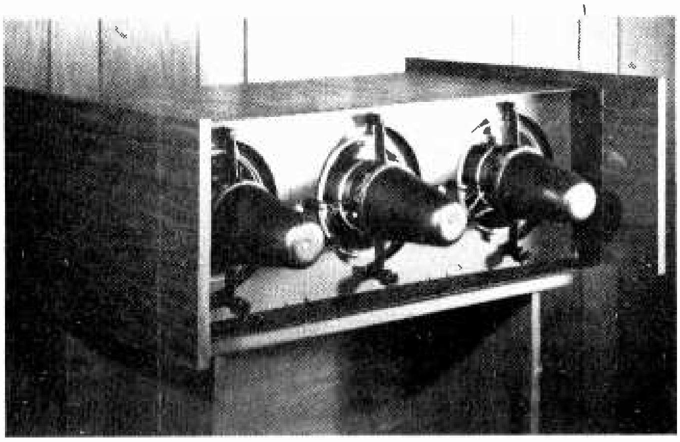

Fig. 3. CV3 Superscreen Schmidt projector.

jection Systems all use this technique. Finally, the refractive technique is the cheapest method, in which a glass or acrylic lens is placed in front of an ordinary c.r.t., usually a 33cm colour Trinitron, and the picture is projected onto a high-gain screen. We can expect to see lenses available separately soon to enable the handyman to modify his own TV set for projection.

Screens

Most video projectors, except possibly Eidophor, have low light outputs when compared with ciné projectors. For instance, refractive projectors have an output well below 50 lumens, Schmidt projectors emit between 200 and 500 lumens and the high power Eidophor produces 7,000 lumens. An ordinary 16mm ciné projector, with a 250W, 24V lamp, provides around 650 lumens while in motion and an overhead projector is usually rated at between 1,500 and 2,500 lumens.

To increase the apparent brightness of the projected image, it is common practice to use special screens which have "gain". Since no more light may be reflected from the screen than falls on it, the screen is made directional so that available light is concentrated into a small angle.

Projectors such as the Advent use an Ektalite-foil screen material, developed by Kodak. The material provides an on-axis gain of between eight and ten, with a 40° viewing angle but, to eliminate hot spots, the screen must be compound curved (both horizontally and vertically) and this necessitates a solid screen frame, usually fibreglass. Zygma Electronics use a specially-developed, solid, compound-curved screen that uses a highly-reflective spray-on paint instead of the more usual foil. Gain is 4.7 times with a horizontal viewing angle of 90°. While these are fine for permanent installations, they usually need a van for transportation and may only be concealed with difficulty, unlike a roll-up screen. A matt screen surface has a unity gain, while a beaded screen usually has a gain of 1.8. Projection Systems Inc. market a silver lenticule screen with a 2.5 gain and the exceptional viewing angle of 170°. This screen material, which is rollable, also has excellent ambient light rejection characteristics, this light being reflected sideways away from the viewers — ideal for hire work where the locations used rarely seem to have adequate black-out.

Mechanische Weberei, in West Germany, manufacture a projection screen with a gain of 3.5. This is also roll-up but it does not have the same ambient characteristics as the previous screen. It is however perfect for use where adequate black-out is provided. Ideal Image Inc. has produced a plastic lenticular screen with a gain of five but the lenticule (lens) size is such that minimum viewing distance is 6m and it must be compound curved. The company is presently developing a new plastic material similar to the Ektalite foil but which requires only horizontal curving rather than the compound curve. Single curves are used for large cinema screens and only require a curved frame lattice rather than the solid frame required for Ektalite. Although the screens being presently manufactured are 25m by 7.5m for wide-screen (and why not?) television projection, smaller sizes are available to order.

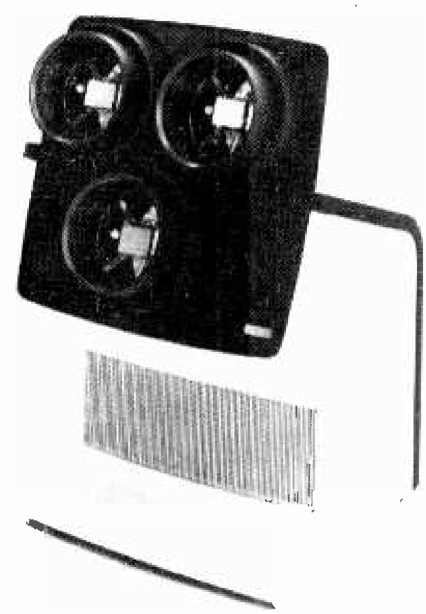

Fig. 4. Videobeam 1000A from Advent.

Rear projection. Although front projection is common there are certain applications where rear projection is preferred. For instance the Eidophors installed at the NASA flight control centre are rear projected for convenience; it would be impractical in that particular location to project the image onto the front of the screen. Screens used for rear projection are usually of high density and low gain in order to minimize "hot spots". To obtain the projected image the correct way round, current to the horizontal scanning coils is reversed. On some projectors scan reversal is achieved by a switch, on others, it is a case of resoldering two wires on each scanning yoke.

Although not yet commercially available, a rear projection screen has been developed in the USA with a gain of about eight. No further details are known nor do I know of any other rear projection screens with a gain greater than unity.

Screen brightness. Projector light output is usually quoted in lumens, which have the advantage of being identical in imperial and metric units. The illumination falling on the screen is measured in lumens/m^2 (lux) but since most screens provide some gain, luminance in candelas/m^2 (nits) is the unit used (except by the Americans who still use ft lamberts). **Example:** A projector light output is 500 lumens. Screen size is 3m x 4m = 12m^2. Screen illumination is

$$\frac{500}{12} = 41.7 \text{ lux.}$$

If the screen gain is two, screen luminance is

$$\frac{41.7 \times 2}{\pi} = 26.53 \text{ cd/m}^2.$$

Resolution. A 625-line, 50-field television signal has a bandwidth of 5.5MHz and a horizontal resolution of 570 lines. The resolution of colour c.r.ts is limited by the number of phosphor dots or stripes; therefore, the larger the screen, the higher the possible resolution. Since most colour projectors project each colour separately, resolution is usually only limited by the electronics associated with each channel. For the display of computer-generated data and command applications, higher definition is often required and the use of 1,029 lines per frame and video bandwidths of up to 40MHz enables a horizontal resolution of over 1,000 lines to be achieved. Digital techniques are sometimes used to obtain accuracy in the corners of the picture. When displaying characters which combine more than one colour, registration accuracy is critical; otherwise double characters will be displayed.

Schmidt projectors

Fig. 1 shows the principle of the external Schmidt c.r.t. projector, in which tube diameter can vary between 75mm and

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150mm for different projectors. The reflector needs to be two or three times the raster size, which precludes the use of large colour tubes on purely physical grounds. The centre of the mirror is removed to prevent light being reflected directly back towards the c.r.t. faceplate and a fan is inserted in the hole to cool the high-intensity faceplate.

Light output from Schmidt projectors depends upon tube and reflector size. RCA quote a light output of 450 lumens from a 125mm c.r.t. when operating with 45kV and 500μA. Tubes operating with more than about 30kV produce X-rays and care is required in the construction of such projectors to provide adequate shielding. Some projectors include interlock circuits which remove e.h.t. when the protection covers are removed for maintenance.

For colour projection, three optical systems are used with green, red and blue c.r.ts. Usually, these are mounted in-line, but one manufacturer uses a triangle formation. Complex analogue circuits are included to enable registration of the three images in much the same way as a shadow mask tube – a process which is made easier by the in-line layout. Projectors usually have a built-in cross-hatch generator and basic registration controls are often mounted on a separate control unit for convenience.

Another facility usually included is keystone correction. When a projector is mounted on the ceiling (out of the way), the projected image is angled down at the screen giving a picture wider at the bottom than the top. Keystone correction enables the verticals to be electronically corrected, usually to correct for angles of ±15°. An optical keystone corrector may be provided which adjusts the c.r.t. position to provide equal focus over the screen. The tube is usually mounted on a carriage which enables it to be moved in relation to the reflector to provide optical focus for differing projection distances. The corrector plate is designed to compensate for deficiencies in the optical system and is optimized for a particular projection throw. Although most Schmidt projectors allow focusing at variable distances, often the corrector plates must also be changed if a wide range of projection distances is to be accommodated.

Image Magnification Inc. The Magna Image I is a monochrome projector which uses a 125mm c.r.t. Picture width is variable between 1.2m and 6m with a resolution of 600 lines in the centre. Price: £3,500. The Magna Image IIIH, shown in Fig. 2, is a colour projector using three heads in-line. Picture widths between 2.4m and 6m with a resolution of 500 lines. Price: £12,750.

Kalart Victor Corp. The Telebeam II projects a monochrome picture between 1.8m and 3.6m wide (specified

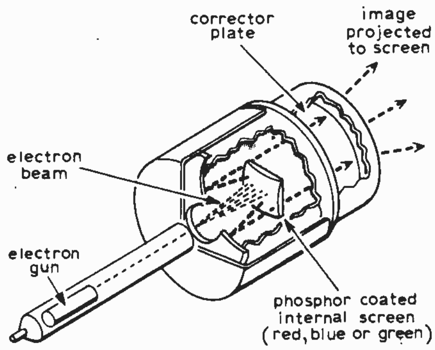

Fig. 5. Advent Lightguide tube, with complete Schmidt system inside envelope.

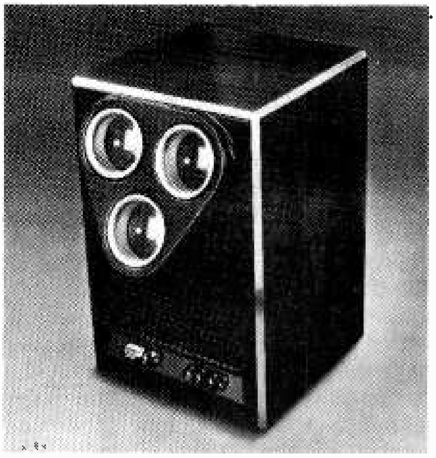

Fig. 6. Zygma Teleprojector.

when ordered) with a resolution of 550 lines. Light output is 384 to 576 lumens from a 125mm tube. Price: £3,810.

Projection Systems Inc. The CV3 Superscreen, Fig. 3, projects a colour picture with widths between 1.8m and 2.4m from 75mm tubes. Light output is about 200 lumens. Price: £4,490. Model 270A is a monochrome projector with a light output of 800 lumens for screen widths between 1.8m and 6m. Resolution is 1,000 lines in the centre. Price is $11,800. Model 560 is a colour projector with a light output of 600 lumens for a screen width of 3.6m. Price: $14,750. Amphicolor 1000 uses three 150mm tubes for colour projection with 4800 lumens. Screen widths of either 2.4m or 4.2m. Price: $29,500.

Pye TVT. The Mammoth is a colour projector with a claimed light output of 800 lumens onto a 4m wide screen. Centre resolution is 600 lines and price is on application.

Ikegami. The TPP-2C is a colour projector with a light output of 360 lumens, intended for a maximum 4m by 3m screen. Price: £16,000.

Advent Corp. The Videobeam 1000A in Fig. 4 uses the Schmidt technique, but instead of having separate tube, reflector and corrector plate, all are vacuum sealed in the same envelope, as seen in Fig. 5. The electron beam scans a 75mm phosphor coated target (red, green or blue). Emitted light is then reflected onto the spherical mirror and back through the corrector plate to the screen. Although this approach has manufacturing advantages, the projection distance is fixed at 2.54m exactly, and light output is low since all parts are sealed within the tube and it is not possible to cool the target. Although not specified by Advent, working backwards from the screen brightness gives about 60 lumens light output. Thus a bulky, high gain screen is required to obtain an adequate screen brightness. Screen dimensions are 1.32m by 1.75m. Advent has however, recently announced a set of lenses which may be attached externally to the sealed tubes enabling a 2.4m x 1.8m picture on a flat screen. The screen brightness thus obtained would necessitate a well darkened room.

Advent are intending to introduce a new, cheaper projector on the American market this summer. No further details are available nor has a British launch date been announced.

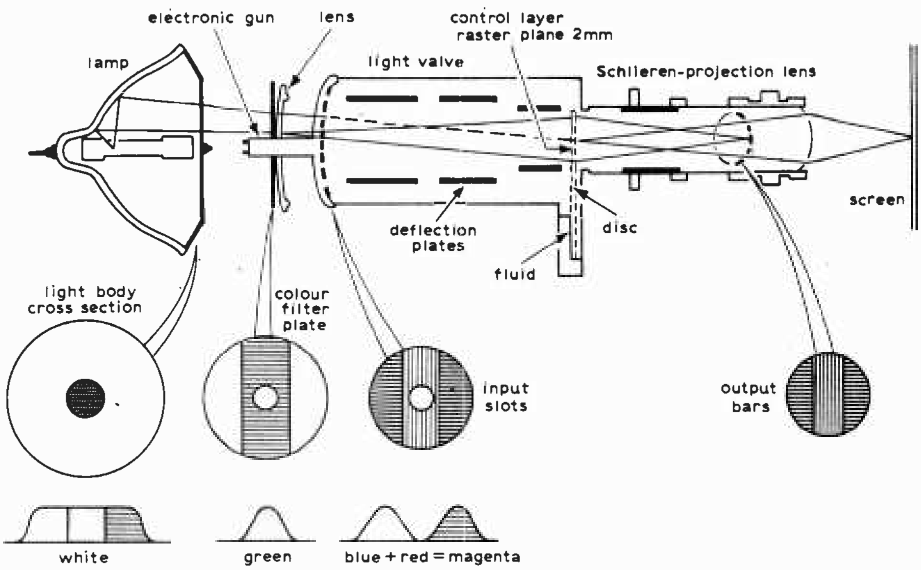

Fig. 7. General Electric light-valve projector.

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Zygma Electronics manufacture a projector which has characteristics which are very similar to the Advent Videobeam. The Type 2001 Teleprojector shown in Fig. 6, uses internal Schmidt optics tubes with a fixed projection distance of 2.54m onto a high gain screen 1.75 x 1.32m. Screen brightness is 140cd/m and the price is £4,950.

Light valves

General Electric use transmission light valves in monochrome and colour projectors. Colour pictures are produced from a single projection tube using a diffraction grating to separate the colours. The projector, seen in Fig. 7, uses a separate xenon light source, a fluid control layer in the light valve, and a projection lens. Optically it is similar to a slide or ciné projector.

Miniature grooves are created on the deformable surface of the fluid control layer by electrostatic forces from the charge deposited by the electron beam, which is modulated with video information. These groove patterns are made visible by use of a "dark field" or schlieren optical system consisting of a set of input slots and output bars. The resulting television picture is imaged on the screen by the projection lens.

Cross sections of the light body, colour filters and input and output slots are shown below the light valve in Fig. 7. Green light is passed through the horizontal slots and is controlled by modulating the width of the raster lines themselves, by means of a high-frequency carrier applied to the vertical deflection plates and modulated by the green video signal. Magenta (red and blue) light is passed through the vertical slots and is modulated by the diffraction gratings created at right angles to the raster lines by velocity modulating the electron spot in the horizontal direction. This is done by applying a 16MHz (12MHz for blue) signal to the horizontal deflection plates and modulating it with the red signal. The grooves created have the proper spacing to diffract the red portion of the spectrum through the output slots while the blue portion is blocked. For the 12MHz carrier the blue light is passed and the red blocked. Thus, simultaneous and superimposed primary colour pictures are written with the same electron beam and projected to the screen as a completely-registered full-colour picture.

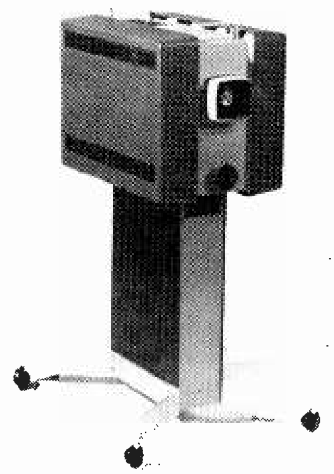


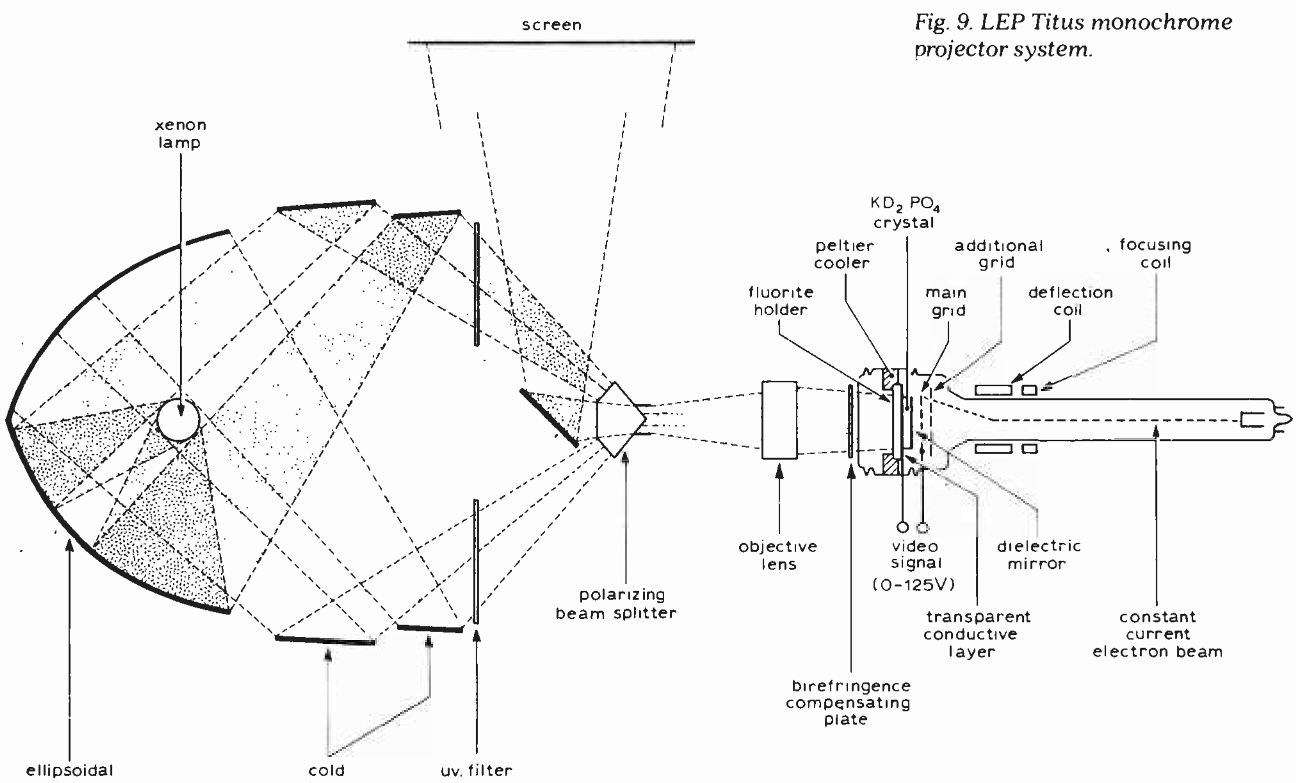
Fig. 8. General Electric PJ6000.

Because of problems of heat dissipation, and the avoidance of frequent repairs (the light valve costs about \$12,000), the xenon lamp is limited in power to 650W. The PJ7000 monochrome projector has a light output of 750 lumens and is suitable for picture widths between 0.75m and 3.6m, with a typical horizontal resolution of 1,000 lines. Three lenses are available to accommodate different throw/width distances. The PJ6000, Fig. 8, and PJ5000 colour projectors have a light output of about 280 lumens, a resolution of 600 lines and the same focusing ability, although a 2.4m screen width is optimum for colour. Light output of the colour projectors is less than the monochrome projectors since light is lost in the diffraction process. Life of the light valve is usually over 3,000 hours but 7,000 hours has been achieved in the laboratory. Price of the PJ7000 is \$46,000, and the PJ6000 and PJ5000 cost \$52,500.

Titus light valve. Developed by the Laboratoires d'Electronique et de Physique Appliquée (LEP), part of the Philips organisation, the Titus projector uses the Pockels effect in a refractive light valve. This works on the principle that certain crystals, in this case potassium di-hydrogen phosphate, rotate the plane of polarization of a beam of incident light through an angle proportional to modulation by the accelerating voltage of a constant-current electron beam. Fig. 9 shows a tube using these principles in a monochrome projector. A peltier cooler is required to keep the temperature of the plate just above its Curie temperature of about —50°C.

The target is bombarded by an electron beam whose accelerating voltage lies between 500 and 1,000V, a grid

Fig. 9. LEP Titus monochrome projector system.



being placed in front of the target at a distance of about 40µm. The electron beam, of constant intensity, functions as a flying-spot short circuit between this main grid and the point of impact of the target, which thus reaches a potential close to that of the grid. The video signal is applied between the transparent conductive layer and the grid, to ensure that the various points of the target are charged to the corresponding video voltage when they are hit by the electron beam, irrespective of their previous potential. Erasure and writing are therefore simultaneous and this, coupled with the long discharge time-constant of the target, results in flicker-free operation. In addition, since the voltage pattern stored on the target does not depend on the intensity of the electron beam, it is found that no line structure is apparent on the picture. The absence of line structure, however, is not accompanied by loss of vertical resolution.

Twin ellipsoidal mirrors are used to provide high collection efficiency from the 2.5kW xenon lamp. A calcite polarizing beam splitter which transmits only light whose electric vector is parallel to the plane of Fig. 9 is used to transmit light to the Titus tube. The projection lens is placed between this polarizer and the tube and acts as a collimating lens so that the luminous beam incident on the plate has a mean directional normal to the latter. When the light beam is reflected at the dielectric mirror and passes through the lens and beam splitter again, only the light component with its electrical vector perpendicular to the plane of Fig. 9 is transmitted to the screen. In practice, light output from the monochrome projector is about 2,500 lumens, with a horizontal resolution reaching 750 lines. A 4kV xenon lamp may be used to increase this output.

A colour projector using Titus tubes is shown in Fig 10, in which two dichroic mirrors are used to split away blue and red beams. Ellipsoidal mirrors similar to those of the monochrome projectors are used but not shown here. Using a 4kW xenon lamp, 3,200 lumens output have been obtained from an experimental prototype.

The Titus is the only television projector that has an output capability comparable to the Eidophor. Efficiency is about half that of the Eidophor since half the light is lost in the original polarization.

Hughes liquid crystal. This projector uses a liquid-crystal reflective light valve which is addressed by a c.r.t. Fig. 11 shows the various layers which make up the liquid-crystal light valve. In operation the cadmium sulphide photoconductor acts as a high-resolution, light-controlled voltage gate for the liquid-crystal layer. The dielectric layer serves to reflect the projection light while the cadmium telluride light-blocking layer prevents residual pro-

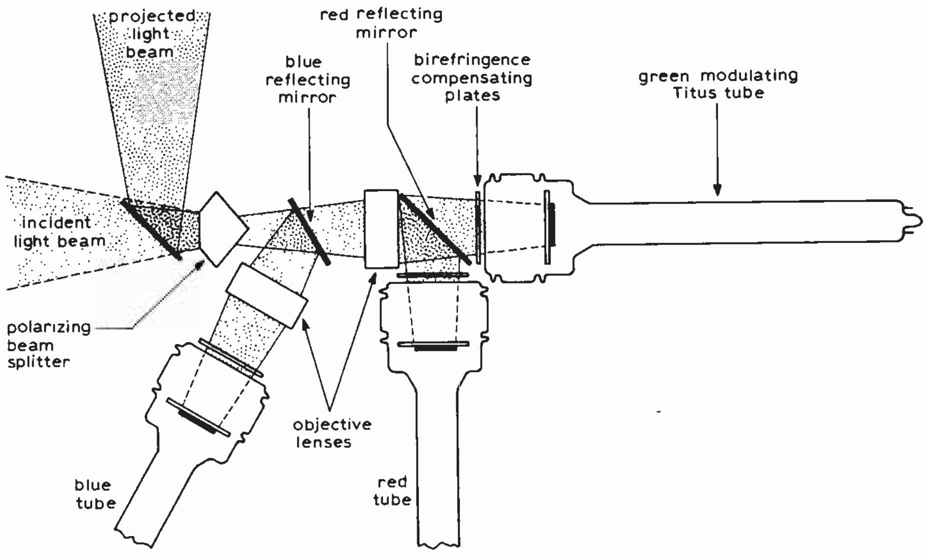


Fig. 10. Three Titus tubes used for colour projection.

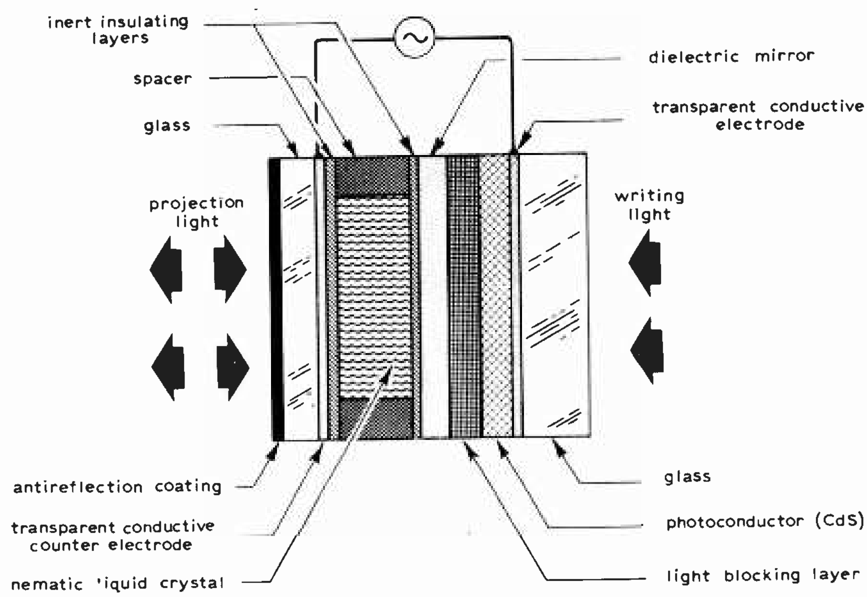


Fig. 11. Sectional view of a liquid-crystal light valve.

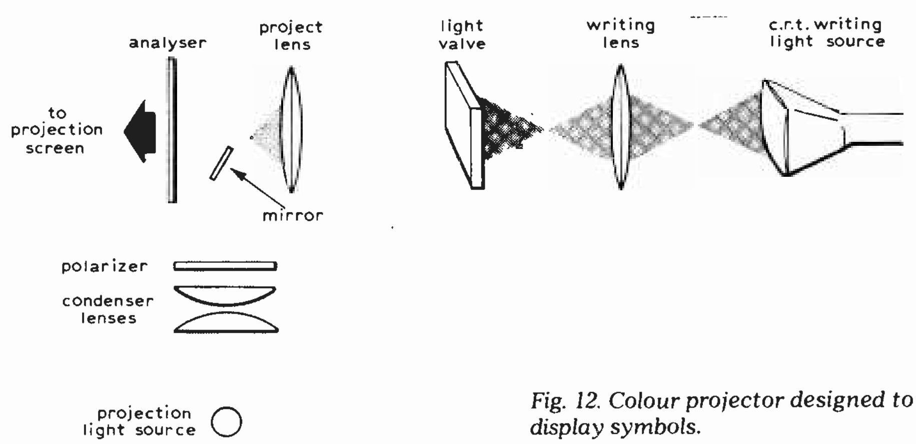


Fig. 12. Colour projector designed to display symbols.

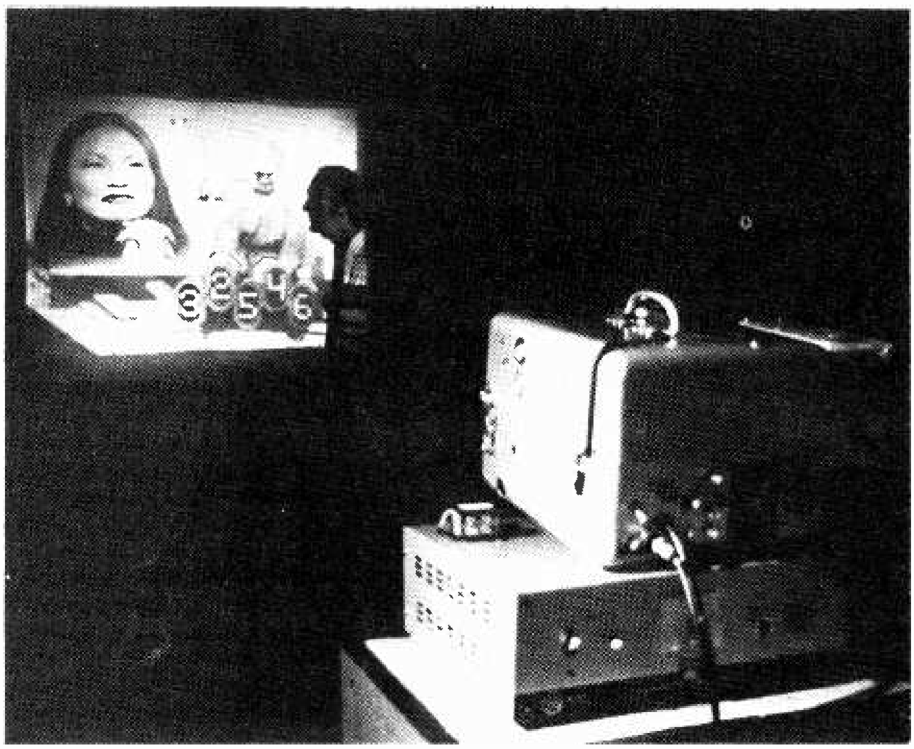


Fig. 13. Hughes light valve projector.

jection light reaching the photoconductor. Because of the high d.c. resistivity of the dielectric mirror, the device is operated with an alternating voltage impressed across the sandwich structure. This has the added benefit of extending the life of the liquid crystal. The device is used in the optical system shown in Fig. 12. Light from the projection lamp is collimated, polarized and directed to the cell. The light passes through the liquid crystal and is reflected from the dielectric mirror.

The second polarizer, which is crossed with respect to the first, is placed in the projection beam that is reflected from the light valve. The display operates in the following manner. The liquid crystal is aligned with its optical axis nearly perpendicular to the device electrodes so that, in the off state, no phase retardation occurs and the projection light is blocked from the screen by the crossed polarizers. With imaging light incident on the photoconductor, a voltage above the field effect threshold is switched onto the liquid crystal layer. The liquid crystal has negative dielectric anistropy, so that the molecules tend to align normally to an applied electric field. Thus the applied voltage rotates the molecules from their initial state parallel to the field and introduces a phase retardation between ordinary and extraordinary rays in proportion to the spatial intensity variation of the imaging light. This phase retardation changes the polarization of the projection light and, due to the dispersion effect, allows selected colours to pass the crossed polarizers.

In the display of symbols, the colour of a selected character in the projected image may be selected by the level of intensity of the input imaging light. Low imaging light intensity (low voltage switched to the liquid crystal) leads to a white (all colours present) on black image, while higher imaging intensity increases the alternating voltage on the liquid crystal and leads to the selection of certain colours; blue, green, yellow and magenta. These colours have only one luminance and are thus suitable only for displaying coloured characters or symbols superimposed upon a black and white grey-scale picture

So far, images of 350 lumens have been projected, using a 150W lamp, by the equipment shown in Fig. 13. This projector was developed by Hughes in co-operation with the US Navy, and in its present form is intended for symbol displays.

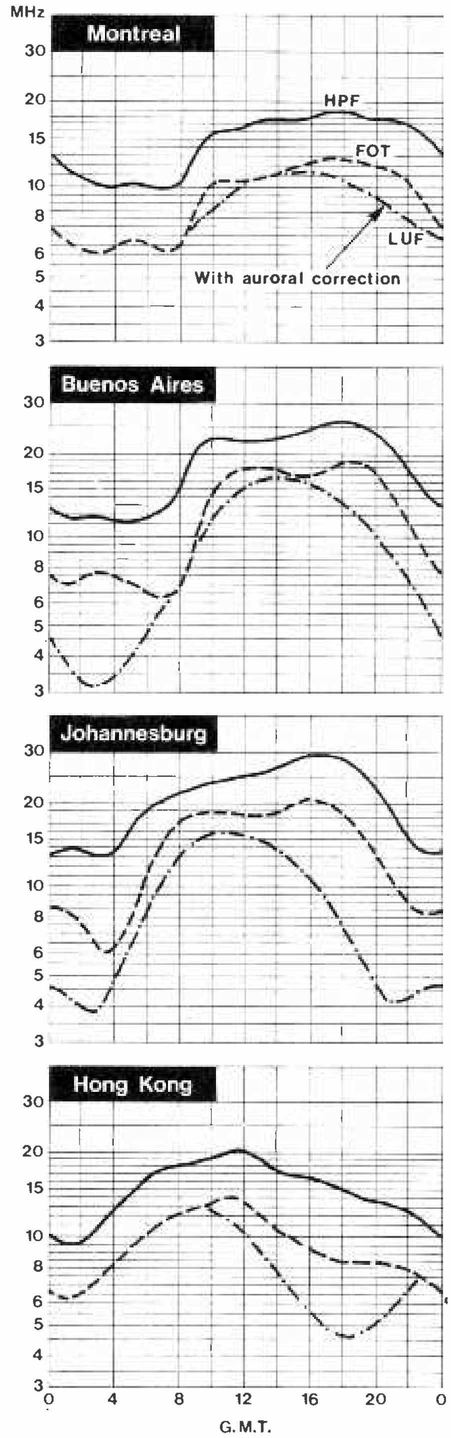
To be continued next month with a look at refractive projectors

75MHz counter

A set of p.c.bs is now available for the 75MHz counter which was published in the 1976 Wireless World Annual. The set comprises six boards to accommodate the count-store-display circuitry, divider, crystal clock, function select, input amplifier, and power supply. Wire links are used where necessary to avoid the expense of double-sided boards. The set is priced at £12.00 inclusive of v.a.t. and postage and is available from M. R. Sagin at 11 Villiers Road, London N.W.2.

HF predictions

Long periods of subnormal days are unlikely to occur as duration and intensity of magnetic disturbances have decreased rapidly over the past two months. Coupling this with the general seasonal trend toward higher frequencies becoming available should produce a noticable improvement in daytime working particularly on the North Atlantic path.



Surround-sound decoders—4

QS Variomatrix circuit — construction and setting up

by David Heller, B.Sc.(Eng.)

In agreeing to reveal the QS Variomatrix circuit in *Wireless World,* Sansui give constructors the chance to evaluate the QS system for much lower cost than has hitherto been possible. Kits for this decoder design are available from the address given in the article. A previous instalment in this series (August) gave details of operation.

In the circuit of Fig. 5, transistors Tr_1 and Tr_2 act as buffer amplifiers with collector loads C_3, R_7 and C_6, R_{13} providing some roll-off in the high frequency response of the system. The signals are attenuated by R_{14} & R_{17} and R_{15} & R_{16}, to keep distortion low, the HA1328 having a gain of 14dB to make up for this. Resistors R_{18} to R_{21} supply d.c. negative feedback.

The Variomatrix control points, pins 9 to 12, are connected to resistors R_{30} to R_{33} which determine a fixed gain for the control amplifiers. In addition these points are a.c. coupled to the drains of the f.e.ts inside the HD3103P, whose constantly varying impedences change the gains of the control amplifiers about their fixed positions. The control terminals are also provided with phase-compensating circuits R_{26} to R_{29} and C_{14} to C_{17} to ensure stability.

Pins 3 to 6 supply the various outputs: resistors R_{35} and R_{36} are inserted between pins 5 and 6 and pins 3 and 4 to cancel crosstalk between L_F & R_F and L_B & R_B outputs.

The circuitry has been designed so that its variable matrix is affected by the frequency of the input signals as well as the control signals. Low frequencies are prevented from entering the phase discriminator i.cs and thus influencing the control signals; they would otherwise superpose ripples with long time-constants on the control signals feeding the f.ets.

The output signals pass through criss-cross circuits made up of R_{37} to R_{42} and C_{28} to C_{31}, situated between the front left and front right outputs to give the appropriate matrix coefficients in the low frequency range. The criss-cross circuits in the rear channel outputs perform the same function. The signals finally pass through the phase shifters Tr_3 to Tr_6 and emitter followers Tr_7 to Tr_{10}.

Control circuitry

The Variomatrix control circuitry comprises of two HA1327 phase discriminators and one HD3103P consisting of five p-channel m.o.s.f.e.ts. The L_T and R_T signals pass through high-pass filters made up of C_{48}, R_{72} and C_{49}, R_{71} so that 100Hz signals are attenuated by 40dB. The processed signals pass into the buffer amplifiers of each of the HA1327 i.cs (pin 1) and produce in-phase and out-of-phase outputs at pins 2 and 3 which are then fed to the input terminals of the front/back control phase discriminator IC_2 and also to phase shifting networks R_{106} to R_{109}, C_{74} to C_{77} and R_{77} to R_{79}, C_{54} to C_{56}, so that L_T and R_T are given a 45° phase difference. These last-mentioned signals are then applied to pins 6, 7, 14 and 15 of the left/right control phase discriminator IC_4, which derives $L_T+R_T\angle -45°$ and $L_T-R_T\angle -45°$ and passes both through limiters to the phase discriminator to provide an output dependent on phase difference. Outputs appearing at pins 9 and 10 are rectified and low-pass filtered by C_{87}, R_{131}, R_{122}, C_{90} and C_{91} to eliminate any ripple components. The resultant control signals are then applied via the potentiometers R_{127} and R_{128} to the gates of respective f.e.ts inside IC_3. In a similar way, IC_2 derives a control signal dependent on the phase difference of L_T and R_T.

The output signals of the two phase discriminators are added through R_{87}, R_{88}, R_{119} and R_{120} and produce the 16V direct voltage that determines the operating point for the f.e.ts. The networks connected between the gate and drain of each f.e.t. (e.g. C_{94} and R_{134}) form the negative feedback circuit for reducing the distortion created by the f.e.ts. The drains are coupled to the control pins of IC_1 and control the gains of the F, B, R and L amplifiers.

Characteristics

Fig. 6 shows the separation characteristics of the QS Variomatrix decoder for a left-front encoded signal. Low frequency separation is 3 to 6dB as l.f. signals do not pass through the control circuitry; this is not a serious drawback because the ear has some difficulty in determining the location of low frequency sound sources.

A right-front encoded signal produces similar results, while left and right back encoded signals produce slightly worse separation (10dB instead of 12dB) at 10kHz. Fig. 7 shows the separation characteristics for a centre front encoded signal.

The decoder has a gain of just over unity and will operate with input levels of 5mV to 3V r.m.s. However, the HA1328 i.c. has very little power supply ripple rejection and any ripple passes through the decoder as if it was an input signal. For this season it is best to ensure that the minimum signal entering the decoder is 100mV r.m.s. and the volume control should therefore appear after the decoder. Distortion is typically 0.04% from 500Hz to 20kHz and worsens to around 0.2% at about 50Hz.

Construction

To conserve space, the module is designed to be constructed on two boards, one stacked upon the other with the aid of Varelco "vertical plus" pins. The lower board houses the basic decoder chip HA1328. The upper board houses both phase discriminator i.cs (HA1327) and the m.o.s. i.c. which together form the control circuitry.

Insert the resistors before the capacitors. The capacitors are mostly of the Siemens B32540 polycarbonate type, with a distance of 7mm between pins. If the mounting holes vary from this, the legs of the capacitors are prone to break off, so, if the capacitors do not fit exactly into the positions, do not force them in. Rather, widen the holes or support each lead with a pliers and bend

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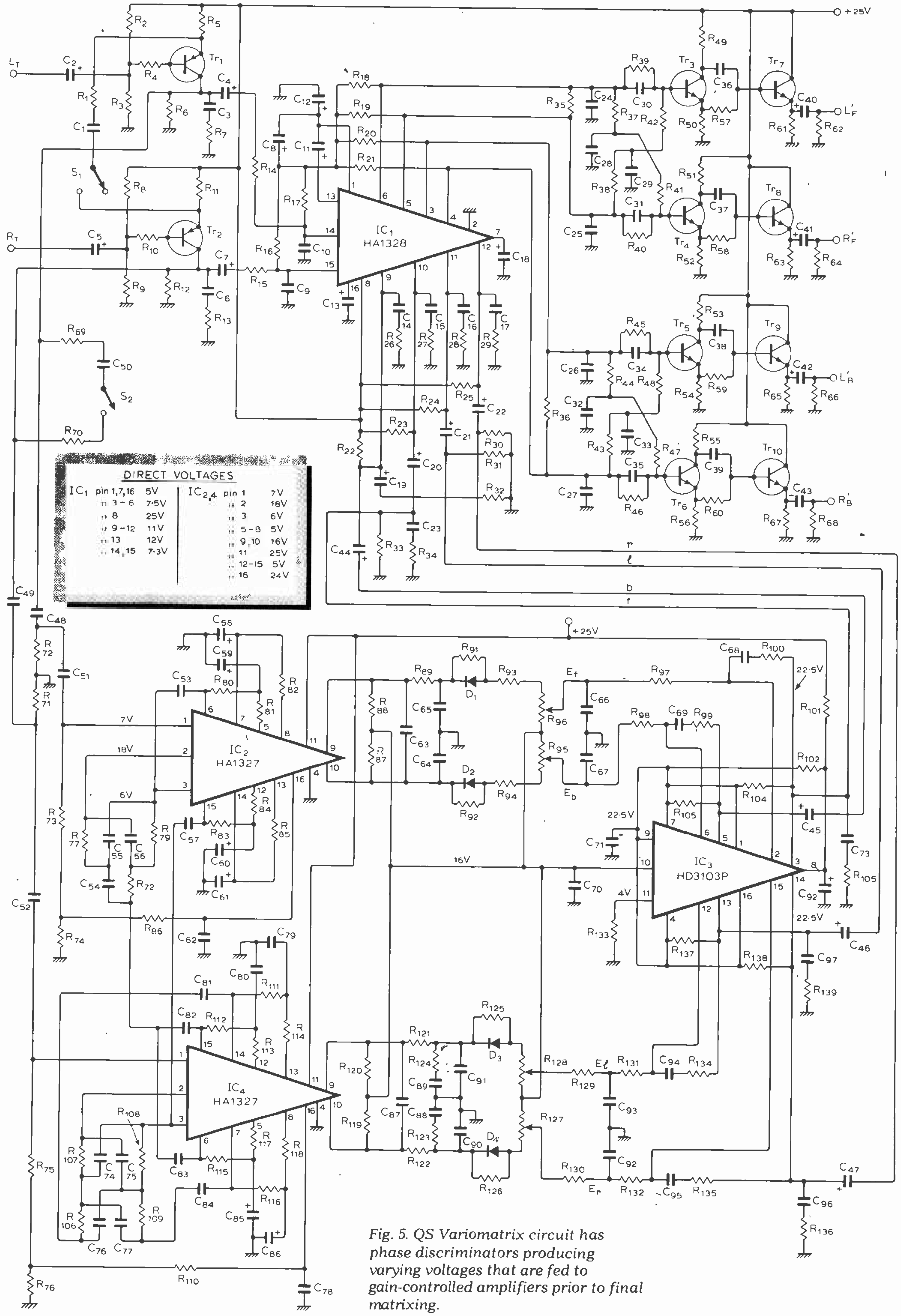

DIRECT VOLTAGES

IC1 pin		IC2,4 pin	
1, 7, 16	5V	1	7V
3 – 6	7·5V	2	18V
8	25V	3	6V
9 – 12	11V	5 – 8	5V
13	12V	9, 10	16V
14, 15	7·3V	11	25V
		12 – 15	5V
		16	24V

Fig. 5. QS Variomatrix circuit has phase discriminators producing varying voltages that are fed to gain-controlled amplifiers prior to final matrixing.

them gently in the direction required. Do not apply too much heat to the polystyrene capacitors; they are of the low voltage type and too much heat causes shorting of the layers.

Once all the components have been soldered into position insert the horizontal Varelco pins into the lower board. These are used to mate with similar pins in the master switchboard. The pins are mounted in plastics strips in groups of four. Three strips are supplied and should be inserted and soldered in the first four holes, the middle four holes and the last four holes. The other holes are not used.

The upper board has certain circular marks silk-screened on its top side. Take the Varelco vertical pins one at a time and insert these through the copper side of the board into the marked positions. With the tail protruding about ⅛in. through the top side of the board, solder the pin in position. Solder each of the pins individually before inserting the next pin. Try to ensure that these pins are soldered perpendicular to the board. Once they are soldered into position, they should not be subjected to any twisting or force.

After inserting and soldering all the vertical pins in the upper board, insert the mating pins into the pins already soldered. Each pin should have its mate. Once all the pins are in position, insert the tails of the mating pins into the lower board, ensuring that no components touch the bottom of the upper board, and solder in position. When soldered, it should be possible to unplug the two boards from one another and to plug them together again. Mate the two boards together gently as excessive and rough handling may either bend the pins or lift the copper track from the board.

Setting-up

Apply a well-stabilized 25V supply (130mA) to the decoder. Construct an encoder for testing the QS module as in Fig. 8. This consists of a simple transistor buffer stage fed from a 1kHz oscillator and gives three outputs a, b, and c (300mV and −120mV). A combination of any two of these gives the necessary decoder inputs.

Set R_1 to give 300mV output at point a. Set R_2, R_3 to give outputs of 120mV at points b and c.

Adjustments of f and l. Set pre-set potentiometers R_{95}, R_{96}, R_{127}, R_{128} to mid-position. Next, feeding a 300mV, 1kHz signal to the encoder input and using the L_F outputs, adjust R_{96} to set the L_F to R_F separation at 18dB. Similarly, with the same encoder outputs, adjust R_{128} to set the L_F to L_B separation at 17dB.

Adjustments of b and r. Feeding a 300mV, 1kHz signal to the encoder and using the R_B outputs, adjust R_{95} to set the R_B to L_B separation at 18dB. Similarly, with the same encoder outputs, adjust R_{127} to set the R_B to R_F separation at 17dB.

Confirmation. Feeding a 300mV,

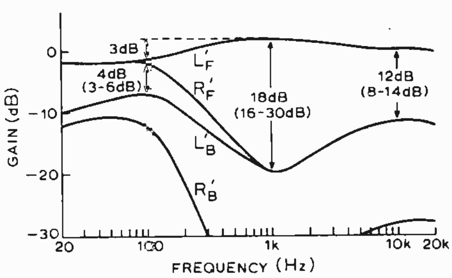

Fig. 6. Variomatrix decoder output levels for a left-front encoded signal (L_T input 300mV, R_T input 124mV.)

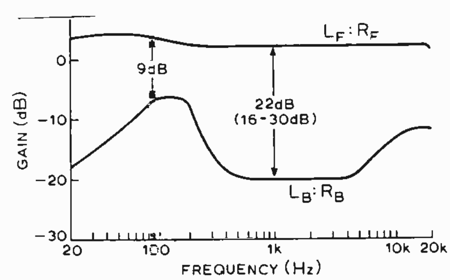

Fig. 7. Decoder output levels for a centre-front encoded signal. (L_T and R_T inputs 424mV.)

Components

Resistors ¼W 10%, except those marked * which are 5%.

R_1	5.6k	R_{78}	33k
$R_{2, 8}$	47k	$R_{80, 83}$	270k
R_3	100k	$R_{81, 84}$	120k
$R_{4, 10}$	1k	$R_{82, 85}$	390k
$R_{5, 6}$*	2.2k	R_{86}	680k
R_7	3.3k	$R_{87, 88}$*	120k
R_9	100k	$R_{89, 90}$	56k
$R_{11, 12}$*	2.2k	$R_{91, 92}$	1.5M
R_{13}	3.3k	$R_{93, 94}$	470k
$R_{14, 15}$*	68k	$R_{95, 96}$	1M preset
R_{16-21}*	22k	$R_{97, 98}$	1M
R_{22-25}*	15k	$R_{99, 100}$	100k
R_{26-29}	47	R_{101}	4.7k
R_{30-33}*	1.2k	R_{102}*	2.7k
R_{34}	680	$R_{103, 104}$	12k
$R_{35, 36}$	120k	R_{105}	470
$R_{37, 38}$*	27k	$R_{106-109}$*	68k
R_{39-42}	220k	R_{110}	680k
$R_{43, 44}$*	27k	$R_{111, 112}$	330k
R_{45-48}	220k	$R_{113, 114}$	120k
R_{49-56}	2.7k	$R_{115, 116}$	330k
R_{57-60}	33k	$R_{117-120}$*	120k
$R_{61, 63}$	4.7k	$R_{121-124}$	56k
$R_{62, 64}$	100k	$R_{125, 126}$	2.2M
$R_{65, 67}$	4.7k	$R_{127, 128}$	1M preset
$R_{66, 68}$	100k	$R_{129, 130}$	330k
$R_{69, 70}$	1.8k	$R_{131, 132}$	1M
$R_{71, 72}$*	220k	R_{133}	10k
$R_{73, 75}$*	680k	$R_{134, 135}$	100k
$R_{74, 76}$	330k	$R_{136, 139}$	560
$R_{77, 79}$*	6.8k	$R_{137, 138}$	15k

Capacitors

Types E are electrolytic, PC Siemens B32540 polycarbonate, PS 30V polystyrene. Those marked * should be 5% tolerance.

C_1	10µ	E	C_{63}	6.8n	PC
$C_{2, 5}$	3.3µ	E	$C_{64, 65}$	5.6n	PC
$C_{3, 6}$	6.8n	PC	$C_{66, 67}$	10n	PC
$C_{4, 7}$	1µ	E	$C_{68, 69}$	2.2n	PC
$C_{8, 12}$	100µ	E(10V)	$C_{70, 71}$	33µ	E
$C_{9, 10}$	100p	PS	C_{72}	10µ	E
$C_{11, 13}$	47µ	E(10v)	C_{73}	2.2n	PC
C_{14-17}	3.3n	PC	$C_{74, 75}$*	6.8n	PC
C_{18}	47µ	E(10V)	$C_{76, 77}$*	470p	PS
C_{19-22}	10µ	E(10V)	C_{78}	33µ	E
C_{23}	15n	PC	$C_{79, 80}$	4.7µ	E
C_{24-27}	470p	PS	C_{81-84}*	1n	PC
$C_{28, 29}$	33n	PC	$C_{85, 86}$	4.7µ	E
$C_{30, 31}$	10n	PC	C_{87}	6.8n	PC
$C_{32, 33}$	33n	PC	$C_{88, 89}$	1µ	E
$C_{34, 35}$	10n	PC	$C_{90, 91}$	5.6n	PC
$C_{36, 37}$	39n	PC	$C_{92, 93}$	33n	PC
C_{38}	560p	PS	$C_{94, 95}$	2.2n	PC
C_{39}	2.7n	PS	$C_{96, 97}$	18n	PC
C_{40-43}	1µ	E			
C_{44-47}	3.3µ	E			
$C_{48, 49}$*	1n	PC			
C_{50}	10µ	E			
$C_{51, 52}$*	330p	PS			
$C_{53, 57}$*	3.9n	PS			
C_{54}*	470p	PS			
$C_{55, 56}$*	3.3n	PC			
C_{58-61}	4.7µ	E			
C_{62}	33µ	E			

Semiconductor devices

IC_1	HA1328	Hitachi
$IC_{2, 4}$	HA1327	Hitachi
IC_3	HD3103P	Hitachi
Tr_1, Tr_2	BC214K	
$Tr_3 - Tr_{10}$	BC209A	
$D_1 - D_4$	1N4148	

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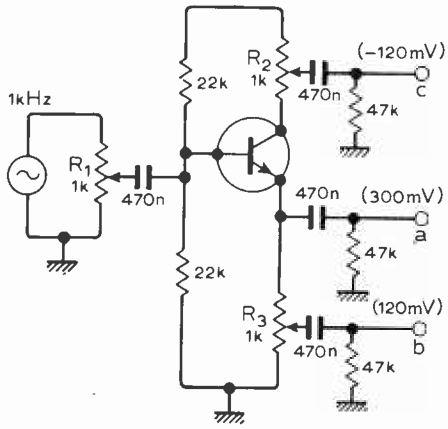
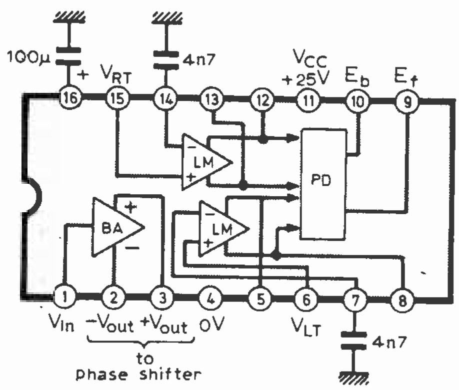
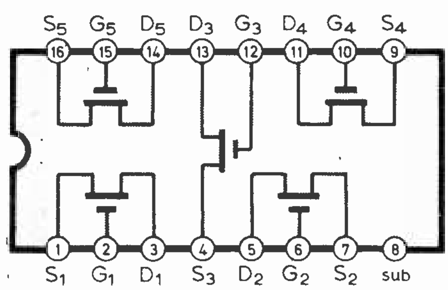


	L_T	R_T
L_F	a	b
R_F	b	a
L_B	a	c
R_B	c	a

Fig. 8. Simple encoder used for setting up decoder. L_t and R_t signals are simulated by combining pairs of outputs from a, b and c.





Connections for integrated circuits HA1327 (top) and HD3101 (bottom). Connections for the HA1328 appear in Fig. 2, August issue.

1kHz signal to the encoder, use the R_F outputs to confirm that the R_F to L_F separation is not less than 14dB and that its R_F to R_B separation is not less than 12dB. Similarly, with a 300mV, 1kHz signal fed to the encoder and choosing the L_B outputs, confirm that the L_B to R_B separation is not less than 14dB and that its L_B to L_F separation is not less than 12dB. If this procedure produces unsatisfactory results, repeat the above adjustments, aiming for greater separation values, such as 20 to 24dB, than those originally specified (18dB and 17dB). Then repeat the confirmation procedure. Differences in separation values between the channels are often due to performance variations of the i.cs and resistors used but the preceding adjustments should eventually create the separation values indicated.

Switching arrangements

For QS decoding, S_1 and S_2 should be open-circuit. For the surround synthesizer function S_1 should be closed (points identified by SU on the p.c. board supplied with the kit) and for the hall mode, S_2 should be closed (points identified by H on the board). In this last-mentioned mode, the two front channels are fed directly from the L_T, R_T signals and the back signals are obtained from the L_B and R_B decoder outputs.

Acknowledgement. Thanks to M. Ishikawa of Sansui Audio Europe SA (London showroom) for help and encouragement with this project.

Correction. We regret a transposition of copy that occured in the August article. In column three of page 57, the sentence starting line 16 should have appeared as the last sentence in the following paragraph.

Kits are available for the decoder described —full details from Compcor Electronics Ltd, 9 Dell Way, London W13 8JH.

Sixty Years Ago

Admiralty regulation 37B was printed in our issue for September, 1916. It states that all vessels of greater than 5000 tons would be required to take out a licence for a wireless installation. The difference that "wireless" made to life at sea is illustrated by the fact that regulation 37A enforced ships over 500 tons to carry signalling flags for use by day and flash lamps for use on clear nights.

We have remarked before on the decidedly snooty approach adopted by our predecessors when answering readers' queries. The following example is, we feel, approaching the limit.

"Now we have answered all your questions, we would point out to you that if you intend to take up wireless operating, you will have to pay much greater attention to your spelling and grammar that you have done in the letter under reply. We find in it no less than nine bad spelling errors, the frequent use of "has" for "as", and many other bad mistakes in grammar. Before worrying yourself as to whether a wireless operator in the Navy can rise to the position of an Admiral, don't you think you had better consider whether you can rise to become an operator?"

Literature Received

A catalogue from Telonic fully describes a range of r.f. filters of low-pass, band-pass and band-stop types for use in the range 30MHz to 12GHz. A range of wavemeters is also described and mention is made of diplexers, multiplexers and microwave assemblies. Telonic Altair UK Ltd. 2 Castle Hill Terrace, Maidenhead, Berks WW401

A leaflet from INSPEC, which is the information service of the I.E.E., describes the new series of 24-page monthly Key Abstracts — single-discipline periodicals. Inspec, Savoy Place, London WC2R 0BL WW402

We have received the latest Chromasonics catalogue — a very full listing of components for the experimenter. In addition to a comprehensive list of semiconductors, including integrated circuits, there are passive components and hardware, together with r.f. and audio modules. Chromasonics Electronics, 56 Fortis Green Road, London N10 3HN WW403

Miniature switching power supplies from Advance are described in a new leaflet. Type MMG 5-5 provides 5V at 5A and is accompanied by MMG 12-2.5, 15-2.0 and 24-1.4. The units will accept 110V or 240V inputs and an optocoupler provides 5.7kV peak isolation between input and output. Gould Advance Ltd, Raynham Road, Bishops Stortford, Herts WW404

Four types of video filters for band limitation, low-pass gaussian filters, colour sub-carrier pass and rejection types and l.p. sections for "I" and "Q" band limitation are covered in a catalogue from Matthey. Both electrical and mechanical information is provided. Matthey Printed Products Ltd, William Clowes Street, Burslem, Stoke-on-Trent, Staffs ST6 3AT WW405

The range of resolvers by Moore Reed is the subject of a new leaflet. The types described include computing, feedback, data transmission, brushless, phase-shift, slab and multipole resolvers and 3-phase to 2-phase transolvers. Single-output pick offs are also covered. Moore Reed Co. Ltd, Walworth, Andover, Hampshire SP10 5AB WW406

Counters made by Hewlett Packard are briefly described in a new leaflet. The instruments cover the range from the low-cost 5381A (80MHz) to an automatic microwave counter, the 5340A 23GHz type. Hewlett-Packard Ltd, King Street Lane, Winnersh, Wokingham, Berks RG11 5AR . WW407

A range of flow-meters, designed to cope with high temperatures (130°C), high pressures (2000 p.s.i.) and low rates of flow (two drops per second) has been produced by Litre Meter and is fully described, together with the associated electronics and application information, in a new brochure, available from Ryefield Crescent, Northwood, Middx HA6 1NN WW408

Full information on racks and consoles in the Imhof-Bedco range is contained in a new catalogue from Imhof-Bedco Standard Products Ltd, Ashley Road, Uxbridge, Middx WW409

Thyristors and triacs are comprehensively treated in a new book from RCA, "The RCA Thyristor and Rectifier Manual, TRM-445". Theoretical and practical information is provided in 376 pages and there are performance figures for all devices, together with a circuit section. RCA Ltd, Solid State — Europe, Sunbury-on-Thames, Middx. Price is £2.80, by post.

Electronic timers, type ETA, are specified briefly in a new leaflet. The units are available for a.c. or d.c. working, are adjustable or fixed and can be either surface mounted or plugged into a 11-pin socket. Timing periods are from 1 second to 20 minutes. Appliance Controls Ltd, Cordwallis Street, Maidenhead, Berks SL6 7BQ WW410

British Library R and D report 5257 is a study of principles, practice and prospects for facsimile transmission in the UK. The 43-page book is obtainable, at a cost of £2.50 by post, from Publications section, British Library Lending Division, Boston Spa, Wetherby, West Yorkshire LS23 7BQ.

Strain gauge applications and specifications are given in a catalogue from Tinsley Telcon, which includes descriptions of several new gauges. Tinsley Telcon Ltd, Werndee Hall, South Norwood, London SE25 4BR WW411

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Communications 76

Topics from the Brighton conference

The Communications 76 conference attracted 100 contributions, given in three concurrent sessions to an audience of 660 delegates from 32 countries. Organized this time by the IEE, the biennial conference was held in June at Brighton.

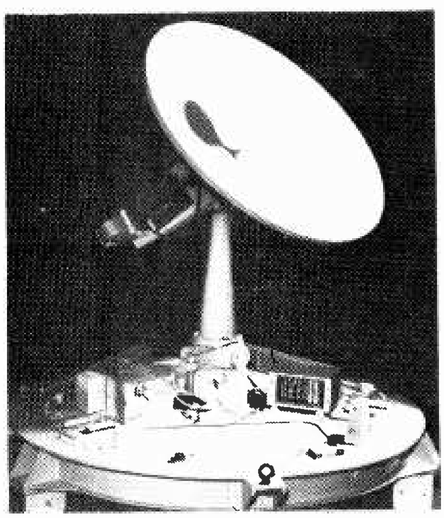
Increased demand in all areas of mobile radio use, bringing with it allocation problems, interference, propagation and other social and legal considerations, had many delegates pursuing and participating in the mobile radio presentations with concern and determination, in the hope that they would find the answer to some of their own particular problems.

Further interest came from the mobile radio research consortium formed between the universities of Bath, Birmingham and Bradford, and the advances announced by the Bath team in producing the "sideband diversity radio system" aimed at reducing mobile fading (see News, August issue, and block diagram). Ideas regarding the implications of a Citizens Band in the UK, not least being the choice of a spectrum allocation, were undoubtedly in the minds of some of the delegates pursuing the mobile radio theme.

In discussing the future of civil mobile radio systems W. P. Nicol of the Home Office directorate of telecommunications commented that, bearing in mind that mobile communications is concerned with people and vehicles in motion under the sea, on the sea, under the land, on the land, in the air and in space, only 3% of the hard-worked 30-1000MHz radio spectrum is allocated for mobile use. Of the rest of this spectrum, 60% is for broadcasting, 30% is for defence and 7% is for everything else in the field of radio communications. "Now that would scarcely reflect very strong interest or a fair share of the frequency spectrum for mobile radio," he said.

He added that although no communication system will develop in isolation from the society or organisations which it serves, mobile radio, which should have developed accordingly, is still in its infancy, often providing speech communications in simple, nevertheless limited-range, networks little different from those of the early days. However, over the past 20 years modifications in the channel spacings from 100kHz to 12.5kHz have taken place in the v.h.f. band and, despite equipment repercussions, are seen to be successful demonstrations of how to get a quart into a pint pot.

Continuing, he said that users and manufacturers alike might be excused — as they constantly battle within the channel-space constraints and pick up the financial tab — if they are increasingly prompted to question the basic restrictive framework governing the work. Although there has been a succession of commissions of enquiry and parliamentary committees considering evidence and making recom-



Antenna unit of the Arion shipborne satellite communication terminal from Marconi. Arion, which is the first British commercial marine satellite terminal, made its debut at Communications 76 and is designed to work into the Marisat satellite system. The terminal provides duplex real-time telephony and telex and is capable of carrying facsimile and up to 4,800bits/s two-way data.

IS FURTHER REDUCTION IN V.H.F. CHANNEL SPACING POSSIBLE?

The implications of amplitude modulation in a channel spacing of 6.25kHz, which is the next logical step from the present 12.5kHz, has been studied by Pinches and King of Marconi Communications Systems. Factors considered were transmission and reception bandwidths, frequency stability, receiver selectivity and radiated and impulse interference. Experiments showed that, for an audio cut-off frequency of 2kHz, an increased rate of attenuation above the cut-off frequency was experienced, as compared with the same conditions in a 12.5kHz-spacing system. Quality was found to be improved by introducing a fall-off in response at the lower frequencies to provide a balanced effect. Synchronous detection, using tracking i.f., was considered by the authors to be useful because it permitted reduced i.f. filter bandwidth while at the same time improving the receiver selectivity. To remain within the Home Office requirements for frequency stability, temperature compensation or frequency synthesis would be necessary in the 150MHz region only; in the lower frequency regions the tolerances could be readily achievable.

Adjacent-channel protection ratio was up to 10dB worse for the proposed 6.25kHz system, increasing interference radius by up to three times. Initial trials indicated that there was little or no extra degradation due to impulse noise and that intermodulation is not a problem where doubling of the number of channels is coupled with halving of channel loading. Frequency modulation would be less satisfactory than a.m., in terms of transmitted sidebands; receiver filtering would introduce 5-10% distortion at 1.5kHz.

AQUEOUS AUDIO

At frequencies normally used for radio, energy is largely reflected from the surface of the ocean and any refracted into the water is rapidly absorbed. The magnitude of this effect is proportional to frequency and at around 1kHz, radio waves can penetrate to a reasonable depth, but the size of the transmitting aerials and the power needed at this frequency mean that radio communication is limited to one direction. On the other hand, compression waves travel well through water and can be used, as was described in a paper by D. W. Watson, of Marconi.

The base signal (speech or data) is modulated onto a carrier in the 10kHz to 100kHz range, depending on the range required (long range — low frequency), and the bandwidth needed. For very long range communication, 1kHz is used, but the bandwidth is only a few hundred hertz and such a channel can only be used for "digital" tones. Problems include multipath propagation, which is more common in sonar than in radio; reverberation due to scattering in the water or from the sea bed (not a serious problem) and Doppler effect, which can result in a 2% shift in frequency and which can badly affect reception without automatic frequency correction. Selective fading is counteracted by frequency diversity switching and deep fading or active-sonar interference can be overcome by time-diversity operation.

The electronics used are well-known, although the load presented by the transducer is considerably more complex and variable than that seen by a normal audio power amplifier.

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mendations on financial viability, efficiency and social service in sound broadcasting, television, postal, telegraph and telephone services, so far land-mobile radio had not featured in public evaluation. "I believe one answer lies in a lack of organisation of users and manufacturers alike; a second lies in the fact that so far there has been little attempt to create public interest or demand," he said. "Indeed I would say that there have been positive indications of action to smother such demand on the extremely negative basis that there are enough fixed land-line telephone problems already without creating more by introducing mobile-radio telephones."

Mr Nicol could see a clear necessity for a massive structure of transmitter and receiver stations to provide coverage linked to terminals within the fixed service distribution networks. Civil maritime and civil aviation have limited systems already but they have had a great deal of direct spin off from military research and development which civil land-mobile has not enjoyed because of distinctly different user problems involved in military land-mobile communications systems.

Civil land-mobile radio, he believed, would dominate the development of systems for vehicles and associated equipment in the next decade and could provide the vast, as yet, untapped markets. Secondly, he believed that advantages can be obtained from joint project co-operation between marine, air, space and land-mobile users; this was almost non-existent and must be improved upon. Attention should also be given to universities and other institutions, and to obtaining public opinion such as can be obtained from conferences and exhibitions like Communications 76. "Governments and men in corridors of power must be properly informed by the evidence derived from all levels of the business and this evidence must be published to develop public opinion," he said.

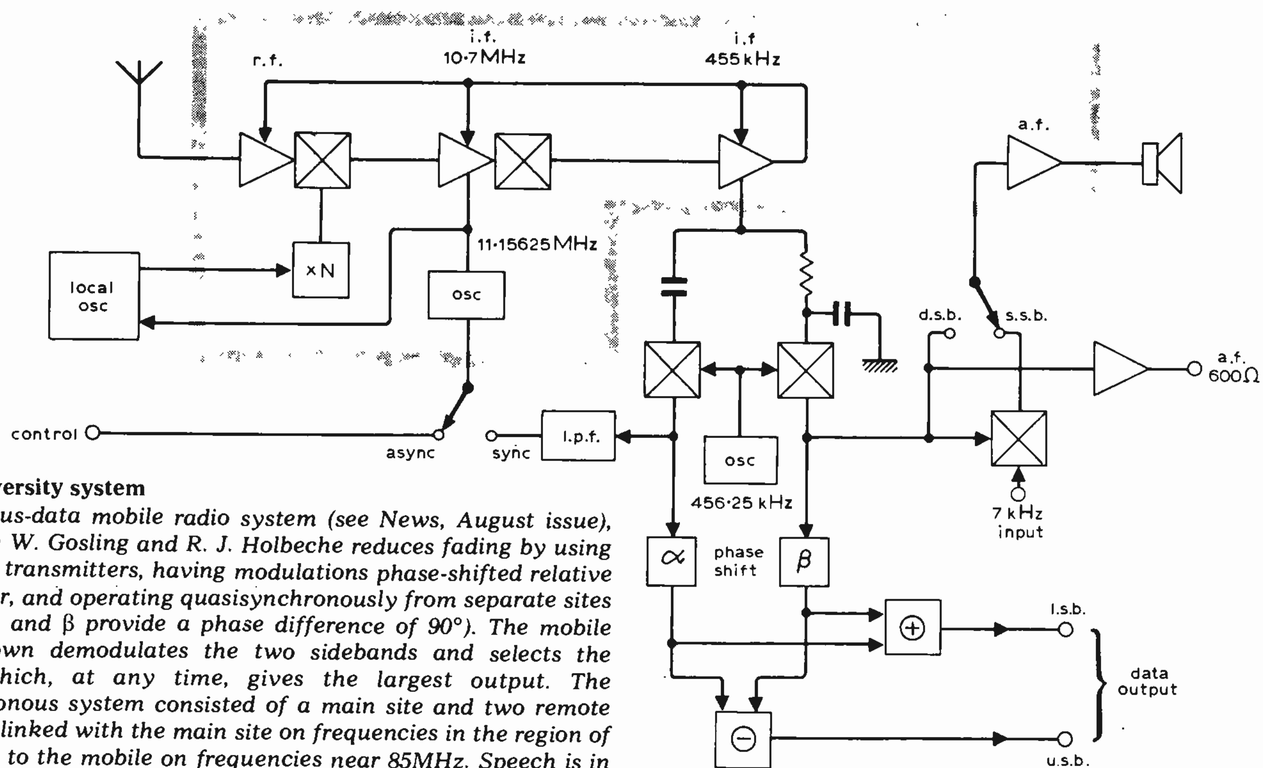
"The time is ripe for such an examination to assist clear policy and to properly exploit radio in the mobile environment. This time is already overdue." One of the greatest problems, was not that of knowing what should be done but of convincing other people that something is practical, economical, necessary, maintainable and not too progressive for use in a conservative organisation advancing at its own pace. We must lift our eyes from the circuit board and get on with the job. It should be done now, it should done well, and it should be to the advantage of all the people.

MICROPROCESSOR IN MARISAT SHIP TERMINAL

Marisat, the ship-to-shore satellite communication system, is to employ a microprocessor and associated logic in its antenna terminal. The microprocessor, which is described in a paper by J. H. Hollom of Marconi, uses a p.r.o.m. for the programme and a r.w.m. for the data, teleprinter interface and radio transmit and receive interfaces. A microprocessor was chosen because it was considered doubtful that discrete logic could handle the many tasks it would be expected to perform, and a mini-computer would have been too expensive. Marisat has a t.d.m. (time division multiplexed) communication system and the ship terminal itself will have available one voice or data channel and one telegraph channel, the voice channel being independent of the t.d.m. carrier. The received signal is divided into frames, each subdivided into three parts, providing both calling and signalling information. There are also 22 telegraph channel slots. Tasks of the microprocessor include detection, decoding, channel selection, transmitter and receiver control, error checking and testing, monitoring and other control operations.

DIRECTION FINDING IN THE H.F. BAND

Plessey, in collaboration with the Ministry of Defence, have succeeded in extending the bandwidth of their multibeam direction-finding (d.f.) system to cover the band 1.5 to 30MHz. The previous system was suitable for use from only 1.5 to 10MHz. J. T. Starbuck of Plessey described in his paper how the system, which uses a circular arrangement antennae, is extended in range by the addition of a smaller circle of antennae and a corresponding beam-forming network. The outer antennae provide coverage from 1.5 to 15MHz and the inner ones from 6 to 30MHz. A goniometer, consisting of a stator having 24 equally-spaced combs, each fed from an antenna, and a rotor (revolving at 500rev/min and having 24 combs capacitively coupled to the stator combs but only covering a third of the circumference) enables groups of eight adjacent antennae to be scanned sequentially. Hybrid networks vectorially add and subtract the received signals and generate beams containing the required d.f. data. Although the d.f. system is subject to errors caused by time-dependent propagation and fading, in trials measuring the bearings of Berne-listed transmitters overall accuracies varying between 1 and 2° r.m.s. were obtained; ground-wave tests gave accuracies as good as 0.6° r.m.s.



Sideband diversity system

The voice-plus-data mobile radio system (see News, August issue), described by W. Gosling and R. J. Holbeche reduces fading by using two or more transmitters, having modulations phase-shifted relative to each other, and operating quasisynchronously from separate sites (Networks α and β provide a phase difference of 90°). The mobile receiver shown demodulates the two sidebands and selects the sideband which, at any time, gives the largest output. The quasisynchronous system consisted of a main site and two remote transceivers linked with the main site on frequencies in the region of 150MHz and to the mobile on frequencies near 85MHz. Speech is in s.s.b. form and data, in either f.s.k. or d.p.s.k. form, is a d.s.b.s.c. modulated onto a carrier offset from the channel centre.

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India's satellite broadcasting

Interim report on SITE, the television broadcasting experiment using the ATS-6 satellite

by Jack Dinsdale, M.A., M.Sc. *Cranfield Unit for Precision Engineering*

Regular readers of *Wireless World* will be aware of the Indian SITE (Satellite Instructional Television Experiment) project, in which a geo-stationary satellite has been used for the twelve-month period from August 1, 1975, to beam monochrome television programmes to receiving stations in villages in selected areas of rural India. This has been an attempt to promulgate adult knowledge and accelerate learning in the general areas of agriculture, health and hygiene, domestic science and current affairs, in addition to giving children the broader view of geography, science and the arts that can only be gained from television. The initial experiment was completed on July 31, 1976, when the satellite was moved to a new location.

During a recent trip to India, the author visited a number of establishments concerned with the SITE programme, and spoke to some of the scientists and sociologists responsible for the project. Although a detailed study of the experiment will not be completed for several years, some of the early results are already becoming available, and they are proving to be of great interest. To assist in the analysis of these results, this article provides some background information about India and places the project in its sociological context, illustrating some of the problems facing the organising team in the matters of population, language, accessibility and communication.

Audience

The Indian subcontinent extends over 1,269 million sq. miles (13 times the area of the British Isles) and has a population of over 600 million (11 times that of the UK). Of this population, 80 per cent live in the 570,000 villages which are situated mainly in outlying positions away from the towns and have very little day-to-day contact with the rest of India or even with neighbouring villages. Because of the lack of transport and communication facilities, each of the 27 states in India has developed independently from earliest times, and still retains its own individual language; thus there are still currently spoken within India at least 16 major languages with a further 60 intermediate languages and over 700 dialects. Although 35 per cent of the population now speak Hindi, which is being strongly sponsored by the government as the official national language, and a smaller percentage, principally the well-educated, speak English, the great majority of Indians can only converse with those living within the close vicinity and hence speaking the same dialect. An additional factor, which may seem amazing to Europeans, is that 80 per cent of Indian women are illiterate; when one considers the important role played by women in birth control, hygiene, and food preparation, i.e. in those very areas that SITE is trying to cover, some idea begins to emerge of the difficulties facing the SITE team.

Communication

In spite of the overwhelming problems posed by geography and the multiplicity of languages, India has for many years made serious and realistic attempts at mass-communication. The printing process was introduced to India by western missionaries at the time of the Mogul Empire during the 16th century, and India is one of the leading producers of newspapers, journals and technical books. During the last century, at the time of the British Raj, India adopted the movie film as an obvious and essential adjunct to the process of mass communication, especially among the semi-illiterate, and today India leads the world in this field, producing over 500 full-length movies each year. The majority of these use the Hindi language, and they aim to teach by way of a simple "plot" the elements of technology, agriculture and the social and domestic sciences.

Early this century a regular sound radio transmission service was introduced, but this medium did not generate any widespread interest until the 1939-45 war years, when its great potential became apparent. Today there are some 15 million licensed radio receivers in India (plus perhaps a further 10 million unlicensed sets) but this represents only 20 per cent of the total number of "family units", and whereas 90 per cent of the licensed radio sets are in the cities, 80 per cent of the population live in the villages. During the mid-1950s the government made a serious attempt to generate an interest in radio communication in the villages through a "Radio Rural Forum" scheme. Unfortunately, this has not achieved any real success, partly because radio sets are very rare outside the cities, and since the experience of sound radio is no longer a novelty it often fails to make an impact. The programmes which are planned and presented by All India Radio (AIR), are generally urban-orientated and thus they often have little relevance or interest to village-dwellers. Furthermore, the programme producers themselves have been trained either in the cities or overseas, and they have virtually no concept of the mentality or requirements of the villages. Many observers now feel that the planning of programmes for rural areas should *start* with the local needs, and that only then will the local centre approach achieve any significant success.

Message

Television, as understood in the UK, could be regarded strictly as a luxury which India cannot afford at present. However, the government considers it essential for their social programme, and after starting an experimental transmission in Delhi in 1954 All India Television (AIT) provides a mono chrome service in seven major cities. At present there are only 350,000 receiving sets in the whole of India, to serve over 600 million people, but the Indian Government is proposing to augment the present transmitters in Delhi, Bombay, Calcutta and Madras with additional transmitting centres in Jaipur, Hyderabad, Raipur and Cuttack by March, 1977, and with further centres at Muzaffarpur, Gulbarga, and Kanpur later that year. The same criticisms could be levelled at the TV programme

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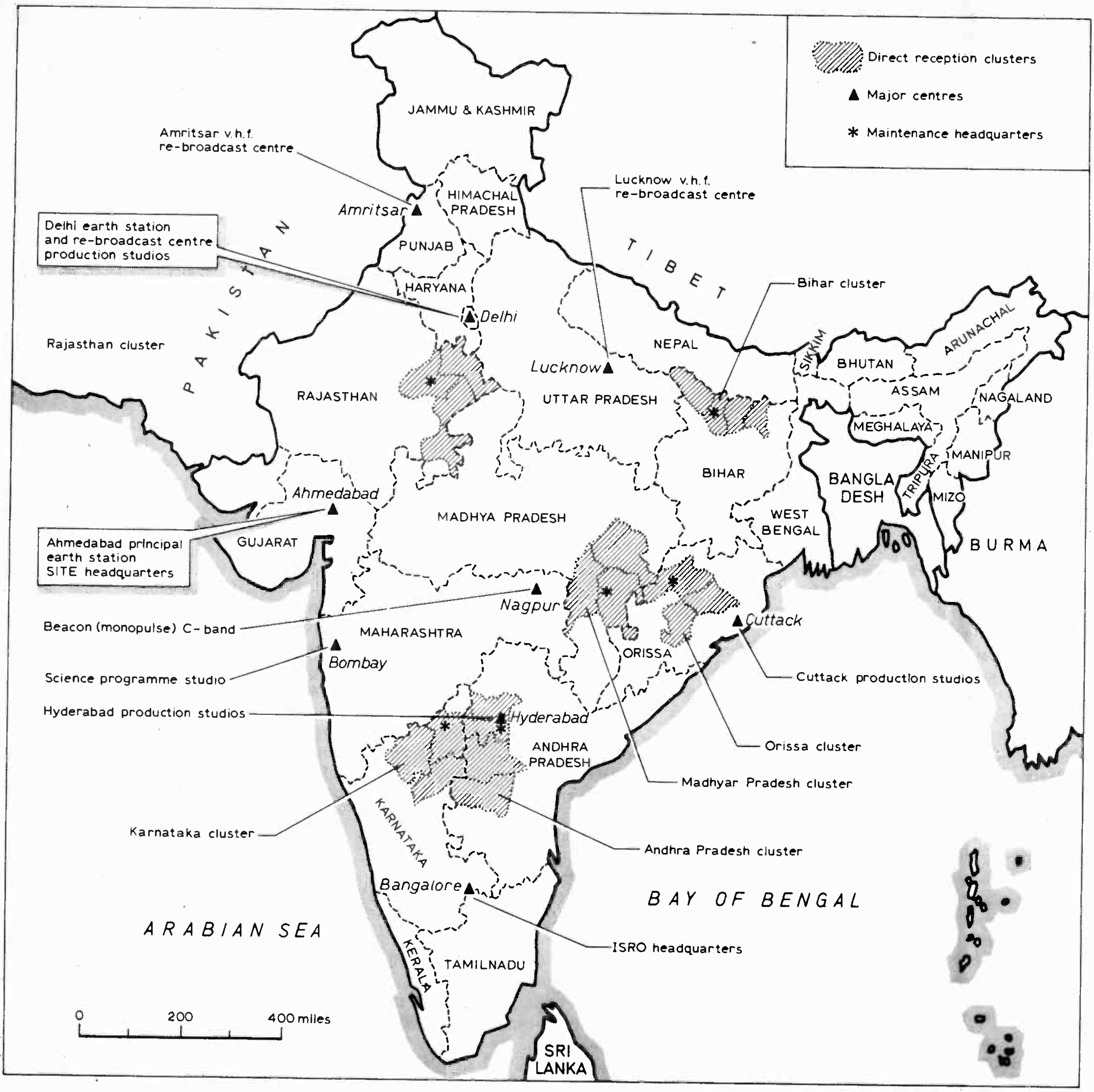

Map showing the clusters of villages which received the SITE broadcasts; also the major technical and programme centres.

producers, that they are urban-orientated; but as it is not possible to receive the AIT transmissions outside the cities, this criticism is at present hardly relevant. However, serious problems have arisen when using these same production staff to prepare programmes for SITE, which is specifically directed at the villages.

The SITE project originally stemmed from an agreement between the Indian Government and NASA in 1969 to make available a maximum of four hours per day of the Applications Technology Satellite 6 (ATS-6) which would be positioned over the Indian Ocean from August 1, 1975, until July 31, 1976. It was decided to utilise this transmission time for

(a) A programme for school children aged from 6 to 11, transmitted from 10 to 10.30 a.m., using a common video channel but with a number of audio channels to cater for different language groups.

(b) A series of evening programmes for adults, covering the broad areas of: technology, largely devoted to agriculture, i.e. pesticides, seeds, fertilisers and new techniques; family planning; health and hygiene; and nutrition.

Each evening the transmission started with the common National Integration programme from 7 to 7.30 p.m. in the Hindi language, produced in Delhi, and this was followed by three 40-minute local-dialect programmes until close-down at 9.30 p.m.

The children's programmes were not curriculum-orientated; rather, they attempted to provide a broad-based back-up to local teaching effort in: science, including physics, chemistry and elementary technology; social science, including georgraphy, history and traditions; and arts and crafts.

In addition there were a number of specialist seminars conducted "over the air" to help in the training of local teachers. Recently it was reported that

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24,000 primary school science teachers had been trained in the content and methodology of the teaching of elementary science by means of a 12-day course organised by the National Council of Educational Research and Training (NCERT). The course used SITE, radio and printed material, and was aimed at helping the science teachers to handle their job more effectively. Ninety-four per cent of the teachers felt that they had learned a lot, and 83 per cent considered television to be the best medium for this type of training.

The SITE satellite was geo-stationary over the Indian Ocean, and beamed at Nagpur. It served six clusters of villages, as shown on the map: Rajasthan, Bihar, Madhya Pradesh, Orissa, Karnataka, and Andhra Pradesh. Each of the states in which these clusters lie has its own language; for example the natives of Andhra Pradesh speak Telegu, while those in Karnataka (formerly Mysore) speak Kannada or one of its many dialects. The village clusters were selected to form three groups with closely-related tongues so that the audio channels of the SITE could be limited to three (plus of course the transmission on all three channels using the national Hindi language).

Reception

The receivers were 23-inch sets developed in India by ECIL at Hyderabad. Attempts to establish a small number of primary receiving stations linked to the villages by microwave links proved difficult due to the mountainous and in many cases forested nature of the terrain. However, direct reception in the villages themselves, using a 13ft diameter chicken-mesh antenna and a front-end converter proved very effective, and in general gave excellent quality of reception. As reported in the July issue of *Wireless World*, Arthur C. Clarke (of *2001 Space Odyssey* fame) obtained excellent reception at his home in Sri Lanka (formerly Ceylon) which is a considerable distance from the beam centre. Unfortunately, only 2,400 receiving sets were available for the project, equally divided among the six clusters, thus limiting still further the number of individuals actually able to participate in the experiment. The receivers were generally set up in a local school, hospital or village centre, and the size of the rooms available, together with the screen size, limited the maximum number of viewers to about 30 at any one time. There was also the prime requirement of a reliable domestic mains electricity supply, which is very difficult to provide continuously in many of the more distant villages, and of course the sets themselves had to be maintained in operation by a few small teams of technicians, who often were not able to repair sets until many weeks after a fault had been reported. In order to alleviate the problem of an uncertain electricity supply, NASA sent to India last May two solar cell arrays, each capable of supplying 260 watt-hours per day under Indian sunlight conditions and hence capable of running two of the SITE receivers.

The preparation of suitable programmes has been a great learning experience for the production, script-writing and camera staff. In many cases, the research personnel allocated to the SITE project had no experience of camera techniques, and have had to learn as they go. The cameras do not function above 110°F, the temperature obtaining in much of Southern India for the greater part of the year, and at one of the three major production centres (Hyderabad, Cuttack and Delhi) there were only two cameras available for the SITE project.

Audience reaction

The reactions of the villages presented with the SITE programmes have been varied. It has of course to be appreciated that many of the rural population have never seen a picture before, let alone a moving one with sound as well, and for these the experience has been traumatic. In the evening programmes for adults, it was found that straight talks and interveiws did not hold the rural population. What they preferred were features and documentaries, especially those produced "on location". The majority of villagers work in the fields from 5 a.m. to 7 p.m., and they were not interested in serious instructional agricultural items at the end of a hard day's toil; what they liked best was pure unadulterated entertainment. They generally went to bed around 8 p.m. and since in the north the winter nights are cold, the incentive offered by television had to be extremely strong. In general they were willing to watch the National Integration programme in Hindi from 7 to 7.30 p.m. but on several occasions observers found the entire audience sound asleep in front of the receiver during the local dialect programmes from 7.30 to 9.30 p.m. It was also found that villagers had as many evening commitments as their urban cousins, and were certainly not in a position to sacrifice seven evenings a week to SITE. For this reason, it is now felt that programmes on alternate nights are likely to get a better attendance. In many villages the receiver was installed in a small room which became hot and stuffy during the crowded evening viewing period. Consequently, the women often refused to come, and unfortunately much of the information directed at the women had little impact.

The problem occasionally arose (as already mentioned) that some of the urban-orientated programmes did not hold the interest of a rural audience, to whom the concept of stainless steel utensils and pressure cookers for example was quite alien. The opposite situation also applied: a control group of city children watching in an auditorium in Bangalore lost all interest in a programme on snakes, and some of them even went out to play. This was probably because the programme was rural-orientated, and the urban children had no liking for it.

Nevertheless, the SITE project already has a number of "success stories" to its credit. For example, in Bijapur, a far-flung district of Karnataka, the SITE programmes have helped the villagers to adopt more advanced techniques in agriculture and even prompted the women folk to go to the nearby town to buy vegetables. On the other hand, the villagers of Hirekasbi, although keen to improve their lot with advanced techniques conveyed to them via television, have found themselves unable to adopt better sanitary conditions, use better seeds or eat more nutritious food because of their lack of money.

Some success

In conclusion, the SITE hardware can be regarded as a qualified success. The programming on the other hand seems to indicate a lack of sufficiently detailed planning, in terms of the budget, available trained manpower, and time, to exploit the full capability of the medium. There has to be a clear understanding not only of the instructional objectives of SITE, but of how to make best use of the social scientists and communication researchers working on the project. However, the organising team have been pleased to see clear signs of success in many areas. They accept that one year is clearly far too short a period for the development and optimisation of the major exercise presented by SITE, not only for the researchers and programme producers but also for the village audiences, and the Indian Government has recently announced that six terrestrial transmitters will be set up for television transmission to SITE areas after the withdrawal of the NASA satellite. These transmitters will cover about 40 per cent of SITE villages — about 1,000 out of the 2,400 covered by the SITE project. This will enable the programme techniques and timings to be perfected, and hence give a greater chance of success for the experiment. Thus it appears that the valuable work started last year will be able to continue in the future, to the growing benefit of a great nation working successfully to bring to all of her people the human dignity and freedom from poverty, hunger and disease which is surely their birthright.

The author wishes to acknowledge the assistance in the preparation of this article readily given by the Indian engineers, scientists and sociologists concerned with the SITE project. However, responsibility for opinions expressed must rest firmly with the author.

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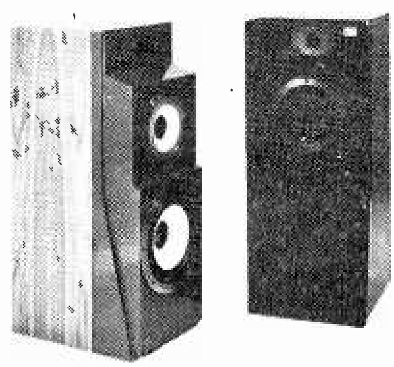
Audio 76, Harrogate

Traditionally the audio show at Harrogate has been the event at which manufacturers introduce their new products to the UK. This year is no exception, and on this page are listed the trade names that will be represented. Audio 76 will be at the Hotels Majestic and Cairn, Harrogate, Yorkshire, September 2-5. It opens at 11 a.m. each day. Trade visitors only on 2nd and 3rd till 6 p.m. Public and trade on 3rd, from 6 to 9 p.m.; on 4th till 9 p.m.; and on 5th till 7 p.m.

The capability of playing CD-4 records is claimed for this Shure M24H four-channel cartridge. The stylus tip is hyperbolic and the low stylus mass of 0.39mg enables the tracking force to be as little as 1 to 1.5g.



Stepped mounting of drive units in this Leak 3080, largest of the new 3000 range, is to provide time-delay compensation, which is said to provide an improved stereo image and a greater impression of depth in a single speaker.

Accuphase
Acoustic Research
ADC
Aiwa
AKG Acoustics
Alba
Alpha
Altec Lansing
Armstrong
Arnold Electronics
Atron
Audiomaster
Audio Packs
Audio Reflex
Audio Technica
Autocar Accessories
BASF
Beyer Dynamic
BIC
Bose
BSR McDonald
BWG
Castle Acoustics
Celestion
Collaro
Condor
Connoisseur
Curb
DBX
Doram Electronics
Direct (Design)
Disc O Vac
DSC (Consumer Products)
Dual
Empire
Falcon / Badger
A. C. Farnell
Farnell KF
Federation of British Audio
Ferrograph
Fisher
Fons International
Fuji
Garrard
Goldring
Harman Kardon
Howland-West
Infinity
Isophon
Janorhurst Ltd
Jecklin Float
JVC
KEF
Keesonic
KLH
Koss
Lecson Systems
Leak
Lentek
Loewe Opta
Lowther Onlife Developments
Lux
3M United Kingdom
Marantz
Maxell
Metrosound
Micro Acoustics
Mordaunt-Short
NAD
Nakamichi
National Panasonic
NEAL
Ortofon
Peerless
Pickering
Pioneer
Poly Planer
Pyral Magnetics
Quad
Record Housing
Richard Allan
Ross Electronics
Ross Unison
C. Rogers (Trade name to be announced)
Jim Rogers
Rotel
Sansui
Sanyo
Scan Dyna
Sennheiser
Shure
Sony
Stanton
Stax
Strathearn Audio
Studiocraft
J. E. Sugden
Superex
Tandberg
Tannoy
TDK
Teac
Technics
Tenorel
Thorens
Toshiba
Trio
Uher
Vac O Rec
Wharfedale
Yamaha
Zerostat

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Self-setting time code clock

2 — Construction

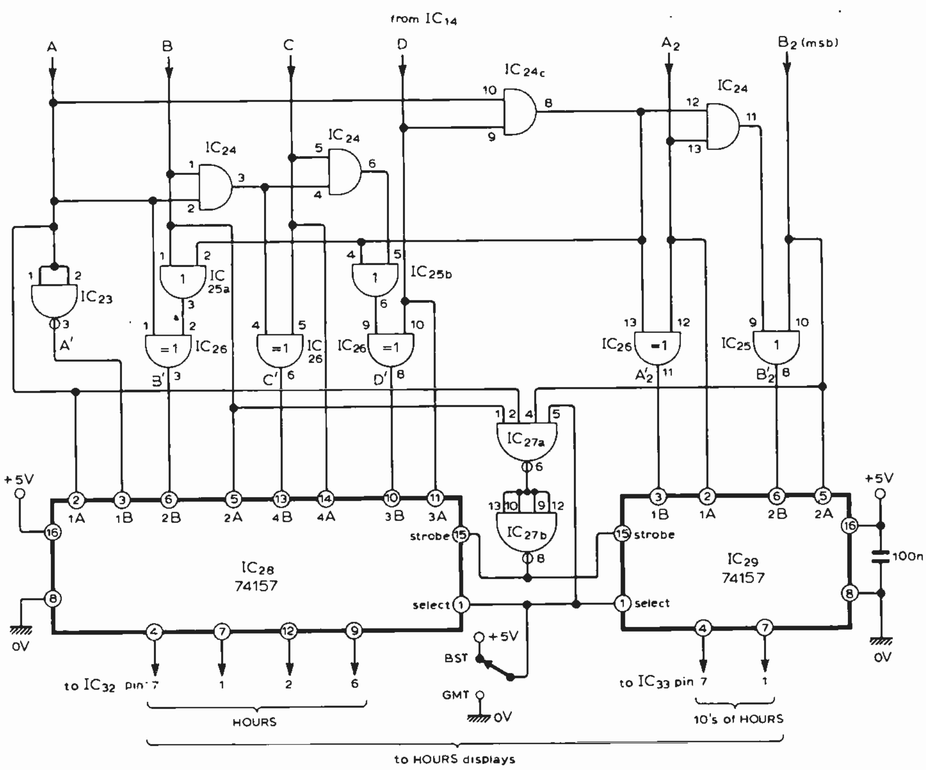
by N. C. Helsby, M.A., *University of Essex*

This second article describes the remaining circuitry and details the construction and alignment procedure using the specified printed circuit boards.

The time code arrives in serial form which facilitates the process of parity checking. The first shift register output QA in Fig. 4 represents the signal as received by the decoder whilst the 555 timer is running. This clock signal is taken to the input of IC_{17b} in Fig. 6. The clock itself is delayed a few micro-seconds by R_{15}, C_7 and Tr_9. The delayed clock is taken to the other input of IC_{17b}. Therefore, if QA is high the delayed clock pulse causes IC_{17b} output to go low and clock IC_{22b} via the inverter. If, however, QA is low no clock pulse is received by IC_{22b} and the $\bar{Q}$ output is returned to the D input so that IC_{22b} changes state for every positive clock edge received. The flip-flop is cleared just before the first negative-going edge (waveform E, Fig. 5) when IC_{8a} $\bar{Q}$ is low. Therefore, IC_{22b} commences with its $\bar{Q}$ output high and changes state for every high present in the received signal including the marker and parity bit. Because the marker bit is included in the parity check on reception, IC_{22b} should always receive an even number of clock pulses which leave it with its $\bar{Q}$ output low if parity is achieved. If one of the transmitted bits is incorrectly received the Q output ends high causing an l.e.d. to turn on. Alternatively, incorrect parity could be arranged to blank the display. The output of the flip-flop has been buffered by a spare NAND gate to reduce the effects of wiring to the front panel. This indicator compliments the out-of-lock indicator also on the front panel.

GMT to BST converter

Because the transmitted time code corresponds to GMT, one hour must be added when British summer time is in force. A static code converter (requires no clock pulses) which can be switched in or out is shown in Fig. 9. The six input lines of the hours and tens-of-hours display decoders are fed, without the converter, from the shift register outputs. These outputs have been lettered A, B, C, D, A2, B2 and connect to the converter circuitry which is made up of IC_{23}, IC_{24}, IC_{25}, IC_{26} and IC_{27}. They also connect to the data selectors IC_{28} and IC_{29}. When the switch is in the GMT position the data selectors route the shift register outputs to the display decoders as before. In the BST position the outputs of the converter circuitry, lettered A′, B′ . . . are selected and fed to the display decoders. The data selectors function as a six pole two way switch and provide an additional facility. The circuitry for addition of 1 to the hours uses the standard half-adder configuration as shown in Fig. 10. This works for the four bits A, B, C and D comprising the hours up to 9 (1001). At this point the output code becomes 10 in binary (1010) but is required to be 0 (0000) for b.c.d. with a 1 carried to the tens of hours. Thus B′ and D′ are both high when lows are required. With IC_{24c} added the output goes high when the input code is 9 and provides a carry for the tens of hours. It is also fed to IC_{25a} and $_b$ which cause lows on B′ and D′ respectively. The same circuitry is effective at 19 and the only remaining difficulty is 23 hours GMT which is required to be 00 BST. This is achieved



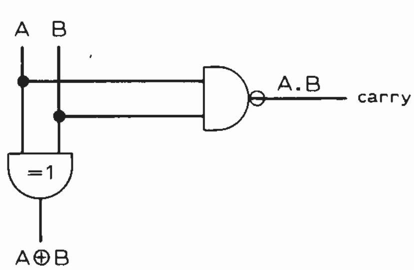


Fig. 10. Conventional half-adder configuration.

Fig. 9. GMT to BST converter.

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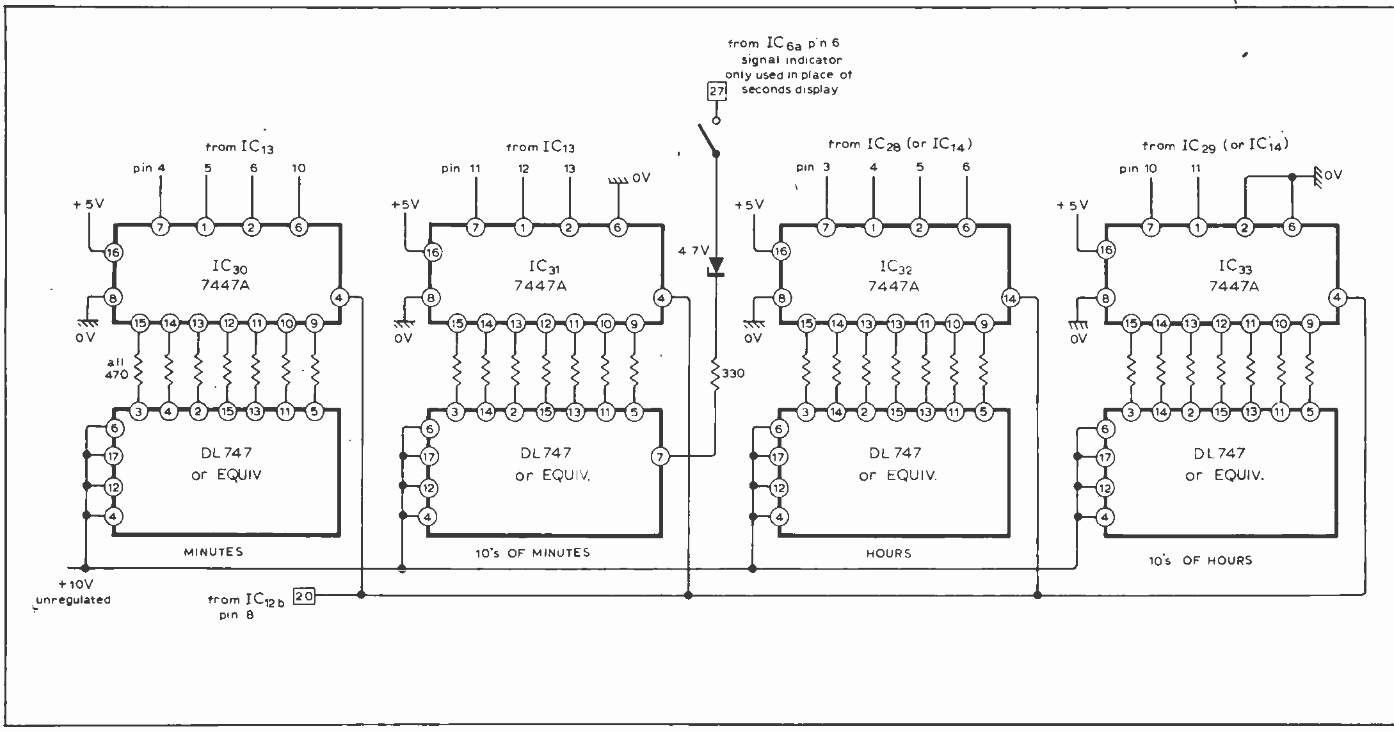
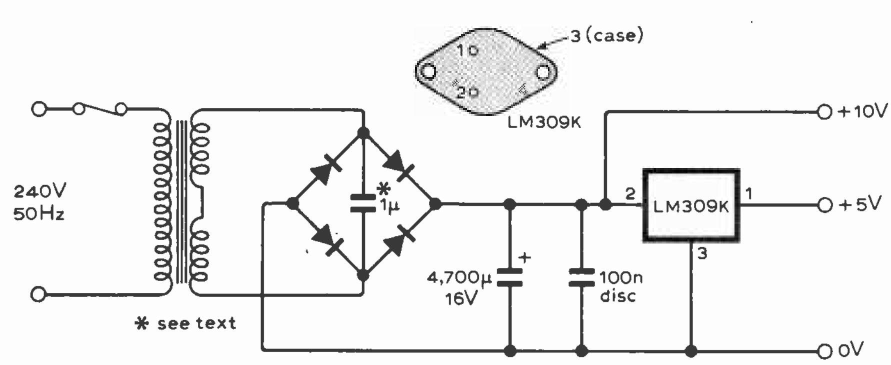


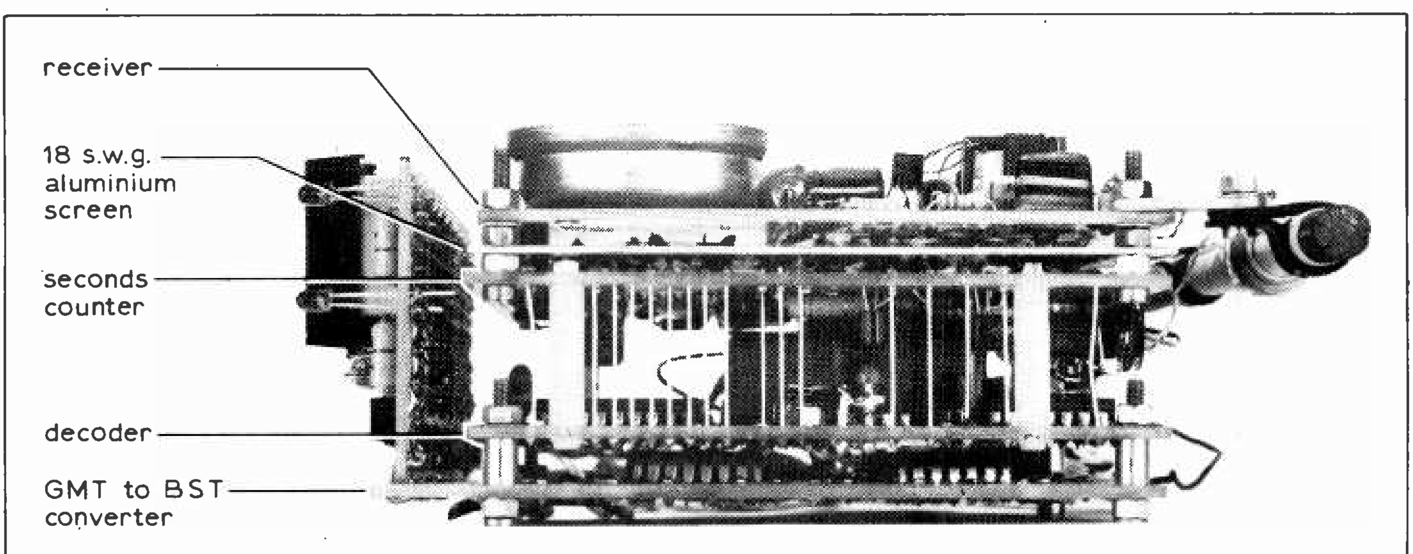
Fig. 11. Hours and minute display. If a seconds display is not used the pulses can drive a decimal point as shown. The 4.7V zener blocks 5V which is always present because the displays are powered from 10V.



Power supply

A single regulated supply is used throughout. The unregulated side of the supply is used to feed 10V to the receiver, and also to the display anodes. A 9V r.m.s. supply is required which may be obtained from a 20VA transformer, 0-4.5V, 0.-4.5V, A 1μF capacitor is wired across the secondary to reduce noise radiated from the transformer, due to the action of the bridge rectifier, which may be picked up by the ferrite rod aerial.

Fig. 13. Side view of board assembly. An aluminium screen separates the receiver and seconds counter. The last mentioned and the remaining three boards are all connected via links along edges of the boards. These form hinges so the assembly can be opened out for access.



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by detecting 23 when BST is selected by means of IC_{27a} which, via IC_{27b} operates the strobe lines of IC_{28} and IC_{29}. This causes the selector outputs to go low irrespective of their other input states.

The GMT/BST circuitry is applicable to conventional digital clocks in which the time is available in b.c.d. form.

Construction

Five printed circuit board assemblies plus a simple power supply make up the complete design. Connections between these boards are by links which simplify the wiring and assembly, but still allow access to the components by forming hinges along the edges of the boards. The bottom board is the GMT to BST converter onto which is mounted the display board by a row of 26 links as shown in Fig. 13. The decoder board is connected to the converter via 25 links along its front edge. Access to the decoder pre-set controls is through four holes in the converter board. Above the decoder is the seconds' counter board which is connected to the decoder with 17 links along the right hand edge. The seconds' counter board is mounted component-side down, and opens out with the component side uppermost when access is required. Pre-set controls on this board are mounted vertically along its rear edge. The receiver board mounts on top of the seconds' counter, with a metal screen between the two, and its output is connected to the decoder by conventional wiring. The complete assembly of five boards can be mounted in a simple metal case with a power supply and external ferrite rod aerial as shown in Fig. 14. The seconds counter and the GMT to BST converter boards may initially be omitted and added as required; in this case the display board must be wired to the outputs on the decoder.

The receiver uses a single-sided board and wiring is provided to allow single-supply operation. If this is not required the zener diode and R_{17} are omitted and the existing five-volt logic supply is used instead. Resistors R_{19} and R_{20} must have low or well-matched temperature coefficients. Metal film types with coefficients of 50 p.p.m./deg C or better are preferred. Metal oxide types are not suitable unless they have matched temperature coefficients. Two alternative cores are suggested for T_1. The 10mm core is smaller but more difficult to wind and gives a lower unloaded Q Thus, the RM6 core is recommended and winding details are given using this type. The turns ratio has been adjusted to give the same loaded Q value as the 10mm core. The ferrite rod is a 7.5in by ⅜in diameter Neosid F14 type. A former of thin card is made and scramble wound with 380 turns, over 2in length, to form the primary. Over the top of this is wound 16 turns for the secondary. The ends of the primary are connected to the trimmer capacitor which is mounted on one of the aerial support

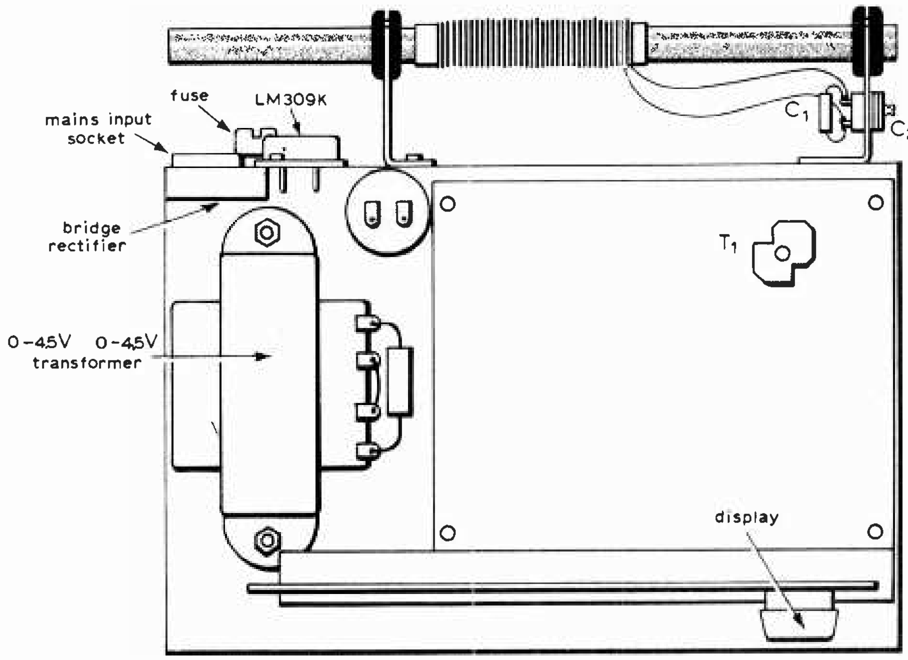


Fig. 14. Recommended layout for clock and power supply.

brackets. Across this trimmer is connected the main tuning capacitor. The ends of the secondary winding are twisted together and taken to the receiver input. Because of the difficulty in obtaining special types of wire the possibility of using a ferrite rod complete with a long wave coil was investigated. A drawback of this scheme is that the inductance of the coil is lower so a higher value of tuning capacitor is required, which means that a suitable trimmer capacitor cannot be obtained. It was found however, that by sliding the coil along the rod, satisfactory tuning could be accomplished. Fig. 15 shows the resonant frequency of the

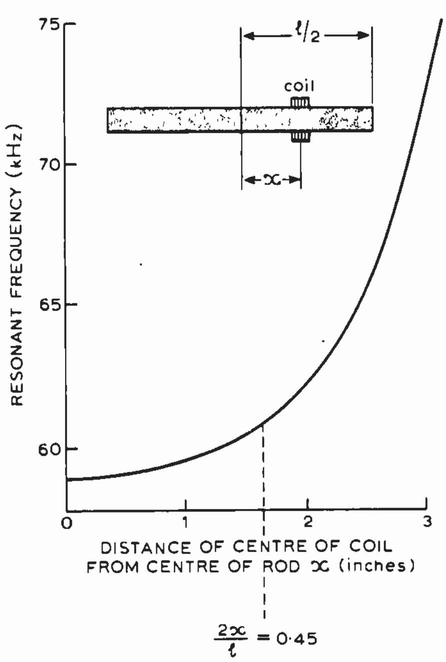


Fig. 15. Tuning aerial by sliding the coil along the ferrite rod.

aerial plotted against coil position. The design position for the coil is 1.7in from the centre of the rod, corresponding to $2X/l = 0.45$ which allows about ±12% adjustment of resonant frequency to cater for variations in permeability. The above measurements were made on the Denco FRAI aerial which has a ½in-wide coil of 180 turns fitted on a 5/16in diameter by 7¾in long F14-grade ferrite rod, shortened to 7½in. A tuning capacitance of 2,500pF is required which gives an unloaded Q of 140 at 60kHz. The wire from the discarded medium-wave coil was used to wind the secondary. Optimum matching into a 1kΩ requires a 12-turn secondary but higher signal levels at both low and high receiver gains were measured with 16 turns. Small polystyrene tuning capacitors are most suitable as they may be fixed to the coil itself leaving only the secondary winding to be connected to the receiver as a twisted pair.

The decoder board is double-sided and wire links must be soldered in position to make connection between tracks on the top and bottom of the board. Note that no links are made via the legs of integrated circuits. Before fitting the four skeleton pre-set poteniometers, holes should be drilled in the board so that these controls may be adjusted from the underside.

To reduce the number of interconnections the display board incorporates the b.c.d. to seven-segment decoders and segment drive resistors, the last mentioned being mounted vertically. The 0.6in displays should be mounted in sockets which can'be constructed from 14 pin d.i.l. sockets cut in half. Current for the display comes from the unregulated side of the power supply. This transfers power dissipation to the segment drive resistors. The display board also carries two l.e.ds which give indication of a parity error and loss of lock in the seconds' counter.

The seconds counting board is double-sided and links are made between top and bottom tracks as for the decoder board. The pre-set controls are mounted vertically along the rear edge and may be adjusted from the back of the completed clock. This board links directly to the decoder board by vertical wire links along one edge. The board is first mounted in position, component side down, on four pillars attached to the decoder board. The links are then made and soldered in position. If subsequent access is required the board may be hinged on the links.

Construction of the double-sided GMT to BST converter board is straightforward. Before commencing construction, holes for access to the pre-set potentiometers on the decoder board should be drilled.

Don't forget . . .

- On the p.c.bs several links through the boards have to be soldered both sides.
- Plastics supporting pillars should be used between boards rather than metal types which may cause shorts.
- In Fig. 6 the 47μF tantalum capacitor should be a 10% type. If R_{18} cannot be adjusted satisfactorily the 18kΩ resistor in series can be altered to suit the capacitor.
- Limitation in clock sensitivity is due to the pick up of self-generated interference. For operation in difficult areas screening, or better still a remote aerial, will improve sensitivity.

(To be continued)

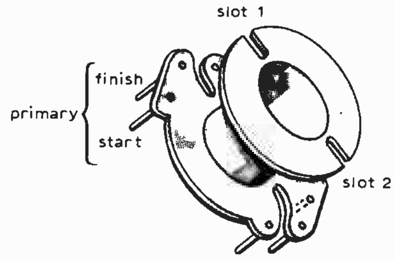
Printed circuit boards

Wireless World has arranged a supply of glass fibre boards for the time code clock. The p.c.bs are available as a set which comprises three double-sided and two single-sided boards for the receiver, GMT/BST converter, decoder, seconds counter, and display. The boards mount on top of each other (see photo) to form a compact module which can be housed in a case approximately 8 × 5 × 3in. The set of boards is priced at £13.50 inclusive or £11.00 undrilled.

A set of special components is also available which comprises an aerial assembly, receiver coil assembly (LA4145), N5596K multiplier, MPS H05 transistor, two 1.5kΩ metal-film resistors, and the NE567 tone decoder. This set is priced at £7.50 inclusive.

Available from M. R. Sagin at 11 Villiers Road, London NW2.

Winding details for T_1



Strip enamel insulation from the wire end and carefully solder to the pin marked start primary. Wind 59 turns clockwise (with pins pointing away) and attach to the finish primary pin. Cover winding with ¼in wide tape. Starting with wire in slot 1 leave about 1½in of flying lead, identified as start and wind on 7 turns also clockwise. Form a loop about 1½in. long, twist the loop together and leave this as a flying lead (centre tap) also in slot 1. Continue to wind a further 7 turns exactly, and take the remaining end across to slot 1. Wind a turn of ¼in tape. Repeat the procedure as shown using slot 2. The bobbin now has six flying leads which are in two groups of three, each of which has a start, centre tape and finish. Wire these to the printed circuit board as indicated on the circuit.

Component summary

Resistors — all ¼W, 5%	Quantity
22	1
100	3
180	2
270	1
330	3
470	43
1k	10
1.5k	1
1.5k 2%, matched temp coeff	2
1.8k	3
2.2k	1
2.7k	1
4.7k	1
5.6k	3
6.8k	1
8 2k	1
10k	1
12k	1
15k	2
18k	1
22k	1
27k	2
33k	3
39k	2
47k	1
100k	2
180k	1
1M	3

Preset potentiometers	
500Ω 10-turn cermet	1
2 5k	1
5k	2
20k	3
50k	1

Capacitors

Types E are electrolytic, T tantalum and P polystyrene

56pf	P63V	±10%	1
560pf	P63V	±2½%	1
680pf	P63V	±10%	1
1000pf	P63V	±10%	1
4700pf	P63V	±2½%	1
0.1μf	P100V		10
1μf	E100V		3
10μf	T6.3V		1
22μf	T15V		2
32or47μf	E10V		4
47μf	T6V	±10%	1
100μf	E10V		1
220μf	E6V		1
1000μf	E6V		1
4700μf	E16V		1

Transistors		Quantity
MPSH05	or equivalent	1
BC182	,, ,,	7
BC212	,, ,,	2

Integrated circuits	
72741P	3
N5596K (Signetics)	1
NE555V	2
SN7400N	3
SN7404N	1
SN7408N	1
SN7413N	1
SN7420N	2
SN7430N	1
SN7432N	1
SN7447AN	6
SN7474N	2
SN7486N	1
SN7490AN	1
SN7492AN	1
SN7493AN	1
SN7412N	2
SN74157N	2
SN74164N	2
NE567V (Signetics)	1
LM309K	1

Displays	
DL747 or DL741 (Litronix)	6
TIL20	2

Miscellaneous	
Ferrite rod 7½in × ⅜ dia. F14 grade	Neosid
Aerial assembly	Denco
RM6 pot core assembly	Mullard
Transformer 4.5-0.4.5V (type 207-122)	RS Components
Meter (type MR100)	RS Components
Bridge rectifier (type REC41A)	RS Components
Plastic supporting pillars (type 63-1896-H)	Vero

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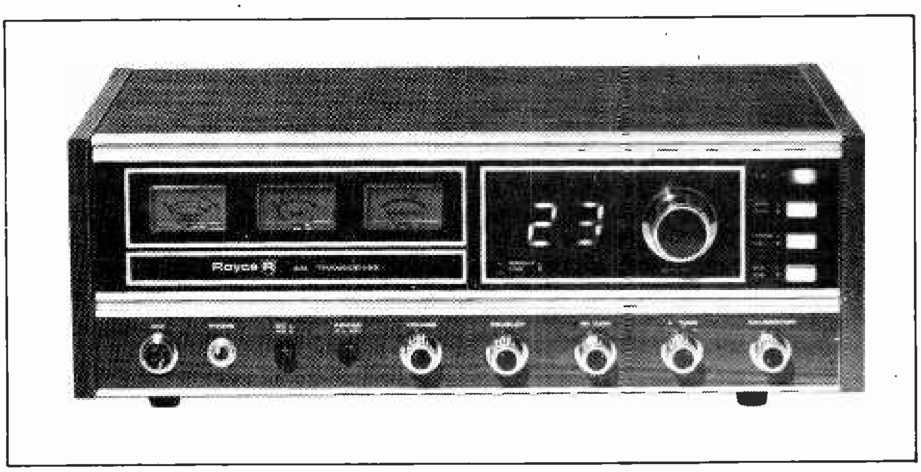
Letter from America

There were 650 exhibitors at this year's Consumer Electronics Show which was held as usual in the huge exhibition hall at Chicago's McCormick Place. This was a record number and it was calculated that if a visitor saw every stand and display he would have travelled a distance of 3½ miles! I can well believe it, but another 100 or so exhibitors were dispersed in hotels all over the town – and this proved even more exhausting to the determined dealers who did not want to miss anything.

A good deal of space was given over to Citizens' Band radio, video games and calculators and although most of these products were segregated in the lower hall with digital watches, telephone answering machines and accessories, there was a strong feeling for a separate audio show or combined audio-television affair. The tremendous boom in CB radio has undoubtedly helped the industry even though a high percentage of these products are imported from the Far East. However, this has resulted in a shortage of certain items and a dealer who said "CB? It sounds like a man talking with his mouth full of granola while using an electric razor" could have been a little biased . . . Be that as it may, CB licence applications are pouring in at a rate of 500,000 a month and industry experts are happily forecasting 15 million sets in operation within a year – and that's a conservative figure. As you might expect, the 27MHz band is rather crowded and the FCC is considering the possibility of granting more channels. This could only be a temporary palliative and an EIA committee has proposed the use of frequencies in the 220-225MHz band. They also recommended that the 900MHz band should not be used, at least at the present time, because equipment would be too expensive and the range limited. At one of the CB seminars, Richard Wiley, the FCC chairman, was asked "why doesn't the government ban housewives and others using the airwaves for idle chit-chat?" He replied that it was not the government's job to censor communications and, for that matter, many TV programmes could be objected to on the grounds of trivial content – which brought forth a cheer.

The average CB mobile transceiver has 23 channels selected by a rotary switch and it would most likely use four crystals in a synthesis circuit. A small meter would read signal strength and double as a modulation indicator, and there would be a switched noise suppressor with possibly a squelch control. The price would be between $100 and $150 and for another $50 it would boast such refinements as a power amplifier switch, better noise reduction and a "delta" tuning control (another name for a fine tuning adjustment) Power output (r.f.) would be four to five watts – the maximum allowed but $300 would buy a s.s.b. model that could radiate an effective power of over 12 watts. Base stations are usually larger than mobile units and some have digital readouts, speech compressors, s.w.r. meters and power microphones (a microphone combined with a built-in preamplifier). Mobile aerials come in all sizes, quarter-wave, eighth- or sixteenth-wave, usually with loading coils. Some are made to clip to the trunk (boot) lid; others use a magnetic attachment and at least one is electrically operated to disappear into the car entrails. The reason is to disguise the fact that a CB radio is installed because thieves are finding a ready market for these units!



Citizens' Band base station transceiver made by Royce. The middle meter is for s.w.r.

One of the few departures from standard CB design was announced by Tennelec who are about to introduce two models with automatic scanning called "Channelfinder." There are three modes: sample, which stops at each channel for three seconds; clear, when the Channelfinder will seek out a clear channel; and in the third mode the scanner will stop at the first first active channel. Other features include a l.e.d. readout and switchable noise blanker. One model has s.s.b. facilities with l.e.d. indication of the sideband in use.

Although the trend towards elaborate, high power, expensive amplifiers and receivers continues, the "budget" market has not been neglected and almost every manufacturer was showing new "bottom of the line" products. For example, Advent introduced an a.m./f.m. receiver at $250 – their first entry into this field. Power rating is 15 watts per channel, and similar receivers were announced by Pioneer, Sansui, Sherwood and many others. Yamaha were demonstrating a sophisticated pre-amplifier which uses two f.e.ts in a bootstrap cascode input circuit. Signal/noise ratio is said to be near the theoretical limit and a further refinement is the employment of double ganged level controls, one section being at the input stage. Connected to the B2 power amplifier (which also has a f.e.t. cascode input stage) the noise level was almost inaudible with the controls wide open! Other features of this pre-amplifier – which incidentally is Model C2 – is a sub-sonic filter, two independent phono sockets plus another input stage for low-level moving coil pickups. The B2 amplifier uses f.e.ts in the output stage and power output is rated at 100 watts per channel at less than 0.004% distortion.

The new Nakamichi 620 power amplifier has some interesting features too: instead of employing multiple parallel output transistors, this amplifier has a single pair of high power transistors. Because bias diodes are not

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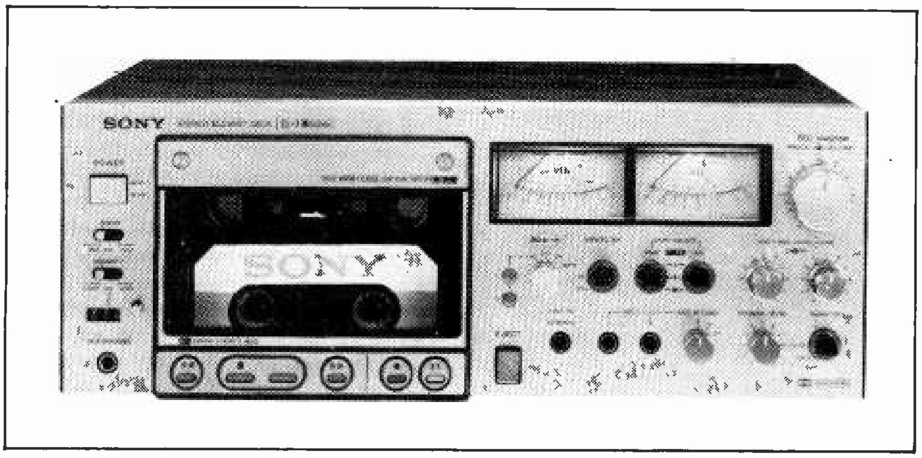

Sony type EL-7 stereo cassette deck intended for the new Elcaset 3¾ i.p.s. cassettes using ¼-inch tape

used, it is claimed that crossover distortion has been eliminated. Rated power is 100 watts per channel at less than 0.005% distortion over the audio spectrum. Very little feedback is used and the open-loop distortion is only 0.1% or less. Styling is rather unusual as the heat sinks are mounted at the front, and built into the fins are peak power indicating l.e.ds. These can be set to indicate two levels, a red light for 25 watts and a green for 50 watts, for example.

Nakamichi were also demonstrating their suppressor which is a complex device that cancels out some of the distortion due to tape saturation on a cassette recorder. It is not a peak limiter but a dynamic non-linear circuit that is used on playback only and it actually increases the dynamic range. Obviously, it cannot correct gross distortion but it is astonishing what it can do.

The big news in the tape world was the introduction of the "Elcaset" 3¾i.p.s. cassette by Sony. Not only is the speed faster but it uses full size quarter-inch tape so the frequency range and signal to noise are considerably better than conventional cassettes. They are somewhat larger too, being roughly 2½ times the size. Sony were showing two recorders using Elcasets, Model EL-5 and EL-7; the latter having a d.c. servo motor with two reel motors, logic controls, a Dolby system and provision for FeCr tapes. It is expected that the price will be between $850 and $900. The EL-5 has only one motor and it lacks some of the refinements like the built-in 400Hz calibrator, but the price will be $200 less. Panasonic were showing a prototype model and there were rumours that Akai are working on Elcaset designs, but no details are available.

Another interesting and even more expensive cassette deck was introduced by Teac. This is the well-named Esoteric 860 which is the first deck to have a built-in DBX noise reduction system. The specifications are most impressive: over 30dB of noise reduction over the audio range, an expanded dynamic range up to 85dB and a gain in headroom of 10dB! There are three motors, including a d.c. servo type, and the wow and flutter is claimed to be less than 0.04% r.m.s. Among the other features are a four-in, two-out mixer, three heads with signal/source monitoring, full logic control, tape inching facility and a variable speed control. And there is a built-in Dolby system too!

As far as, well, *ordinary* cassette decks are concerned, the trend towards front loading now seems firmly established and there is now a wide choice of models in all price ranges. Many use servo motors and wow and flutter figures are well below 0.1%. Even so the tape transmission depends on the mechanics of the actual cassette – which is not the case (sorry!) with the new Elcaset.

There was a great number of loudspeakers at the Show and space does not permit a description of more than a few. One of the most interesting was the Infinity "Quantum" line source column which stands 66 inches high. The bass speaker is a 12-inch model and it uses a Watkins twin speech coil (see *W.W.* April 1975, p.182) crossing over to a four-inch cone unit at 200Hz. Mid-range frequencies are handled by a vertical array of six 1½-inch domes, and eight planar units take over the high frequencies. ESS released three new models using the Heil "air motion transformer" and Dr Heil told me that he has developed more efficient units using different magnet materials. It would seem that matching these to dynamic bass speakers could cause problems: meanwhile Dr Heil is still experimenting with a full range model employing the air transformer principle. Both Dayton-Wright and Accustat were demonstrating full-range electrostatic loudspeakers; the last-mentioned incorporates quarter- and eighth-wave equalisers to compensate for wall reflections (it is, of course, a dipole). The phase distortion syndrome seems to have crossed the Atlantic (although I am not certain where it originated). A company called Sonic Energy were demonstrating a three-speaker system with the mid and high frequency units set back from the bass speaker: unlike the B & W system, these two are in the same plane. Overall sound was well balanced and clean. Another system with low colouration was the Dahlquist, which is a dipole radiator styled like the Quad. B & W's John Bowers was demonstrating the DM6 monitor, which sounded most impressive. I missed the KEF demonstration but I was told that Raymond Cooke and his colleagues put on a good show.

There was not a great number of television set manufacturers at the Show although several took space at nearby hotels. GE receivers, or some of them, will soon be using a system of automatic colour control called VIR, which stands for Vertical Interval Reference, and the circuit uses a coded reference signal transmitted on a vertical blanking interval line to control colour intensity and tint. Zenith have a number of new 23-inch models with full remote control and the close up "zoom" feature introduced last year. All the new models use a picture control that adjusts contrast, brightness and colour level all at the same time.

Admiral introduced an optional remote control that can be installed by the user "in a matter of seconds". It consists of a hand held transmitter which duplicates the electronic tuning panel on the set. All the owner has to do is to remove a small cover plate on the front of the set, insert a plug-in amplifier unit and he can go back to his easy chair! Many of the new models from Motorola, Panasonic, JVC, RCA and Zenith use photo-cell circuits to adjust the brightness to suit the ambient light. Magnavox are using time and channel digital displays on many of the newer models which also feature electronic tuning. All in all the TV set market looks very healthy and sales forecasts indicate more than 7 million receivers this year.

But the surprising thing is not the increased sales of TV but the sudden boom in video games. Some of these are complete, others are designed to be attached to the set, usually via the aerial terminals. Some models like the "Pong" feature digital scoring and most offer a variety of games complete with sound effects. For example, the Unisonic 200 gives a choice of table tennis, hockey, squash, skeet shooting, and pop-up target shooting. A similar model without some of the refinements is offered by Federal at a retail price of under $80.

Digital watches were well in evidence but manufacturers (already disturbed by $6.95 calculators) were further shaken by the release of two models supposed to sell for $19.95. As for me, I was saddened by the introduction of a digital grandfather clock: I did not investigate too closely but I would not be surprised if the chimes were generated by an i.c. with an amplifier!

G. W. Tillett

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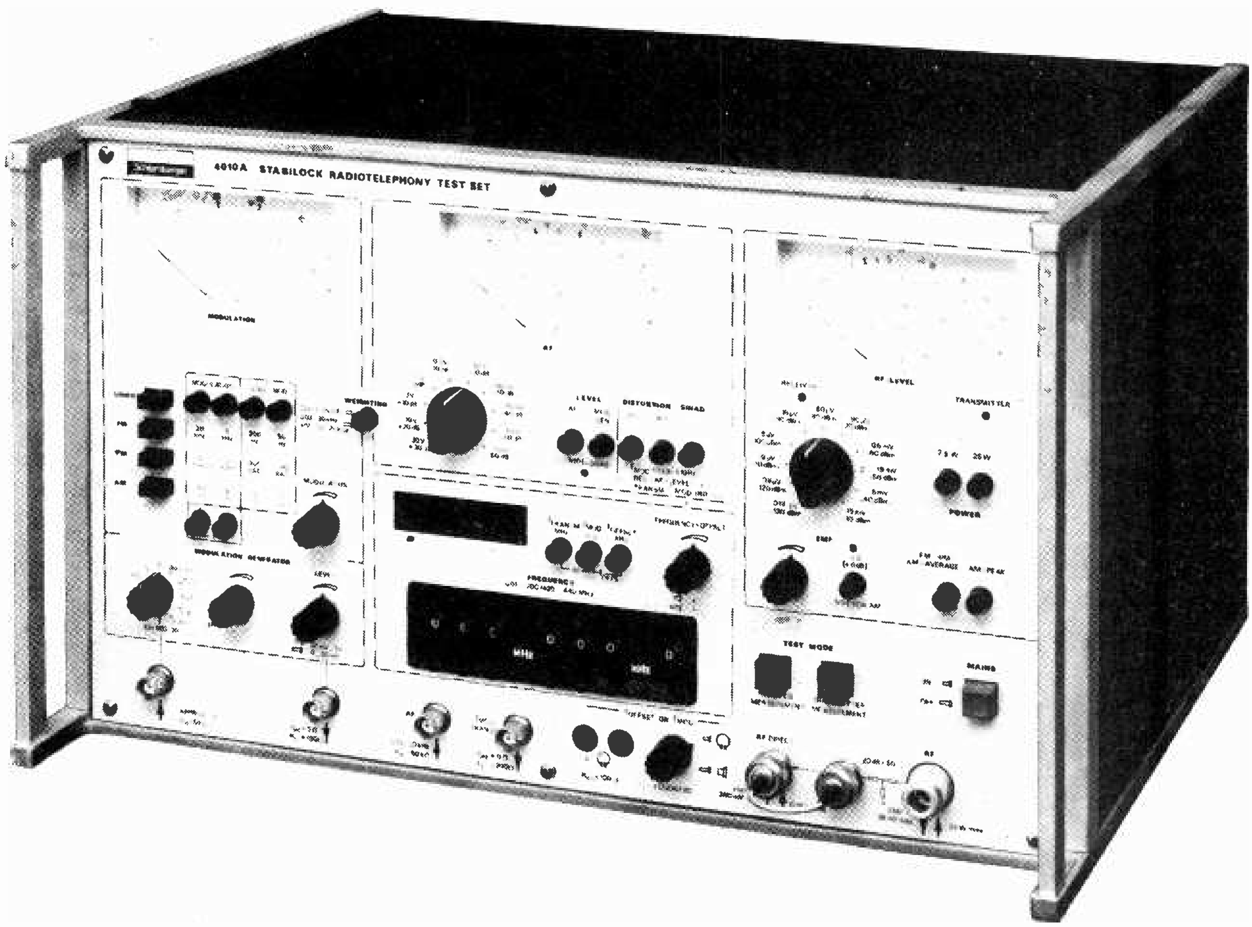

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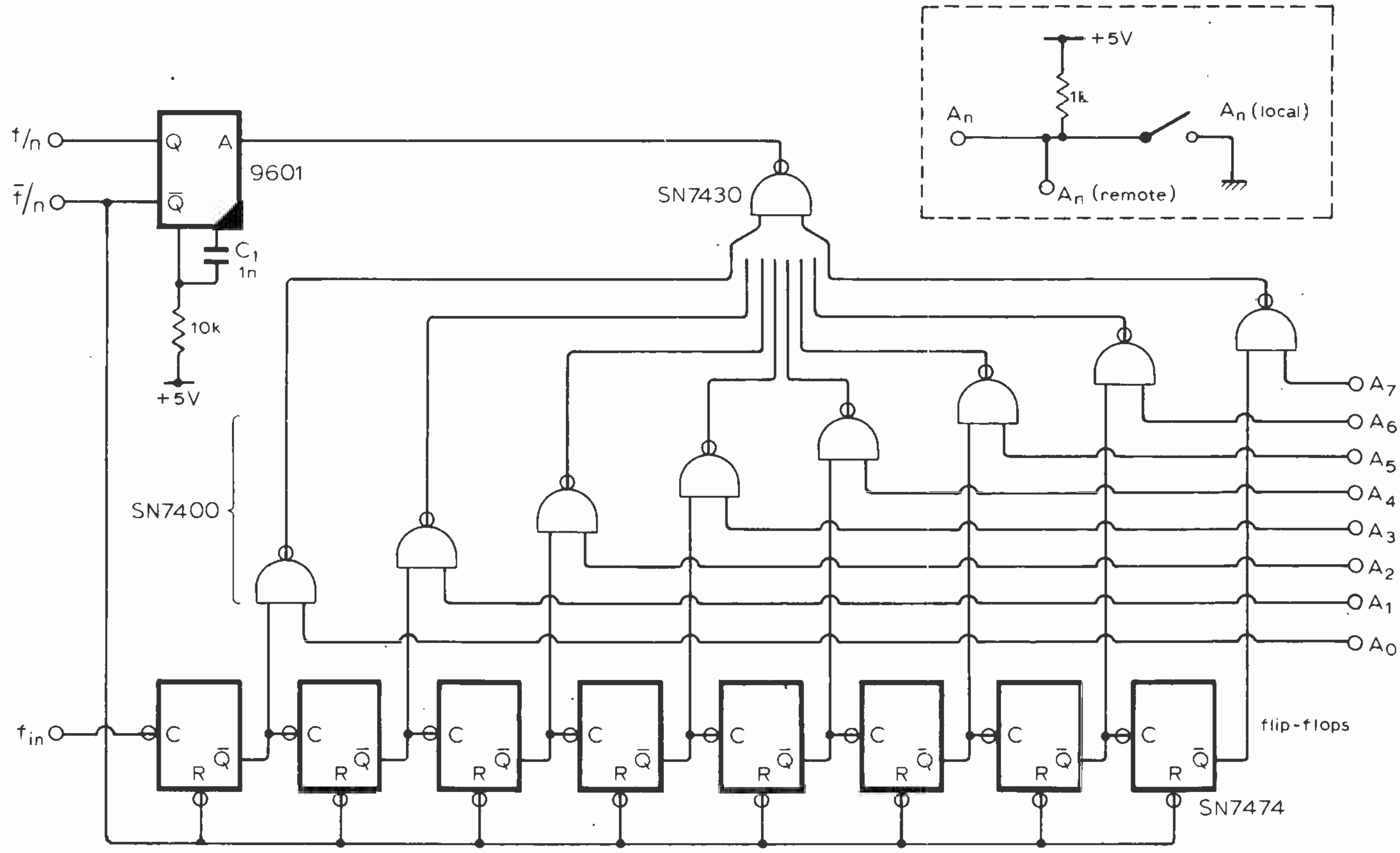
Circuit Ideas

Programmable ratio frequency divider

This programmable frequency divider has the advantage of low cost, simple design and expandability. The circuit is basically an eight-bit ripple counter with a programmable binary 1 detector. Whenever the programmed sequence appears at the counter outputs, it is reset by the monostable multivibrator which prevents latch up by only allowing a short pulse to the reset line. The desired division ratio is addressed to the inputs, A_0 to A_7, as a binary number. When all inputs are at 0V there is no output. When all inputs are at 5V the output is 1/255 of the input frequency.

If both remote and local programming is required, the local switches must all be set to 5V when remote is in use. Inputs and outputs should be buffered with inverters. The counter was tested from 10Hz to 100kHz and the limiting factor appeared to be the value of C_1. With 1nF the counter should divide accurately up to about 200kHz.

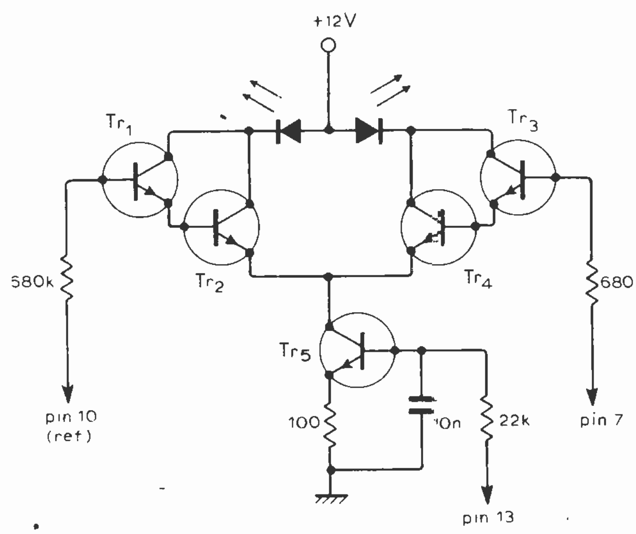
M. F. Smith,
University College Galway,
Ireland.



Tuning indicator

This circuit can be used with many quadrature detector systems or ratio detectors, by taking the reference to an appropriate d.c. point. If used with a CA3089E, the meter output can be used to suppress illumination between stations. Non linear l.e.d. characteristics make the brightness vary with signal strength, and a high input impedance causes very little loading on detector systems in current use.

W. Poel,
Ambit International,
Essex.



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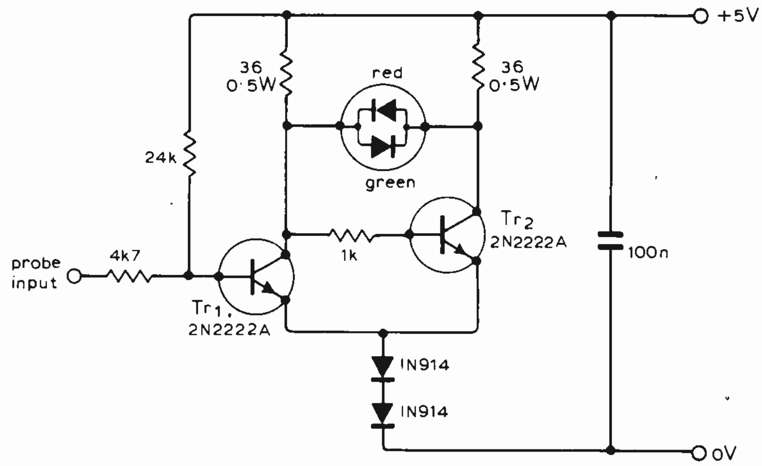
Logic probe

This logic probe will indicate the t.t.l. states high, low, open circuit and pulse train by using the voltage drop of a l.e.d. in a Schmitt trigger circuit. Transistor Tr_1 is saturated by a high, and cuts off Tr_2 which turns on the red l.e.d. in the dual package (Monsanto MV5491). When Tr_1 is cut off by a low, the reverse occurs. Adjustment of the base bias resistor will turn Tr_1 sufficiently on to bring its collector below the l.e.d. forward voltage threshold and extinguish both l.e.ds. Thus, both l.e.ds. will be off for high impedances.

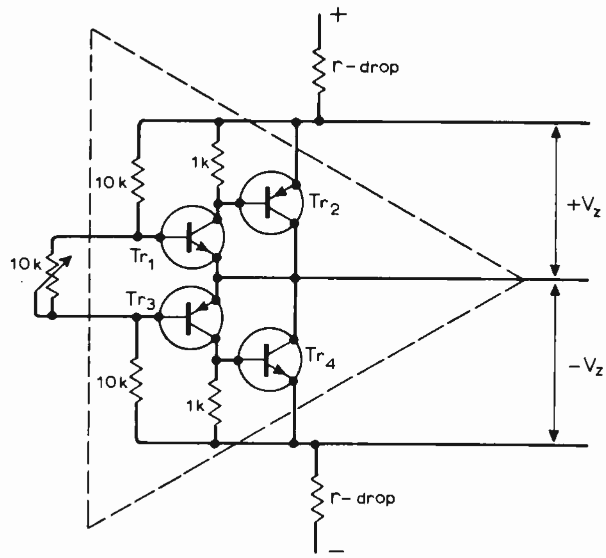
Rectangular waves up to about 1MHz will turn on both l.e.ds and some indication of the mark/space ratio can be seen by the relative brightness of the two light sources. The circuit draws 90mA from a 5V supply.

J. C. Flower,
Madrid,
Spain.



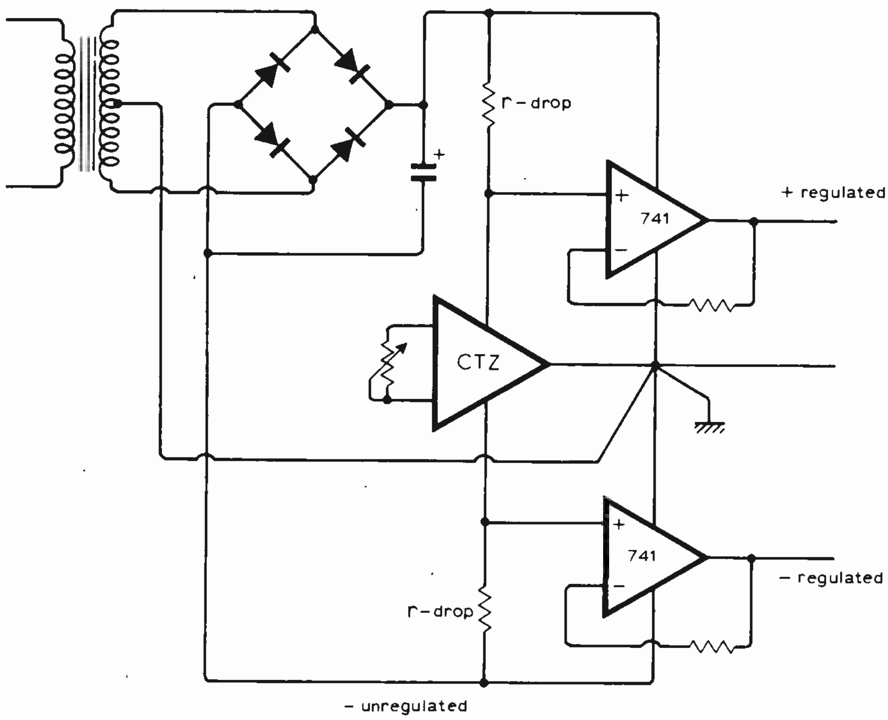
Hard action centre-tapped zener

A conventional zener arrangement is not an ideal voltage regulation element because the voltage across it is dependent on the series resistor and the load. By using a feedback pair (Tr_1 and Tr_2 or Tr_3 and Tr_4) the voltage is self correcting and the action can be defined as hard. The four transistors shown form a centre tapped version which can be used to obtain a dual shunt-regulated supply from a single floating source, or a stable dual reference voltage for a dual series-regulated power supply. Voltage adjustment is continuously variable by a potentiometer and loading one half of the circuit will not affect the other half.



In the practical circuit shown, the two dropping resistors are equal. Maximum unregulated voltage is 72V, and the 741's provide short-circuit protection. The transformer secondary need not be centre tapped.

C. R. Cathles,
Gt Bookham,
Surrey.



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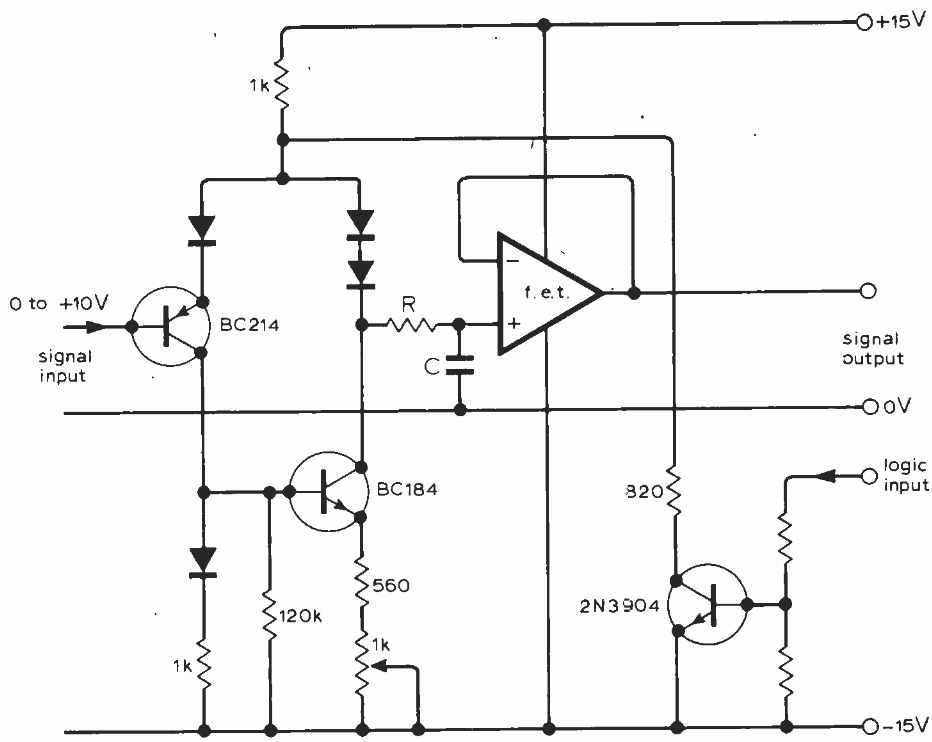
Sample and hold

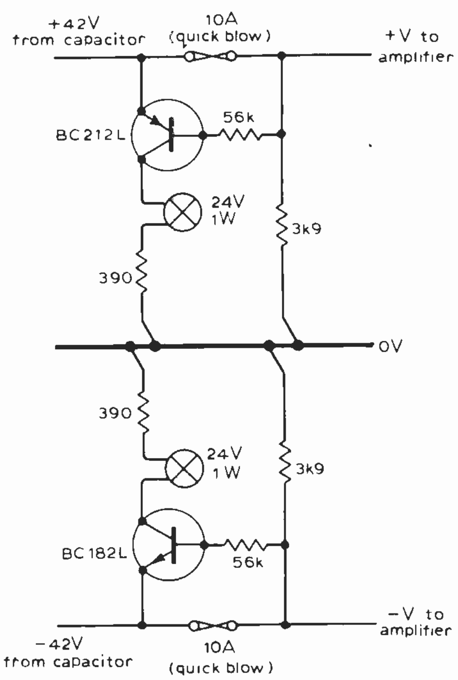
The offset voltage and tracking error in J. Kilvington's clever follow and hold circuit, *Wireless World*, June 1972, page 275, may be greatly reduced by balancing the currents flowing in the two branches of the compound emitter follower. In the modified circuit shown, the 1kΩ potentiometer reduces offset error for the most important input voltage. This error is now in the order of 0.1% for a 10V input swing. The 120Ω resistor has been added to ensure that the BC184 is cut off in the hold state. All diodes should be silicon types.
J. H. J. Dawson,
Amsterdam,
Holland.



Amplifier blown-fuse indicator

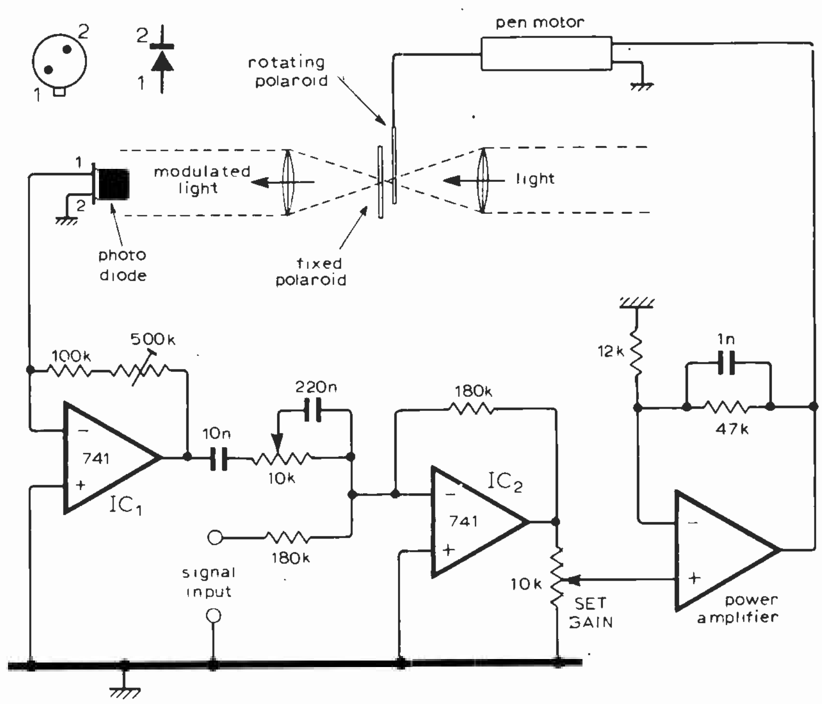
This circuit was designed for use in a high power audio amplifier using a split power supply. It was decided to provide overload and short-circuit protection by using quick-blow fuses in the h.t. rails instead of the more usual current limiting networks. While the fuses are intact the transistors are biased off. However, if a fuse blows the transistor is turned on and supplies current to the indicator lamp.

The circuit is independent of amplifier load impedance and the maximum current it can pass in the fuse-blown condition is limited by the transistor base resistors, in this case less than one milliamp. Component values are not critical but the h.t. leads should not be diverted from their most direct route.
I. Flindell,
Northfleet,
Kent.



Constant amplitude light modulator

A pen motor carrying a Polaroid vane is a device used to modulate the intensity of a light beam. Unfortunately, the amplitude is not constant with change in frequency so the amplitude has to be adjusted for changes between 10Hz and 100Hz. The beam of light is sampled by a silicon photodiode which is linearized by IC_1. The input signal and feedback signal are mixed in the summing amplifier IC_2 which drives a non inverting power amplifier. The last mentioned consists of a 741 op-amp driving two OC28 power transistors in a closed feedback loop with a gain of five.
R. F. Cartwright,
Telford,
Shropshire.



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Characteristics and load lines

2—Non-linear characteristics

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

Part 1 (concluded in this issue) was devoted to applications of linear characteristics and to methods of effectively linearising non-linear characteristics. However, input-output characteristics are not always required to be linear: there are circuits which require non-linearity for their action and where performance is improved by increasing the degree of non-linearity of the input-output curve. Such circuits are described in this article.

A.m. detectors

We saw in Part 1 that one of the properties of a device with a non-linear input-output characteristic is that it generates new signals with frequencies equal to the sum and difference of those of the input signals. One circuit application where the difference-frequency component is required is in an a.m. detector. An r.f. carrier of frequency f_1 amplitude modulated by an audio tone of frequency f_2 gives rise to two sidebands, an upper one of frequency (f_1+f_2) and a lower sideband of frequency (f_1-f_2): these sidebands, together with the carrier frequency f_1, constitute three components which are presented to the input of an a.m. detector for each audio-frequency tone in the modulating signal. As a result of non-linearity of the detector characteristic, the output contains signals with a frequency equal to the difference between the upper-sideband and carrier frequencies and to the difference between the carrier and lower-sideband frequencies. Both these difference-frequency components are at the wanted audio frequency f_2. Another difference-frequency component produced is due to inter-action between the upper and lower sidebands and is at $2f_2$. This is the second harmonic of the wanted audio signal and represents distortion.

This sideband approach to the process of a.m. detection is useful because it shows that both sidebands are not strictly necessary: either one, with the carrier, enables the required a.f. signal to be obtained.

Fig. 1 shows how detection occurs. Because of the curvature of the characteristic the current swings due to positive half cycles of r.f. input are larger than those due to negative half-cycles. If the r.f. component is removed from the output current what is left is the a.f. waveform shown in dashed lines in Fig. 1. Any characteristic which is not linear will detect a.m.

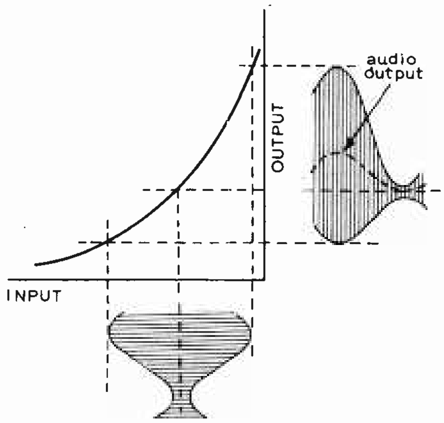


Fig. 1. Detection of a.m. signals by a non-linear input-output characteristic.

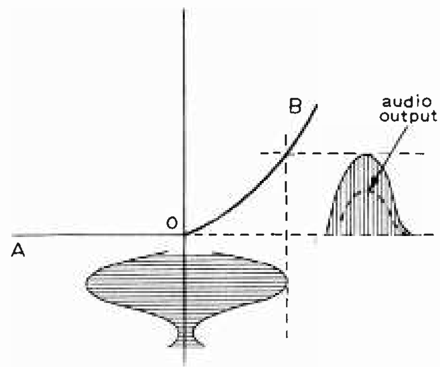
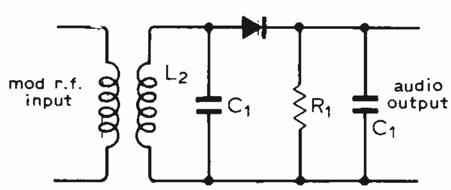


Fig. 2. Suppression of negative r.f. peaks by biasing to cut-off point O.

Fig. 3. Basic diode detector circuit.



signals in this way. This is the reason why some a.f. amplifiers operating near high-power a.m. transmitters reproduce the radiated programme even though there is no tuning or detector stage. The non-linearity of the early stages, though slight, is sufficient in the high field strength area of the transmitter to provide the later stages with an adequate audio signal.

To give a good a.f. output from the detector the non-linearity of the characteristic should be more pronounced than that shown in Fig. 1. In fact the ideal characteristic is one which does not respond to negative half-cycles at all. This can be achieved by biasing the detecting device so that it is cut off by negative half-cycles as illustrated in Fig. 2. The effective characteristic is now AOB. The horizontal section AO represents inputs for which the device is cut off and OB represents inputs for which the device conducts. OB could be straight, in which case the overall characteristic would consist of two linear sections intersecting at O. O, the point of discontinuity, is important in detection because it represents the voltage at which the device should be biased for most efficient detection. If a detector were made to operate on this principle it would give considerable distortion because OB, which should ideally be straight to give a faithful rendering of the a.f. envelope, is in practical devices far from linear.

In practical detector circuits this distortion is avoided by including an RC circuit which fundamentally changes the mode of operation of the detector. Such a network is R_1C_1 in the diode detector circuit of Fig. 3. Positive half-cycles of r.f. from L_1C_2 drive the diode into conduction and the resulting current charges C_1 to the peak value of the r.f. signal. Negative half-cycles of r.f. input cut the diode off and C_1 loses very little of its charge during negative half-cycles – only sufficient, in fact, to enable the voltage across C_1 to follow the most rapid falls in the a.f. modulation envelope. The small loss in voltage across C_1 during negative half-cycles is made up when the diode is driven into conduction by the succeeding positive half-cycle. This period of conduction is brief – less than 180° – because with good design only a small amount of energy is needed to restore the voltage across C_1 to the peak value of the r.f. input to the diode. Thus the voltage generated across C_1 is at all times slightly less than the peak r.f. input to the diode and so follows the a.f. modulation envelope. This voltage is the output of the detector. Superimposed on this a.f. waveform is a carrier-frequency ripple caused by the succession of partial discharges of C_1 and the subsequent recharges but this can easily be removed by a simple RC filter.

The fact that the voltage across C_1 never reverses in polarity shows that there is also a d.c. component in the detector output: this is commonly used for a.g.c. The polarity of the voltage across C_1 is such as to reverse-bias the diode and the input to the diode consists of this voltage together with the r.f. voltage from L_1C_2. Because the voltage across C_1 is slightly less than the peak voltage from L_1C_2 there is only small net positive voltage to drive the diode into conduction. Consequently only a small length of the characteristic OB is used in the detection process and, as mentioned in Part 1, this means that distortion is small despite the non-linearity of the characteristic. This is illustrated in Fig. 4 and comparison of this with Fig. 2 shows how little of the characteristic is used when R_1C_1 are present. The effect of R_1C_1 in providing bias for the diode is similar to that of the biasing circuit used in the Hartley oscillator circuit of Fig. 13 in Part 1.

Mixers

There is another circuit familiar in electronics where the difference-frequency component is wanted: this is in the mixer stage of superhet receivers where the intermediate-frequency output is at the difference of the signal-frequency and oscillator inputs. Here again non-linearity in the input-output characteristic is essential and operation of the mixing device is arranged to achieve this. The usual technique is to choose the bias and oscillator amplitude so that the operating point sweeps over the non-linear part of the characteristic.

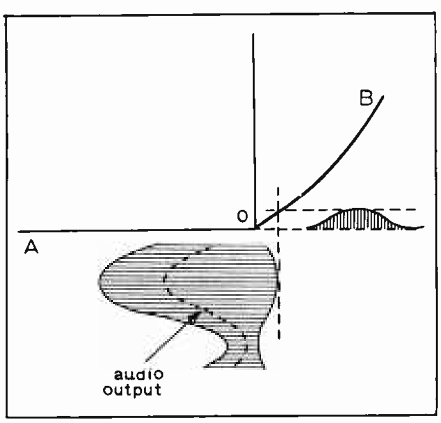


Fig. 4. Operation of diode detector.

The signal-frequency input is very small (when weak signals are being received) and movement of the operating point by this input is too restricted to achieve any significant difference-frequency output. The useful part of a mixer characteristic is the non-linear section and one device which can be used as a mixer is a diode.

A good example of a diode so used is in the inter-carrier method of sound detection used in television receivers. The input to the vision detector consists of an a.m. vision signal at an i.f. (carrier frequency) of 39.5MHz and an f.m. sound signal at an i.f. of 33.5MHz. As a result of the non-linearity of the diode characteristic the sound signal emerges as an f.m. signal at a difference frequency of 6MHz.

An a.m. detector and a mixer are both required to produce an output at the difference of the two input frequencies and it is not surprising therefore that the mixer stage in early superhet receivers was known as a "first detector," the "second detector" being at the end of the i.f. amplifier.

It should not be assumed that non-linearity is an essential feature of a mixer. This is quite untrue. Mixers can operate on two quite different processes. The first type is that just described and for which non-linearity is necessary: this is the *additive type of mixer* and one of its properties is that the two signals to be mixed are applied to a single input terminal. Thus a diode can be used as an additive mixer.

The second type of mixer has two input terminals and an essential property of them is that either can be used to reduce the output current to zero. The two inputs to be mixed are connected to the two inputs and in effect are multiplied together in the device, the output current therefore containing multiplication products. These products include outputs at the sum and difference of the two input frequencies as shown by the trigonometrical identity

$$2 \sin \omega_1 t \sin \omega_2 t = \sin (\omega_1 + \omega_2)t + \sin (\omega_1 - \omega_2)t$$

The significant feature of this process is that the sum and difference components are produced entirely without non-linearity: the input-output characteristic for either input can be accurately linear. Mixers operating on this principle are termed *multiplicative* and examples are pentodes (using control grid and suppressor grid), hexodes, heptodes, octodes and dual-gate mosfets.

The process of applying two signals to an electronic device to obtain an output at the difference frequency, which we have called mixing, is sometimes termed beating. For example the oscillator used in a communications receiver for reception of c.w. signals is known as a beat frequency oscillator. The term beat is also used to describe the effect heard when two sound waves of nearly equal frequency are heard simultaneously. It is unfortunate that the same term should be used for both processes because the mechanism of acoustic beat production is quite different from that of an electronic mixer. This is shown in the following account of the production of acoustic beats.

Acoustic beats

Suppose two sinusoidal sound waves of nearly-equal amplitude and nearly-equal frequency are generated. The ear responds to the sum of the two signals and this has the form shown in Fig. 5. The combined wave has a large amplitude where the original waves are in phase and a low amplitude where they are in phase opposition. It is the rhythmic rise and fall in amplitude of the combined wave which gives rise to the changes in volume which we describe as beats. Mathematically the waveform of the combined signal can be obtained from the trigonometrical identity

$$\sin\omega_1 t + \sin\omega_2 t = 2 \sin \frac{\omega_1 - \omega_2}{2} t \cos \frac{\omega_1 + \omega_2}{2} t$$

in which for simplicity the original waves are both assumed to have an amplitude of unity. This expression shows that the combined wave has a frequency equal to *half the sum* (i.e. the average) of the two original frequencies and an amplitude equal to *half the difference* of the original frequencies. Thus the envelope of the combined wave, shown in dashed lines in Fig. 5, is also sinusoidal but is at half the difference frequency. The ear cannot distinguish positive envelope peaks from negative envelope peaks and thus hears two beats per cycle. The beat frequency is thus equal to the difference of the original frequencies.

This process differs from the generation of sum and difference frequencies in a non-linear device in the following respects:

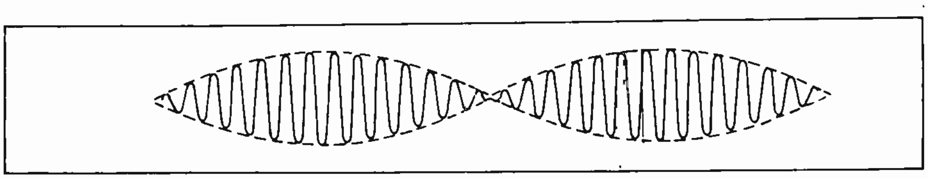


Fig. 5. Waveform of sound waves for acoustic beats.

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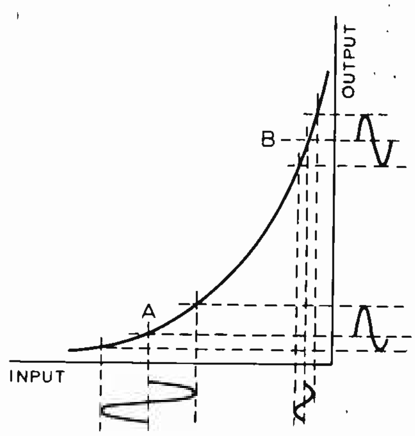
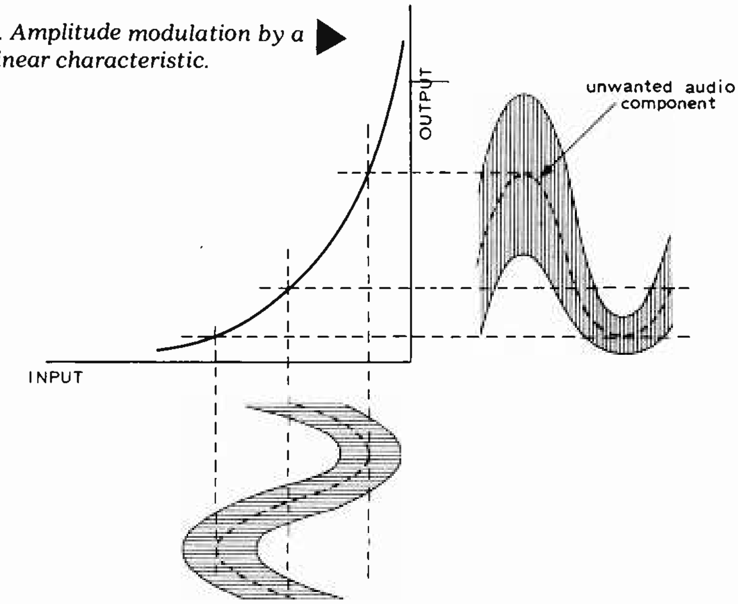


Fig. 6. Variation of gain with bias for a non-linear characteristic.

Fig. 7. Amplitude modulation by a non-linear characteristic.



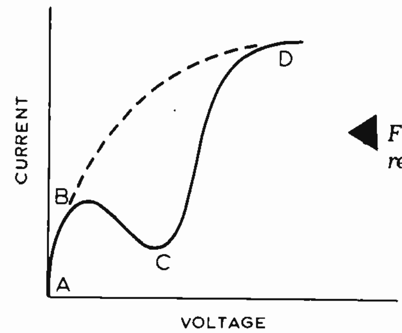


Fig. 8. A characteristic containing a region BC of negative slope resistance.

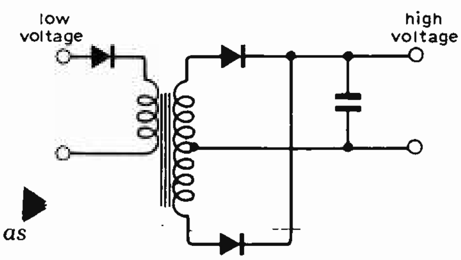


Fig. 9. Circuit diagram of a d.c. converter using a tunnel diode as oscillator.

(a) non-linearity is not necessary to produce acoustic beats which arise as a result of simple addition of two sine waves;
(b) the new frequencies which arise in the generation of acoustic beats are equal to *half the sum* and *half the difference* of the two input frequencies.

Frequency multipliers

A device with a non-linear characteristic gives an output at multiples of the frequency of an input signal. By placing an LC circuit at the output of the device and by tuning this to one of the harmonic frequencies it is possible to produce a frequency multiplier. Clearly for successful results a large harmonic content is required in the output current and this requires marked non-linearity in the characteristic. The best way of achieving this is to operate the device in class C so that it is cut off for more than half of each cycle of input and the output current flows in the form of pulses at the input frequency. The amplitude of the harmonics falls off with increasing frequency and the efficiency of the multiplier is therefore low for high multiplication factors. For example to obtain a factor of 8, it is better to use three frequency doublers in cascade than to attempt the 8-fold frequency increase in a single stage. Even harmonics cancel in a push-pull stage and thus by designing a multiplier to operate in class-C push-pull it is possible to favour the generation of odd multiples of the input frequency.

Slope of non-linear characteristics

So far we have discussed applications of non-linear characteristics based on their ability to produce harmonics of one input signal or difference-frequency components from two inputs. There are other circuits which depend on non-linearity and where the circuit operation is best explained in terms of the slope of the characteristic. In general the slope is a measure of the gain of the device – voltage gain if input voltage is plotted against output voltage and current gain if input current is plotted against output current. For many devices the characteristic relates output current to input voltage and the slope of the characteristic then measures the mutual conductance of the device.

For a linear characteristic the slope is constant and independent of the point at which it is measured. For a non-linear characteristic the value of the slope depends on the point of measurement, that is to say the gain depends on the bias. For example the mutual conductance of an f.e.t. or valve depends on the gate, or grid, bias. Thus one property of such a non-linear characteristic is that it permits the gain of the device to be controlled by adjustment of the bias. This is illustrated in Fig. 6 which shows the shape of a suitable characteristic. If the bias is set to point A the gain is low but the device can accept a large-amplitude signal without appreciable distortion. When, however, the device is biased to point B the gain is high but the signal-handling capacity of the device is low. This technique is useful particularly for remote control of gain because it requires only the adjustment of a voltage to effect it and there are no signals in the control lead.

For effective control of gain the slope of the characteristic should vary smoothly as the bias is altered and an ideal form of curve for this purpose would be exponential: this is difficult to achieve in practice. Variable-mu valves (at one time extensively used as automatic-gain-controlled i.f. amplifiers in superhet receivers) had characteristics which approximated to this ideal.

Since a device with a characteristic such as that illustrated in Fig. 6 enables gain to be controlled by a voltage it can also be used as an amplitude modulator by arranging for the r.f. gain to be controlled by the modulating signal. To do this the input can consist of a mixture of the modulating signal and the r.f. carrier voltage. The amplitudes of these two components are adjusted, as shown in Fig. 7, so that the gain to which the r.f. carrier is subjected depends on the instantaneous value of the modulating signal, being a maximum for positive peaks and a minimum for negative peaks. In this way the output of the device consists of an audio component (distorted by the non-linearity of the characteristic) and, superimposed on it, the r.f. signal amplitude modulated by the audio component. By including at the output of the device an LC circuit resonant at the carrier frequency the audio component can be suppressed leaving the wanted modulated r.f. signal. This technique is used with thermionic valves (grid modulation) but the quality of modulation is not high, deviations from the ideal characteristic causing distortion of the modulation envelope. Nevertheless grid modulation is a simple and effective method of achieving amplitude modulation.

Negative-resistance kink

Fig. 8 shows the shape of a non-linear characteristic familiar to most electronic engineers. It was first encountered many years ago in the $I_a - V_1$ curves of a tetrode valve. The region BC is unusual in that it has a negative slope: all the other characteristics encountered in this series have a positive slope throughout their length although, if the characteristic, is non-linear, the slope is clearly not constant. If a device is biased to the region BC an *increase* in voltage results in a *decrease* in current. For this region, therefore, the device has a negative a.c. resistance (slope resistance, incremental resistance or differential resistance – not a negative absolute resistance).

The negative-resistance kink is a nuisance if the device is required for use with large-amplitude signals. If load lines cross this region, severe distortion results and if the kink is to be avoided the signal amplitude must be severely limited. It was to avoid these limitations that the additional grid (suppressor) was introduced into the tetrode, so producing the pentode: this had the smoother characteristic (of positive slope throughout) shown in the dashed line in Fig. 8 and permitted the successful amplification of large-amplitude signals.

The kink has, however, one interesting application. If an LC circuit of suitable dynamic resistance is connected to the device, assumed biased to the mid-point of the kink, oscillation results at the resonance frequency of the circuit. The amplitude of oscillation grows until it is limited by the regions of positive slope which begin at B and C. Thus the peak-to-peak amplitude of oscillation so generated is equal to the horizontal distance between B and C – probably about 50V for a tetrode with a screen potential of 80V.

The negative-resistance kink has reappeared recently in the $I_a - V_a$ characteristics of the Esaki or tunnel diode but at a smaller voltage than for the tetrode: in fact the kink may extend only from an anode voltage of 0.1V to 0.3V. Nevertheless by biasing the diode to 0.2V and by adding a suitable LC circuit a negative-resistance oscillator can be produced. These have been used as the basis of low-power d.c. converters, generating, for example, 15V from a 1.5V input. The circuit of such a converter is shown in Fig. 9: it is extremely simple and the converters can be made very compact.

* Load lines will be dealt with in Part 3 of this series

British electronics giants endorse protectionism

'Free enterprise claptrap': Mullard chief

"Unless we stop the flood of imports, in three or four years there will not be an electronics industry in the UK," the managing director of Mullard, Mr Jack Akerman, said at a recent press lunch. His fear, which, he said, was already being realised, was that once the Japanese had achieved a monopoly they would put their prices up, and the cheapness they had been able to sustain by hidden government subsidies would disappear. They had already put up the prices of some tv picture tubes by 25%, having forced the closure of Thorn's Skelmersdale plant, with the loss of 1400 jobs. Despite agreements to reduce the scale of tube imports, "in the first five months of this year the Japanese continued to put tubes into the UK at the same rate as in the previous three or four years." Import controls should be introduced to protect the industry.

He drew attention to Mullard's new pride in the "Philip's connection" and, with what some might regard as a distasteful reference to "the yellow peril", asserted that the Philips group represented "the last chance for Europe". Asked if his desire for import controls, already called for by the TUC, meant abandoning the principle of free enterprise he said: "Free enterprise is claptrap. I have now abandoned free enterprise, because free enterprise to me has got us into the mess we are in."

Mr Akerman's remarks are just one shot in a campaign by certain sections of the consumer electronics industry for some form of government help. Those who advocate import controls do so partly because they feel it is a last resort. The government, they say, persists in investing either in industries like motors which already have gross world overcapacity or in those which the developing countries, the biggest potential market, can create for themselves.

Although his after-lunch remarks seemed impromptu, journalists were handed figures for the sales of colour tv sets in the UK and West Germany in tabular and graph form. The figures, supplied by BREMA, were an appendix to a report on the UK industry prepared by Mullard, Philips, GEC and Thorn. The report, which may appear at any time, will contain two sections. The first of about 40 pages will contain all the data available from the UK and Japanese sources on the state of the market and an outline of the consequences if action is not taken. The second section of five pages will consist of recommendations, notably that for import controls.

The big objection to import controls has always been that the Japanese would retaliate, not necessarily in the electronics industry. Arthur Banford of Fidelity, whose call for import controls we reported last month, seemed unafraid of retaliation. He told Wireless World: "We have the undeveloped countries and the whole of Europe to sell to, and if we can't make a go of it in those markets we may as well give up."

Another difficulty about import controls, however, is that it runs against the General Agreements on Tariffs and Trade and the general tendency, to which the government is committed, to removing trade barriers. Under GATT legislation you can only bring in import controls if you can prove dumping, and investigation in Japan has shown that picture tube prices there are little different from here.

Under GATT agreements, specific industry import controls can be introduced but it must also be demonstrated that imports are increasing. This has not been the case since, as the figures Mullard handed out show, the total UK market has been shrinking and the Japanese have only to hold their sales in order to claim a greater market share. In addition, such controls can only be brought for specific industries if they are non-discriminatory; they must apply to other countries as well as Japan.

Some sections of the industry think that the television makers are putting too much blame on the Japanese simply because of their own failure to compete. (Neither BREMA nor RIC, though sympathetic, has associated itself officially with the campaign, although Mullard says that had they done so it would have meant "another layer of negotiations".) As Minister of State for Industry Alan Williams pointed out in his reply to Edward Lyons, much of the trouble stemmed from the sudden releasing of credit controls in 1971, when British manufacturers themselves imported Japanese tubes to meet demand, and their equally sudden reimposition at the end of 1973. The market slumped, but the Japanese tubes kept coming. Also, the hiatus of two weeks between the announcement of 25% VAT in April 1975 and its imposition on May 1 caused another rush with which only the Japanese seemed equipped to deal. After the deadline the market once more went dead.

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Letters to the Editor

EQUAL TEMPERED PITCHES

Referring to the article "Generation of Equal Tempered Pitches" in the June issue of *Wireless World*, I would suggest that in order to save cost on components, the master oscillator frequency could be derived from a standard frequency crystal (1 MHz or 10 MHz). There seems to be no need to have master oscillator frequencies such as were given: crystals for these frequencies would have to be specially ordered, which could delay completion of the unit.

For a 1 MHz master oscillator frequency (×2, ×4, ×8, ×16) the divisors would be as follows: (3 × SN74193 would cope).

Pitch	Frequency	Divisor	Resultant Frequency	% error
C	261.6256	3822	261.643	+.007
C♯	277.1826	3608	277.162	-.007
D	293.6648	3405	293.686	+.007
E♭	311.1270	3214	311.139	+.003
E	329.2282	3034	329.598	-.009
F	349.2282	2864	349.162	-.019
	or	2863	349.284	+.016
F♯	369.9944	2703	369.959	-.009
G	391.9954	2551	392.003	+.002
G♯	415.3046	2408	415.282	-.005
A	440.0000	2273	439.947	-.012
B♭	466.1637	2145	466.200	+.008
B	493.8833	2025	493.827	-.011

WIRELESS ACROSS SPACE

With reference to Mr Tang's article (June 1976) on interstellar communication, may I suggest that *any* natural frequency, such as that of the hydrogen line, is likely to be noisy. Hence a hypothetical transmitter, designed to attract the attention of distant radio-telescopes, might use a frequency related to a natural line.

I suggest that a frequency of $\pi \times 1.42$ GHz, 2.7183×1.42 GHz, or some simple combination of these would identify a signal as emanating from an artificial transmitter. Precise measurement of the frequency over a period of time would allow the identification of the star involved from its line of sight motion, as well as the location of the transmitter on planet, or natural or artificial satellite.

W. T. Gartland,
Hollingbourne,
Kent.

Mr Tang replies:

Gartland is of course right in pointing out that natural frequencies such as those of OH and H1 (hydrogen one, i.e. neutral atomic hydrogen), which exist in interstellar dust clouds, will be noisy. However, using π or e times the H1 frequency does not appear to me as more anti-cryptographic or "obvious" than using its second harmonics. A multiplication by two is at least as good as, if not numerically simpler than, a multiplication by one of the many (all equally important) mathematical constants. His second point is also correct. If the extraterrestrial station has not corrected its transmitting frequency for Doppler shifts on its side, then we can deduce its orbital data from the periodic variations of the received signal frequency, the only disadvantage being that to detect such signals in the first place may be more difficult.

T. B. Tang,
Cavendish Laboratory,
Cambridge.

PHASE — MOIR AND HARWOOD

James Moir, in his article, "Phase and sound quality," *Wireless World*, March 1976) quotes the paper "On Aural Phase Detection" (*JAES*, Jan/Feb 1974) by E. Rorbaek Madsen and the undersigned, I would like to correct a couple of points which he appears to have misunderstood.

The use of passive phase-shifting networks was not rejected, but as it was not the purpose of the experiment to study the effect of amplitude changes, the use of such filters was considered outside the scope of the work. Concentrating on the effect of phase without corresponding changes in amplitude, one could of course use separate generators and phasing networks, but this is equivalent to the use of excess phase networks. Thus, the paper suggests that the use of minimum phase shifting networks, which alter amplitude ratios simultaneously with phase, does not have any relevance to the primary aim of investigating the audibility of phase shifts, but that the use of excess phase networks is necessary. In either case the phase shifting networks may be simply passive or active, without affecting the results.

The technique requiring "four recordings and replays of a square wave" also called the time inversion method, is acknowledged in the paper as causing repetitive addition of amplitude errors, while removing phase errors. If the amplitude characteristics in the two cases are identical, this test can give meaningful results. However, the results were included in the paper as documentation of preliminary results, which justified proceeding with further investigation. It is therefore relevant to add that the test quoted by Mr Moir is only a small section of the first part of the paper, Part II (*JAES* Dec. 1974) of which gives results showing the amount of phase shift detectable by the human ear.

Villy Hansen,
Bang & Olufsen,
Denmark.

It pains me to perpetuate the controversy generated by H. D. Harwood's January article on the audibility of phase effects in loudspeakers[1]. However, seeing a report of mine[3] quoted by both Mr Harwood and Mr Gerzon in support of their respective viewpoints (March issue, p.60-62), has moved me to try and clarify the issue.

Briefly summarizing, Mr Harwood maintains that gross phase anomalies in a single monophonic sound channel have little if any subjective consequences (at any rate, if programme material as opposed to a specially devised test signal is used). There seems little doubt that this is true for the vast majority of listeners. He then cites results[1,2] showing that high frequency phase anomalies, above 2khz, have little effect on stereophonic image localization. Whilst the evidence of my report substantially confirms this, it is not wholly correct to conclude, as he does, that phase has little apparent effect about 2khz. The report indicates that, for the example of equal amplitude but antiphase stereo signals cited, the tonal quality of the resulting sound image is degraded. Some people, myself included, found the quality to be nasal, forced, and tinny. However, the effect was qualitatively different from the "phasiness" shown by out-of-phase lower frequencies. The evidence thus seems to indicate that high frequency phase disturbances do not manifest themselves by causing localization errors, but that they may cause sound quality changes. This appears to support Mr Gerzon's observation that a poor pickup phase response can cause a shrieky top-end colouration, despite a flat amplitude response. However, the evidence for this is not conclusive, since it appears that gross interchannel phase differences would be necessary to cause such disturbances.

I would like to point out that I am no longer working under the auspices of the BBC and that the views expressed here are therefore purely personal. I also have no connection with Mr Bowers of B&W Loudspeakers.

J. S. Bower,
15 Samantha Close,
Markhouse Rd.,
London, E17.

References:

1 Harwood, H. D. "Audibility of phase effects in loudspeakers". *Wireless World*, Jan. '76

2 Shorter, Harwood & Manson "Stereophony: The effect of interchannel differences in the phase/frequency and amplitude/frequency response". BBC Engineering Monograph No. 56, 1964

3 Bower, J. S. "The subjective effects of interchannel phase shifts on the stereophonic image localisation of narrowband audio signals". BBC Research Dept. Report No. 1975/28

James Moir's article "Phase and Sound Quality" contains much interesting material, but it is not good enough, in an article described as a review of this subject, to leave unresolved the problem of defining simultaneously the phases of a number of sine-waves of different frequencies. Indeed

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he even suggests that the idea of phase is inappropriate to discussions involving signals whose frequencies are not all multiples if a common fundamental! To provide the required definition one begins by specifying a particular "synchronizing time," and then determines the phase of each sine-wave component of the waveform under consideration (which may itself be non-periodic) with respect to a sine-wave of the same frequency which crosses the zero axis in an upward-going direction at the synchronizing time. If one had chosen instead a synchronizing time T_d later than the first, then the phase determined for a component of frequency f would change by an amount $2\pi T_d$ which is independent of the shape of the particular waveform under consideration, and any two components whose frequencies differed by a small amount Δf would have their relative phases altered by $2\pi\Delta fTd$. Thus if a device such as an amplifier or loudspeaker produces a relative phase shift over this frequency range of $\Delta\phi$ it will cause these components to recombine as if the original waveform had been delayed by a time $\Delta\phi/2\pi\Delta f$, the "group delay." Only if the phase shift produced by the device changes linearly with frequency will the group delay be independent of frequency, and the waveform unaltered by transmission through it.

As a rule each particular choice of synchronising time will give rise to a distinct set of phases for the components, but if they are all harmonics of a common fundamental, the phases determined for synchronising times separated by a whole number of periods will differ only by multiples of 2π radians.

Mr Moir invites us to believe that, because a periodic square wave applied to a high quality loudspeaker gives rise to waveforms in a normally lively room which vary with position in the room, and from which all evidence of the steep rising and falling edges has disappeared, it is unnecessary for a loudspeaker to preserve wave-shapes. In fact no feature of a periodic waveform observed in such a room can be a transient, since each period of the observed waveform contains reflected contributions from all preceding periods of the driving signal, and these reflections will rarely arrive in synchronism with either the direct wave or each other. True transients, such as cymbal clashes, the attack of harpsichord and pizzicato string notes, etc., can be heard only during the brief interval between the arrival of the direct wave at the ear and the arrival of the first reflection, typically two or three milliseconds. As Michael Gerzon remarks in your March letters, differences in these true transients may allow one to distinguish between linear phase speakers and speakers which introduce phase shifts which are not linear functions of frequency into the components of the radiated waveform. Such differences are more likely to be detected by players thoroughly familiar with their own instruments than by listeners accustomed to hearing those instruments at a more respectful distance.

Some years ago I. C. Whitfield[1] demonstrated that a mechanism exists by which the ear informs the brain of waveform details which would definitely be affected by changes in the relative phases of the components, a fact which Mr Moir fails to mention. It is admittedly hard to reconcile the existence of this mechanism with the observations of Mr Moir and others, including Mr. P. Taylor (March Letters), that one has great difficulty in distinguishing periodic waveforms which differ only in the relative phases of their components. However, it would clearly be rather awkward if we all associated the phase and amplitude changes which arise from listening to periodic sounds at different places in the same room with significant changes in the quality of the speech or music and it is possible that in such circumstances we have trained ourselves to ignore this information. On the other hand Dr Hodgkinson[2] has shown that when a waveform is synthesized from harmonics of a single fundamental, but the fundamental itself and some of the lower order harmonics are missing the ear does interpret changes in the relative phases of the remaining harmonics in terms of changes in tone quality, and points out that the lower register of the bassoon shows just such a distribution of harmonic amplitudes.

Mr Taylor's March article on the synthesis of frequency-modulated waveforms contains a nice demonstration of the way in which the sine-wave components combine to generate a constant-amplitude variable frequency resultant. It would be interesting to see what emerges when a synthesized waveform is applied to a band-pass filter whose centre frequency lies within the range swept out by the 'instaneous frequency' if the frequency deviation is kept constant, but the number of sidebands falling within the filter pass-band is reduced by increasing the modulating frequency. The changes in the sharpness of the signal bursts emerging from the filter might serve to bring home the significance of the acoustical uncertainty limit. If one considers a 10kHz signal frequency-modulated at a frequency of 0.5Hz with a frequency deviation of ± 1kHz, and applied to a filter with a bandwidth of 100Hz and a centre frequency of 10kHz, one expects the output to be a succession of bursts of approximately 70msec duration repeating at intervals of 1 sec. However the sidebands of the input signal which lie within the pass band are present in the output at all times, but for 90% of the time are busy almost cancelling one another out. Does anyone seriously doubt that by suitable changes in the phases of the components passed by the filter the output could be turned into a continuously audible, if rather noisy and erratic, 10kHz tone?

C. F. Coleman,
Wantage,
Oxon.

References

1 I. C. Whitfield in 'Frequency Analysis and Periodicity Detection in Hearing' (Ed. Plomp and Smoorenberg) A. W. Suithoff, Leiden, (1970)

2 K. Hodgkinson, 'The Psycho-Acoustics of Phase', Hi-Fi News and Record Review Annual, p23 (1976)

RC CIRCUIT CALCULATIONS

In part 5 of his generally excellent series "Electronic circuit calculations simplified," I fear Mr Amos has missed a trick and also made a mistake. He presents a table of the frequency response of an *RC* circuit without pointing out the useful property that the discrepancies between the true curve and the straight line approximation are symmetrical about the cut-off (−3 dB) frequency; indeed, his table contains an error which conceals the symmetry.

For a top-cut circuit (Fig. 3 of Mr Amos's article) the response in decibels is

$$20\log_{10}\frac{1}{\sqrt{1+(2\pi fCR)^2}}$$

$$\text{or } 20\log_{10}\frac{1}{\sqrt{1+(f/f_0)^2}}$$

where f is the frequency at which the response is being considered and f_0 is the cut-off frequency.

Up to the cut-off frequency, the straight line approximation indicates that there is no loss. The difference Δ_1 between the true loss and the approximation is therefore

$$20\log_{10}\frac{1}{\sqrt{1+(f/f_0)^2}}$$

Above the cut-off frequency, the straight line approximation shows a 6 dB per octave fall, i.e. a response $20\log_{10}f_0/f$. The difference Δ_2 between the true and approximate losses is thus

$$\Delta_2 = 20\log_{10}\frac{1}{\sqrt{1+(f/f_0)^2}} - 20\log_{10}f_0/f$$

$$20\log_{10}\left[\frac{1}{\sqrt{1+(f/f_0)^2}} \div f/f_0\right]$$

$$20\log_{10}\frac{1}{\sqrt{1+(f_0/f)^2}}$$

These expressions for Δ_1 and Δ_2 are very similar and tell us that the discrepancy between the true and approximate curves is the same at for example a quarter of the cut-off frequency as at four times it.

Hence Mr Amos's table could be written

Frequency response of RC circuit

Freq. for top-cut cct.	Freq. for bass-cut cct.	Extra loss rel. straight line approx.
f/4	4f	0.25 dB
f/2	2f	1
f*	f*	3
2f	f/2	1
4f	f/4	0.25
8f	f/8	0
16f	f/16	0
32f	f/32	0
etc.etc.etc.		

*f is the frequency for which the reactance C equals R.

In practice only two numbers have to be remembered, 1 and 0.25 dB. The mistake in the published table becomes apparent as well; $2f_0$ the straight line approximation would give a loss of 6 dB (one octave above cut-off at a rate of 6 dB/octave), so the truth must be 6+1 dB, not the published 7.5 dB (a more accurate calculation gives 6.99 dB).

K. J. Gundry,
Teddington,
Middlesex.

The author replies:

I am grateful to Mr Gundry for pointing out the error in my article and, more particularly, for drawing attention to the symmetry of the response curve which the error concealed. As he says, this symmetry makes calculations on the frequency response of RC circuits even simpler than I tried to show in my article.

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CITIZENS' BAND IN UK

Recent correspondence on the possibility of a Citizens' Band radio network in the UK ranges from the naive to the downright selfish. A typical example of the latter is Mr D. J. Martin's letter in your May issue. He states that there are between 70 and 80,000 users of the 27MHz band and then spoils it by saying that not all (how many – 40,000?) are licenced. He attempts to gloss over this by saying that all the equipment used is legitimate (!) whatever that means. A rather sweeping statement I might say.

I think this about sums up the current situation in the 27MHz band which appears to be regarded by Mr Martin and his friends as their special preserve. I wonder why the "bulk of (their) equipment would not be compatible with the operation of CB systems". Would it perhaps be because of wide receiver bandwidths and spurious transmitter frequencies? Are such matters as safety of life and the day to day convenience of the citizens of this country to be subordinated to the childish activities of playing with toy boats and aeroplanes? Indeed, the image conjured up by Mr Inwood's description of a runaway model helicopter weighing 11 lbs makes one wonder whether such activities should be allowed at all.

Your correspondents have been talking about the 27MHz band as if a full megahertz of bandwidth was required. They may not be aware that there are many thousands of base and mobile radio stations in this country operating quite satisfactorily within 12.5 kHz r.f. bandwidths. I am sure many such channels could be made available for CB use in the 27MHz band or elsewhere for that matter. Also, the equipment operated by Mr Martin and his friends would have to conform to much tighter specifications and why not?

Comparison with the United States is completely irrelevant to the discussion. For better or worse, the Home Office has a very tight hold on the radio frequency spectrum in the UK and is well equipped to deal with transgressors. I am quite sure they would be capable of enforcing the strict regulations necessary for the successful operation of CB systems.

I fear, however, that approved CB equipment would not be cheap. I would put the cost at between £200 and £300 per transmitter/receiver plus a licence fee of around £10/annum. Added to this, of course, would be the cost of maintenance which nowadays is not cheap.

I cannot see why anyone can assume that making the 27MHz band available for CB systems will automatically result in chaos. After all, there is nothing except the laws of the country stopping anyone from using whatever part of the radio spectrum they want.

Citizens Band in the UK would provide thousands of people who have no means of getting a frequency allocation from the Home Office, with much needed radio communication facilities. I am thinking particularly of doctors, vets, nurses and people like Mr Leeves who live in remote parts of the country. There are many such places in the Highlands of Scotland.

J. G. Kelly,
Edinburgh.

There has been a large number of letters in your columns recently supporting the idea of a Citizens' Band in the UK. I would like to comment from a radio amateur's point of view.

Firstly, there seems to exist the mistaken belief that amateur radio is a difficult and expensive hobby. Many people seem daunted by the prospect of taking an examination. The radio amateur's examination requires a certain amount of technical knowledge certainly, but it is not particularly difficult for those who are assiduous enough and many people from all walks of life are successful. In any case it cannot be a bad thing to ensure that radio operators have some idea of how radio works since even low power transmitters can cause havoc if maladjusted. It is unreasonable to assume that a perfectly adjusted transmitter straight from the manufacturer will remain so throughout its lifetime and the effect is a lot less parochial than, say, a television set which is out of adjustment.

The other useful part of the R.A.E. tests the candidate's knowledge of licence regulations. I find it disturbing that, presumably, operators of CB wold not be required to observe standard operating protocols.

As for the expense of amateur radio, it is certainly true that high power multiband operation costs a lot of money. However, for low power single band operation (which is presumably what CB would be) it is not too expensive to buy one of the 'black-boxes' which proliferate on the amateur market nowadays.

Secondly, there is unfortunately a minority of amateurs who indulge in pirate operation with disregard for the licence regulations. Even though the number is small they are capable of causing widespread chaos and in some cases prove difficult to stop or even detect. In my opinion it would be no more easy to track down illegal CB operators thus stretching the resources of the authorities even further. The problems of CB regulations enforcement in the US are numerous and the job is becoming more hazardous as mentioned in the Amateur Radio section of the May edition of this magazine. We surely do not want this to happen in this country.

Thirdly, there is the 1979 World Conference on the use of the frequency spectrum and all frequency usage will have to be justified. It is important, therefore, that all users ensure that good operating practices are adhered to.

In conclusion my amateur radio colleagues and I do not regard ourselves in a privileged club but rather as belonging to a movement, into which anyone is welcome, to encourage the sensible use of radio communication.

C. D. Friel, G4AUF
Harrow,

In reply to the letters in the May issue of *Wireless World*, I would like to add my own views and suggestions on the subject of a Citizen's Band in the UK.

The first assumption of all those who oppose a CB in the UK is that it would be in the 10 metre band, with its obvious pitfalls of TVI and intrusion into the amateur part of the band. The use of a much higher frequency in the public service band – 155 to 175 MHZ – would ensure a much smaller distance cover per watt of output leading to smaller frequency allocation being required. The GPO already has monitoring facilities on these frequencies and un-licensed use is easily spotted. Additionally, second-hand and new equipment is already available and conforms to the GPO and ITU requirements as to stability, power out, etc. An extra point in its favour is that its use by untrained, unlicensed, non-technical personnel in the above band, eg mini-cab drivers, bricklayers on building sites, etc, has not led to an increase in TVI, BCI or any public outcry.

The license fee for CB work could be made high, increasing the Post Office revenue: this would also lessen the chance of uninterested people trying it out for fun. As a final point to deter anyone who has not paid his or her high licence fee from getting a CB set it would be easy to insist on the buyer showing his or her licence or quoting the serial number before the retailer is permitted to sell the set.

C. Knowles,
Chingwood,
London, E4.

Since my first letter to *Wireless World*, which was published in the January issue, a veritable hornet's nest of pro- and con-CBers has been stirred up. All of the letters published by *Wireless World* have contained interesting points, but there are two facts which have so far gone unremarked:

Firstly, why do the anti-CB brigade always mention the USA as a country where CB has run rife? It's true enough that the interest in the last two years in CB has caused a vast increase in the number of illegal users – but the *percentage* of illegal users, which sounds very impressive in round numbers, is still roughly the same percentage as it was five years ago. And for that matter, it is a little unfair to pick on the USA at all; why no mention of West Germany, where there has been a substantial increase in CBers over the last few years with little illegal use, few conflicts with radio-control fans, and many proven examples of the usefulness of a well regulated and supervised Citizen's Band?

Secondly, why is it assumed that providing a Citizen's Band in the UK would cause an immense increase in workload for the Post Office/Home Office department involved in supervising the licensing of such a band? Would it not be possible to establish a self-regulating Citizen's Band organisation, similar to the RSGB, with powers of licence revoking and report-back to the Post Office?

I really cannot see why the Home Office has adopted such a peculiar attitude to the CBers; on the one hand we have the model radio-control fans and other users of the 11-metre band who can easily obtain licences; and on the other hand we have the CBers who are for some reason regarded as socially unacceptable Hertzian intruders. Surely the time is ready for an unbiased study by the Home Office of countries where CB is allowed – perhaps the USA, BRD, Sweden and Denmark would provide useful data – followed by a published report and, hopefully, a trial period on a limited basis? I, as a licenced and legal West German CBer, would welcome any such action by the Home Office.

Robin A. Flood,
Darmstadt,
West Germany.

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Magnetic pick-up preamplifier

A design with an equalization method to reduce amplifier noise

by B. S. Wolfenden, B.Sc.

The most common method of producing the equalization for a magnetic pickup is to apply frequency-dependent feedback around the first stage of the amplifier, which also provides the necessary amplification to bring the pickup output to a reasonable level. As any noise generated inside the amplifier is not completely attenuated by the feedback when the frequency correction is applied the high frequency part of the signal will be attenuated slightly more than the noise. In the following design this process is split into two. The signal is first amplified flat, and then the correction is applied with the result that the signal and noise from the first stage are both subjected to the equalization. The high frequency noise is thus also attenuated, resulting in what could be called "brown" noise and an improved signal-to-noise ratio.

The circuit is built around a dual op-amp type 747. This is effectively a dual version of the 741 and there is no reason why a pair of these should not be used as an alternative.

In the circuit of Fig. 1 the first op-amp is used as a flat amplifier and is adjusted to have a gain of 13. The pickup impedance will be low compared to the input impedance of the amplifier and so series feedback is chosen to keep the noise as low as possible.*

The output from this amplifier is then fed to the second op-amp which has frequency-dependent series feedback to give the RIAA compensation required. The gain of this stage is unity at 1kHz. No coupling capacitor is used between amplifiers as the gain of the stage is relatively low at d.c. and hence no significant shift of the output level will be caused by any offset voltages, due to the op-amps.

The overall gain of the amplifier is such as to give an output of 65 to 70mV with most modern pickups which give an output of about 5mV at 5cm/s. The gain of the first stage of the amplifier can be adjusted for other sensitivities with the proviso that the bandwidth will be reduced as the gain is increased due

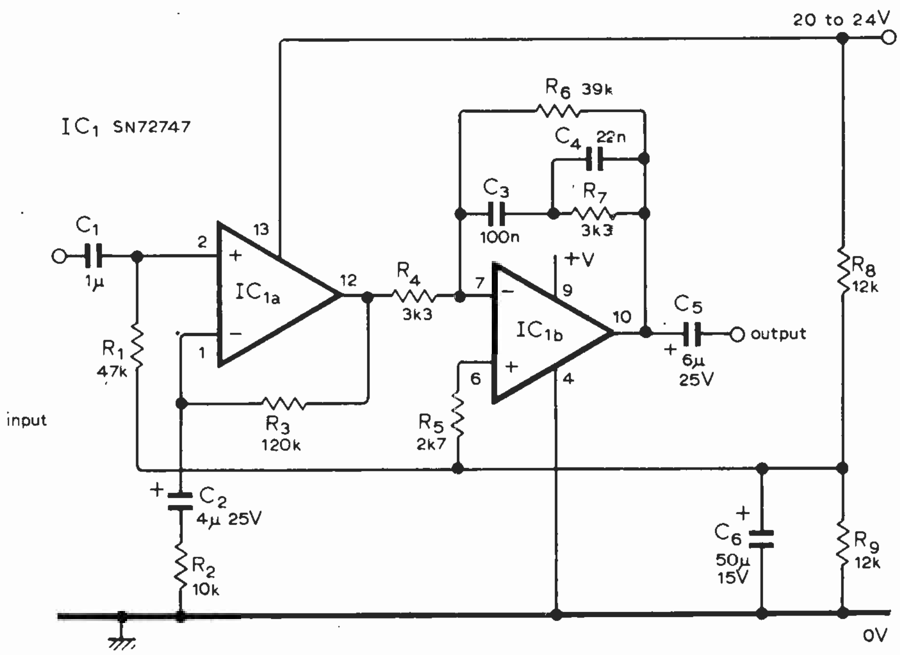

Fig. 1. Circuit of the preamplifier.

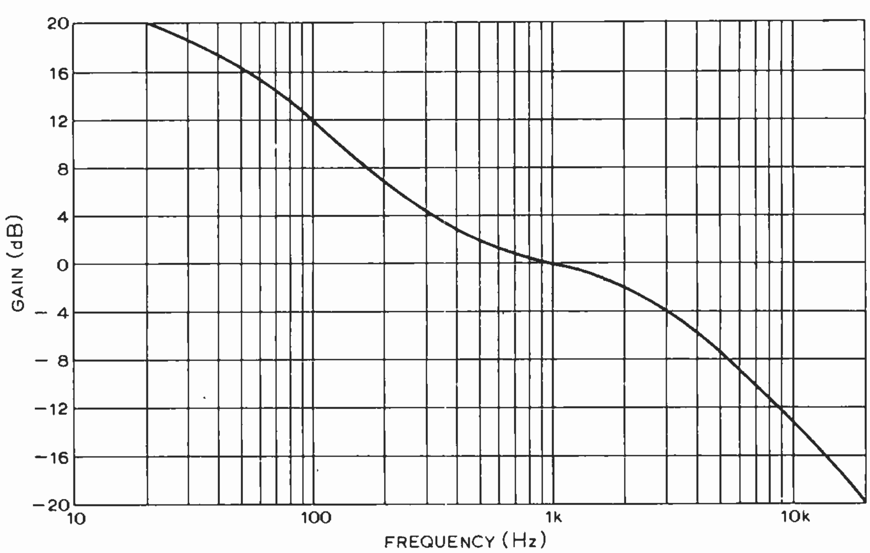

Fig. 2. Measured RIAA equalization curve.

* Walker, H. P., Low-noise audio amplifiers, *Wireless World* May 1972.

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Specification of the prototype

Output	70mV
Signal-to-noise ratio	>65dB

Overload capacity<40dB for a 24V supply
Equalization correct to within ½dB (RIAA)

to the fixed internal compensation of the 741-type op-amp.

Squaring takes place practically symmetrically at an output of just over 7V r.m.s. for a 24V supply. This gives an overload capacity greater than 40dB. If a low-noise i.c. (e.g. MFC8040) were used as the first stage of the pre-amplifier intead of the 741 type a better noise figure could probably be obtained. This has not been tried within the prototype.

The R.I.A.A. equalization of the prototype is correct to within ½dB.

Improvement in noise

In order to determine the improvement in signal to noise ratio, the more traditional circuit in Fig. 4 having essentially the same gain and frequency response as the prototype circuit, was constructed.

Both circuits used the same batteries for power, and the output of each was amplified by the same amount by the same amplifier. The noise due to the above circuit, after amplification, was measured as 2.7mV while that from the prototype design was only 0.7mV. The improvement in signal to noise ratio is thus approximately 12dB over the traditional method using the same basic amplifier.

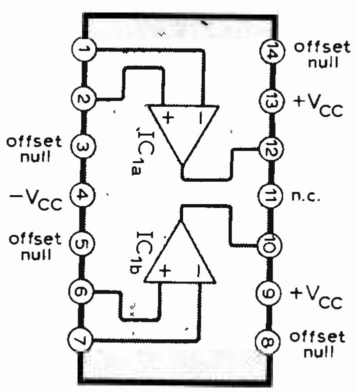

Fig. 3. Pin connections of the 747 14-pin d.i.l. package.

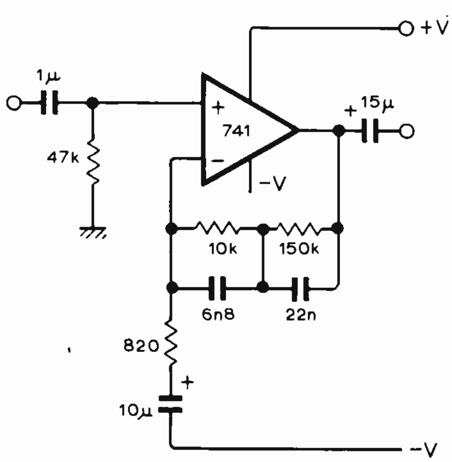

Fig. 4. Traditional circuit for noise figure comparison with the prototype preamplifier.

New Eurovision control centre

Solid-state digital control techniques are to be used throughout a new broadcasting control centre in Brussels. The Eurovision Control Centre, known as the EVC, is an operational control room established by the Eurovision Broadcasting Union (EBU) to co-ordinate, and supervise the routing of, television signals transmitted into the system by members of the EBU. Most of the television broadcasting authorities in Europe, and many of those in Middle East and North African countries, are full members of the EBU and participate in Eurovision transmissions. Many more authorities in countries remote from Europe or North Africa are associate members of the EBU and are also able to link into the system in certain circumstances. The network is in continual use for international distribution of television news and programme material; spectacular Eurovision events, such as international sport, forming only a part of the total activity. During normal services there are usually about ten members on the network, and during big events there can be as many as 35.

At present the EVC is located in the Palais de Justice in Brussels, and operates in conjunction with Belgium's national broadcasting organizations RTB and BRT. The new EVC will occupy a wing of the new production centre, Cite Radio-TV in the Boulevard Reyers.

The contract for engineering, installation and commissioning of the entire television monitoring, audio switching and associated control systems in the centre has been awarded to Crow of Reading Ltd. This contract, which will take about two years to complete, is worth approximately £300,000.

"Sticky time" for disc

Plessey are clearly hoping that charge coupled device memories and magnetic bubble memories will prove to have complementary rather than competing uses. This emerged from two papers presented on the first day of the IERE Golden Jubilee conference on video and data recording held at Birmingham University on July 20 to 22. In the first John Dickson of Plessey's Allen Clark Research Centre said that Plessey were evaluating a prototpye 16kbit c.c.d. memory chip and that sample quantities would be available by the end of 1976. The device should operate, he said, up to 5MHz with a mean access time of 400μs.

In the second, David Hunter of Plessey Memories Ltd, described the design and performance of a 256k bit magnetic bubble memory system composed of sixteen 16kbit chips each in a dual in line package complete with drive coils and permanent magnet circuits.

Mr Dickson showed that if access time were plotted against system cost per bit both bubbles and c.c.d. memories compared well with the fixed head disc. "The fixed head disc is in for a pretty sticky time of it unless it can be improved," he said. Mechanically addressed storage systems tended to be fairly cheap but had access times between 1/100s and 100s. Electrically addressed random access memories such as the m.o.s. r.a.m. and the core store were more expensive with a cost per bit of around 1c. The bipolar r.a.m. cost around 40c but this group of devices had access times around 10^{-8} and 10^{-6}s. The fixed head disc cost around the same as c.c.d. or bubble devices at ten bits per cent, but while a c.c.d. device had a best access time of 10^{-5}s and the magnetic bubble device could manage 10^{-4}s the fixed head disc achieved less than 10^{-3}s. Another advantage of c.c.ds was that, being semiconductor devices they remained cost effective even for small amounts of serial storage.

C.c.ds now also appeared to have an inherent complexity advantage over m.o.s. r.a.m. "Initially the complexity doubles every year, mainly due to design improvements. In the case of m.o.s. r.a.m. this is typified by the transition from latches to the one transistor cell. In the second phase most of the design improvements have been exhausted, and further improvements must rely heavily on improvements in technology such as reduced photoengraving tolerances and reduced chip size. In this second phase, the rate of progress is reduced to doubling the chip complexity every two years. It appears that this has already happened with m.o.s. r.a.m.s . . ."

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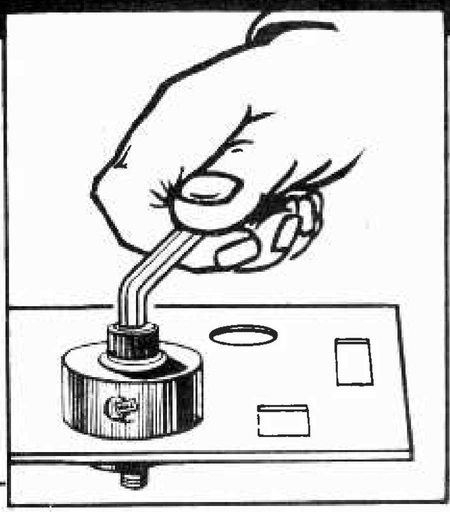

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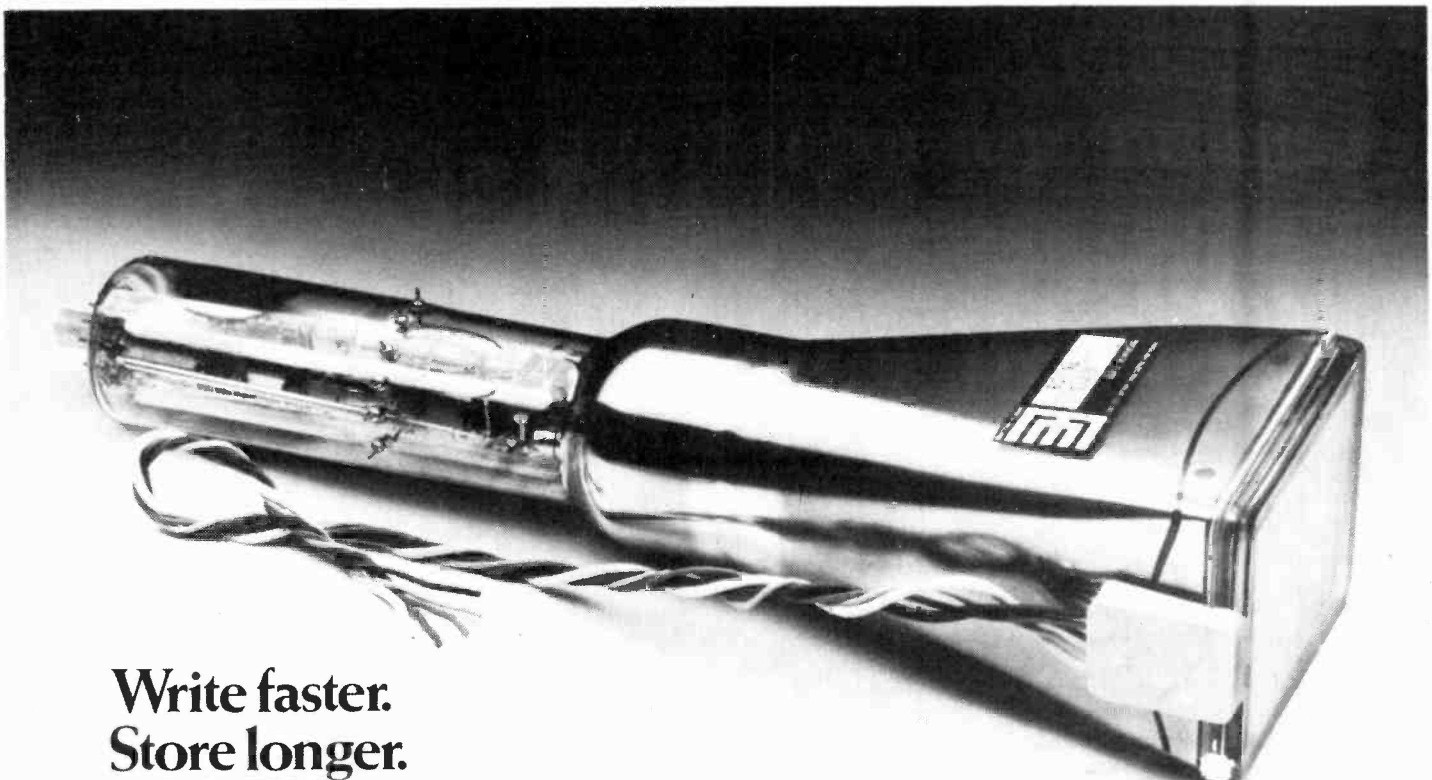

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Earthing, shielding and filtering problems

2 — Stray capacitance and feedback

by R. C. Marschall, M.A., M.I.E.E. Rank Xerox Ltd

Grounding and shielding problems often occur only when systems are coupled together, and then may appear only spasmodically. This makes them difficult to locate, and underlines the importance of dealing with them at the design stage. This short series of articles considers the basic effects, setting the scene with first-order numbers, and the cures that can be achieved by changing magnitudes and circuit configurations. The August article dealt with unwanted series impedance. This second article considers some of the unwanted effects due to stray capacitance between two parts of an electronic circuit, how these can be eliminated by adding shields, and how these shields themselves can introduce further problems.

Very small capacitances are sufficient to cause trouble if the frequency and circuit impedance are high enough. Design calculations of stray effects can use approximate figures: 15pF has a reactance of 10kilohms at 1MHz. This corresponds to 6in of shielded or coaxial cable or 3ft of parallel 0.015in wide 1oz copper strips, printed 0.03in apart.

Case 4

Situation: Subassembly amplifier or digital buffer with high source impedance and large gain-band-width product, see Fig. 4(a).

Symptoms: Oscillation, or unexpected gain or phase characteristic or rise time.

Problem: stray capacitance from output to input, often called Miller capacitance. Ungrounded metalwork, even labels, can substantially increase this capacitance.

Cures: Reduce source resistance, increase source capacitance, or reduce amplifier bandwidth. In digital systems increase response time.

Rearrange physical layout to reduce capacitance.

Interpose a grounded shield between input and output, either as a box or shielded wiring. This substitutes larger capacitances C_3 and C_4 to ground for the original feed back capacitance as shown in Fig. 4(b).

If there is a significant impedance between shield and amplifier ground, shown in Fig. 4(b) as R though it may be inductive, then instability will return, together with increased susceptibility to outside interference. Further, the shield return should be amplifier ground to avoid common-impedance coupling with the input (c.f. case 1)

The loading effects of shields can be reduced by driving them to the signal potential with a near unity-gain amplifier, i.e. boot-strapping them as shown in Fig. 4(c). The amplifier with gain A in this figure has feedback arranged so that its closed-loop gain is $(1-1/A)$. An emitter follower can provide such a configuration. The e.m.f. across the stray capacitance and leakage resistance of the input cable is then reduced to $1/A$ of the input signal. Consequently, the effect of these strays is reduced by the factor A. A second shield is usually added over the driven shield. This technique is commonplace in digital voltmeters.

In case 3, the second and fourth cures raise the impedance to earth of parts of the circuit, and required cables with earth potentials developed along their outer shields. This brings the likelihood of stray capacitance coupling of ground potentials, discussed in case 5. The two cases together illustrate the general problem of interconnecting boxes, and the cures can be carefully extended to greater numbers. Remember that d.c. power supplies, if decoupled at both ends, effectively parallel the ground connection.

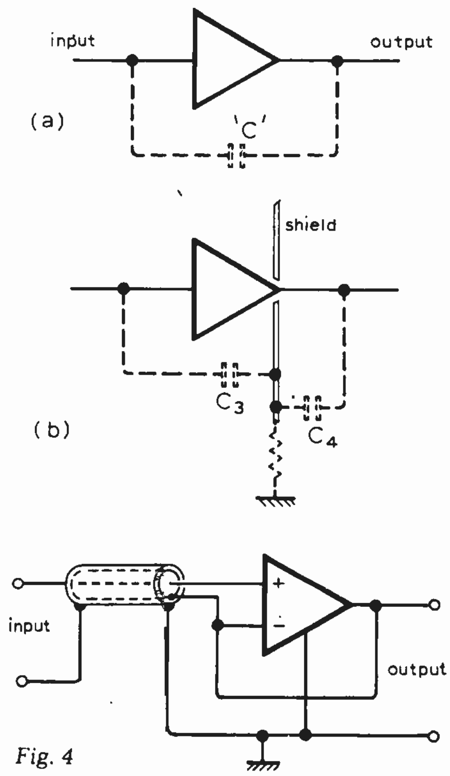

Fig. 4

Case 5

As in case 3, fourth cure (amplifier 2 grounded at amplifier 1 box), but with significant ground capacitance effects. These are probably enhanced by shields added in accord with case 4.

Symptom: Inter-box ground potentials, particularly switching noise, appears at amplifier 2 output.

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Problem: Relative to amplifier 2 input, the e.m.f. JK appears on box 2, and so is coupled in via C_1 and C_2, as shown in Fig. 5(a).

Cures: Lower circuit impedance or reduce bandwidth.
Make impedances and voltage sensitivity of the two input wires equal as shown in Fig. 5(b). To do this, use a balanced push-pull input to amplifier 2 together with balanced twin cable *and balanced output from amplifier 1.* Thus C balances C_2, and C_3 balances C_4. This is the standard method for connection of low impedance microphones, which can be visualized as replacing A1 and its transformer.
Lower capacitances, either by increased separation or by interposing a second shield around amplifier 2 and using triaxial cable, as in Fig. 5(c).

NOTE: This last cure is imperfect because the capacitance between the shields is large and couples part of the JK.e.m.f. onto the inner shield despite its low impedance. Balanced twin inside 2 shields would be better . . .!
Some of the merit of triaxial cable can be obtained by coaxial cable with an adjacent substantial ground conductor. Another major reason for using shields is the elimination of signal pickup from the environment. This general problem will be considered next month.

Fig. 5(a)

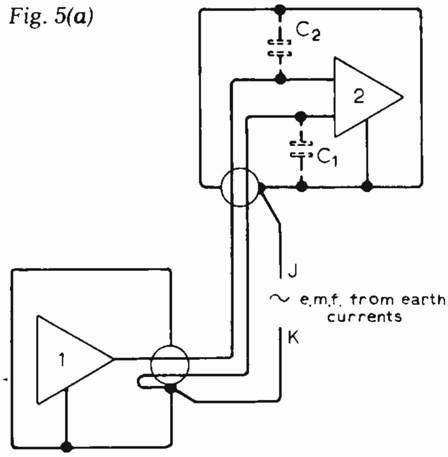


Fig. 5(b)

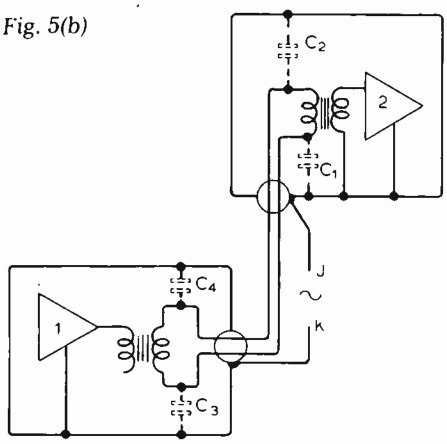
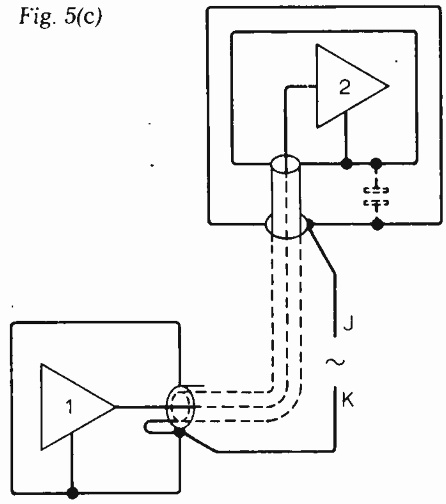


Fig. 5(c)



Further reading

Grounding and Shielding Techniques in Instrumentation, Ralph Morrison. Wiley 1967. Practical treatment, with emphasis on basic physics and multiple shields.

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continued from page 77

The market the British manufacturers were going for was the large-screen colour tv market which was dominated by the rental companies. These wanted sets which would not need to be changed very often and the market was soon saturated. In other areas, the British manufacturers also grossly over-estimated the frequency with which users would want to change sets. As the BBC is now finding to its cost, the market for colour sets has saturated quicker than was thought at first, as disposable income has been squeezed between inflation and pay restraint. Combining all this with the effects of the Barber budget and the imposition of 25% VAT, the British firms soon found themselves with a huge overcapacity in large screen colour tv production at a time when overheads were going through the roof.

Investment is a sensitive issue. Jack Akerman chose to make his remarks at a press visit to Mullard's new £3 million clean room for the production of m.o.s.n. channel i.c.s. He pointed out that Philips/Mullard was spending a great deal in this country and expected the government to help them in return.

Ironically it was a former chairman and managing director of Mullard, Dr Francis Elgar Jones, now a director of Philips Industries, who has pointed out just what some of the crucial differences between Japanese and British industry are. Since last year he has been leading what *The Times* called a crusade to get industry to analyse its performance in terms of added value – the difference between the cost of raw materials and energy at one end and the sale price of the finished products at the other – per employee.

He has analysed over 1,000 company accounts both here and in Japan and among those he studied were Plessey, GEC, Philips, Hitachi and Sony; added value per Sony employee was nearly four times that of his counterpart at Plessey. But then each Sony employee had £34,470 worth of assets behind him compared with the £2,457 provided by Plessey. The Plessey employee, in other words, manages to produce a quarter of the added value with less than a fourteenth of the total assets. The Philips employee added nearly £6,000 of value (compared with the Sony employee's £10,402) backed by total assets of £12,483.

Jones's figures also showed that the money kept in the company for depreciation was much greater in Japan, and that the amount of added value per employee taken up in wages and salaries was much higher in the UK. Yet in evidence to the Commons Select Committee on Science and Technology in February he noted that the average salary in Japanese engineering industry was £4,000, more for graduates, but that GEC paid an average of £2,136 and Thorn £2,180.

Again, last January the National Economic Development Council commissioned reports from each of the industrial sector working parties as a preliminary to the second part of the government's industrial strategy. The sector working party on electronic components recommended that the imports of colour tv tubes and the prices at which they entered the UK should be watched, but added that "recent marked increases in the price of Japanese colour tubes should ease the immediate problem and strengthen the financial position of the one remaining UK colour tube manufacturer." Far from considering the rise of 25% in the price of the Japanese tubes a threat, the working party considered it a blessing. More important perhaps is that the working party gave more prominence to a recommendation that the quality of the goods should be improved. The radio industries council is investigating the reliability of UK electronic components and the Department of industry is thinking of giving help in the approval of civil components to BS9000.

A rather different, and perhaps more positive attitude to the Japanese threat was shown by Garrard, a reluctant subsidiary of Plessey, at a recent product launch. Admitting that Garrard had been in a mess only 18 months ago, the marketing manager, Ron Fone, said "We aren't going to allow the Japanese competition to take markets away from us any more. We must export better . . . It isn't easy at the moment, but the only way to is to develop products which are better than the competition's."

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An audible voltmeter and bridge-indicator

"Bellbird" — an aid for the blind

by R. A. Hoare, B.Sc. *Manurewa High School, New Zealand*

Most of us will realise how much we owe to our eyes in the pursuit of our electronics profession or hobby. We may feel that blindness would completely end our participation in such activities, but this is wrong, as many blind radio amateurs have proved. However, there are many difficulties and a major one is the making of measurements. Various methods have been devised to enable the blind to read moving-pointer instruments, and most of these use photocells and buzzers. There are also null-type instruments with large dials labelled in Braille, but these are slow and inconvenient. Modern digital methods seem to offer the answer.

Clive is a seventh-form physics student who has been blind from birth. His hobby is electronics and he builds all sorts of things, relying on written descriptions of the circuits. Sometimes he is helped by having an integrated circuit mounted on a larger printed circuit board as a sub-mount, but apart from that he is self-reliant. It was with Clive in mind that a rather old digital voltmeter (using r.t. logic) was bought with the idea that it could be used to give an audible output. The meter could be used not only in his hobby activities but also in his 7th form physics experiments and later in his university studies.

The voltmeter is conventional in that it has three digits with an over-range 1 and an automatic polarity indication. Overloading results in blanking and an X display on a Nixie tube. It seemed that the problem was that of converting the parallel display, where all the digits are seen at once, to a serial presentation, where only one figure is seen at a time. I believe that a device which announces the digits orally is available, but this is expensive and difficult for the lone worker to make. The information inside the voltmeter is, of course, in binary form and there seemed to be no reason why this should not be suitable for direct communication with the user, if translated into suitable sound and presented bit by bit. There are several possibilities: changing note length, note pitch, or note quality. The first method is used in Morse code but would possibly be confusing in this new application, unless the five-bit Morse numerals themselves were used. These are rather cumbersome and would present difficulties in decoding. The translation of a binary 1 into a high pitched note and a 0 into a low pitched note seems natural and has proved acceptable in practice. If the X, +, — and over-range 1 can be combined into one digit then we have four 4-bit digits to convey, in addition to the decimal point, which suits the capability of a 16 to 1 multiplexer very well. This, as many will know, is an i.c. with an output which can take up the state of any one of sixteen inputs, as selected by the binary number on four address pins. It was found possible to invent a simple code for the prefix digit, thus:

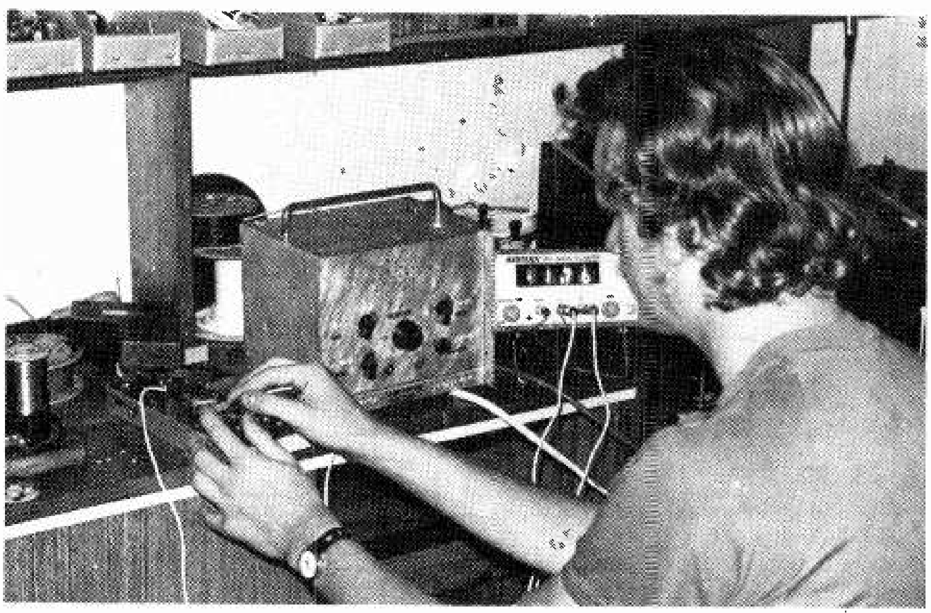
+0	1	1	0	0
−0	1	0	1	0
+1	1	1	0	1
−1	1	0	1	1
X	1	1	1	1

All of these are binary numbers greater than 9, so there is no possibility of confusion with other digits.

The multiplexer is made to select each of its 16 inputs in turn by means of a binary counter connected to its address pins. The counter is operated by a multivibrator (two monostables) working continuously.

We now come to a point where two distinct design approaches are possible. There must be pauses between the digits, a long pause at the end of each reading, and extra pauses to enable a brief "decimal point" pulse to be inserted at the correct point between digits. These delays can be provided either by monostables, which switch off the counter for a period, or they can be arranged to span a given number of counter pulses. The latter method uses a fully digital system. There are advantages and disadvantages to each system, but I was attracted by the simplicity and flexibility of the monostable method because it was difficult to know in advance the exact time intervals required, and monostables offer simple and almost infinite adjustment.

The tone frequencies are provided by an LM566 voltage-controlled oscillator, the output from which is amplified by



Measuring instrument being used by Clive, an electronics hobbyist who has been blind from birth.

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an LM380 2½ watt amplifier. The frequencies generated by this device depend upon the input direct voltage and the value of a capacitor connected to the i.c. It seemed to be wasteful merely to use this versatile component to give two pitches, and a circuit was devised so that the instrument could also be used for an entirely different purpose, as a bridge null-detector. In the latter application the suitably amplified out-of-balance voltage from almost any bridge circuit is used to alter the frequency. (A bridge rectifier circuit gives a rise in pitch for both positive and negative input voltages.) In the digital application a fixed voltage is switched in and the multiplexer is used to change the capacitor values.

Clive had no difficulty in learning the code. A speed control was fitted, and it was not long before new timing capacitors had to be provided to allow him to work faster. The rather strange warbling note gave rise to the name "Bellbird," bearing some resemblance to the song of that New Zealand bird.

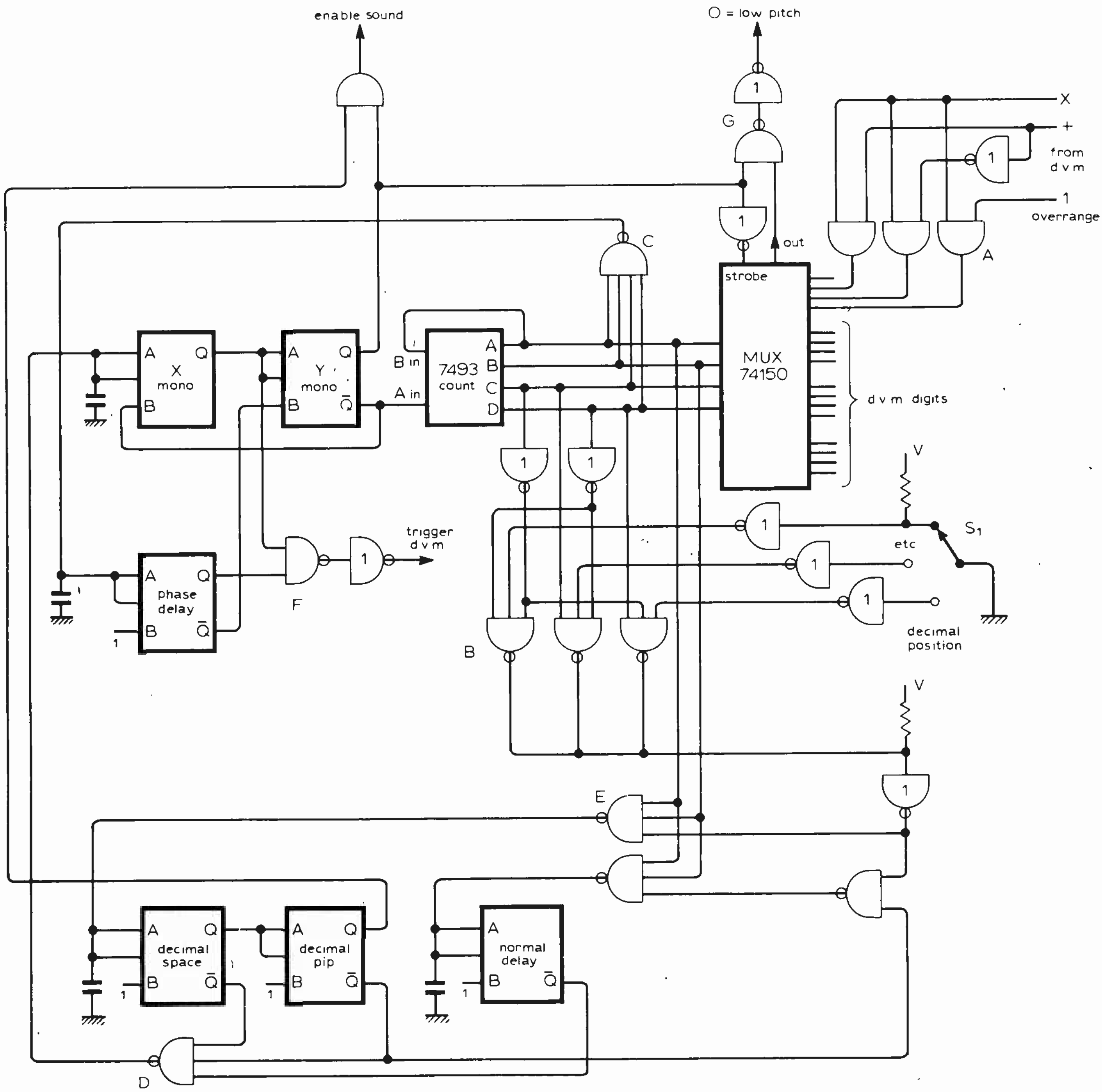
I consider that sighted workers may have a use for such a machine, as it enables one to concentrate on the circuit under test instead of dividing attention between that and a meter reading.

Fig. 1. Digital circuits for translating a measured voltage, represented by the digits within the digital voltmeter, into a series binary code suitable for triggering a circuit (see Fig. 2) to produce audible low/high pitches. Spaces between numbers and readings are also produced by these circuits, together with a decimal point when required.

Circuit description

For clarity, the digital circuit diagram (Fig. 1) omits power supplies, irrelevant connections, and timing resistors and capacitors. The various delay i.c.s are all type 74121, though dual devices could be used. Doubtless improvements could be made, not least of which would be the avoidance of "glitches" caused by race conditions, which are the reason for small capacitors on the A inputs.

Monostables X and Y, operating as a multivibrator, cause the binary counter 7493 to select each of the voltmeter digits in turn to be presented at gate G. The OR gates A provide the prefix code already discussed. The action of the multivibrator is interrupted by gate D,



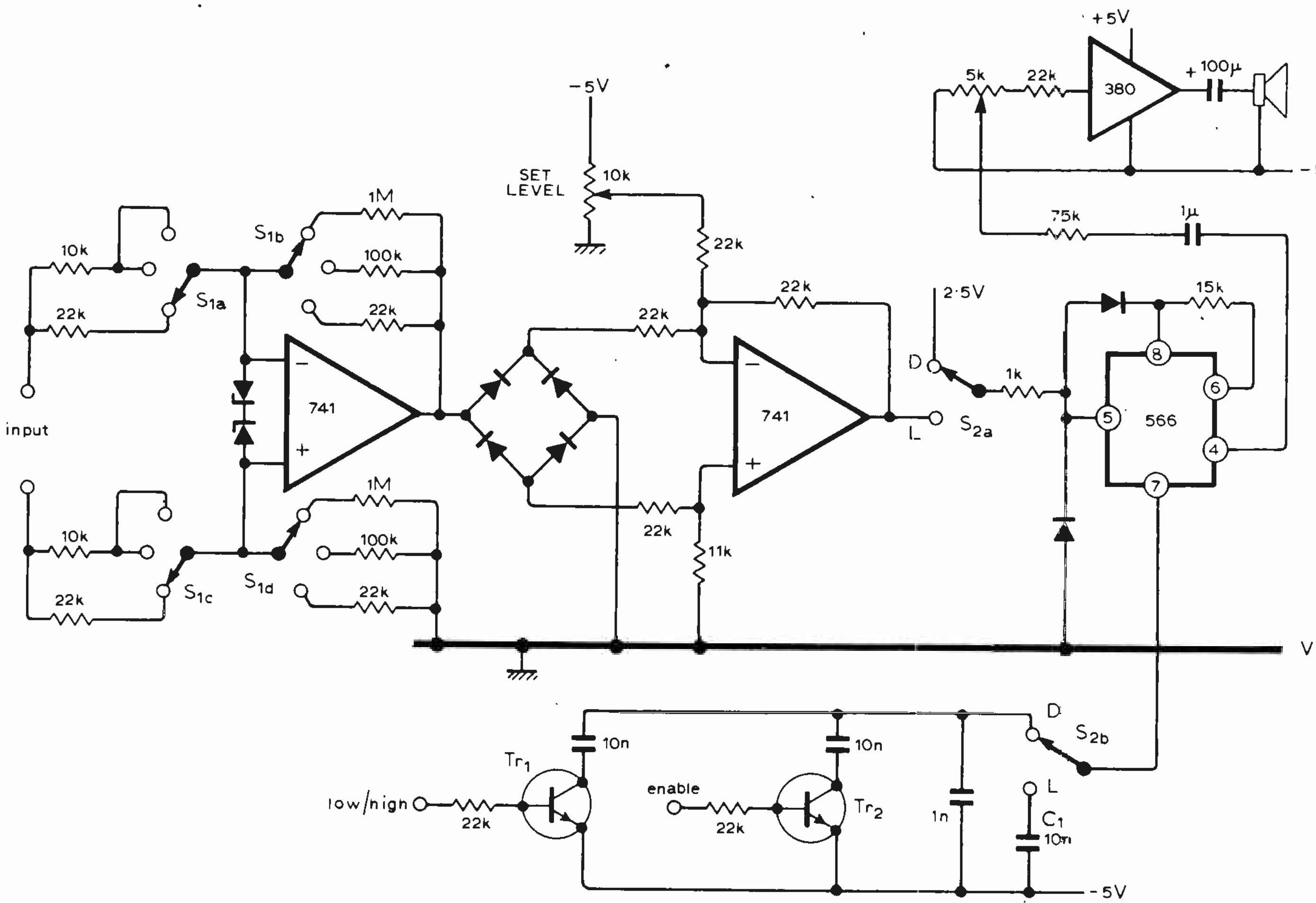


Fig. 2. Bridge-indicator and sound circuit. Switch positions D enable the circuit to be used in the digital voltmeter mode, the v.c.o. LM566 producing a low pitch for an input binary "0" and a high pitch for an input binary "1". Switch positions L enable the circuit to be used as a bridge null-detector, the null point being at the point of lowest pitch.

which operates whenever the "decimal space" "decimal pip" or "normal delay" monostables fire. Gates B control these in the following way: with S_1, the decimal point switch inside the voltmeter, in the position shown, the wired-OR output from gates B goes to logical 0 on a count of C = 0, D = 0. In the mid position the output goes to 0 on C = 1, D = 0 and in the bottom position on C = 0, D = 1. The A and B lines of the counter output are connected, as well as the inverted B gates output, to gates E. It will be seen that the upper gate fires the decimal-point delay on a count of 0011, 0111 and 1011 in the three switch positions mentioned. This will put the decimal delay after the prefix, first or second digits respectively. When the decimal delay monostable finishes its pulse it triggers the decimal-pip monostable, which takes over the job of arresting X and Y and sends a signal to the sound enable gate.

The lower gate E is operated, giving normal delay, whenever the A and B lines are high and the B gates output is also high, provided that the decimal-pip monostable has not fired. This means that it is triggered at the end of digits when the decimal point signal is not given. At the end of the whole cycle or phrase a count of 1111 forces the output of gate C low, thus firing the phrase-delay monostable and operating gate F to send a trigger signal to the voltmeter, which luckily has provision for this external control of its cycle. It is possible that spurious readings would be obtained with some meters if the outputs were multiplexed while they were half way through their cycle. In the Bellbird system the digital voltmeter measures only between phrases.

It will be noticed that if there is no connection at S_1 no decimal point indication is given.

Bridge indicator and sound circuit

Referring to Fig. 2, S_{2a} connects the input of the voltage controlled oscillator to either the amplified out-of-balance voltage or to a fixed 2.5V potential, to give the two modes of operation. At the same time S_{2b} connects the oscillator to either C_1, for linear operation, or a circuit controlled by Tr_1 and Tr_2 for the voltmeter application. Safety diodes protect the LM566 from negative inputs, which could result from failure or wrong connections in the previous circuits. Two type 741 operational amplifiers perform the tasks of amplifying input signals with gains of 1, 10 and 100, selected by S_1, and adjusting the d.c. output level to give a suitable range of tone. The input to the first 741 is protected by two 5V zener diodes. A rectifier bridge ensures that when the output from the first 741 goes either positive or negative from zero the oscillator input voltage, and therefore the tone, will rise. This bridge should be constructed with germanium diodes to avoid a large "dead zone" caused by the higher forward voltage of silicon types.

The switching circuit enables one or two capacitors to be connected to the oscillator, giving high and low audible tones.

The audio circuit is as simple as possible: the a.c. component from LM566 is attenuated by a volume-control potentiometer before being fed to the LM380 amplifier. The loudspeaker coupling capacitor need not be of a high value since no low tones are required.

In use no special difficulties were noted. In linear operation the null point was obtained by listening for the point of lowest pitch. Greater sensitivity was obtained by adjusting S_1 and 1mm discrimination could easily be obtained on a metre bridge experiment. In the digital mode, as already noted, the learning process was fast. Sighted pupils were also interested, and as they had already some knowledge of binary code they were able to translate for themselves, though at a slower rate. After practice, of course, recognition of the "digit pattern" occurs, as with Morse code.

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World of Amateur Radio

Ladder crystal filters

Although the h.f. transceiver market continues to be dominated by Japanese firms there are signs that the Americans are fighting back by concentrating on innovation in all-solid-state designs. Technically, one of the most interesting of the current designs would appear to be the Atlas 210 based on semiconductor circuitry by Lester Earnshaw, formerly ZL1AAX. This compact unit also includes a high-grade eight-pole ladder filter designed by Bob Crawford; this is claimed to have an ultimate rejection, when installed in the equipment, better than 130dB, a band-with of 2700Hz at —6dB, 4300Hz at —60dB and 9200Hz at —120dB. Centre frequency is 5.52MHz.

Traditionally most of the crystal bandpass filters used by amateurs have been based on the half-lattice configuration but with the increasing use of filters between 5 and 10.7 MHz the ladder configuration has become extremely attractive, not only for manufactured units but also for home constructors. The French amateur J. Pochet, F6BQP, has shown in *Radio-REF* how very attractive s.s.b. filters with centre frequencies between 8 and 10 MHz can be readily constructed using a handful of identical-frequency crystals plus a few 10% tolerance capacitors, eliminating the need for carefully spaced crystal frequencies found in the lattice configurations. A four-crystal unit can provide an ultimate rejection of about 95dB with a ripple (when correctly terminated) of only 0.8dB and an insertion loss of 1.4dB. His measured bandpass characteristics are 2050Hz at —6dB, 5200Hz at —40dB and 6950Hz at —50dB, though rather steeper sides can be achieved at some cost in extra ripple.

Licence facts and figures

The Home Office is to introduce next year a new, comprehensive form of British amateur licence document that will cover all modes of operation and types of transmission, including fixed, mobile and hand-held operation, facsimile, slow-scan and "fast" TV, etc. An annual charge of about £5.50 is likely to be made for this form of licence but the document will reduce the present need for special letters of permission and additional licences. A draft is currently with RSGB for comment.

Of more than 30 v.h.f. and u.h.f. "repeater" stations now licensed in the UK, about 20 are operational. Recent additions include Luton, Weymouth with Dover, Bushey, Cheshunt, Brighton, Birmingham and Margate expected this summer.

An investigation into the interference problems experienced by amateurs made by the RSGB Interference Committee indicates that many cases are solved by amateurs without intervention by the Post Office. The average amateur, it found, has a more than 80% chance of experiencing tvi problems but a 50% chance of curing these simply by the fitting of external filters. The Post Office is involved in less than 15% of the cases of interference to radio reception. Interference to audio equipment is becoming an increasing problem, and in 33% of cases it was found necessary to modify the equipment internally, 18% externally. The report stresses that the manufacturers of domestic equipment could do more to make their equipment less susceptible to strong r.f. fields.

The number of amateur licences issued by the FCC in the USA at the end of February was 263,896, including 24,154 novice; 51,664 technician; 25,633 conditional; 80,313 general; 67,636 advanced; and 14,149 "extra." As an instance of American "incentive" licensing, Ted Karas, WB3ZEA was licensed as a novice on March 11, 1975; passed his general/advanced examinations on August 8, 1975, and his "extra" examination on March 19, 1976 — while still only 13 years of age.

U.h.f., v.h.f. long delay echoes

Two amateurs working on moonbounce (earth-moon-earth) systems have reported hearing additional echoes one or two seconds later than the usual moon returns. Hans Lohmann Rasmussen, OZ9CR, in Denmark first heard such echoes in the summer of 1974, about 2 seconds after hearing his e-m-e return on 1296MHz when using 500 watts c.w. and a 26ft diameter parabolic dish aerial. Alan Goodacre, VE2AEJ, has also reported weak unexplained echoes on 144MHz moonbounce signals about a second after the normal return.

Statistics on the use of the Oscar amateur space satellites put the number of amateurs who have used these facilities as: USA 997; West Germany 315; England 172; France 170; Japan 136. On 432MHz, however, the order becomes: West Germany 146; USA 114; England 58; and France 41. During recent Oscar low-power tests stations using as little as 500mW to a dipole successfully worked through the satellite.

21 years of GB2RS

The first news bulletin broadcast from GB2RS for radio amateurs was made by Frank Hicks-Arnold, G6MB, on September 25, 1955. The weekly, Sunday morning, broadcasts have continued regularly ever since and are now made on 3.5MHz and 144MHz. For many years the 3.5MHz newsreader for south-east England has been Arthur Milne, G2MI, on 3600kHz at 9.30 a.m. It is perhaps the only "interactive" news broadcasts to be made in the UK with listeners able to contact the newsreader (using his own callsign) immediately after the bulletins. As the British amateur licence is specifically limited to two-way communication, special authorisation is needed for this service and the scripts are subject to vetting by the Home Office Radio Regulatory Division.

In brief

The special American-style callsign "WG1JFK" was used from Runnymede on July 4 to mark the American bicentenary . . . The remarkable weather of June was notable for frequent Sporadic E conditions — these occurred almost daily on 21MHz and included several 144MHz "openings" to Eastern Europe . . . Limits may be imposed on local-oscillator radiation from amateur and Citizens' Band receivers capable of tuning between 26 and 30MHz. This follows checks on spurious radiation from CB equipment that showed that many equipments were not reaching the specified limits . . . An amateur "moonbounce" station is expected to operate from Barranquilla, Colombia, South America during August. It will be on 432.040MHz using high power and a portable 16-element Yagi aerial . . . Some 178 delegates attended the third All India Amateur Radio Convention in Madras recently. Indian amateurs expect that amateur equipment will increasingly be limited to home-made and Indian-made units, presumably due to currency problems . . . During 1975 the International Amateur Radio Union issued 1658 "worked all continents" certificates including 760 endorsed for s.s.b. operation, 13 for slow-scan television, 6 for r.t.t.y., 44 for 3.5MHz-only and 24 for 1.8MHz only. 35 "five-band" certificates and one "six-band" certificate were issued . . . The hourly propagation forecasts at 18 minutes past the hour are no longer being made on the standard frequency transmission of WWV . . . A new publication by Plessey Semiconductors — "SL600 series transceiver applications" by Brian D. Comer gives ideas for building simple and multimode s.s.b. f.m. and a.m. transceivers using the SL600 series of integrated circuits, including the use of r.f. compression, voice-operated switching, noise blanking and incorporating the Anzac MD108 double balanced mixer.

PAT HAWKER, G3VA

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New Products

Low-cost oscilloscope

A low-cost single-beam oscilloscope, suitable for use at frequencies up to 8MHz, has been introduced by Alcon Instruments Ltd. The P73, which is intended for educational or service applications where bandwidths rarely exceed 6MHz, is designed for simplicity and reliability. A differential comparator i.c. provides synchronization even with weak h.f. signals, an f.e.t. circuit gives an input impedance of 1MΩ at 30pF, and attenuators provide sensitivity ranging from 30mV/div to 30V/div in 1, 3 and 10 steps with an accuracy of ±5% and rise-time of less than 0.05μs. The horizontal amplifier has a bandwidth of from 3Hz to 700kHz, an input impedance of 10MΩ at 30pF and a sensitivity of 0.25Vpeak. The instrument, which measures 225 × 300 × 125mm and weighs 3.7kg, costs £124 (incl. VAT) complete with probe and handbook. Alcon Instruments Ltd, 19 Mulberry Walk, London SW3 6DZ.

WW 301 for further details.

Coaxial relays

A series of r.f. coaxial relays with high sensitivity at low operating power can handle up to 150 watts of r.f. power. The 122 series by Diamond H. Controls Ltd offers a variety of single and dual coaxial switching capabilities. They are available with contact configurations up to 2p.d.t. 4p.d.t. or 8p.s.t., normally-open. A supporting range of coaxial relays offer a wide variety of alternative r.f. contact combinations. The series can additionally be equipped with auxiliary contacts, external to the relay's integral r.f. cavity, and these contacts are rated at up to 10A. Control of the relays may be effected by either a.c. or d.c. power supplies. Diamond H. Controls Ltd, Vulcan Road North, Norwich NR6 6AH.

WW 302 for further details.

Photosensor uses two-colour l.e.d.

An infra-red pulse modulated beam provides immunity to ambient light up to 10klx and sunlight to 30klx in the Omron photosensing switch. It is claimed to sense any type of material, including transparent glass or cellophane. The two-colour l.e.d. indicator shows red when an input signal is received and then changes to green when the value of the signal reaches twice the operating level. This unique feature is said to guarantee fully stable operation during the life of the device, despite any change in the external operating conditions, particularly where sensitive settings are involved. A variety of models in the E3N series are available from stock for use across setting distances of up to 30 metres. Both reflex and separate receiver and transmitter types are available, with an aluminium housing using 'O' ring seals to be oil and water tight. Operation is from 24V directly to the switch or from 110/240V mains through a series of compatible amplifiers with instantaneous, single shot or on/off delay functions. Service life is claimed to be typically 100,000 hours. Prices start at £50 for a reflex-type switch. IMO Precision Controls Ltd, 349 Edgware Road, London W2.

WW 303 for further details.

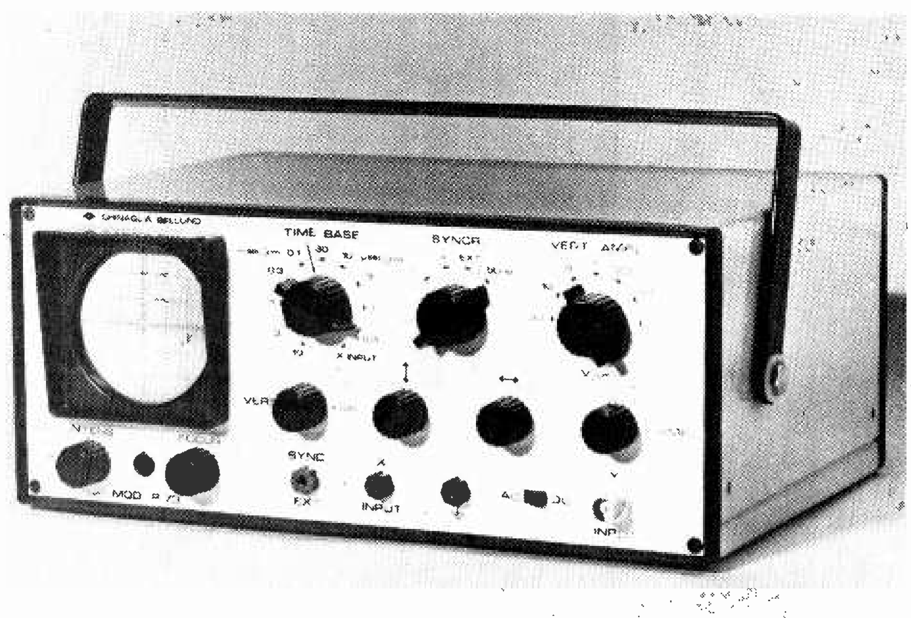
Low-pass active filter

A low-pass three-pole active filter, available from Analogic Ltd, is intended for processing sensitive low-level signals for integrating analogue-to-digital converters or data-sampling systems requiring precision l.f. passband filtering in the presence of extremely low offset and noise voltages. The MP230 has a flat passband from zero to the −3dB cut-off frequency and then a roll-off of 60dB/decade beyond the cut-off point. The filter, which is available with cut-off frequencies of 0.5, 1, 2, 3.3 and 100Hz, has a maximum low offset voltage of 2μV, a low output noise of 1.4μV p-p and passes an input voltage of ±10V with a gain of unity ±0.01% at d.c. Analogic Ltd, The Centre, 68 High Street, Weybridge KT13 8BN.

WW 304 for further details.

Surveillance receiver

A compact panoramic receiver has been introduced by Watkins-Johnson International for surveying the 20 to 500MHz frequency band. The WJ-7332 presents a



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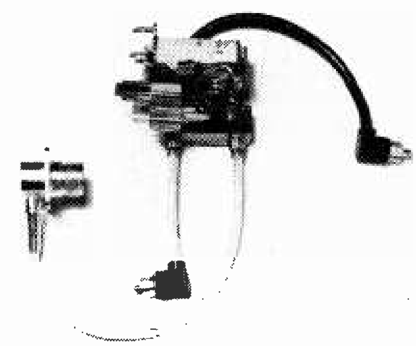

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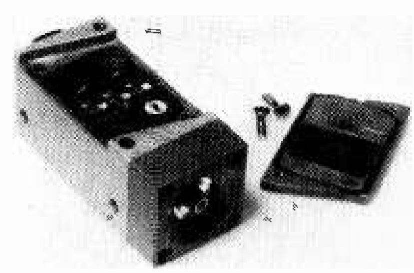

WW 303

10 × 8cm dual-trace logarithmic-vertical-scale display of signal activity in any double-octave band of the range. Tuning is provided by two VH series tuning heads, plugged into the main frame, which can be operated separately or sequentially. The centre frequencies and sweepwidths are adjustable and, to optimize the resolution, two i.f. bandwidths are provided, the narrow bandwidth being selected automatically when the sweepwidth is set below 20MHz. For reference and security purposes a trace marker system, which can be driven by b.c.d. information, is incorporated. Watkins-Johnson International, Shirley Avenue, Windsor, Berkshire, SL4 5JU.
WW 305 for further details.

Military Avometer

A military version of the Avometer Model 8, known as the Test Set Multirange No. 1 mk2, comprises a Model 8 instrument with minor changes in a special carrying case with leads, prods, clips and an instruction booklet. This Test Set has been approved for military use following extensive and exacting tests by the Ministry of Defence and has been allocated a NATO stock Number. The instrument in the Test Set differs from the standard Model 8 only in respect of two labels and one tiny metal part. The industrial user thus gains the additional reassurance of knowing that the instrument has passed the Ministry of Defence tests, and the Ministry and the taxpayer avoid paying the higher price associated with a special design. Avo Ltd, Archcliffe Road, Dover, Kent CT17 9EN.
WW 306 for further details.

Frequency counter

A 200MHz frequency counter, the TC12, has been added to the range of equipment manufactured by Telford Communications. The timebase comprises a high-stability 1MHz crystal clock generator and a series of divide-by-ten dividers for gate times of 1ms and 1s, giving counts down to 1Hz using either input. A front-panel l.e.d. indicates correct clock operation and the crystal stability, which is rated at 0.05% between 0°C and 60°C, can be improved by an optional crystal oven. Output markers of 1MHz, 100kHz and 10kHz are provided on the rear panel. The TC12 has a sensitivity of 20mV, a h.f. input impedance of 10kΩ and a v.h.f. impedance of 50 or 75Ω. The display consists of seven-segment minitron units (l.e.ds to order) and is fully buffered. Telford Communications, 78B High Street, Bridgnorth, Salop, WV16 4DS.
WW 307 for further details.

Low-light-level camera tube

A high-sensitivity c.c.t.v. camera tube, the Newvicon, is claimed to be up to 20 times more sensitive than a standard vidicon and twice as sensitive as a silicon vidicon. The tube, which is intended for surveillance and security applications, is claimed to operate satisfactorily where the viewed scene is illuminated at a "dim twilight" level of one lumen/m and with almost zero blooming when a highlight is met. This performance is obtained using a heterojunction photoconductive target composed of cadmium and zinc tellurides. Three versions of the Newvicon are available; types XQ1274 and XQ1440 are magnetically deflected and focused and type XQ1275 is magnetically deflected but electrostatically focused. Resolutions for the XQ1274, XQ1275 and XQ1440 are 650, 600 and 800 lines respectively, spectral response is 750nm max; cut-off is 900nm and heater consumption is 95mA at 6.5V. Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD.
WW 308 for further details.

Thumbwheel-switch mounts

The Fast-mount hardware system, provides instant panel mounting for thumbwheel switches without the use of tools, screws, nuts or washers, and is made by Electronic Engineering Corporation of California. The system is designed for the EECo thumbwheel-switch series' 1776, 1976 and 5000/6000 and will accommodate panel thicknesses from 1/16in to 1/8in. The dimensions permit the Fast-mount to be fitted where standard mounting systems have previously been used, enhancing the appearance by eliminating front-panel screws. Waycom Ltd, Wokingham Road, Bracknell, Berkshire, RG12 1ND.
WW 309 for further details.

Instrumentation tape recorder

Hewlett Packard have introduced a four-channel version of their eight-channel instrumentation recorder, model 3968A. The four-channel tape recorder, model 3964A, has all the

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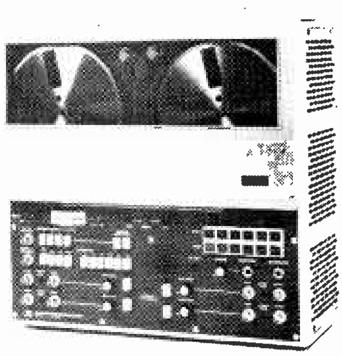

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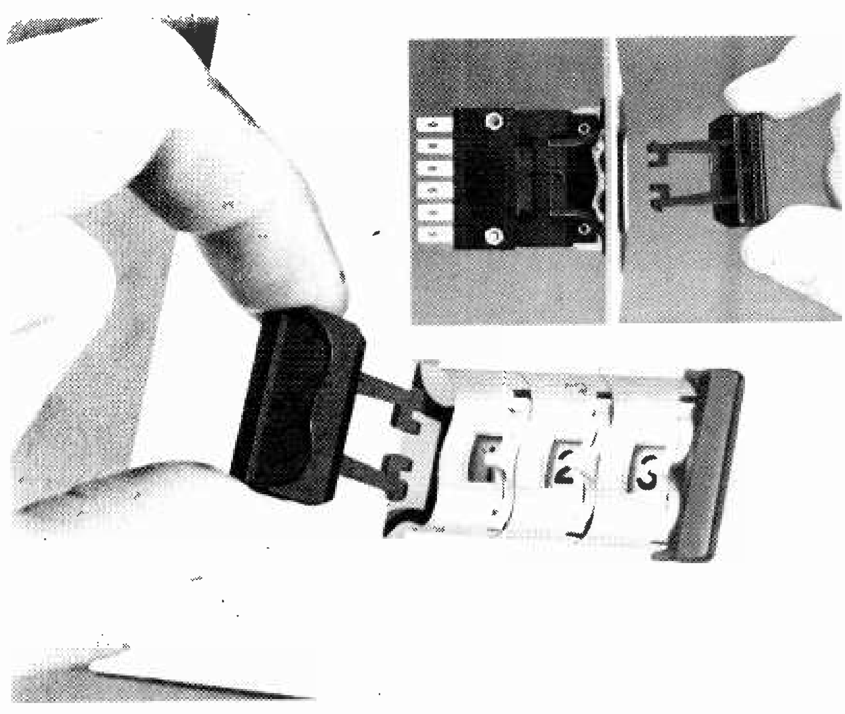


WW 309

features of the 3968A and can record and reproduce continuous data on 1/4in tape with six tape speeds from 15/32in/s to 15in/s. Features of the recorder, which is designed to meet the needs of the researcher and the o.e.m. user, include remote control and status of all tape speeds and operational modes, internal a.c./d.c. calibrator, tape/tacho servo mode and flutter compensation. In addition to recording data, channel 2 may be interrupted for voice recording using the microphone and speaker included. The user may choose either direct or f.m. recording or a combination of the two by selecting appropriate plug-in cards. F.m. recording is from zero to 5kHz with a signal-to-noise ratio of 48dB at 15in/s. Direct recording is from 50Hz to 64kHz with a signal-to-noise ratio of 38dB. Equalization and filtering for all speeds is included on each card and is automatically switched when a particular speed is selected. This recorder has many more standard features and available optional extras. Hewlett Packard Ltd, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.

WW 310 for further details.

Low-cost digital meter

The 3½-digit Beta multimeter from Gould Advance is portable, battery-powered and uses a 0.4in liquid-crystal display. Apart from the Motorola-designed c.m.o.s. integrated circuit, which carries all analogue and digital circuitry, the meter employs very few separate components, these being limited to three range trimmers, attenuator resistors and the power unit. The a-to-d converter is of the dual-ramp variety for stability and contains over and under range detectors. Measurement capability is 200mV to 750V and 200μA to 2A full-scale a.c.; 200mV to 1000V and 200μA to 2A f.s.d.c., separate 10A a.c. and d.c. ranges and resistance from 200Ω to 200MΩ full-scale. Common-mode rejection ratio with the battery eliminator option in use is greater than 90dB. Total power consumption is 50mW and the company say that the instrument will work for 300 hours on a set of four SP11 "C" cells. A two-year guarantee is offered and price is £99. Gould Advance Ltd, Roebuck Road, Hainault, Essex.

WW 311 for further details.

Tubular power resistors

A range of tubular wire-wound resistors, with a power range of 8.5 to 293W, has been manufactured by Erg Industrial Corporation Ltd. The resistors, which are claimed to undergo sample quality checks to BS6001, range from 1Ω to 100kΩ and are available with tab connections or mounting devices. Some of the resistors are approved to BS415 and BEAB safety requirements. Two types of coating are offered with these resistors; a smooth inorganic glass-bonded material which is highly refractive, strong and resistant to impact or abrasion, or a silicone resin coating which provides a low-cost humidity protection. Erg Industrial Corporation Ltd, Luton Road, Dunstable, Bedfordshire LU5 4LJ.

WW 312 for further details.

V.h.f. tunerhead

The EF5800 is a precision v.h.f. tuner head designed to operate from 88 to 108MHz. Manufacturers specification for model HQ are a typical power gain of 37dB, noise figure of 7.8dB, image rejection of —97dB (referred to a 1μV input), i.f. bandwidth of 300kHz (−3dB), tracking (88-104MHz) within 2.5dB, and a thermal stability of 6kHz/deg C (25—55). The makers say that certain aspects of the performance may be tailored to customers requirements.

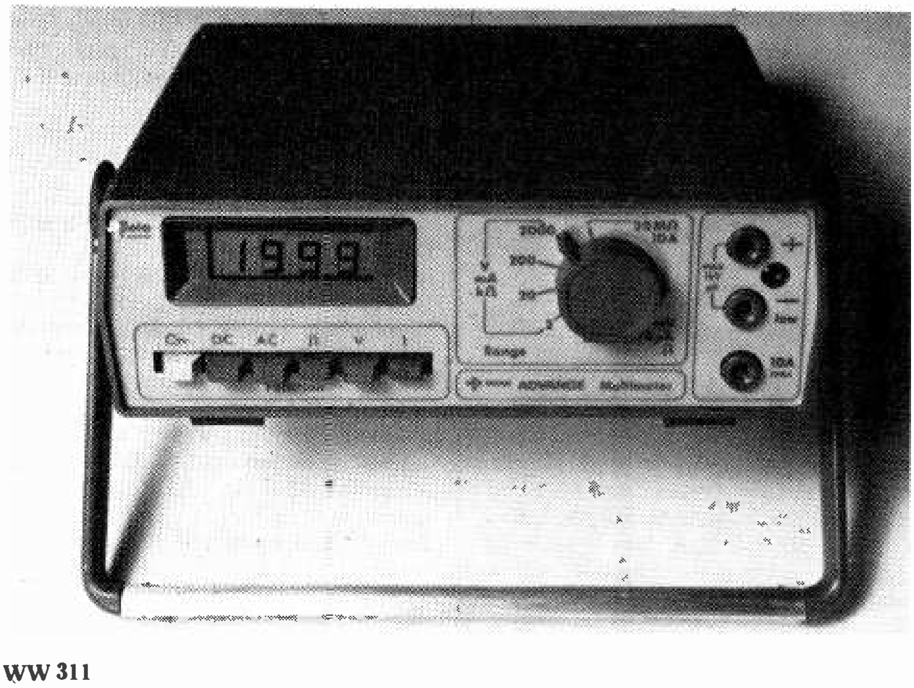
The circuit uses six tuned stages symmetrically arranged in a case measuring 145 x 70 x 24mm. The module is priced at around £14.50 and is available from Ambit International, 37 High Street, Brentwood, Essex.

WW 313 for further details.

Perspex boxes

Glazer Plastics has informed us that they are able to supply a custom built perspex box suitable for a digital clock (as featured in this issue). The box is constructed from smoked perspex with a transparent red front panel and uses mitred joins throughout. A bottom (or top) panel is removable for access. Overall dimensions are approximately 8 × 5 × 3in and the cost is £10 inclusive of v.a.t. and carriage. The manufacturer also has facilities for precision machining, in production quantities, of acrylics and other plastics used in the electronics industry. Glazer Plastics Ltd, Braemar Works, Braemar Avenue, Neasden, London NW10 ODH.

WW 314 for further details.



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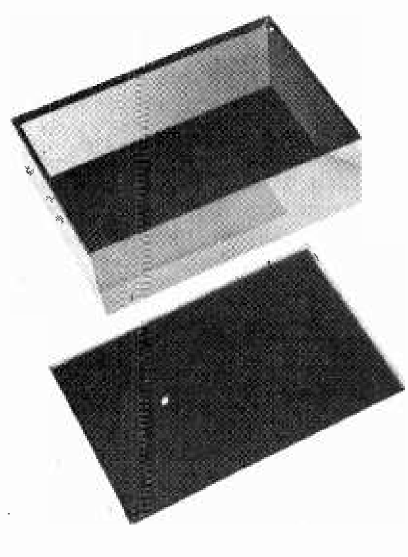

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Two-phase function generator

Two sets of outputs, each providing sine, square and triangular waveforms are available from the Prosser D314 digitally-synthesized variable-phase function generator. The frequency range, which extends from 0.0001Hz to 1kHz, is switch-selectable in decade steps and incorporates a fine analogue control for more precise adjustment. Phase ranges can be selected by thumbwheel switches in increments of 0.1° between −180 and +180° to within ±0.05° between any two selected outputs. Each output has a peak amplitude of ±10V and can be independently controlled by a coarse attenuator providing steps of 10, 20, 30 and 40dB. Separate controls give fine attenuation adjustment from 20% to 100%. Half or quarter cycles, starting at either the peak or zero, may be selected by push button. Prosser Scientific Instruments Ltd, Lady Lane Industrial Estate, Hadleigh, Ipswich, Suffolk, IP7 6DQ.
WW 315 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.

Dual-tracking regulators

The RC4194 is a dual-tracking voltage regulator designed to provide balanced or unbalanced positive and negative output voltages which can be adjusted by a single external resistor simultaneously between the limits of ±50mV and ±32V. This device, which has built-in current limiting and thermal shutdown, can supply output currents of up to ±200mA on its own, and several amperes when used with external power transistors. Typical line and load regulations for the RC4194 are 0.02% and 0.001% respectively with a temperature coefficient of 0.003%/ deg C and an output tracking capability better than 2%. The tracking deviation can be adjusted to zero. A similar device, the RC4195, is also available and offers fixed dual-tracking regulated outputs of ±15V for maximum currents of ±100mA. Both the RC4194 and RC4195 are specified for 0 to +70°C, but RM4194 and RM4195 are available for use from −55 to +125°C.
WW 316 **Raytheon**

Receiver i.cs

Three integrated circuits from Hitachi have recently become available in the UK. Type HA1137, an i.f. sub-system, is pin-compatible with the CA3089E, and offers 15μV for 3dB limiting, signal strength and tuning meter facilities, a.f.c. mute and delayed a.g.c., 60dB s/n and 0.1% t.h.d.

Type HA1196 is a p.l.l. stereo decoder which provides an overall gain of six. Separation at 1kHz is typically 55dB and 42dB at 10kHz. Stereo t.h.d. is typically 0.1% at 1kHz rising to 0.15% at 10kHz. The device is suited to 12V operation and offers a threshold switching facility.

Type HA1197 is an a.m. radio device and is claimed to produce the best result a.m. will permit. Manufacturers specifications are, a maximum s/n ratio of 55dB (24.5dB with 15μV input), 0.25% t.h.d. with 30% modulation, and a 75dB a.g.c. figure of merit. The i.c. also offers a meter output.
WW 317 **Ambit**

Varactor diodes for h.f.

Three hyperabrupt junction h.f. diodes, KV1401, KV1402 and KV1403, have been produced by KSW Electronics Inc. for wideband tuning applications in voltage-controlled LC or crystal circuits up to 100MHz. The diodes, which are manufactured using the ion implantation process, are claimed to replace two conventional hyperabrupt diodes. The KV1401 offers Q values from 75 to 140 at 10MHz, more than twice that of the MV1404. Both the KV1402 and the KV1403 have Q values from 200 to 700 at 1MHz, the KV1402 meeting the specifications of two MV1404 diodes operated in series. Frequency ratios as high as 4:1 are offered with these diodes using a capacitance of 57pF at 2V. Other features include large capacitance ratios, closely specified capacitance/ voltage curves and a linear frequency performance over the tuning range 1.5 to 4V.
WW 318 **Intime**

High-voltage transistors

A series of germanium power transistors, the 2N1157-2N1157A family, has a peak current capability of 40A and can handle up to 80V. The p-n-p transistors are available from Germanium Power Devices Corporation in the standard MT-7 package.
WW 319 **GPD**

Low-noise op amp

A low-noise operational amplifier, designated type TDA1034, has a 10MHz bandwidth and an output drive capability of 10V r.m.s. into a 600Ω load. This general purpose amplifier has a noise figure of 0.9dB, a slew rate of 13V/μs, and is internally compensated for gains of at least three. An external capacitor, if used to optimize the frequency response, enables the amplifier to be used for a wide range of applications such as studio and recording equipment and telecommunication systems.
WW 320 **Mullard**

C.m.o.s. clock circuits

Two c.m.o.s. clock circuits, the ICM7051A and the ICM7051B, have dividers, output drivers and over-voltage protection circuitry on single chips and operate from a 4.19MHz crystal. The ICM7051B has 23 divider stages, which allow division down to 0.5MHz, and drives a bridge output providing a 31.2ms pulse at 1Hz for stepper motor applications. The ICM7051A has 16 divider stages providing a 64Hz square wave output for synchronous motor applications. Both circuits have protected inputs and outputs and characteristics may be modified using metal masks.
WW 321 **Intersil**

Power Darlingtons

Three ranges of fast-switching monolithic power Darlingtons have been announced by International Rectifier Ltd. Types IR6000 to IR6002, IR6060 to IR6062, and IR6251 to IR6253 have I_{cc} and V_{ce} ratings of 15A and 500V, 20A and 450V, and 10A and 500V respectively. The transistors, which offer maximum gains of 40 at I_{cc}(max), are triple diffused high voltage devices each incorporating stabilizing resistors and a fast-switching diode. Each transistor is housed in a TO-3 case.
WW 322 **International Rectifier**

Microprocessor r.a.m.

The HM-6551 c.m.o.s. 256 x 4 r.a.m. has been optimised for microprocessor use. This r.a.m., which has three-state latched outputs, an on-chip address register and an access time of 285ns(max) is suitable for microprocessors or other small memory applications. It exhibits a low power consumption of 15μW/bit at 1MHz and, though designed to operate at V_{cc} = 5V, data can be retained with V_{cc}=2.2V with a correspondingly low power consumption of 50nW/bit. The HM-6551 is packaged in a 22-lead d.i.l. package.
WW 323 **GDS**

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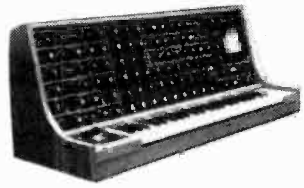

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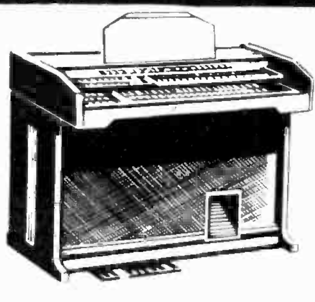

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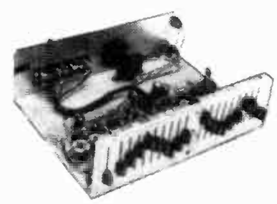

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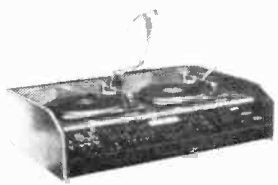

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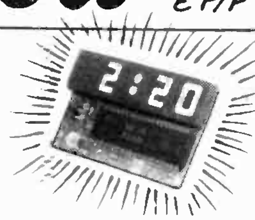

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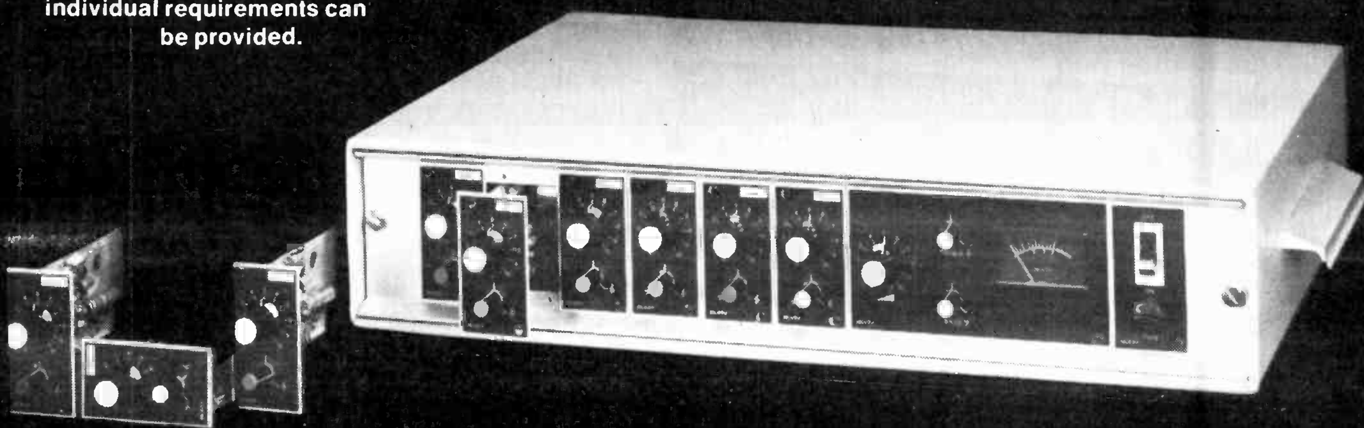

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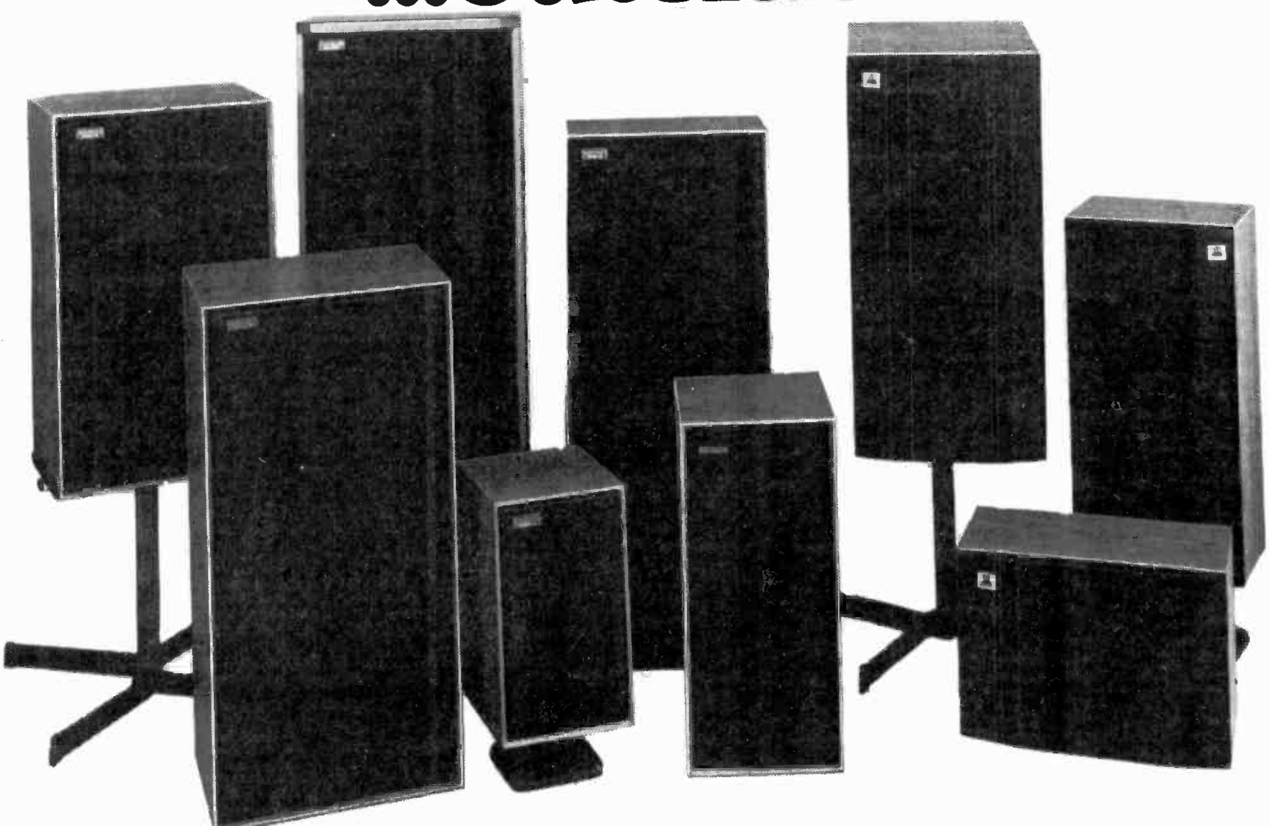

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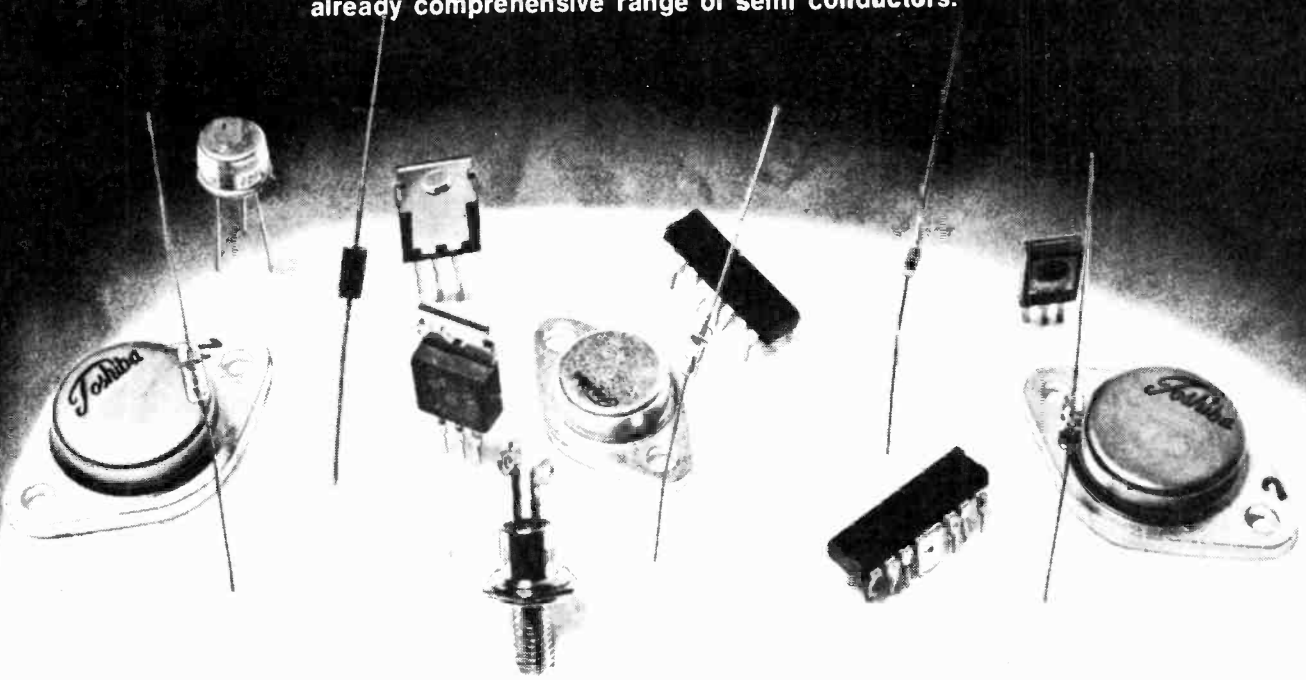

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BC 547	12
BC 548	12
BC 550	14
BC 557	13
BC 558	12
BC 327	13
BC 328	13

TYPE	Price (p)
BC 337	12
BC 338	12
BD 135	29
BD 138	33
BD 139	37
BD 140	39
BD 233	43
BD 234	49
BD 235	49
BD 236	53
BD 237	49

TYPE	Price (p)
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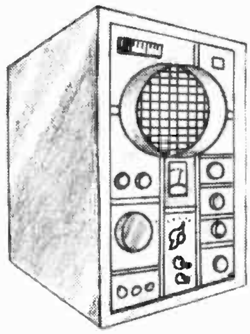

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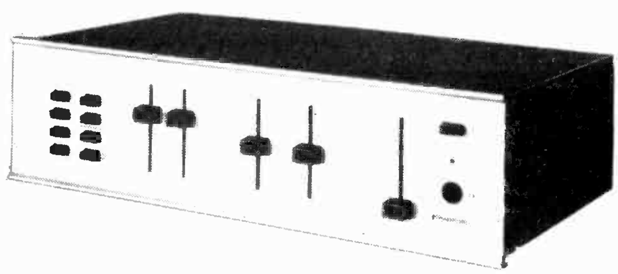

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AF118	45	BC172	10
AF124	38	BC173	15
AF125	27	BC178	18
AF126	38	BC178B	20
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BC114	15	BC327	13
BC115	17½	BC328	13
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BC116A	25	BC338	12
BC117	14	BC546	13
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BC119	27	BC548	12
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BC184	0.11*
BC184L	0.11*
BC207B	0.12*
BC212	0.11*
BC212L	0.11*
BC213	0.12*
BC213L	0.12*
BC214	0.14*
BC214L	0.14*
BC237	0.16*
BC238	0.16*
BC300	0.34

BC301	0.32
BC323	0.60
BC327	0.18*
BC328	0.16*
BC337	0.17*
BC338	0.17*
BCY70	0.12
BCY71	0.18
BCY72	0.12
BD115	0.55
BD131	0.36
BD132	0.40
BD135	0.36
BD136	0.39
BD137	0.40
BD138	0.48
BD139	0.58
BD181	0.86
BD182	0.92
BD183	0.97
BD232	0.60*
BD233	0.48*
BD237	0.55*
BD238	0.60*
BD184	1.20
BDY20	0.80
BDY38	0.60
BDY60	0.60
BDY61	0.65
BDY62	0.55
BF178	0.28
BF179	0.30
BF194	0.10*
BF195	0.10*
BF196	0.12*
BF197	0.12*
BF224J	0.18*
BF244	0.17*
BF257	0.30*
BF258	0.35
BF337	0.32
BFW60	0.17*
BFX29	0.26
BFX30	0.30
BFX84	0.23
BFX85	0.25
BFX88	0.20
BFY50	0.20
BFY51	0.18
BFY52	0.19
BFY64	0.35
BFY90	0.65
BR100	0.20
BRY39	0.40
BSX19	0.16
BSX20	0.18
BSX21	0.20
BSY95A	0.12
BT106	1.00
BT107	1.60
BT108	1.60
BT109	1.00
BT116	1.00
BU105	1.80*
BU105/02	1.90*
BU126	1.60*

BY206	0.15
BY207	0.20*
BYX36-300	0.12*
BYX36-600	0.15*
BYX36-900	0.18*
BYX36-1200	0.21*
BYX38-300	0.50
BYX38-600	0.55
BYX38-900	0.60
BYX38-1200	0.65
BZX61 Series Zeners	0.20
BZX83 or BZX88 Series Zeners	0.11
C106A	0.40
C106B	0.45
C106D	0.50
C106F	0.35
CRS1/05	0.25
CRS1/10	0.25
CRS1/20	0.35
CRS1/40	0.40
CRS1/60	0.65
CRS3-05	0.34
CRS3-10	0.45
CRS3-20	0.50
CRS3-40	0.60
CRS3-60	0.85
MJ480	0.80
MJ481	1.05
MJ490	0.90
MJ491	1.15
MJE340	0.40*
MJE371	0.60
MJE520	0.45
MJE521	0.55
OA5	0.50*
OA90	0.08
OA91	0.08
OC41	0.15
OC42	0.15
OC44	0.12
OC45	0.10
OC70	0.10
OC71	0.10
OC72	0.22
OC84	0.14
SC40A	0.73
SC40B	0.81
SC40D	0.98
SC40F	0.65
SC41A	0.65
SC41B	0.70
SC41D	0.85
SC41F	0.60
ST2	0.20
TIP29A	0.44
TIP30A	0.52
TIP31A	0.54
TIP32A	0.64
TIP34	1.05
TIP41A	0.68
TIP42A	0.72
1N2069	0.14
1N2070	0.16
1N4001	0.04*
1N4002	0.05*

1N4003	0.06*
1N4004	0.07*
1N4005	0.08*
1N4006	0.09*
1N4007	0.10*
2N696	0.14
2N697	0.12
2N706	0.10
2N929	0.14
2N930	0.14
2N1131	0.15
2N1132	0.16
2N1304	0.20
2N1305	0.20
2N1711	0.18
2N2102	0.44
2N2369	0.14
2N2369A	0.14
2N2484	0.16
2N2646	0.50
2N2905	0.18
2N2905A	0.22
2N2926R	0.10*
2N29260	0.09*
2N29267	0.09*
2N2926G	0.10*
2N3053	0.15
2N3054	0.40
2N3055	0.50
2N3440	0.56
2N3442	1.20
2N3525	0.75
2N3570	0.80
2N3702	0.10*
2N3703	0.10*
2N3704	0.10*
2N3705	0.10*
2N3706	0.10*
2N3707	0.10*
2N3714	1.05
2N3715	1.15
2N3716	1.25
2N3771	1.60
2N3772	1.60
2N3773	2.10
2N3819	0.28*
2N3904	0.16*
2N3906	0.16*
2N4124	0.14*
2N4290	0.12*
2N4348	1.20
2N4870	0.35
2N4871	0.35
2N4919	0.70*
2N4920	0.50*
2N4922	0.58*
2N4923	0.64*
2N5060	0.20*
2N5061	0.25*
2N5062	0.27*
2N5064	0.30*
2N5496	0.65

DIGITAL DISPLAYS & LED'S

DL704	99p	DL747	£1.75	2 RED LED ONLY	13p
DL707	99p	DL750	£1.75	GREEN CLEAR	15p

THYRISTORS

	8A (TO92)	1A (TO5)	3A (C106 type)	6A (TO220)	8A (TO220)	10A
50	20	25	35	41	42	47
100	25	25	40	47	48	54
200	27	35	45	58	60	68
400	30	40	50	87	88	98
600		65	70	1.09	1.19	1.26

TRIACS (PLASTIC TO-220 PKGE. ISOLATED TAB)

	4A		6 5A		8 5A		10A		15A	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
100V	0.60	0.60	0.70	0.70	0.78	0.78	0.83	0.83	1.01	1.01
200V	0.64	0.64	0.75	0.75	0.87	0.87	0.87	0.87	1.17	1.17
400V	0.77	0.78	0.80	0.83	0.97	1.01	1.13	1.19	1.70	1.74
600V	0.96	0.99	0.87	1.01	1.21	1.26	1.42	1.50	2.11	2.17

N B Triacs without internal trigger diac are priced under column (a) Triacs with internal trigger diac are priced under column (b) When ordering please indicate clearly the type required

74 TTL mixed prices

	1-24	25-99	100+
7400	14p	12p	10p
7401	14p	12p	10p
7402	14p	12p	10p
7403	15p	12½p	10p
7404	16p	13p	11p
7408	16p	13p	11p
7409	16p	13p	11p
7410	16p	13p	11p
7413	29p	24p	20p
7417	27p	22½p	20p
7420	16p	13p	11p
7427	27p	22½p	18p
7430	16p	13p	11p
7432	27p	22½p	18p
7437	27p	22½p	18p
7441	75p	62p	50
7442	65p	55p	43p

	1-24	25-99	100+
7445	85p	71p	57p
7447	81p	75p	65p
7448	75p	62p	50p
7447A	95p	83p	67p
7470	30p	25p	20p
7472	25p	21p	17p
7473	30p	25p	20p
7474	32p	26p	21p
7475	47p	39p	31p
7476	32p	26p	21p
7482	75p	62p	50p
	£1.30	£1.09	87p
7486	32p	26p	21
7489	£2.92	£2.80	£2.10
7490	49p	40p	32p
7491	65p	55p	45p
7492	57p	46p	36p

	1-24	25-99	100+
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74107	35p	28p	22p
74121	34p	28p	23p
74122	47p	39p	31p
74141	78p	63p	53p
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74181	£3.20	£2.50	£1.90
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74193	£1.35	£1.14	90p
74196	£1.64	£1.34	99p

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741 8 pin DIL	28p*
741 14 pin DIL	
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566 8 pin DIL	£1.50*
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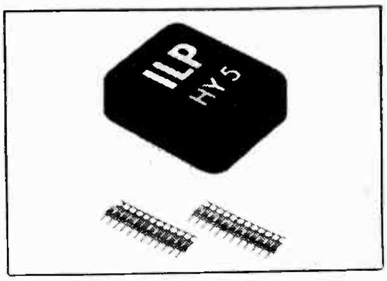
15—240 Watts!

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.



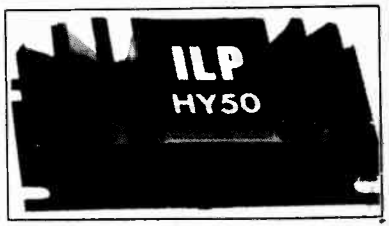
HY30
15 Watts into 8Ω

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

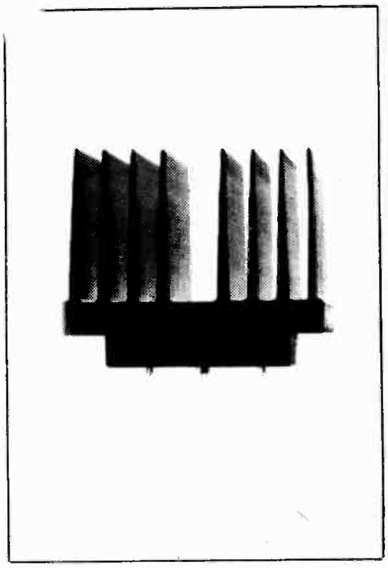
HY50
25 Watts into 8Ω

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

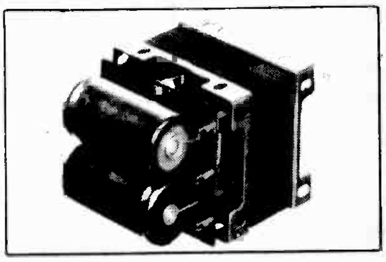
The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral heatsink — No external components
APPLICATIONS: 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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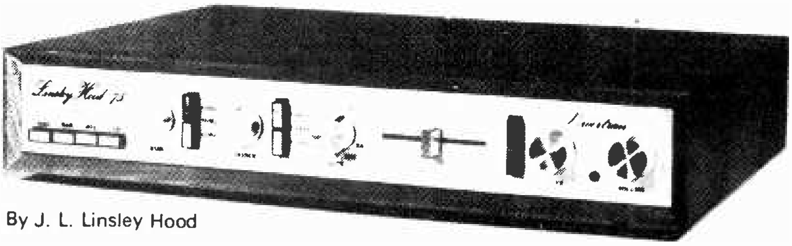
HI-FI NEWS 75W/CHANNEL AMPLIFIER



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	£1.15
2. Set of resistors, capacitors, pre-sets for power amp	£2.15
3. Set of semiconductors for power amp	£6.50
4. Pair of 2 drilled, finned heat sinks	£1.10
5. Fibreglass printed-circuit board for pre-amp	£1.75
6. Set of low noise resistors, capacitors, pre-sets for pre-amp	£3.40
7. Set of low noise, high gain semiconductors for pre-amp	£2.40
8. Set of potentiometers (including mains switch)	£3.15
9. Set of 4 push-button switches, rotary mode switch	£4.50
10. Toroidal transformer complete with magnetic screen/housing primary: 0 117-234 V: secondaries: 33-0-33 V, 25-0-25 V	£10.95
11. Fibreglass printed-circuit board for power supply	£0.85
12. Set of resistors, capacitors, secondary fuses, semi-conductors for power supply	£4.60
13. Set of miscellaneous parts including DIN skts, mains input skt, fuse holder, inter-connecting cable, control knobs	£5.35
14. Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£7.30
15. Handbook	£0.30
16. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

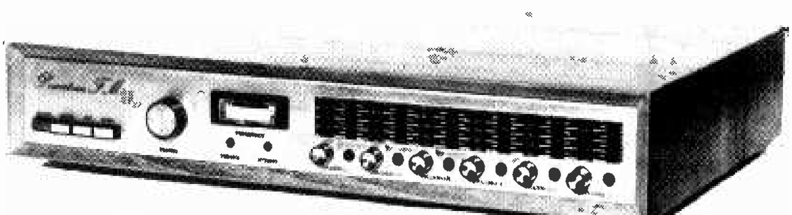
2 each of packs 1-7 inclusive are required for complete stereo system. Total cost of individually purchased packs £83.75

FREE TEAK CASE WITH FULL KITS

KIT PRICE ONLY **£73.90**

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	£4.30
3. Set of transistors, diodes, LED, integrated circuits for mounting on pack 1	£5.25
4. Pre-aligned front end module, coil assembly, three section ceramic filter	£8.50
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	£2.90
8. Set of components for channel selector switch module including fibreglass printed circuit board, push-button switches, knobs, LEDs, preset adjusters, etc.	£8.80
9. Function switch, 10 turn tuning potentiometer, knobs	£5.30
10. Frequency meter, meter drive components, fibreglass printed circuit board	£9.45
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.	£7.50
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**

NEW KIT!

LINSLEY-HOOD CASSETTE DECK

A full kit has been prepared for this excellent new design. The above illustration is of Mr. Linsley-Hood's own unit but the Powertran kit is, though not identical, very similar and of course in the same cabinet (that used for the outstandingly successful 75W Linsley-Hood Amplifier design).

Pack	Price
1. Stereo PCB (accommodates 2 rep. amps, 2 rec. amps, 2 meter amps, bias/erase osc. relay)	£3.35
2. Stereo set of capitors, M.O. resistors, potentiometers for above	£9.80
3. Stereo set of semiconductors for above	£8.90
4. Miniature relay with socket	£2.45
5. PCB, all components for solenoid, speed control circuits	£3.20
6. Goldring Lenco mechanism as specified	£19.10
7. Function switch, knobs	£1.60
8. Dual VU meter with illuminating lamp	£7.20
9. Toroidal transformer with E.S. screen prim. 0-117V, 234V, Sec. 15V	£4.45
10. Set of capacitors, rectifiers, I.C. voltage regulator for power supply (Powertran design)	£2.80
11. Set of miscellaneous parts, including sockets, fuse holder, fuses, interconnecting wire, etc.	£2.50
12. Set of metalwork including silk screened facia panel, internal screen, fixing parts, etc.	£7.10
13. Construction notes	£0.25
14. Teak cabinet 18.3" x 12.7" x 3.1"	£9.85

One each of packs 1-14 inclusive are required for compete stereo cassette deck. Total cost of individually purchased packs £82.55

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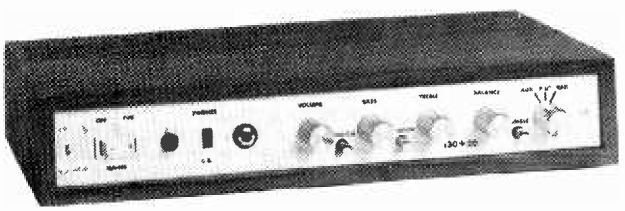
AUDIO KIT SUPPLIERS TO THE WORLD



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	1.40	1.50
2. Set of small capacitors	2.20	2.80
3. Set of power supply capacitors	1.90	2.30
4. Set of miscellaneous parts	3.20	3.20
5. Set of slide, mains, P.B. switches	1.20	1.20
6. Set of pots, selector switch	2.80	2.80
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	3.20	3.60
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

SPECIAL PRICES
FOR COMPLETE KITS!

T20+20 KIT PRICE only **£28.25**

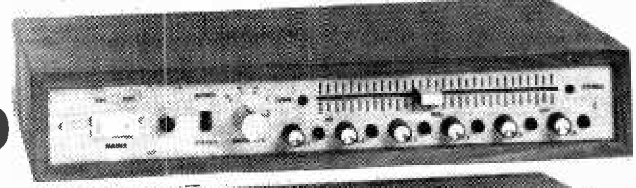
T30+30 KIT PRICE only **£32.95**

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.

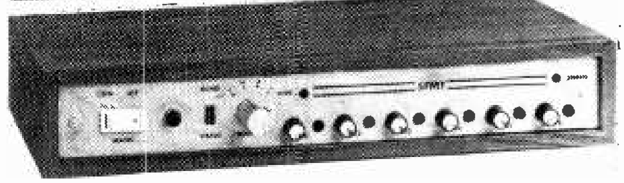
KIT PRICE **£45.50**



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.

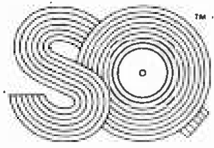
KIT PRICE **£32.60**



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.



SQ is a trade mark of CBS Inc

Special offer to T20 + 20 and Texan owners!
Owners of T20 + 20 and Texan amplifiers, which have no tape monitor outlet, purchasing an SQM 1-30 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 SQM 1-30 quadrophonic decoder/rear channel amplifier.

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
Regulator Power Sypply	
60VS Pk 1 F/Glass PCB	£0.85
60VS Pk 2 Resistor, Capacitor set	£2.20
60VS Pk 3 Semiconductor set	£3.10
60VS Pk 6A Toroidal transformer (for use with Bailey)	£8.80
60VS Pk 6B Toroidal transformer (for use with 20W LH)	£7.25
Bailey Burrows Stereo Pre-Amp	
BBPA Pk 1 F/Glass PCB	£2.80
BBPA Pk 2 Resistor, capacitor semiconductor set	£6.70
BBPA Pk 3R Rotary Potentiometer set	£2.85
BBPA Pk 3S Slider Potentiometer set with knobs	£3.10
Active Filter	
FILT Pk 1 F/Glass PCB	£1.40
FILT Pk. 2 Resistor, Capacitor set (metal oxide 2% polystyrene 2½%)	£4.20
FILT Pk 3 Semiconductor set	£2.25
2 off Pks 1, 2, 3 rqd for stereo sctive filter system	
Read/Texas 20W Amp	
READ Pk 1 F/Glass PCB	£1.00
READ Pk 2 Resistor, Capacitor set	£1.20
READ Pk 3 Semiconductor set	£2.30
6 off pks 1, 2, 3 required for stereo active filter system	£2.30
Stuart Tape Recorder	
TRRP Pk 1 Replay Amp F/Glass PCB	£1.30
TRRC Pk 1 Record Amp F/Glass PCB	£1.70
TROS Pk 1 Bias/Erase/Stalilizer F/Glass PCB	£1.20

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

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" for increased front back separation. All components, PCB	£22.60
L3A. Decoder similar to L2A but with discreet component front end with high precision 6-pole phase shift networks for increased frequency response. All components (carbon film resistors), PCB	£25.90
Also available with M.O. resistors, cermet pre-set — add	£4.20

SEMICONDUCTORS as used in our range of quality audio equipment.

2N699	£0.20	40361	£0.40	BD529	£0.55	MJE521	£0.60	TIP29C	£0.55
2N1613	£0.20	40362	£0.45	BD530	£0.55	MPSA05	£0.25	TIP30C	£0.60
2N1711	£0.25	BC107	£0.10	BDY56	£1.60	MPSA12	£0.35	TIP41A	£0.70
2N2926G	£0.10	BC108	£0.10	BF257	£0.40	MPSA14	£0.30	TIP42A	£0.80
2N3055	£0.45	BC109	£0.10	BF259	£0.47	MPSA55	£0.25	TIP41B	£0.75
2N3442	£1.20	BC109C	£0.12	BFR39	£0.30	MPSA65	£0.35	TIP42B	£0.90
2N3711	£0.09	BC125	£0.15	BFR79	£0.30	MPSA66	£0.40	1N914	£0.07
2N3904	£0.17	BC126	£0.15	BFY51	£0.20	MPSU05	£0.50	1N916	£0.07
2N3906	£0.20	BC182	£0.10	BFY52	£0.20	MPSU55	£0.50	1S920	£0.10
2N4062	£0.11	BC212	£0.12	CA3046	£0.70	SBA750A	£1.90		
2N4302	£0.60	BC182K	£0.10	LP1186	£6.50	SL301	£1.30		
2N5087	£0.25	BC212K	£0.12	MC1310	£2.20	SL3045	£1.20	**FILTERS**	
2N5210	£0.25	BC182L	£0.10	MC1351	£1.05	SN72741P	£0.40	FM4	£1.00
2N5457	£0.45	BC184L	£0.11	MC1741CG	£0.65	SN72748P	£0.40	SFG10 7MA	£1.50
2N5459	£0.45	BC212L	£0.12	MFC4010	£0.95	TIL209	£0.20		
2N5461	£0.50	BC214L	£0.14	MJ481	£1.20	TIP29A	£0.40		
2N5830	£0.35	BCY72	£0.13	MJ491	£1.45	TIP30A	£0.45		

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

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

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For Toshiba say Erie

ERIE

For top quality, reliable transistors, FETs, diodes, LEDs (single and 7-segment), and ICs, choose Toshiba from Erie. Here's a selection from the wide Toshiba range, with prices for quantities from 1 to 24 inclusive.

15% discount applies to all orders for quantities of 25 to 99. If you want 100 or more of any one item, special prices apply—send for price list direct from Erie, or complete the reader service card.

Data sheets for devices ordered are supplied free on request, but if you want data sheets only, please send 10p for each set of device data, to cover costs.

P & P of 30p is applicable on all orders up to 100 devices (any mix of types).

VAT Please add 12½% for VAT to all prices, *except* those marked with an asterisk (•) which are rated at 8% VAT.

NEW SERIES! (TO-92)

Audio Amplifier Small Signal Transistor incorporating the Toshiba perfect crystal technology (P.C.T.) manufacturing process, giving excellent low noise characteristics.

			V_{CBO} (V)	I_C (mA)	P_C (mW)	h_{FE} max	Price Each
Audio Input	BC451	NPN	50	100	300	800	11p
Audio Input	BC452	NPN	30	100	300	800	11p
Low noise	BC453	NPN	30	100	300	800	11p
Driver	BC454	PNP	−50	−100	300	800	12p
Driver	BC455	PNP	−30	−100	300	800	12p
Low noise (2–5B)	BC456	PNP	−30	−100	300	800	12p
Low noise Pre Amp.	2SC1000	NPN	50	100	200	700	16p
	2SC1681	NPN	60	50	200	700	16p

Plastic Power (TO-126)

Audio Medium Power Amplifier Plastic Package also incorporating P.C.T.

Driver	BD135	NPN	45	500	6.5W	250	33.5p
Driver	BD136	PNP	−45	−500	6.5W	250	36.5p
Driver	BD137	NPN	60	500	6.5W	250	36.5p
Driver	BD138	PNP	−60	−500	6.5W	250	40p
Driver	BD139	NPN	80	500	6.5W	250	40p
Driver	BD140	PNP	−80	−500	6.5W	250	44p

LED'S

Erie's range of Toshiba Led's include:—

		V_R (V)	V_F (V)	I_R (µA)	I_F (mA)	P_D (mW)	Iv (mcd)	Price Each
Red Diffused Lens	TLR102	4	2	.5	25	75	.1/.5	21.5p
Red Clear Lens	TLR103	4	2	.5	35	100	.5/3	21.5p
Red Diamond Lens	TLR 105	4	2	.5	35	100	.5/1.7	21.5p
Grn. Diffused Lens	TLG 102	4	2	.5	30	80	.05/.1	35.5p
Grn. Clear Lens	TLG 103	4	2	.5	45	125	.3/3	35.5p
Grn. Diamond Lens	TLG 105	4	2	.5	45	125	.2/1.8	35.5p

NEW! (TO-3) Toshiba introduce the low priced S2530A/ S2530 equivalent to the BUY69A/BUY69B.

		V_{CBO} (V)	I_C (A)	P_C (W)	h_{FE}	Price
•S2530	NPN	800	10	100	15	£3.22
•S2530A	NPN	1000	10	100	15	£3.48

Also range of High Voltage/High Power Switching Transistor in the BU Series.

	V_{CEX} (V)	I_C (A)	P_C (W)	h_{FE} (min)	Price Each
BU 204	1500	2.5	10	2	£2.05
BU 205	1650	2.5	10	2	£2.05
BU 207	1550	5	12.5	2.25	£3.87
BU 208	1650	5	12.5	2.25	£3.45
BU 126	750	3	50	15	£2.37

Note: Ex stock Metal Power 2N3055 Audio Power Amplifier Transistor for immediate delivery price 86p. All TO-3 prices inc. H.W.

INTEGRATED CIRCUITS

Linear Power Amplfier TA 7205P 5.8W/13.2V/4 Ω	S1P 14F	PRICE £1.55
TA 7093P 2W/24V/16 Ω	DIP 8F	PRICE £1.49
Four Channel Decoder TA 7117P	DIP 16P	PRICE £2.35

SEVEN SEGMENT

Common Cathode TLR 301 5.2 x 2.6mm character size, continuous current IF/Segment 20mA, VR3V, VF 2V, power dissipation 400mW. Total Luminous intensity 0.04/0.11 mcd PRICE £1.08

Common Cathode TLR 313 8.3 x 3.8mm character size, continuous current IF/Segment 15mA, VR 3V, VF 2V power dissipation 350mW. Total luminous intensity 0.04/0.11 mcd PRICE £2.22

Common Anode TLR 315 same characteristics. PRICE £2.22

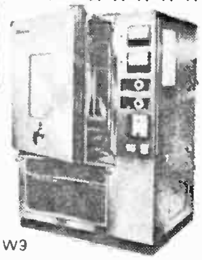
Common Cathode TLR 308 15 x 9mm character size, continuous current IF/Segment 35mA, VR 3, VF 2V, power dissipation 750mW. Total luminous intensity 0.07/0.3 mcd PRICE £3.08

Common Anode TLR 306 same characteristics. PRICE £3.08

ERIE ELECTRONICS LIMITED
South Denes, Great Yarmouth, Norfolk.
Tel: 0493 56122 Telex: 97421

Components ITT

WW—061 FOR FURTHER DETAILS



TABAI

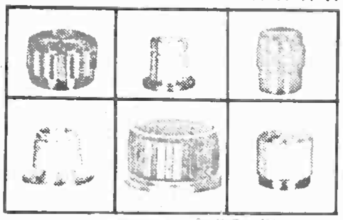
ENVIRONMENTAL TEST EQUIPMENT

A Standard Range offering the following facilities:

High temperatures to 500° C
Low temperatures to − 75° C
Humidity Cycling
Thermal Shock
Vibration
Pressure Cycling
Sand and Dust exposure
Corrosive Gas exposure
Explosion Test

For full information write or phone section W9

WW—092 FOR FURTHER DETAILS

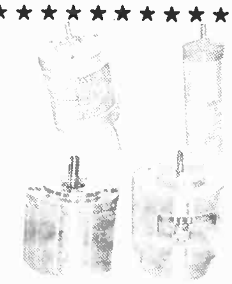


TOYA

High quality competitively priced Knobs in production quantities only.
Min. order 1000 Pcs of any one of 266 types.

WW—093 FOR FURTHER DETAILS

NDI MOTORS



We can now offer a range of Mini and Micro Motors with or without gear heads for AC and DC operation.

WW—094 FOR FURTHER DETAILS

Specialist Stockists of Servomotors, Synchros, Test Equipment, Meters and Connectors

Servo and Electronic Sales Ltd

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sanwa electronic test instruments

We are confident that we now have the widest and best range of multitesters available in the UK today with models specifically designed for special applications as well as sound basic general purpose multimeters. We can offer many different types of measuring instruments with a top spares facility at Lydd in Kent.

Main Models and Specifications

MODELS	DC VOLTAGE RANGES V	NO OF RANGES	SENSITIVITY Ω/V	ACCURACY (%)	CD CURRENT RANGES A A	NO OF RANGES	VOLTAGE DROP mV	ACCURACY (%)	AC VOLTAGE RANGES V	NO OF RANGES	SENSITIVITY Ω/V	ACCURACY (%)	OHM MAXIMUM	NO OF RANGES	VOLUME LEVEL RANGES db	PRICE
N 501	0 06-1 2k	9	500k 50k	2	2 12	11	60 300	2	3 1 2k	6	1M const	3	200M	6	−20 +63	£48 32
N-201	0 3 3k	9	200k 16 6k	3	6-3	6	300	3	3-600	5	10k	4	50M	4	−20 +57	£35 06
460-ED	0 3-1.2k	7	100k 16 6k	2	12-12	7	300	2	3 1 2k	6	5k	3	50M	4	−20 +63	£35 65
N 301	0 25 1k	8	20k	2	50 10	6	250	2	2 5-1k	5	4k	3	20M	5	−20 +62	£36 10
N 101	0 3 600 0 6 1 2k	6 6	50k 25k	3	30-300m 60-600m	4 4	240 480	3	6-600 12 1 2k	4 4	10k 5k	4	50M	4	−20 +63	£32.29
CX-505	0 3-1 2k	7	50k 12 5l	3	30-300m	4	300	3	6 1 2k	5	8k	4	50M	4	−10 +63	£29 81
BX 505	0 12 1 2k	7	33 3k	3	30-12	5	30	3	6-1 2k	5	8k	4	20M	4	−10 +63	£26 74
A 303TR$_D$ II	0 3-1 2k	8	20k	2 5	60 12	6	300	2 5	6-1 2k	5	8k	3	50M	4	−10 +63	£22 37
SH-63TR$_D$ II	0 25 1k	7	20k	3	50-250m	4	250	3	10 1k	4	8k	4	30M	4	0 +62	£20 17
K-30D	0 25 1k	7	10k	3	100-500m	4	250	3	10 1k	5	5k	4	10M	4	−20 +62	£19 90
YX-360TR	0.1-1k	7	20k	3	50 250m	4	100 250	3	10 1k	4	8k	4	20M	4	−10 +62	£17 45
F-80TR$_D$	0 25-1k	7	25k	3	40-500m	5	250	3	2 5 1k	6	5k	4	50M	4	−10 +62	£26 78
U 50$_{DX}$	0 1-1k	6	20k	3	50-250m	5	500	3	2 5 1k	5	8k	4	5M	4	−20 +62	£18 88
SP 10$_D$	0 25-1k	6	4k	2 5	250 500m	3	250	2 5	10 1k	5	4k	3 5	1M	3	−20 +62	£15 53
JP-5$_D$	10-1k	5	2k	3	500-500m	3	560	3	10 1k	5	2k	4	1M	2		£14 93
P-2$_B$	10 1k	5	2k	3	500-250m	3	670	3	10.1k	5	2k	4	500k	2	−20 +36	£13 74
EM-800	0 3.1 2k	8	12M const	4	0 1 300m	4	300	4	1 2 1 2k	7	1M const	4	1000M	4	−20 +63	£62 08
EM 300	0 25 1k	7	10M const	4	25 5	5	250	4	2 5 1k	5	1M const	6	500M	4	−10 +62	£28 36

Postage and Packing FREE for CWO otherwise add £1.00 to above prices
Cases available as optional extra

No hidden extras! All prices include P&P & VAT
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WW—095 FOR FURTHER DETAILS

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ANALYTICAL EQUIPMENT

GAS CHROMATOGRAPHY RESEARCH OVEN
PV4051/4056 (other GC items in stock)
A large capacity oven of low thermal mass for use between 35 and 400 Deg C. Provides a forced air circulating system yielding 1000 changes of air per min. The oven has forced air cooled outer surfaces when the internal temperature is high. 210-240V, 50Hz, 2.6KW **£33.50.** (C.Pd. England).

IONISATION AMPLIFIER PV4075

A modern high grade low noise solid state amplifier to feed a potentiometer recorder. 18 input ranges from 10 to −12 and 5 to −7A with 5 outputs of 1mV to 100mV. Linearity 0.1% f.s. Noise less than 0.5% f.s. at max. sensitivity. Back off facility. Dimensions 28 X 10 X 43 cm deep. With operating information **£29.50.** (C.Pd. U.K.).
Details of these three and other gas chromatography items, price **25p** (C.W.O. only). Handbooks (complete) available.

HILGER AND WATTS LARGE QUARTZ SPECTROGRAPH

With A.C. spark and D.C. arc source units rotating sector and Judd-Lewis comparator, etc. Available for inspection at our Lydd Works.

PANEL DISPLAY RECORDING CAMERA

Manufactured A.G.I. Specifically for the recording of complex instrument displays on 2¼in. x 2¼in. shots. Fitted 80mm F3.5 lens. Shutter speeds 1/100, 1/50, 1/25 sec. and time exp. Focusing at 1.75 to 50ft. in 18 steps. Aperture sttgs. F3.5 to F22. Prismatic viewfinder and facility for viewing direct on ground glass screen. Rotating filter attachment. Cord film advance and shutter cock with septe. Button control and electrical release facility (24V DC). Spool holds 40 exposures. Camera may be wall mounted on bracket supplied. Tripod mounting socket provided in wooden case F/S1. Two grades available as new. Grade A **£35.50** (incl. P&P and VAT). Somewhat used but serviceable Grade B **£28.40** (incl. P&P and VAT).

COMPUTERS AND PERIPHERALS

ICL 7070/2 UNIPLEXER (complete) **£150.** BRPE 110 ch/sec. 8-chan. paper tape punches — some silence covers **£120.** Mullard AW 3331 16K (25 bit) 2µS corestores **£40.** Mullard AW 3795 corestores **£30.** IBM 729/IV MTUs — documentation available. **£200.** Ampex & D.R.I. digital tape heads (7 & 9 track) **P.O.A.** ICL 1971 & 1973 servo motors and vacuum blowers **P.O.A.** CDC/ICL '2802' (EDS8) disc drives — mechanical spares **P.O.A.** RCA/ICL '1500' series — electrical and mechanical spares **P.O.A.** Belling-Lee R.F.I. suppressors — ϕ3 phase 20A (50Hz) **£30.** STC 'Sentrycal' fire (smoke) detectors — date available **£15.** Vactric Shaft position encoders type 11DP101 (10 bit) **£15.** Tolana 8-channel FM instrumentation recorder (complete) **£350.** Add 8% VAT and carriage to items above.
We can also design and construct non-standard interfaces between computers, instrumentation and control equipment, etc. and we have a large number of one-off pieces of test equipment. If you have any problems in this field, do not hesitate to get in touch with us. Contact D.P. Manager, Chris Seton (Extn. 3).
GE Optical Tape Readers 5-, 7- and 8-track, 300 ch/sec., built-in amps and cont. ccts. Excellent condition. Tested **£70** inc. P&P and VAT.

AMP PATCHBOARDS

Type 695448-3 and 695365-2 **£27.50** ea. (P&P & VAT inc).

ELECTRIC AND HYDRAULIC ACTUATORS

We now have in stock a selection of Electric and Hydraulic Actuators providing both linear and rotary motion. A list fully describing these items is available on receipt of SAE.

SHAFT ROTATION INDICATOR

With two concentrically mounted pointers. One reading 0-25 over 360° and the other reading 0-1 in 0.1 divisions over 360°. Black rectangular panel-mounting instrument 3½" square with centrally mounted ½" long drive shaft at the rear **£4.25.** (P.Pd.) inc. VAT.

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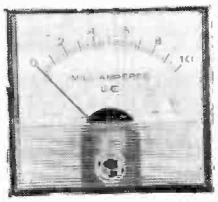

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Dims	48	66	85	118	150
in	x	x	x	x	x
mm	42	50	70	106	110
50µA	£3.73	£3.91	£4.10	£5.00	£5.55
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1mA	£3.37	£3.54	£3.74	£4.63	£5.33
15vDC	£3.40	£3.59	£3.77	£4.67	£5.36
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Dims	43	51	61	82
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mm	43	51	61	78
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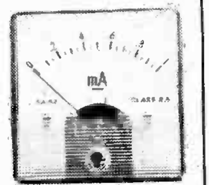
1mA	£3.21	£3.28	£3.53	£3.82
15vDC	£3.25	£3.32	£3.60	£3.86
300vAC	£3.49	£3.56	£3.77	£4.02



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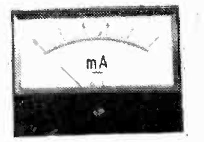
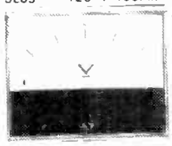
SE85	120 x 100mm





SU45	69 x 53mm
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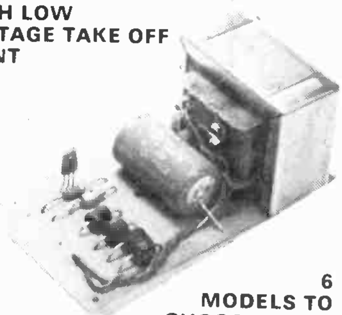

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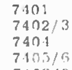

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BC147/8/9	9p	2N706 & 708	11p*
BC157/8/9	12p	2N2646 UJT	38p*
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BFY50	14p*	2N3706/7/8/9	8p
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CBL31	1.40
CL33	1.50
CY31	1.00
DAF91	0.40
DAF96	0.60
DCC90	1.35
DF91	0.40
DF96	0.60
DK91	0.50
DK92	1.00
DK96	0.75
DL92	0.50
DL94	0.85
DL96	0.55
DM70	0.70
DY78/7	0.45
DY802	0.47
EABC80	0.38
EAF42	0.70
EAF801	0.75
EBC33	1.00
EBC41	0.75
EBC81	0.40
EBF80	0.40
EBF83	0.40
EBF89	0.32
EBL31	2.00
ECC40	1.00
ECC81	0.45
ECC82	0.38
ECC83	0.38
ECC85	0.45
ECC88	0.50
ECF80	0.45
ECF82	045
ECH35	1.50
ECH42	0.85
ECH81	0.35
ECH83	0.50
ECH84	0.50
ECL80	0.60
ECL82	0.42
ECL86	0.55
ECLL800	3.50
EF37A	1.50
EF39	1.25
EF41	0.75
EF55	1.50
EF80	0.35
EF85	0.45
EF86	0.50
EF89	0.35
EF91	0.40
EF92	0.50
EF98	0.80
EF183	0.40
EF184	0.40
EH90	0.60
EL33	3.00
EL34	0.70
EL37	3.40
EL41	0.90
EL42	1.65
EL84	0.35
EL91	2.00
EL95	0.60
EL360	1.75
EM80	0.55
EM81	0.60
EY51	0.45
EY86	0.50
EZ40	0.60
EZ41	0.75
EZ80	0.30
EZ81	0.31
EZ90	0.45
GY501	0.90
GZ30	0.65
GZ32	0.65
GZ34	0.75
H63	0.90
HLD41DD	0.70
HN309	1.50
KT61	3.40
KT66	3.40
KT81 (7C5)	2.00
KT88	3.65
KTW61	1.50
KTW62	1.50
N78	5.00
OA2	0.45
OB2	0.45
OZ4	0.55
PC86	0.65
PC88	0.65
PC900	0.55
PCC84	0.45
PCC89	0.55
PCC189	0.65
PCF80	0.40
PCF86	0.65
PCF801	0.60
PCF802	0.56
PCF805	0.90
PCF806	0.80
PCF808	1.00
PCL82	0.45
PCL83	0.70
PCL84	0.50
PCL85	0.60
PCL86	0.50
PD500	1.50
PEN45DD	0.75
PFL200	0.70
PL36	0.63
PL38	1.25
PL81	0.55
PL82	0.50
PL83	0.50
PL84	0.50
PL500	0.85
PL504	0.85
PL508	0.90
PL509	1.55
PL801	1.00
PL802	2.00
PY32	0.63
PY33	0.63
PY81/800	0.50
PY82	0.45
PY83	0.50
PY500	1.10
PY801	0.55
SP41	3.00
SP61	0.85
T41	1.50
U25	1.00
U26	0.85
U191	0.75
U404	0.75
U801	1.18
UABC80	0.40
UAF42	0.75
UBC41	0.60
UBF80	0.50
UBF89	0.50
UCC85	0.50
UCH42	0.80
UCH81	0.50
UCL82	0.40
UCL83	0.70
UF41	0.75
UF89	0.50
UL41	0.85
UL84	0.50
UY41	0.55
UY85	0.45
VP4B	1.25
VR75/30	0.55
VR105/30	0.40
VR150/30	0.45
YR3	1.25
1R5	0.50
1S5	0.40
1T4	0.40
3S4	0.50
3V4	0.85
5R4GY	1.20
5U4G	1.00
5V4G	0.65
5Y3GT	0.65
5Z4G	0.95
6/30L2	0.90
6AL5	0.30
6AQ5	0.50
6AS7G	1.00
6AT6	0.60
6AU6	0.40
6AV5	0.50
6BA6	0.38
6BE6	0.45
6BH6	0.75
6BJ6	0.75
6BQ7A	0.56
6BR7	1.20
6BW6	1.00
6BW7	1.00
6C4	0.40
6DC6G	1.60
6CH6	2.20
6E5GT	1.50
6F23	0.90
6J5G	0.45
6J5GT	0.55
6J7GT	0.45
6K6GT	0.80
6K7GT	0.35
6K8GT	0.50
6P25	3.00
6Q7GT	0.43
6SG7	0.50
6SJ7GT	0.30
6SL7GT	0.55
6SN7GT	0.55
6U4GT	0.75
6U5G	1.50
6V6GT	0.60
6X4	0.45
6X5GT/G	0.55
7B6	0.80
7B7	0.80
7C5	2.00
7C6	1.00
7H7	0.80
7R7	1.30
7S7	2.25
7Y4	0.80
12AC6	0.80
12AD6	0.80
12AE6	0.75
12AT6	0.45
12AT7	0.45
12AU6	0.50
12AU7	0.38
12AX7	0.38
12BA6	0.50
12BE6	0.60
12BH7	0.60
30C15	1.00
30C17	1.00
30C18	0.90
30F5	1.00
30FL1	1.00
30FL14	1.00
30L15	0.95
30L17	0.95
30P12	1.00
30P19	0.95
30PL1	0.95
30PL13	1.10
30PL14	1.10
35L6GT	0.80
35W4	0.60
35Z3	0.80
35Z4GT	0.70
50C5	0.70
50CD6G	1.20
80	0.75
807	1.00
6080	3.80
6146	3.80
6146A	3.80
6146B	4.20

TUBES

Type	Price
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3BP1	4.50
3DP1A	4.00
3EG1	8.00
3FP7	2.00
3GP1	5.00
5BP1	8.00
5CP1	5.00
88D	15.00
CV429	27.50
DG7-5	12.00
VCR138	10.00
VCR139A	8.00

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5B/255M 5B/256M 5B/257M 5C22 5D21 5R4GY 5U4GB 5Z3 5Z4G 6AF4A 6AK5 6AM5 6AM6 6AN5 6AN8 6AR5 6AS6 6AU4GTA 6AU5GT 6AU6 6AV5GTA 6AW8A 6AX5GT 6B4G 6BA8A 6BK4 6BK7A 6BL7GTA 6BN6 6BR7 6BS7 6BX7GT 6BZ6 6CB6 6CH6 6CL6 6CW4 6DK6 6DQ6B 6EA8 6F33 6H6(metal) 6K7GT 6U8A 6V6GT 11E3 11E13 12AY7 12B4A 12BY7A 12E1 12E14 13E1 28D7 29C1 53KU 75B1 75C1 83A1 85A1 85A2 90AG 90AV 90C1 90CG 90CV 95A1 100TH 150B2 150B3 150C1 150C2 150C3 150C4 250TH 328 329

705A 715A 715B 723A/B 725A 801 803 805 807 808 811 811A 812A 813 815 828 829B 830B 860 866 866E 872A 881R 891R 954 955 956 957 1625 2050 2050W 2051 4003A 4212E or H 4242A 4313C 4328A 4687 5544 5545 5642 5644 5651 5670 5672 5676 5687 5696 5702 5718 5719 5725/6AS6W 5726/6AL5W 5727/2D21W 5749 5750 5751 5802 5814 5823 5840 5963 5965 6005/6AQ5W 6021 6057 6058 6059

6060 6061 6062 6063 6064 6065 6067 6072 6073 6074 6080 6097C 6130 6136 6189 6197 6201 6202 6203 6205 6360 6442 6463 6550 6807 6923 6939 7193 7203 7360 7586 8013 8025A 9001 9002 9003 9004 9005 9006 13201A A1834 A2087 A2134 A2293 A2426 A2521 A2900 ACT6 ACT9 B1C 1E BS90 BS156 BT5 BT35 BT45 BT79 BT83 C1C C1K CV5 CV25 CV26 CV28 CV31 CV32 CV45 CV53 CV73 CV74 CV85 CV118 CV121 CV124 CV128

CV131 CV132 CV133 CV135 CV136 CV137 CV138 CV140 CV144 CV160 CV173 CV187 CV188 CV190 CV220 CV261 CV273 CV284 CV286 CV287 CV315 CV329 CV337 CV342 CV345 CV354 CV359 CV360 CV371 CV372 CV378 CV391 CV395 CV397 CV428 CV434 CV447 CV449 CV466 CV469 CV488 CV491 CV492 CV493 CV717 CV808 CV1072 CV1076 CV1092 CV1219 CV1343 CV1475 CV1476 CV1477 CV1478 CV1794 CV1480 CV1481 CV1482 CV1787 CV1832 CV1833 CV1835 CV1994 CV2000 CV2131 CV2154 CV2155 CV2160 CV2179 CV2235 CV2237 CV2238 CV2253 CV2289 CV2520 CV2522 CV2721 CV2901 CV3523 CV3929

CV3986 CV3988 CV3991 CV3998 CV4001 CV4002 CV4003 CV4004 CV4005 CV4006 CV4007 CV4008 CV4009 CV4010 CV4011 CV4012 CV4013 CV4014 CV4015 CV4016 CV4017 CV4018 CV4019 CV4020 CV4022 CV4023 CV4024 CV4025 CV4028 CV4033 CV4035 CV4038 CV4039 CV4040 CV4056 CV4059 CV4060 CV4062 CV4063 CV4064 CV4079 CV4501 CV4502 CV4503 CV4504 CV4507 CV4508 CV5060 CV6004 CV6008 CV6045 DA30 DA41 DA42 DA100 DET22 E55L E80CC E80FC E80F E80L E80T E81CC E81L E82CC E83CC E83F E88CC E90CC E90L E91H E92CC E180CC EA50 EA52 EA76 ECC35 ECF804 EF50

EF54 EF55 EF804 EFP60 EL91 EN30 EN31 EN32 EN91 ESU74 ESU76 ESU77 F6057 F6060 F6061 F6063 FX219 FX225 FX227 G1/371K G120/1B G150/2B G180/2M G240/2D G400/1K GN4 GT1C GTR120W GTR150MS GU18 GU20/21 GU50 GXU1 KT66 KT67 KT88 M8079 M8080 M8081 M8082 M8083 M8091 M8096 M8097 M8098 M8100 M8136 M8137 M8140 M8141 M8142 M8144 M8149 M8157 M8161 M8162 M8163 M8167 M8179 M8190 M8196 M8204 M8212 M8214 M8223 M8224 M8225 M8232 M8237 M8245 ME1400 ME1401 OA2 OA3 OA4G OB2 OB3

OD3 OG3 OZ4 OZ4A PT15 QA2400 QA2403 QA2404 QA2406 QA2407 QB3/300 QB3-5-750 QB4 1100 QF41 QF45 QQV02 6 QQV03 10 QQV03 20 QQV03 20A QQV04 15 QQV06 40 QQV06 40A QS70/20 QS75/20 QS75/40 QS75/60 QS83/3 QS92/10 QS95/10 QS105/45 QS150/40 QS150/45 QS150/80 QS1200 QS1202 QS1203 QS1205 QU37 QV03 12 QV04-7 QV05 25 QV06 20 QY3 125A QY4 250A QY4-400A R10 R17 R18 S11E12 S130 S130P STV280/40 STV280/80 SU41 SU42 TD03-10 TT15 TT21 TTR31MR TZ40 U17 U19 U27 VLS631 Z300T Z759 Z803U

TRANSISTORS & ICs

Type	Price
AA119	0.07
AAZ13	0.12
AAZ15	0.10
AC107	0.51
AC126	0.25
AC127	0.25
AC128	0.15
AC176	0.25
AC187	0.21
AC188	0.20
ACY21	0.35
ACY39	0.78
AD140	0.50
AD149	0.75
AD161	0.44
AD162	0.44
AF115	0.25
AF116	0.25
AF117	0.24
AF186	0.48
AF239	0.44
ASY27	0.40
ASY28	0.25
BA102	0.25
BA115	0.10
BC107	0.14
BA108	0.13
BC109	0.14
BC113	0.15
BC117	0.21
BC143	0.30
BC147	0.10
BC148	0.08
BC169C	0.15
BC182	0.12
BC182L	0.12
BC184L	0.13
BCY32	0.85
BCY33	0.38
BCY34	0.45
BCY70	0.18
BCY71	0.22
BCY72	0.15
BCZ11	0.65
BD121	1.00
BD124	0.65
BD131	0.42
BD132	0.50
BF115	0.20
BF167	0.25
BF173	0.28
BF179	0.33
BF180	0.36
BF181	0.35
BF194	0.10
BF195	0.13
BF197	0.15
BF200	0.32
BFS61	0.25
BFS98	0.25
BFW10	0.61
BFX29	0.28
BFX88	0.24
BFY50	0.21
BFY51	0.20
BFY52	0.20
BR100	0.40
BY100	0.27
BY126	0.14
BY127	0.12
BZX61 series	0.20
BZY88 series	0.10
CRS1-05	0.45
CRS1-40	0.65
CRS3-05	0.40
CRS3-40	0.65
MJE340	0.47
MJE370	0.68
MJE520	0.63
MJE2955	1.27
MJE3055	0.77
MPF102	0.40
MPF103	0.36
MPF104	0.35
MPF105	0.36
NE555	0.42
NKT404	1.00
OA5	0.72
OA10	0.40
OA79	0.10
OA81	0.18
OA91	0.07
OA200	0.08
OA202	0.06
OC16	2.00
OC20	2.00
OC23	1.25
OC25	0.40
OC28	0.75
OC35	0.75
OC36	0.60
OC42	0.40
OC44	0.20
OC45	0.20
OC71	0.25
OC72	0.28
OC76	0.30
OC77	0.54
OC81	0.29
OC81D	0.28
OC81Z	0.75
OC83	0.60
OC140	0.14
OC170	0.30
OC171	0.30
OC200	1.00
OC201	1.50
OC202	1.50
OC203	1.25
OCP71	1.20
ORP12	0.60
ORP60	0.55
TIC44	0.29
TIC226D	1.50
TIL209	0.20
ZTX107	0.12
ZTX108	0.10
ZTX300	0.13
ZTX301	0.14
ZTX302	0.18
ZTX304	0.24
ZTX500	0.13
ZTX501	0.12
ZTX503	0.16
ZTX531	0.25
ZTX550	0.18
1N914	0.06
1N4001	0.06
1N4002	0.07
1N4003	0.08
1N4004	0.08
1N4005	0.10
1N4006	0.12
1N4007	0.12
1N4009	0.06
1N4148	0.06
1S131	0.13
1S921	0.07
1S2033	0.20
1S2051A	0.20
1S2100A	0.20
1S3010	0.25
2N696	0.15
2N697	0.16
2N706	0.12
2N706A	0.12
2N1131	0.25
2N1132	0.24
2N1302	0.18
2N1303	0.18
2N1304	0.22
2N1305	0.22
2N1306	0.28
2N1307	0.28
2N1308	0.28
2N1309	0.30
2N1613	0.21
2N1614	0.45
2N2147	1.25
2N2160	0.78
2N2369A	0.16
2N2646	0.50
2N2904	0.20
2N2904A	0.25
2N2905	0.32
2N2905A	0.25
2N2906	0.20
2N2926	0.25
2N3053	0.10
2N3055	0.65
2N3525	0.91
2N3614	1.00
2N3615	0.65
2N3702	0.11
2N3703	0.12
2N3704	0.14
2N3705	0.15
2N3706	0.11
2N3707	0.13
2N3708	0.07
2N3709	0.10
2N3710	0.11
2N3711	0.11
2N3819	0.38
2N3820	0.50
2N3823	0.12
2N3903	0.15
2N3904	0.20
2N3905	0.25
2N3906	0.25
2N4058	0.15
2N4059	0.10
2N4060	0.13
2N4061	0.13
2N4062	0.14
2N4289	0.30
3N141	0.81
40360	0.40
40361	0.45
40362	0.40
40430	0.85
SN7400	0.16
SN7401	0.16
SN7402	0.16
SN7403	0.16
SN7404	0.28
SN7405	0.22
SN7406	0.42
SN7407	0.42
SN7408	0.28
SN7409	0.28
SN7410	0.16
SN7411	0.25
SN7412	0.30
SN7413	0.50
SN7416	0.36
SN7417	0.36
SN7420	0.16
SN7422	0.25
SN7423	0.37
SN7425	0.37
SN7427	0.37
SN7428	0.40
SN7430	0.16
SN7432	0.37
SN7433	0.37
SN7437	0.37
SN7438	0.37
SN7440	0.22
SN7441AN	0.92
SN7442	0.79
SN7450	0.16
SN7451	0.16
SN7453	0.16
SN7454	0.16
SN7460	0.16
SN7470	0.36
SN7472	0.38
SN7473	0.41
SN7474	0.42
SN7475	0.59
SN7476	0.45
SN7480	0.60
SN7482	0.87
SN7483	1.10
SN7484	1.00
SN7486	0.47
SN7490	0.55
SN7491AN	1.00
SN7492	0.70
SN7493	0.70
SN7494	0.80
SN7495	0.80
SN7496	0.95
SN7497	3.87
SN74100	1.89
SN74107	0.45
SN74110	0.58
SN74111	0.86
SN74118	0.90
SN74119	1.68
SN74121	0.50
SN74122	0.70
SN74123	1.00
SN74141	0.90
SN74145	1.26
SN74150	1.75
SN74151	1.00
SN74154	2.00
SN74155	1.00
SN74156	1.00
SN74157	0.95
SN74170	2.52
SN74174	1.57
SN74175	1.10
SN74176	1.26
SN74190	2.00
SN74191	2.00
SN74192	2.00
SN74193	2.00
SN74194	1.30
SN74195	1.10
SN74196	1.20
SN74197	1.20
SN74198	2.77
SN74199	2.52

DIL SOCKETS 14 pin 15p 16 pin 17p

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SPECIAL OFFER

Terms of Business: Mon. to Fri. Open for callers 9 a.m. to 5 p.m. Closed Sat. Express postage 15p for 1st valve; 2p each additional valve. Express postage: 15p per order for transistors. Prices on application for any type not listed. Obsolete valves a speciality. Prices correct when going to press. This applies to the U.K.

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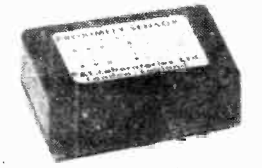
TYPE EP45

ANIMAL VEGETABLE OR MINERAL



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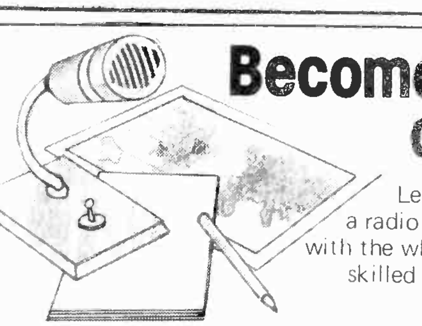

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Fully assembled with black strap **£20.95.** Bracelet **£2.00.**

SINCLAIR IC20

IC20 10W+10W stereo amp kit with printed circuit **£4.95.** PZ20 Power supply for above **£3.95.** VP20 Control and preamp kit **£7.95.**

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IC radio chip **£1.44.** Extra parts and pcb for radio **£3.65.** Case **90p.** Send sae for free leaflet.

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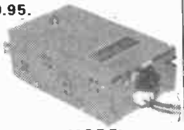
FM tuner **£13.25.** Q16 **£9.50.** PZ5 **£3.95.** PZ6 **£8.70.** PZ8 **£9.10.** Trans for PZ8 **£5.60.** Z40 **£5.75.** Stereo 80 **£11.95.** Project 805Q **£18.95.**

BATTERY ELIMINATORS

STABILIZED POWER UNITS
Millenia series. Switched 1 to 30V in 0.1V steps. 1A output: Kit **£11.45.** Kit + case **£14.40.** Built **£18.40.**
2A output: Kit **£13.95.** Kit + case **£16.90.** Built **£20.95.**



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Switched output of 3, 4½, 6, 7½, 9, 12V at 500mA **£5.20.**
6-WAY DOUBLE RADIO MODEL
Switched output 3+3, 4½+4½, 6+6, 7½+7½, 9+9, 12+12V at 250mA. Also 15, 18, 24V single **£6.20**
3-WAY MODEL
Switched output of 6/7½/9V at 250mA **£2.95★.**
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50mA with press-stud battery connectors for radios etc. 6V **£3.45.** 9V **£3.25.** 4½+4½V **£4.45.** 6+6V **£4.45.** 9+9V **£4.45.** Also 9V 300mA **£3.95.**
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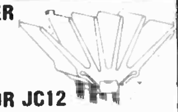
7½V output with 5 pin DIN plug. 50mA model **£3.45.** 300mA model **£3.95.**
CAR CONVERTERS
Input 12V DC. Output 6, 7½, 9V DC 1A regulated **£4.75★.**

JC12 AMPLIFIER



6W IC audio amp with free data and printed circuit **£1.95★.**

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Volume and tone controls and extra parts for the pcb. Mono **£2.33.** Stereo **£4.95.**

JC12 POWER KIT

Supplies 25V 1Amp **£3.55.**
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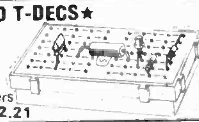

S-DeC **£2.24**
T-DeC **£4.05**
u-DeCA **£4.45**
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16 dil IC carriers with sockets **£2.21**

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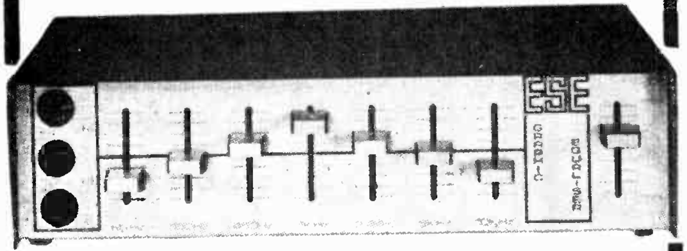

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Frequency response: All filters at central better than ± 2 dB.
Filter slope: Better than ±13 dB per octave.
Filter ranges: Max. ±15 dB at 60, 180, 480 Hz, 1, 2.4, 5 and 10 kHz.

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149	60	**4.69**	.80
150	100	**5.33**	.95
151	200	**8.54**	1.25
152	250	**10.32**	1.53
153	350	**12.47**	1.53
154	500	**14.33**	1.79
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

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12 and/or 24-VOLT

Primary 220-240 Volts

Ref	Amps 12v	Amps 24v	£	P&P
111	0.5	0.25	**1.54**	.36
213	1.0	0.5	**1.86**	.65
71	2	1	**2.41**	.65
18	4	2	**2.97**	.80
70	6	3	**4.43**	.80
108	8	4	**5.09**	.95
72	10	5	**5.50**	.95
116	12	6	**5.80**	1.10
17	16	8	**7.48**	1.10
115	20	10	**10.91**	1.73
187	30	15	**14.20**	1.73
226	60	30	**17.67**	BRS

50 VOLT RANGE

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

Ref.	Amps	£	P&P
102	0.5	**2.71**	.65
103	1.0	**3.55**	.80
104	2.0	**4.95**	.95
105	3.0	**6.10**	1.10
106	4.0	**7.98**	1.25
107	6.0	**12.71**	1.37
118	8.0	**13.63**	1.73
119	10.0	**17.75**	BRS

30 VOLT RANGE

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

Ref.	Amps	£	P&P
112	0.5	**1.90**	.65
79	1.0	**2.52**	.80
3	2.0	**3.77**	.80
20	3.0	**4.70**	.95
21	4.0	**5.56**	.95
51	5.0	**6.73**	1.10
117	6.0	**7.52**	1.25
88	8.0	**10.20**	1.37
89	10.0	**10.36**	1.53

60 VOLT RANGE

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

Ref.	Amps	£	P&P
124	0.5	**2.48**	.80
126	1.0	**3.68**	.80
127	2.0	**5.33**	.95
125	3.0	**7.90**	1.10
123	4.0	**9.19**	1.53
40	5.0	**10.24**	1.37
120	6.0	**12.07**	1.53
121	8.0	**15.75**	BRS
122	10.0	**19.40**	BRS
189	12.0	**20.25**	BRS

AUTO TRANSFORMERS

Ref.	VA Watts	AUTO TAPS	£	P&P
113	20	0-115-210-240V	**1.75**	.59
64	75	0-115-210-240V	**3.05**	.80
4	150	0-115-210-220-240V	**4.33**	.80
66	300	.. ..	**6.11**	.95
67	500	.. ..	**9.36**	1.37
84	1000	.. ..	**14.36**	1.73
93	1500	.. ..	**19.02**	BRS
95	2000	.. ..	**25.41**	BRS
73	3000	.. ..	**36.84**	BRS

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Sec 100/120 or 200/240

VA	Ref.	£	P&P
1.10	243	**4.37**	1.10
1.53	247	**10.93**	1.53
1000	250	**26.31**	BRS
2000	252	**44.12**	BRS

SCREENED MINIATURES

Ref.	mA	Volts	£	P&P
238	200	3-0-3	**1.62**	.46
212	1A, 1A	0-6, 0-6	**1.93**	.58
13	100	9-0-9	**1.56**	.32
235	330,330	0-9, 0-9	**1.64**	.32
207	500, 500	0-8-9, 0-8-9	**2.02**	.65
208	1A, 1A	0-8-9, 0-8-9	**3.07**	.65
236	200, 200	0-15, 0-15	**1.56**	.32
214	300, 300	0-20, 0-20	**2.03**	.65
221	700 (DC)	20-12-0-12-20	**2.38**	.65
206	1A, 1A	0-15-20, 0-15-20	**3.63**	.80
203	500, 500	0-15-27, 0-15-27	**3.15**	.80
204	1A, 1A	0-15-27, 0-15-27	**4.14**	.80
S112	500	0-12-15-20-24-30	**1.97**	.65

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5"	4½"	7"	**£5.59**
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1000VA	**£18.39**	BRS.	Ref. 84W
2000VA	**£28.71**	BRS.	Ref. 95W

BRIDGE RECTIFIERS

200v	2A	**45p**
400v	2A	**55p**
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P&P 15p. VAT 12½%

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10 watt RMS Amplifier	**£2.95**
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Power Supplies for 25w	**£3.00**
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Transformer for 5-10w	**£2.30**
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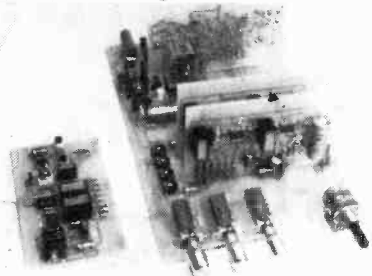
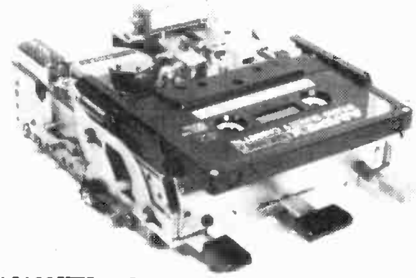


Master Board with one Replay Amp removed

As these circuits in recent issues of "Wireless World" are capable of such an excellent performance we feel that it is not sensible to sacrifice this potential by designing a kit down to a price. We have therefore spent a little more on professional hardware allowing us to design a very advanced modular system. This enables a more satisfactory electrical layout to be achieved, particularly around the very critical input areas of the replay preamps. These are totally stable with this layout and require no extra stabilising components. Many other advantages also come from this system which has separate record and replay amps for each channel plugging in to a master board with gold plated sockets. The most obvious is the reduction of crosstalk and interaction which could cause trouble on a single plane board, with our modular system the layout is compact but there is no component crowding. Testing is very easy with separate identical modules and building with the aid of our component-by-component instructions is childishly simple, but the finished result is a unit designed not to normal domestic standards but to the best professional practice.



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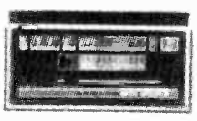
Peripherals and Systems for Data Processing Systems, Equipment and Components

Mini~Computer Exchange

JUST RECEIVED — SUPERB, hardly used, PDP8E SYSTEM ON VIEW IN OUR SHOWROOM NOW AND AVAILABLE FOR IMMEDIATE DELIVERY.



PDP8E 24K Processor complete with CIPHER X100 9-track 800 bpi Magnetic Tape Unit and control, plus ASR33 Teletype. Mounted in double 5ft. rack cabinet complete with AC power distribution unit. Price **£4,750** (including full technical documentation and diagnostic tapes).

PDP8I Rack-mounted 8K Processor with Teletype control module

PDP11/20 20K Processor with Dual DECtape and Control, 64K Disk Drive and Control, Real Time Clock, Line Printer

NOVA 840 Rack-mounted 24K System complete with 128K Novadisc, VDU and Real Time Clock

PDP11 Interface Boards: DR11 Parallel Interface, DC11-AC Serial Line System Unit, DC11-DA Full Duplex Serial Module Set.

PDP8E Option Modules KD8E Databreak, KP8E Power Fail/Auto Restart, MI8E Bootstrap Loader

PDP8, PDP8I — many spares in stock

HEWLETT PACKARD 9830A Programmable Calculator

DEC Power Supplies 728A +10/-150V 50Hz

TERMINALS — LARGE STOCKS AVAILABLE

ASR33 Teletype from **£445.00**
KSR33 Teletype from **£250.00**
ASR35 Teletype from **£750.00**
IBM73 I/O Golfball Typewriter from **£275.00**

SPECIAL OFFER

Cossor DIDS 401.2 Visual Display Units 13 lines x 40 characters (8½x4½" screen) 64 character repertoire with detachable ASCII keyboard. (Control device required.)

Bargain Price: £145.00

Peripheral Equipment

DEC DF32 Disk Drive & Control
DEC TU60 Dual Cassette Drive & Control
DEC RT02 Single-line Alphanumeric Display & Control
(All above supplied complete with control module for PDP8E/F/M series and all connecting cables)

CALCOMP 565 Digital Incremental Plotter

ICL 2802 8 Meg. Disk Drives (=CDC 9450). Control Units available with multiple orders only. From **£450.00**

ELLIOTT 803 Film Handlers Bargain price to clear

SANDERS 720 Data Display System. 6 ASCII-coded visual display units linked via control unit to communications buffer. Complete with all connecting cables, technical manuals, etc. Suitable for use with IBM 360/370 and many other mainframes.

TELETYPE BRPE 110 cps Synchronous Punch 5/7/8 channel. Self-contained, mains-operated unit consisting of punch-unit, base, motor and tape supply spool. Price **£145.00.** Sound reducing cabinet available at **£25.00**

FACIT 4060 rack-mounting heavy-duty punch 5/8 channel, maximum operating speed 150 cps. Complete with supply and take-up spools, tape low/out sensor and large built-in chad box **£595.00.** Control unit also available.

TALLY P120 panel-mounted perforator. Asynchronous operation up to 120 cps. Integral tape supply and take-up spools. Price **£150.00**

TALLY 420 Rack-mounting perforator. Asynchronous operation up to 60 cps. Integral supply and take-up spools. Complete with Model 5088 transistorised drive package **£495.00**

WELMEC LOW-SPEED PUNCH Magnetically driven up to 17 cps ideal for data logging. Large chad box **£45.00**

WELMEC R82 solenoid-operated mechanical reader. Low cost low-speed reader for speeds up to 17 cps. Compact free-standing unit **£45.00**

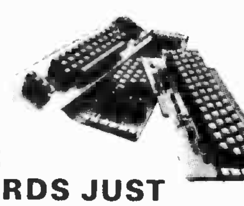
ELLIOTT high-speed photo-electric paper tape readers. 200/250 cps. Compact, table-top unit. From **£145.00.**

MINIATURE MATRIX PROGRAMME BOARDS. X-Y matrix board with 3mm grating. BRAND NEW by Ghielmetti of Switzerland. 20x30 positions (4½" x 3½") **£15.00;** 12x10 (2¾" x 2¼") **£8.00;** 3x10 (1¾" x 1") **£4.00.** P&P 40p. Diode pins available to special order from **40p** each.

MAGNETIC TAPES. Manufacturer's surplus stocks just received. Brand new in original sealed packs ½" x 2,000 ft. **£4** per reel, ¾" x 2,400 ft. **£4.50** per reel. P&P extra.

Keyboards

NEW STOCKS OF CLARE-PENDAR KEYBOARDS JUST RECEIVED . . .



ASCII-Coded TTL-compatible 4-bank alphanumeric reed-switch keyboards with ROM encoder chip, strobed output two-key rollover and debounce. Standard 7-bit ASCII code (no parity). Supplied complete with circuit diagrams and code chart.

SPECIFICATIONS

Power Supply. +5VDC +/−5% 150mA; −12VDC +/−10% 10mA. *Output Logic Levels.* Data Bits 1 through 7. 0v "0" .45V; 2.6v "1" 5.25V *Fan Out* One standard TTL load. *Strobe.* 2.6v "1" 5.25V; 0v "0" .46V *Fan Out* 10 standard TTL loads. Strobe signal delay 10 milliseconds nominal to allow data to stabilise.

KB6: 56-station standard Teletype layout. AS RECOMMENDED FOR PRACTICAL WIRELESS VIDEO-WRITER PROJECT **Price £35.00,** plus £1.00 P&P + 8% VAT

KB7: Similar to KB6 PLUS 8 additional key-stations (standard ASCII 64 character set) PLUS lower-case Alpha facility **Price £42.50,** plus £1.00 P&P + 8% VAT

ALSO AVAILABLE — SPECIAL LOW-COST KEYBOARD

KB5: 3-bank alphanumeric Baudot-coded 36-station keyboard TTL-compatible, strobed output. **Price £20.00,** plus 75p P&P + 8% VAT

Add 8% VAT to all prices shown. Carriage extra details on request.

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1R5	0.50
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1S5	0.35
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1U4	0.70
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2X2	0.70
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3Q4	0.80
3Q5GT	0.70
3S4	0.45
3V4	0.80
4CB6	0.75
5CG8	0.75
5R4GY	1.00
5T4	1.00
5U4G	0.60
5V4G	0.60
5Y3GT	0.55
5Z3	1.00
5Z4G	0.48
5Z4GT	0.55
6/30L2	0.79
6A8G	1.40
6AC7	0.55
6AG5	0.35
6AG7	0.60
6AH6	0.70
6AJ5	0.70
6AJ8	0.35
6AK5	0.45
6AK6	0.70
6AK8	0.40
6AL5	0.17
6AM6	0.50
6AM8A	0.70
6AN8	0.70
6AQ5	0.47
6AQ8	0.43
6AR5	0.80
6AS7	1.00
6AT6	0.50
6AU6	0.40
6AV6	0.50
6AW8A	0.84
6AX4	0.75

6B8G	0.35
6BA6	0.40
6BC8	0.00
6BE6	0.40
6BG6G	1.00
6BH6	0.70
6BJ6	0.65
6BK7A	0.85
6BQ5	0.34
6BQ7A	0.60
6BR7	1.00
6BR8	1.25
6BS7	1.70
6BW6	1.00
6BW7	0.65
6BX6	0.29
6BY7	0.36
6BZ6	0.60
6C4	0.40
6C5G	0.60
6C6	0.45
6C9	2.00
6C10	0.71
6CB6A	0.50
6C12	0.35
6CD6G	1.60
6CG8A	0.90
6CL6	0.75
6CL8A	0.95
6CM7	1.00
6CS6	0.45
6CU5	0.90
6D3	0.75
6DE7	0.90
6DT6A	0.85
6EW6	0.85
6E5	1.00
6F1	0.80
6F6G	0.60
6F12	0.50
6F13	0.90
6F14	0.90
6F15	0.75
6F18	0.60
6F23	0.65
6F24	0.80
6F25	1.00
6F26	0.36
6F28	0.74
6F32	0.70
6G6G	0.60
6GH8A	0.80
6GK5	0.75
6GU7	0.90
6H6GT	0.30
6J5GT	0.50
6J6	0.35
6J7G	0.35
6J7M	0.65
6JU8A	0.90
6K7G	0.35
6K8G	0.50
6K8GT	0.55
6L1	2.50

6L6GC	0.70
6L7(M)	0.60
6L12	0.39
6L18	0.60
6L19	2.00
6LD12	0.40
6LD20	0.80
6N7GT	0.70
6PL12	0.40
6P15	0.34
6Q7G	0.50
6Q7GT	0.50
6Q7M	0.65
6R7G	0.70
6R7(M)	1.00
6SA7	0.55
6SC7GT	0.75
6SG7	0.50
6SH7	0.55
6SJ7	0.60
6SK7GT	0.55
6SQ7	0.60
6U4GT	0.80
6U7G	0.55
6U8	0.50
6V6G	0.30
6V6GT	0.55
6X4	0.45
6X5GT	0.45
6Y6G	0.95
6Y7G	1.25
7A7	1.00
7B6	0.80
7B7	0.80
7D6	2.00
7F8	2.00
7H7	0.80
7R7	2.00
7V7	2.00
7Y4	0.80
7Z4	0.80
8D2	0.50
8D8	0.45
9BW6	0.90
9D7	0.70
10C2	0.70
10D1	0.85
10DE7	0.80
10F1	0.67
10F9	0.65
10F18	0.65
10L14	0.45
10LD11	0.75
10PL12	0.45
10P13	0.80
10P14	2.50
10P18	0.43
12A6	0.65
12AC6	0.80
12AD6	0.80
12AE6	0.80
12AT6	0.45
12AT7	0.34
12AU6	0.50

12AU7	0.34
12AV6	0.60
12AX7	0.34
12AY7	1.00
12BA6	0.50
12BE6	0.55
12BH7	0.55
12BY7	0.85
12E1	3.50
12J5GT	0.40
12J7GT	0.70
12K5	1.50
12K7GT	0.50
12K8	0.75
12Q7GT	0.50
12SA7GT	0.75
12SC7	0.60
12SG7	0.55
12SH7	0.60
12SJ7	0.60
12SK7	0.60
12SN7GT	0.75
12SQ7	0.80
12SQ7GT	0.80
12SR7	0.75
14H7	0.75
14S7	1.00
18	1.25
19AQ5	0.65
19BG6G	1.00
19G6	6.50
19H1	4.00
19Y3	0.40
20D1	0.70
20D4	2.50
20F2	0.85
20L1	1.20
20P1	1.00
20P3	1.00
20P4	0.84
20P5	1.50
25A6G	0.70
25L6G	0.70
25Y5	0.80
25Z4G	0.50
25Z5	0.75
25Z6G	0.80
28D7	2.00
30A5	0.75
30C1	0.40
30C15	0.77
30C17	0.77
30C18	1.00
30F5	0.70
30FL1	1.07
30FL2	1.07
30FL12	1.05
30FL13	0.70
30FL14	1.00
30L1	0.39
30L15	0.75
30L17	0.70
30P4MR	0.98
30P12	0.74

30P19/30P4	0.90
30P16	0.37
30P18	0.50
30PL1	1.00
30PL12	0.40
30PL13	1.29
30PL14	1.29
30PL15	1.00
35A3	0.75
35C5	0.80
35D5	0.90
35L6GT	0.80
35W4	0.55
35Z3	0.90
35Z4GT	0.70
35Z5GT	0.80
42	1.50
50B5	0.95
50C5	0.70
50CD6G	1.20
50EH5	0.85
50L6GT	1.00
72	0.70
77	0.45
85A2	0.75
85A3	0.75
90AG	3.00
90CG	2.80
90CV	2.80
108C1	0.40
150B2	1.00
215SG	0.60
302	1.20
303	1.26
305	1.20
807	1.10
956	0.50
1625	2.50
1821	1.00
5702	1.20
5763	1.65
6057	1.00
6060	1.00
6067	1.00
7193	0.60
7475	1.20
9002	0.55
9006	0.45
A1834	1.00
A2134	3.00
A3042	4.00
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AC2PENDD	1.00
AC6/PEN	0.80
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AC/PEN(7)	1.20
AC/TH1	1.00
AL60	1.20
ARP3	0.60

ATP4	0.50
AZ1	0.50
AZ31	0.60
AZ41	0.50
B36	0.75
B719	0.39
B729	0.79
BL63	2.00
CL33	1.75
CV6	0.60
CV63	1.00
CV988	0.25
CY1C	1.00
CY31	0.70
D1	0.50
D63	0.30
DAC32	0.80
DAF91	0.35
DAF96	0.60
DC90	0.70
DD4	0.80
DF33	0.75
DF91	0.30
DF96	0.60
DH63	0.50
DH76	0.50
DH77	0.50
DH81	0.80
DK32	0.60
DK40	0.70
DK91	0.50
DK92	0.70
DK96	0.70
DL63	0.70
DL82	0.80
DL92	0.45
DL94	0.80
DL96	0.60
DM70	0.80
DM71	1.75
DW4/350	1.15
DY87/6	0.35
DY802	0.45
E80CC	2.50
E80CF	5.00
E80F	2.29
E83F	1.60
E88CC	1.20
E92CC	0.70
E180CC	0.80
E180F	1.15
E182CC	3.00
E188CC	2.50
E280F	5.00
E1148	0.60
EA50	0.40
EA76	1.30
EABC80	0.40
EAC91	0.55
EAF42	0.70
EAF801	0.75
EB34	0.30
EB91	0.17
EBC41	0.75

EBC81	0.45
EBC90	0.50
EBC91	0.50
EBF80	0.40
EBF83	0.45
EBF89	0.40
EBL21	2.00
EC52	1.00
EC53	1.00
EC54	1.00
EC86	0.84
EC88	0.84
EC92	0.55
ECC32	1.00
ECC33	2.00
ECC35	2.00
ECC40	0.90
ECC81	0.34
ECC82	0.34
ECC83	0.34
ECC84	0.35
ECC85	0.39
ECC86	1.25
ECC88	0.51
ECC189	0.80
ECC804	0.79
ECC807	1.40
ECF80	0.50
ECF82	0.50
ECF86	0.80
ECH21	2.00
ECH35	1.00
ECH42	0.71
ECH81	0.35
ECH83	0.50
ECH84	0.50
ECL80	0.45
ECL82	0.40
ECL83	0.74
ECL84	0.65
ECL85	0.70
ECL86	0.45
EF22	1.00
EF40	0.78
EF41	0.75
EF42	0.90
EF73	1.75
EF80	0.29
EF83	1.25
EF85	0.36
EF86	0.45
EF89	0.32
EF91	0.50
EF92	0.50
EF93	0.40
EF94	0.40
EF97	0.90
EF98	0.90
EF183	0.36
EF184	0.36
EF804	1.75
EH90	0.45
EK90	0.40
EL32	0.60

EL34	0.90
EL35	3.00
EL37	3.00
EL41	0.57
EL81	0.65
EL83	0.70
EL84	0.34
EL86	0.60
EL90	0.47
EL95	0.67
EL360	1.80
EL506	1.20
EM80	0.55
EM81	0.60
EM83	0.60
EM84	0.45
EM85	1.20
EM87	1.10
EMM803	2.50
EY51	0.45
EY81	0.45
EY83	0.60
EY84	1.20
EY86/7	0.37
EY88	0.55
EY91	0.50
EZ35	0.45
EZ40	0.52
EZ41	0.52
EZ80	0.32
EZ81	0.32
EZ90	0.45
FC4	1.00
FW4/500	1.80
FW4/800	1.80
GY501	0.85
GZ30	0.48
GZ32	0.60
GZ33	1.80
GZ34	0.75
GZ37	1.10
HABC80	0.80
HL13C	0.60
HL23	0.70
HL23DD	0.68
HL41	1.00
HL41DD	1.00
HL42DD	1.00
HN309	1.70
HVR2	1.00
HVR2A	1.00
KT2	0.90
KT8	3.00
KT41	1.00
KT44	1.00
KT63	0.60
KT66	3.00
KT71	1.00
KT81	2.00
KT88	5.75
KTW61	1.50
KTW62	1.50
KTW63	1.20
L63	0.50
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LN309	0.49
M8162	1.00
MHL4	1.00
MHLD6	0.99
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MU12/14	1.15
N308	0.98
N339	1.25
N379	0.50

P61	0.60
PABC80	0.45
PC86	0.62
PC88	0.62
PC95	0.70
PC97	0.39
PC900	0.40
PCC84	0.39
PCC85	0.47
PCC88	0.61
PCC89	0.49
PCC189	0.52
PCC805	0.75
PCC806	0.70
PCF80	0.40
PCF82	0.45
PCF84	0.70
PCF86	0.57
PCF87	0.77
PCF200	1.00
PCF201	1.00
PCF800	0.77
PCF801	0.60
PCF802	0.54
PCF805	1.00
PCF806	0.53
PCF808	1.00
PCH200	1.00
PCL82	0.40
PCL83	0.49
PCL84	0.46
PCL86	0.54
PCL88	1.29
PCL800	1.00
PCL805/85	0.60
PEN4DD	2.00
PEN25	1.00
PEN45	1.00
PEN45DD	1.80
PEN46	0.60
PEN453DD	2.00
PENA4	1.00
PENDD/4020	1.00
PFL200	0.70
PL33	0.50
PL36	0.60
PL81	0.49
PL81A	0.53
PL82	0.37
PL83	0.45
PL84	0.50
PL302	0.90
PL504/500	0.82
PL505	1.55
PL508	1.00
PL509	1.55
PL801	0.74
PM84	0.75
PY31	0.50
PY33/2	0.50
PY80	0.50
PY81	0.40

PY82	0.40
PY83	0.44
PY88	0.40
PY301	0.30
PY500	1.30
PY500A	1.00
PY800	0.40
PY801	0.40
PZ30	0.50
QP21	1.10
QQV03/10	2.00
QS75/20	4.00
QS95/10	1.00
QS150/15	1.80
QV03/12	1.65
QV06/20	3.50
R11	1.00
R16	2.00
R17	1.00
R18	1.20
R19	0.75
R20	0.60
R52	0.48
RK34	1.00
SP4	1.50
SP13C	0.75
TH/4B	1.00
TH233	1.00
TP2620	1.00
TP22	1.00
TP25	1.00
UABC80	0.45
UAF42	0.70
UBC41	0.50
UBC81	0.55
UBF80	0.50
UBF89	0.39
UBL21	2.00
UC92	0.50
UCC84	0.90
UCC85	0.45
UCF80	0.80
UCH21	2.00
UCH42	0.71
UCH81	0.45
UCL82	0.45
UCL83	0.57
UF41	0.70
UF42	0.80
UF80	0.40
UF85	0.50
UF89	0.45
UL41	0.70
UL84	0.43
UM80	0.60
UR1C	1.00
UU5	0.52
UU9	0.32
UU12	0.32
UY41	0.50
UY42	0.50
UY85	0.35
U10	1.00
U12/14	1.15
U16	1.00

U17	1.00
U18/20	1.80
U19	4.00
U22	0.85
U25	0.71
U26	0.60
U31	0.50
U33	1.75
U35	1.75
U37	2.00
U45	1.20
U47	0.71
U49	0.60
U50	0.55
U52	0.60
U76	0.70
U78	0.45
U81	0.80
U153	0.40
U191	0.50
U192	0.40
U193	0.40
U251	1.00
U281	0.75
U282	0.70
U291	0.50
U301	0.55
U329	1.00
U339	0.50
U381	0.35
U403	0.90
U404	0.75
U709	0.32
U801	0.80
U4020	0.75
VLS492	9.50
VP2	1.50
VP13C	0.60
VP23	0.65
VP41	0.90
VR105	0.50
VT61A	0.75
VU111	1.00
VU120	1.00
VU120A	1.00
VU133	1.00
W76	0.50
W81M	1.20
W107	0.75
W719	0.36
W729	1.20
XE3	0.60
XFY12	0.60
XH15	0.60
XSG15	1.20
X41	1.00
X61	1.00
X63	1.40
X65	1.60
X66	1.00
X76M	0.75
X719	0.35
Z145	0.67
Z152	0.29
Z329	0.70
Z719	0.29

Z729	0.45
Z749	0.65
Z759	5.85

Transistors and Diodes

1N1124A	0.61
1N4744A	0.16
1N4952	0.58
2N404	0.21
2N966	0.61
2N1756	0.58
2N2147	0.98
2N2297	0.26
2N2369	0.16
2N2613	0.45
2N3053	0.38
2N3121	2.90
2N3703	0.23
2N3709	0.23
2N3866	1.16
2N3988	0.58
2S323	0.58
AA119	0.18
AA120	0.18
AA129	0.18
AAZ13	0.21
AC107	0.18
AC113	0.30
AC114	0.47
AC126	0.14
AC127	0.20
AC128	0.23
AC132	0.23
AC154	0.30
AC156	0.23
AC157	0.30
AC165	0.30
AC166	0.30
AC167	0.69
AC168	0.44
AC169	0.38
AC176	0.64
AC177	0.32
ACY17	0.30
ACY18	0.23
ACY19	0.23
ACY20	0.21
ACY21	0.23
ACY22	0.18
ACY28	0.21
AD140	0.42
AD149	0.58
AD161	0.53
AD162	0.53
AF102	1.04
AF106	0.58
AF114	0.30

AF115	0.18
AF117	0.23
AF121	0.35
AF124	0.30
AF125	0.20
AF126	0.21
AF139	0.76
AF178	0.79
AF180	0.56
AF186	0.64
AF239	0.44
ASY27	0.50
ASY28	0.38
ASY29	0.58
BA102	0.53
BA115	0.16
BA116	0.21
BA129	0.14
BA130	0.12
BA153	0.18
BCY10	0.53
BCY12	0.58
BCY33	0.23
BCY34	0.26
BCY38	0.26
BC107	0.14
BC108	0.14
BC109	0.14
BC113	0.30
BC115	0.18
BC116	0.30
BC118	0.26
BF154	0.30
BF158	0.21
BF159	0.30
BF163	0.23
BF173	0.44
BF180	0.35
BF181	0.47
BF185	0.47
BFY50	0.26
BFY51	0.23
BFY52	0.23
BTX34/400	2.31
BY100	0.21
BY101	0.18
BY105	0.21
BY114	0.21
BY126	0.18
BY127	0.21
BYY23	1.16
BYZ10	0.30
BYZ11	0.30
BYZ12	0.30
BYZ13	0.30
BYZ15	2.03
CG12E	0.23

CG64H	0.23
FSY11A	0.26
FSY41A	0.26
GD4	0.38
GD5	0.32
GD6	0.32
GD8	0.23
GD9	0.23
GD11	0.23
GD12	0.23
GD14	0.58
GD15	0.47
GD16	0.23
GET113	0.23
GET118	0.23
GET119	0.30
GET573	0.44
GET587	0.50
GET872	1.11
GET873	0.18
GET882	0.58
GET887	0.26
GET889	0.26
GET896	0.26
GET897	0.26
GET898	0.26
GEX113	0.21
GEX35	0.26
GEX36	0.58
GEX45	0.38
GEX55	0.87
GT3	0.30
M1	0.18
MAT100	0.45
MAT101	0.50
MAT120	0.45
OA9	0.14
OA47	0.12
OA70	0.18
OA73	0.18
OA79	0.11
OA81	0.11
OA85	0.11
OA86	0.23
OA90	0.14
OA91	0.11
OA95	0.11
OA200	0.11
OA202	0.12
OC19	1.48
OC22	0.44
OC23	0.44
OC24	0.44
OC25	0.44
OC28	0.60
OC29	0.73
OC36	0.50

OC38	0.50
OC41	0.58
OC42	0.73
OC43	1.37
OC44	0.12
OC45	0.13
OC46	0.18
OC65	1.31
OC70	0.14
OC71	0.13
OC72	0.13
OC74	0.26
OC75	0.13
OC76	0.18
OC77	0.32
OC78	0.18
OC78D	0.18
OC79	0.47
OC81	0.13
OC81D	0.13
OC82	0.13
OC82D	0.13
OC83	0.23
OC84	0.28
OC123	0.26
OC140	1.11
OC169	0.26
OC172	0.41
OC200	0.55
OC201	0.53
OC202	0.50
OC203	0.35
OC204	0.35
OC205	0.50
OC206	1.05
OC812	0.47
ORP12	0.61
SFT237	0.50
SM1036	0.58
ST1276	0.58
SX1/6	0.21
U14706	0.30
XZ30	0.30
Y543	0.21
Y728	0.21

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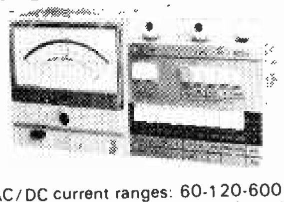
MULTIMETER F4313 *(Made in USSR)*



SENSITIVITY:
1200V DC range: 10,000 Ω/V
Other DC ranges: 20,000 Ω/V
1200 AC range: 6,000 Ω/V
600V AC range: 15,000 Ω/V
300V AC range: 15,000 Ω/V
Other AC ranges: 20,000 Ω/V

AC/DC current ranges: 60-120-600μA-3-12-300mA-1.2-6A
AC/DC voltage ranges: 60-300mV-1.2-6-30-120-300-600-1200V
Resistance ranges: 300Ω-10-100-1000K
Accuracy: 1.5% DC; 2.5% AC (of full scale deflection)

Mirror scale and knife edge pointer. Taut suspension of movement. Transistor amplifier is used for all AC ranges thus achieving a common linear scale for both AC and DC ranges.

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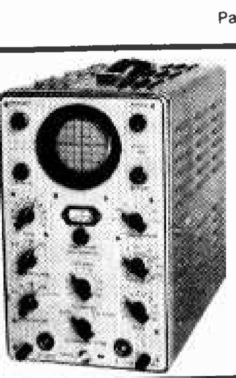
OSCILLOSCOPE CI-5
Made in USSR



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6BZ7	0.70	EBC41	0.75
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6EA8	0.75	EBF83	0.50
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6J6	0.35	ECC40	0.80
6L6GT	0.60	ECC81	0.45
6SL7GT	0.55	ECC82	0.38

ECC83	0.38	EF86	0.40
ECC84	0.35	EF183	0.35
ECC85	0.45	EF184	0.40
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ECC189	0.80	EL41	0.80
ECF80	0.45	EL81	0.60
ECF82	0.45	EL82	0.60
ECF86	0.75	EI83	0.60
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ECH42	0.85	EL95	0.70
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ECH83	0.50	EM80	0.55
ECH84	0.50	EM81	0.60
ECL80	0.40	EM84	0.40
ECL81	0.75	EY51	0.45
ECL82	0.42	EY51	0.45
ECL83	0.75	EY87	0.50
ECL84	0.60	EY88	0.50
ECL85	0.65	EZ40	0.60
ECL86	0.55	EZ41	0.75
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PCC85	0.45	PY82	0.45
PCC88	0.65	PY88	0.50
PCC89	0.55	PY500A	1.10
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PCF82	0.40	TT22	5.90
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PCF200	0.80	UAF42	0.70
PCF201	0.85	UBC41	0.50
PCF801	0.55	UBC81	0.50
PCF802	0.55	UBF80	0.50
PCH200	0.75	UBF89	0.50
PCL81	0.55	UCC84	0.75
PCL82	0.40	UCC85	0.50
PCL83	0.70	UCF80	0.75
PCL84	0.50	UCH42	0.80
PCL85	0.60	UCH81	0.50
PCL86	0.60	UCL82	0.40
PCL200	0.75	UCL83	0.70
PD500	1.70	UF41	0.75
PFL200	0.70	UF42	0.75
PL35	0.40	UF80	0.40
PL36	0.60	UF85	0.50
PL38	0.65	UF89	0.50
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PL82	0.50	UL84	0.50
PL83	0.50	UY41	0.55
PL84	0.50	UY42	0.55
PL95	0.70	UY82	0.60
PL504	0.90	UY85	0.50

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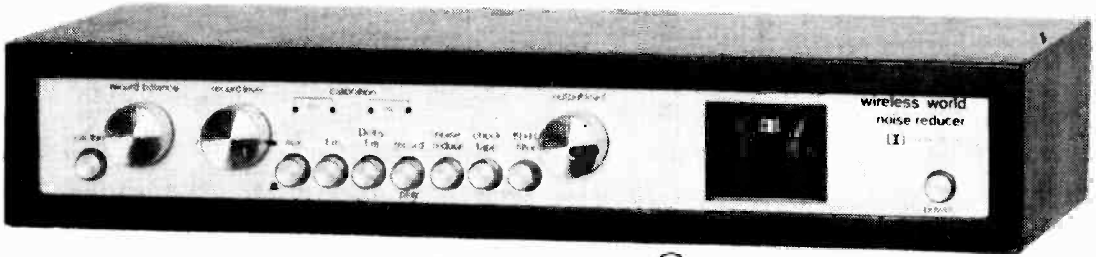

Wireless World Dolby(TM) noise reducer

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We are proud to announce the latest addition to our range of matching high fidelity units.

Featuring:

- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter
- provision for decoding Dolby f.m. radio transmissions (as in USA)
- no equipment needed for alignment
- suitability for both open-reel and cassette tape machines
- check tape switch for encoded monitoring in three-head machines

The kit includes:

—complete set of components for stereo processor
—regulated power supply components
—board-mounted DIN sockets and push-button switches
—fibreglass board designed for minimum wiring
—solid mahogany cabinet, chassis, twin meters, front panel, knobs, mounting screws and nuts

Typical performance

Noise reduction: better than 9dB weighted

Clipping level: 16.5dB above Dolby level (measured at 1% third harmonic content)

Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%.

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output.

Dynamic Range > 90dB

30mV sensitivity.

PRICE: £37.90 + VAT

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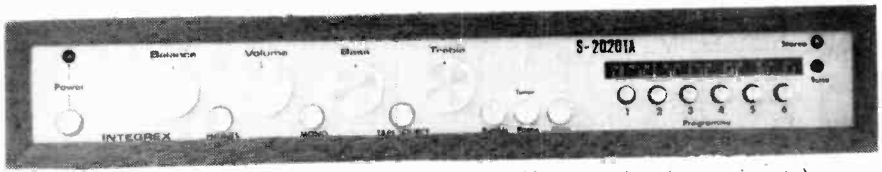
S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET



A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

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: £53.95+VAT

NELSON-JONES STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.

Brief Spec. Tuning range 88—104MHz. 20dB mono quieting @ 0.75μV. Image rejection — 70dB. IF rejection—85dB. THD typically 0.4%
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price

Mono £29.15+VAT
With ICPL Decoder £33.42+VAT
With Portus-Haywood Decoder £35.95+VAT

STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the Mullard LP1186 RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC

Sens. 30dB S/N mono @ 1.8μV
THD typically 0.4%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

PRICE: Mono £26.85+VAT
Stereo £29.95+VAT

S-2020A AMPLIFIER KIT

Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring

Type Spec. 24+24W r.m.s into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

PRICE: £31.95+VAT

ALL THE ABOVE KITS ARE SUPPLIED COMPLETE WITH ALL METALWORK, SOCKETS, FUSES, NUTS AND BOLTS, KNOBS, FRONT PANELS, SOLID MAHOGANY CABINETS AND COMPREHENSIVE INSTRUCTIONS

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CD4001	0.16	CD4029	1.16	CD4054	1.20	CD4093	0.89
CD4002	0.16	CD4030	0.56	CD4055	1.37	CD4094	1.94
CD4006	1.22	CD4031	2.24	CD4056	1.37	CD4095	1.09
CD4007	0.17	CD4032	1.11	CD4057	27.95	CD4096	1.09
CD4008	0.95	CD4033	1.45	CD4059	4.96	CD4097	3.87
CD4009	0.56	CD4034	1.98	CD4060	1.16	CD4099	1.90
CD4010	0.56	CD4035	1.22	CD4062	9.07	CD4502	1.29
CD4011	0.17	CD4036	3.18	CD4063	1.14	CD4510	1.41
CD4012	0.17	CD4037	0.99	CD4066	0.64	CD4511	1.62
CD4013	0.58	CD4038	1.22	CD4067	3.87	CD4514	2.85
CD4014	1.05	CD4039	3.09	CD4068	0.22	CD4515	3.25
CD4015	1.05	CD4040	1.11	CD4069	0.22	CD4516	1.41
CD4016	0.55	CD4041	0.87	CD4070	0.60	CD4518	1.30
CD4017	0.99	CD4042	0.87	CD4071	0.22	CD4520	1.30
CD4018	0.99	CD4043	1.05	CD4072	0.22	CD4527	1.64
CD4019	0.56	CD4044	0.97	CD4073	0.22	CD4532	1.50
CD4020	1.16	CD4045	1.45	CD4075	0.22	CD4555	0.94
CD4021	1.05	CD4046	1.39	CD4076	1.61	CD4556	0.94
CD4022	1.00	CD4047	0.94	CD4077	0.60	MC14528	1.18
CD4023	0.17	CD4048	0.58	CD4078	0.22	MC14552	8.05
CD4024	0.81	CD4049	0.55	CD4081	0.22	MC14553	5.24
CD4025	0.17	CD4050	0.55	CD4082	0.22	IM6508	8.05

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751238D	2.15

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75492	1.22
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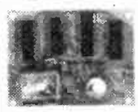
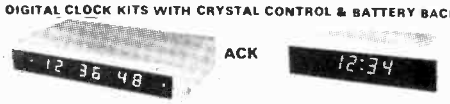
KITS



50Hz CRYSTAL TIMEBASE KIT: provides an extremely stable output of one pulse every 20msec. Uses ● May be added to all types of digital clocks to improve accuracy, to within a few seconds a month ● If used with battery back-up also makes clocks power-out or switch-off proof ● Replacing 50 Hz signal on battery-powered equipment ● Providing film synchronisation ● Monitoring or improving turntable speed. Order as "XTK" **£6.28**

DIGITAL CLOCK KITS WITH CRYSTAL CONTROL & BATTERY BACK-UP



These two kits incorporate our Crystal Timebase Kit (XTK), together with components for battery back-up. All components, plus a PP3-type battery, fit neatly in the clock cases. Accurate to within a few seconds a month. If mains power is disconnected (through a power cut, accidental switching off or moving clock) the clocks will still keep perfect time. While on back-up, the displays are off to conserve battery life.

ATTRACTIVE 6-DIGIT ALARM CLOCK: Uses Red 0.5" displays. Features bleep alarm, "Touch switch" snooze control and automatic intensity control. Alarm remains fully operational while clock is on back-up. Complete kit including case
Order as "ACK + XTK + BBK" **£33.58**
Kit also available less crystal control and back-up. Order as "ACK" **£26.80**

SLIM GREEN CLOCK. Attractive 4-digit Mantelpiece Clock with bright 0.5" Green display
Complete kit including case. Order as "GCK + XTK + GBBK" **£19.65**
Kit also available less crystal control and back-up. Order as "GCK" **£12.90**

microprocessors

Please. Microprocessors should only be bought by experienced constructors. Sorry, we cannot answer technical queries or supply data other than from our selection below

MPU'S

IM6100CCDL	£58.00	6820	£17.67
8080A (2 uS)	£43.65	6850	£17.67
6800	£33.87	8224	£9.76
ISPA/100 (SC/MP)	£18.75	8228	£12.16
2650	£27.00	8251	£17.67
		8255	£17.67

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These include main IC's, PCB, Manuals and Data

MEK680001 — with the 6800 MPU	£137.00
ISP8K/200E — SC/MP Intro Kit	£93.55
MCS-80 Kit C — with 8080A (no PCB)	£176.65

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New 1976 RCA CMOS and Linear IC Combined Databook	£4.95
New 1976 RCA "Power and Microwave" Databook	£4.95
1976 National Semiconductor 7400 series TTL Databook, c. 200 pages	£3.45
TTL Pin-Out Card Index. Set of cards with pin-outs (top and bottom views) of T.I. TTL range and many other T.I. IC's	£2.95
Intel Memory Design Handbook, c. 280 pages	£4.75
Intel 8080 Microcomputer Systems Users' Manual, c. 220 pages	£4.85
Motorola McMOS Databook (Vol. 5, Series A) c. 500 pages	£2.77
Motorola M6800 Microprocessor Applications Manual, c. 650 pages	£12.45

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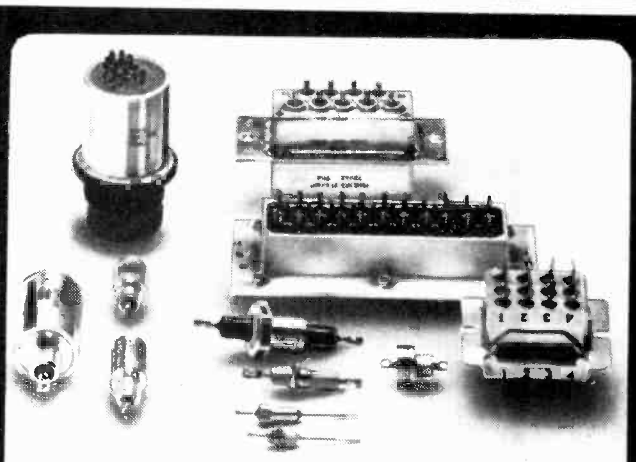

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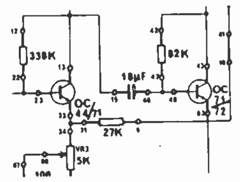
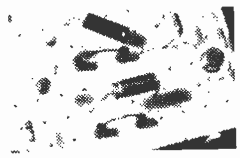
SINE WAVE OSCILLATOR



FROM THIS

S-DeC

MAKE THIS



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NEW Premises + NEW Staff = NEW Super Service

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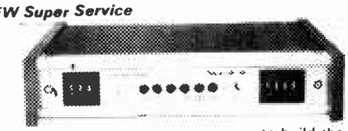

Our kit contains all the printed circuit boards and components necessary to build the complete decoder. The power supply and video switching circuitry are normally installed within the television cabinet and the main decoding control and memory circuitry in a separate cabinet positioned on top of the television. **PRICES ARE AS FOLLOWS:**

Set of 5 PCBs (incl. PSU & Video Switching)	**£16.00+VAT=£18.00**
Component Kit (incl. PCBs)	**£96.02+VAT=£104.10**
Add-on Unit for Lower Case: PCB only	**£2.00+VAT=£2.25**
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Cabinet	**£12.00+VAT=£13.50**

Post & Pkg.—PCBs are post free but add £1 for component kit and 50p for cabinet

Components are also available separately with Special Prices for Semiconductor kits. SAE for price list

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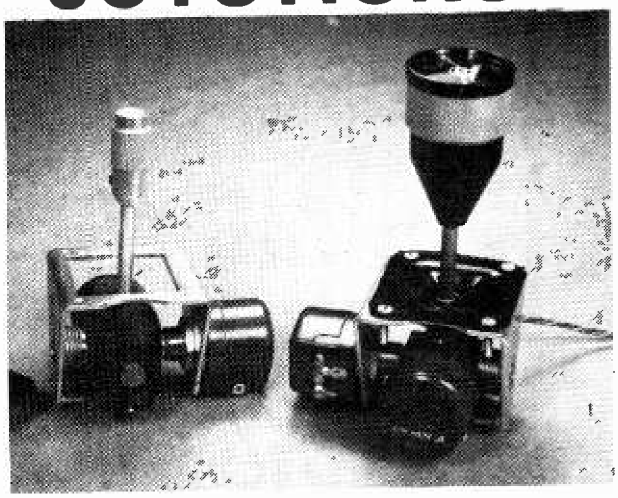
JOYSTICKS



Precise, reliable, long-life Joystick Control Units, in single, dual or triple axis forms. Sprung to centre, or held by adjustable friction locks. Choice of wirewound, cermet or plastic film potentiometers (all standard 3/8" bush types) — or rotary switches.

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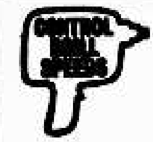


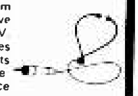
DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum Full power at all speeds by finger-tip control Kit includes all parts, case everything and full instructions **£3.45** including post & VAT Made up model **£1.00** extra

NUMICATOR TUBES

For digital instruments counters timers clocks, etc Hi-vac XNII Price **£1.25** each inc Post and VAT

RADIO STETHOSCOPE



Easiest way to fault find traces-signal from aerial to speaker when signal stops you ve found the fault Use it on Radio TV amplifier anything Complete kit comprises two special transistors and all parts including probe tube and crystal earpiece **£2.95** twin stetho-set instead of earpiece inc VAT & Postage

MAINS TRANSISTOR PACK

Designed to operate transistor sets and amplifiers Adjustable output 6v . 9v . 12 volts for up to 500mA (class B working) Takes the place of any of the following batteries PP1, PP3 PP4 PP6 PP7 PP9 and others Kit comprises main transformer rectifier, smoothing and load resistor condensers and instructions Real snip at only **£1 90** including Post & VAT

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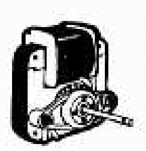
With six 10 amp changeover switches adjustable over 360 switches are rated at 10 amp each so a total of 2000w s can be controlled and this would provide a magnificent display for mains operating **£4.25** Post & VAT paid Ditto 9 switch **£4.95** Post & VAT paid
Ditto but 12 switch **£4.75** Post & VAT paid

MAINS MOTOR

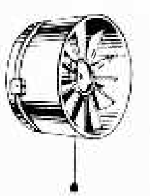


Precision made — as used in record decks and tape recorders — ideal also for extractor fans blower heaters etc New and perfect Snip at **95p** + VAT & Postage 35p
1" stackmotor **£1.50** + VAT & Postage 35p 1½" stackmotor **£2** + VAT & Postage 40p

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions All parts and instructions to make **£3.75** plus post and VAT

EXTRACTOR FAN



Cleans the air at the rate of 10 000 cubic feet per hour Suitable for kitchens bathrooms factories changing rooms, etc It s so quiet it can hardly be heard Compact 5½" casing comprises motor fan blades sheet-steel casing pull switch mains connector and fixing brackets **£5.25** including post & VAT
Monthly list available free send long stamped envelope

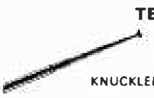
28 R.P.M. GEARED MAINS MOTOR

This is a substantial motor (1" stack induction type) quite powerful definately large enough to drive a rotating display or a tumbler for polishing stones etc Approximate overall size 4" x 3¼" x 2½" these are ex-unused equipment carrying our normal ex-equipment guarantees
PRICE **£2.95** POST & VAT PAID

GLAMORISE YOUR ROCKS

The way to make rock samples stamps etc really show themselves off is to light them by means of our miniature UV tube This is only 6w s so the electricity costs are negligible Complete kit comprises UV tube and its 2 mounting holders control choke and starter
Total price **£3.75** POST & VAT PAID

TELESCOPIC AERIALS

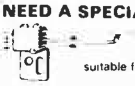


for portable, car radio or transmitter. Chrome plated— six sections, extends from 7½ to 47in. **50p** + 15p Post & VAT
KNUCKLED MODEL FOR F.M. **80p** + 17p Post & VAT

SPEED CONTROLLED 9V MOTOR

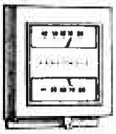
This is a motor with a governor 9v operation intended for record players and tape recorders These are reversible and electro magnetically and acoustically screened Size approx 1½" diameter by 1" deep with good length spindle Japanese made portable replacement in a good many popular cassette and record players
PRICE **95p** inc POST & VAT

NEED A SPECIAL SWITCH



Double Leaf Contact Very slight pressure closes both contacts **12p** each Plastic pushrod suitable for operating **10p** each 10 for **68p**.

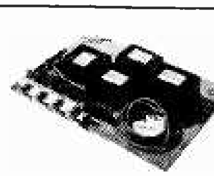
THERMOSTAT WITH THERMOMETER



Made by Honeywell for normal air temperatures 40-80 F (5-25 C) This is a precision instrument with a differential which can be adjusted to better than 1 5 F A mercury switch breaks on temp rise Elegantly styled and encased in an ivory plastic case with clear plastic windows thermometer above and switch setting scale below — size approx 3 8"x3 2"x1 4" deep — can be mounted on conduit box or directly on wall Price **£2.25** plus 50p Post & VAT

SPECIAL PRICES THIS MONTH

MULLARD UNILEX



A mains operated 4 + 4 stereo system Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one In easy-to-assemble modular form and complete with a pair of Hi-Fi speakers this should sell at about £30 — but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£14.00** including VAT and postage

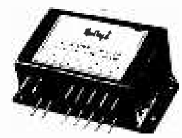
GPO PUSH-BUTTON DIALLING UNIT

Will take the place of the normal rotating dial, has 10 numbered keys so suitable for other digital systems A desk mounting unit with rubber feet this is a very intricate and expensive piece of apparatus New and unused — our price only £9 each including post and VAT

TWIN OUTPUT POWER PACKS

These have two separately R C smoothed outputs so can operate two battery radios on a stereo amp without cross mudulation (they will of course operate one radio/tape/cassette/calculator, in fact any battery appliance and will save their cost in a few months) Specs Full wave rectification, double insulated mains transformer — total enclosed in a hard P V C case — three core mains lead-terminal output — when ordering please state output voltage 4½v 6v 7½v, 9v, 12v or 24v Price **£3.95**. Post and VAT included

MULLARD THYRISTOR TRIGGER MODULE



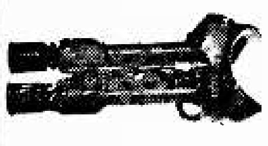
This produces pulses for phase control triggering, it has two isolated outputs, so one thyristor or two thyristor (in separate arms of bridge) may be controlled by one module. The timing circuit is synchronised to the mains frequency and control is by an external variable resistor or from a voltage or current source Provision is made for feed-back where automatic control is required Price **£5.95**.

THIS MONTH'S SNIP

250 WATT TRANSFORMER

Heavy duty power transformer which can be used for many purposes Rated at 250 watts it is very well built with frames for upright mounting and is varnish impregnated Its primary is for 230/240 volts 50 cycles, it has four secondaries each 10v very high current windings Just a few of the circuits it can power are 10-0-10v at up to 12 amps, 20-0-20v at up to 6 amps single 10v at 25 amps single 20v at 12½ amps, single 30v at 9 amps, single 40v at 6 5 amps The transformer can be used for power circuits (charging etc) or for amplifiers there being an earth screen between primary and secondaries A transformer like this today would cost at least £15 from the makers however we are making a special offer at **£4.50** + 36p post £1 + 8p each Grab some while you can our stock may not last long

INFRA RED BINOCULARS



Made for military purposes during and immediately after the last war to enable snipers vehicle drivers etc to see in the dark The binoculars have to be fed from a high voltage source (5KV approx) and providing the objects are in the rays of an infra red beam then the binoculars will enable these objects to be seen Each binocular eye tube contains a complete optical lens system as well as the infra red cell technical data on which is available The binoculars are unused believed to be in good order In fact they were never issued and are still in original cases but since they were made a long time ago they can hardly be called new Sold without guarantee Price **£17.50** per set

SMITHS CENTRAL HEATING CONTROLLER

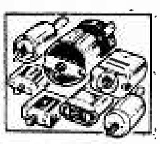
push-button gives 10 variations as follows (1) continuous hot water and continuous central heating (2) continuous hot water but central heating off at night (3) continuous hot water but central heating on only for 2 periods during the day (4) hot water and central heating both on but day time only (5) hot water all day but central heating only for 2 periods during the day time (6) hot water and central heating on for 2 periods during the day time only — then for summer time use with central heating off (7) hot water continuous (8) hot water day time only (9) hot water twice daily (10) everything off

A handsome looking unit with 24-hour movement and the switches and other parts necessary to select the desired programme of heating Supplied complete with wiring diagram Originally sold we believe at over £15 — we offer these while stocks last at **£7.50** each including VAT & Postage

SHORTWAVE CRYSTAL SET

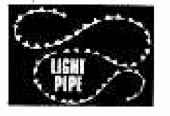
Although this uses no battery it gives really amazing results You will receive an amazing assortment of stations over the 19 25 31 29 metre bands — Kit contains chassis front panel and all the parts **£1.50** — crystal earphones **55p** including VAT & Postage

ONLY £1.50 FOR SEVEN ELECTRIC MOTORS



7 powerful batt motors as used in racing cars and power models Output and types vary for use in hundreds of projects — Tools, toys, models, etc All brand new reversible and for 1½ 12v batts Wiring diag inc VAT & post paid

LIGHT PIPE



A mains operated travelling light array 24ft long it uses 130 miniature bulbs which flash in sequence to make bands of light move along the tube — The tube can be draped around a particular item or set and cannot fail to attract attention — complete kit consists of — 24ft of translucent tubing — 140 min lamps — 8 yds multicore cable — motorised switch — taps for quick connections and full wiring instructions
£15.00 FOR COMPLETE KIT POST AND VAT PAID

INSTANT START FLUORESCENT LIGHTING BARGAINS

Starterless control gear complete with tube ends and tube clips for window lighting signs fascias etc 4ft 40w **£1.90**; 5ft 65w **£2.00**; 5ft 80w **£2.20**; 6ft 80w **£2.45**; and for pairs as follows — twin 2ft 20w **£2.55**; twin 3ft 30w **£3.55**; twin 4ft 40w **£3.25**; twin 5ft 65w **£3.25**; twin 5ft 80w **£3.95**; twin 8ft 125w **£5.75**. These are about one half of maker s current prices and can t be repeated once stocks are cleared Please add 30p per peice to cover postage or carriage and 8% VAT

SALE LIST FREE SEND SAE

SWITCH TRIGGER MATS

So thin is undetectable under carpet but will switch on with slight pressure For burglar alarms shop doors, etc
24in x 18in **£2.33**, post & VAT 30p 13in x 10in **£1.85**, post & VAT 25p

MAINS TRANSFORMERS

All standard 230-250 volt primaries

		£ p
1v	1 amp (special)	2.33
2.4v	5 amp	1.05
6.3v	2 amp	1.57
6.3v	3 amp	2.19
9v	1 amp	1.19
9v	3 5 amp	3.13
12v	1½ amp	1.85
12v	1 amp	1.25
6.5v-0.6 5v	1 amp	1.85
18v	1 amp	1.85
24v	2 amp	2.82
24v	3 amp	4.75
12.0-12v	50mA	1.56
6.0-6v	50mA	1.56
8 0-8v	½ amp	1.85
25v	1½ amps	2.44
50v . . . 2 amp & 6.3v	1 amp	5.63
60v . . . 5 amp & 5v	1 amp	9.35
27v	8 amp	5.63
30v	37 amp	27.50
80v tapped 75v & 70v	4 amp	6.87
250v-60mA & 6.3v	1 5 amps	2.19
275-0 275v at 90mA & 6.4v	3 amps	2.82
EHT Transformer 5000v 23mA	(intermittent)	6.87
Charger Transformers		
6v and 12v	2 amps	1.87
6v and 12v	3 amps	2.82
6v and 12v	5 amps	4.25

Add 30p per £1 to cover postage and VAT

MULTI-SPEED MOTOR

Six speeds are available 500 850 and 1 100 r p m and 8 000 12 000 and 15 500 r p m Shaft is ¼in diameter and approximately 1in long 230/240v Its speed may be further controlled with the use of our Thyristor controller Very powerful and useful motor size approx 2in dia x 5in long Price **£2.00** including post & VAT
SPEED CONTROL SWITCH **50p** + 4

SPIT MOTOR WITH CARTER GEARBOX

Probably one of the best spit motors made Originally intended to be used in very high priced cookers however this can be put to plenty of other uses, for instance your garden barbecue or to drive a colour disc for a dance or display or to drive a tumbler for stone polishing in fact there is no end to its uses Normal mains operation **£3.25** including post & VAT

SOUND TO LIGHT UNIT

Add colour or white light to your amplifier Will operate 1 2 or 3 lamps (maximum 450W) Unit in box all ready to work **£7.95** plus **95p** VAT & Postage

SMITHS 24-HR. TIMER HEART

Really the 'Autoset' without its plastic case This is a 24-hr twice on, twice off, clock switch which will repeat until re-programmed Switches rated at 15 amps Limited supplies—**£4.45** including VAT & post

PRESSURE SWITCH

Containing a 15 amp change over switch operated by a diaphragm which in turn is operated by air pressure through a small metal tube. The operating pressure is adjustable but is set to operate in approx. 10in. of water. These are quite low pressure devices and can in fact be operated simply by blowing into the inlet tube. Original use was for washing machine to turn off water when tube had reached correct level but no doubt has many other applications. £1.95 including post & VAT.

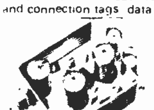
DC HIGH CURRENT PANEL METERS

3½" wound wide angle 240 movement meters, flush mounting fitted with external shunts made by Crompton Parkinson, brand new still in maker s cartons These are a real bargain at **£6.00** each including post & VAT Reasonable quantities available in the following ranges 0-10 amps 0-20 amps 0 30 amps 0-40 amps 0-50 amps

PP3/PP9 BATTERY ELIMINATOR

Made in Japan for Bush Radio This is very neat little transformer driven full wave unit totally enclosed with input mains and output leads This power supply unit which was originally marketed by Bush at over £6 is offered as this months snip
PRICE **£2.75** INCLUDING POST & VAT

MULLARD AUDIO AMPLIFIERS



all in module form each ready built complete with heat sinks and connection tags data supplied
Model 1153 500mW power output **£1.50** including post & VAT
Model 1172 1w power output **£1.85** including post & VAT
Model EP9000 4 watt power output **£2.90** including post & VAT
EP9001 twin channel or stereo pre amp **£2.90** including post & VAT

Terms: When order under £5 please add 40p to offset handling and packing charges. Cash with order except Institutions and Public Companies.

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KINNIE COMPONENTS
10 NELMES WAY, HORNCHURCH, ESSEX RM11 202
HORNCHURCH 45167

CIRCUIT BOARD
P.C.B. 1/16 1 oz. COPPER.

FORMICA
Dim. 8.4 x 7.7 in 3 pcs. **80p.**
Dim. 9.4 x 8.1 in 3 pcs **90p.**
Dim. 10.1 x 7.9 in 3 pcs. **£1.00.**
Dim. 13.1 x 9.4 in 3 pcs. **£1.20.**
Dim. 17.0 x 9.0 in 2 pcs. **£1.20.**
P.P. 35p on each pack.

BARGAIN PACK
10 pcs. 10.1 x 7.9 in. (Formica) plus free ½lb etching Xtals. **£3.30.**

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Dim. 6 x 6 in. **55p** each.
Dim. 12 x 6 in. **85p** each. P.P 15p
Dim. 12 x 12 in. **£1.40** each

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ETCH RESIST PENS (55p. P.P. 5p).

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10.1 x 7.9 in. **70p** ea. (Formica).
6 x 6 in. **75p** ea. (Fibre glass).

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Etch resist use with any pen. Much cheaper than ready loaded pens. 50 c.c., **55p**, p.p. 10p.

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1lb—1 litre pack, **70p**, p.p. 35p.
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PRINTED CIRCUIT KIT
The no-frills-all-value kit containing 4 pcs 8 x 7 Formica laminate. 1 pce 6 x 6 Fibre glass laminate. 1 lb Etching Crystals. 50 c.c. Resist ink with instructions. **£2.40**, p.p. 65p.

BARGAIN PACK FIBRE GLASS P.C.B.
200 sq in all usable pieces. **£1.40.**

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1 Spacing
Vero size, etc. Can be cut to any length. **65p**, p.p. 10p. Side guides to suit above, **15p** each.

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Geared tuning. AFC. 88/108 MHz. A.M. gangs fitted. Full circuit diagram and conn. details supplied. **£3.50**, p.p. 25p.

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500μa 1½ x 1½ clear plastic panel type, **£1.30.**

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125-0-125μa Edgewise, 1½ x ½, **£1.10.**

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250μa illuminated edgewise 1½ x ½, **£1.10.**

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500 micro-amp (level-stereo beacon, etc.), scaled half black/half red. Size 1 x 1 in, **65p**, p.p. 15p.

3 GANG TUNING CAPACITOR
8 5pf to 320pf, **80p**, p.p. 20p.

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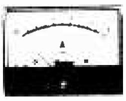
445-LQU-901B (25KHz spacing), **£4.00**, p.p. 20p.

V.H.F./U.H.F. POWER TRANSISTORS
(Type BLY 38), 3 watt output at 100-500 Mhz, **£2.25**, p.p. 10p.

PANEL METERS



2⅜ in x 1⅞ S8 500mA
S1 50μA S9 1 Amp
S2 100μA S10 50v a.c.
S3 500μA S11 300v a.c.
S4 1mA S12 50/0/50μA
S5 10mA S13 100/0/100μA
S6 50mA S14 500/0/500μA
S7 100mA All at **£3.75**, p.p. 15p.

PANEL METERS
4½ in x 3¼ L3 200μA
L1 50μA L4 500μA
L2 100μA — All at **£5**, p.p. 15p.

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4 digit (non reset) 24v or 48v, 4 x 1 x 1in, **£1**, p p. 20p
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RESET COUNTER (BRAND NEW)
6 digit 24v 25 I.P.S . **£4**, p p. 25p.

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Resistors/Capacitors 600 new components, **£2.75**, p.p. 40p.
Trial order 100 pcs, **75p**, p.p 20p.

HIGH CAPACITY ELECTROLYTICS

250mfd/63 volt	**20p**	p.p. 8p
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2,200mfd/100 volt	**90p**	p.p. 25p
4,700mfd/25 volt	**65p**	p.p. 20p
6,800mfd/16 volt	**50p**	p.p. 15p
10,000mfd/25 volt	**75p**	p.p. 25p
25,000mfd/40 volt	**£1.25**	p.p. 30p
47,000mfd/40 volt	**£2.00**	p.p. 50p
100,000mfd/10 volt	**£1.50**	p.p. 50p
160,000mfd/10 volt	**£2.00**	p.p. 50p

BULK COMPONENTS OFFER
Resistors/Capacitors 600 new components, **£2.75**, p.p. 36p.
Trial order 100 pcs, **75p**, p.p. 20p.

SMITHS GEARED MOTORS 240V AC

3 rev. per min.	**£1.50**	p.p. 25p
4 rev. per min.	**£1.50**	p.p. 25p
6 rev. per min.	**£1.50**	p.p. 25p
2 rev. per hr.	**£1.50**	p.p. 25p
6 rev. per hr.	**£1.50**	p.p. 25p

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SIEMANS MINIATURE RELAYS
6v. 4 c/o, **65p.** 24v. 2 c/o, **50p.** 24v. 4 c/o, **65p.** p.p. 5p.

MINIATURE RELAYS
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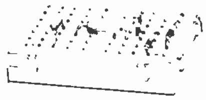
MAINS RELAY 240V A.C.
3 c/o 10 amp. contacts, **80p** with base, p.p 20p.

MINIATURE REED RELAY
(1 x ¼), 12v. 1 c/o, **50p**, p.p. 10p.

S-DECS AND T-DECS



S-DEC **£1.90**
U-DEC A, **£4.20**
T-DEC, **£3.60**
U-DEC B, **£6.90**

S.C.R. - THYRISTORS
1 amp 400 P.I.V., **35p**
5 amp 400 P.I.V , **40p**

POWER UNIT 20V D.C.
500 MA rectified and smoothed by 1250 Mfd. cap and OC25 Trans. circuit, **£2.50**, p.p 55p.

POWER UNIT OUTPUT 17½V RECTIFIED. UNSMOOTHED. £2.00, p.p. 50p.

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Panel mounting 800 M/A 1 8 amp. 10 amp **55p** ea.

H.D. ALARM BELLS
6in. Dome 6/8v. d.c. Heavy cast housing for exterior/interior use **£3.75**, p.p. £1.

1,000 TYPE KEY SWITCHES
Single 2 x 6 make locking centre off, **60p**, p.p. 10p
BANK of 4-2 x 4 c/o ea. switch (one bias **£1.30**, p.p 25p

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H.T. TRANSFORMERS. Prim. 110/240v. Sec. 400v. 100 M/A. **£3**, p.p. 65p.
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MAINS MOTOR

Type used in quality record decks and tape recorders suitable for extractor fans, heaters, etc.
⅞" stack, **85p.** 1" stack, **£1.25.** p.p. on both 30p.

MAINS MOTOR (EX-EQUIP.)
24 pole as used in quality tape equipment 1360 r.p.m., size 3¾ x 3¾ x 3½, **£2.25**, p.p 50p.

MULTICORE CABLE
6-core (6 colours) 14/0076 Screened P.V.C. **30p** per yard 100. yds. at **£16.50**, p p 2p a yard. 7-core (7 colours), 7/22 mm Screened P.V.C. **30p** per yard; 100 yards **£16.50.** P.P. 4p per yard.

MAIL ORDER ONLY : CALLERS BY APPOINTMENT

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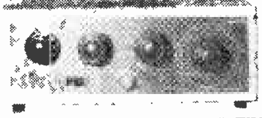
WORKSHOP TEST EQUIPMENT
Designed by Mr. J. L. Linsley Hood

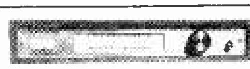
1. AUDIO OSCILLATOR
Simple design. Very low distortion.
10HZ-100KHZ. Sine/Square output



Kit Form **£16.50**
Made and tested **£20** Tax 8% (pp £1)

His famous 30-75 watt
HI-FI AMPLIFIER £65 (tax 12½%)
Distortion is below normal measurement.
Available in pack form or made up units

P.L.L. F.M. STEREO TUNER
Requires no adjustments. **Kit £40** (Tax 12½%)



We can also supply REG P S.V 0 60v, 0-1A £18 00 Tax 8% F M SIG/GEN Wobbulator £12. T H D Analyser £18 50 MVMT £15 25, Blomley & Bailey Amps
Detailed leaflets available Send 1 cap s a e

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The following modules currently being described in Wireless World, are offered. Each kit comprises of glass fibre PCBs and Components Each module functions independently, but a universal system may be constructed by means of a master switch into which the boards may be plugged.

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BI-PAK SEMICONDUCTORS

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
R4.	50 Mixed 100K ohms — 820K ohms ⅛th W	0.60
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
R8.	30 Mixed 100K ohms — 820K ohms ½ W	0.60

These are unbeatable prices.

LOW COST CAPACITORS

500	µF	50V	Elect	0.09 each
01	µF	400V		0.03 each

REPANCO CHOKES & COILS

RF Chokes	CH1	2.5mH	0.27
	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

CARBON POTENTIOMETERS
Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC 1	Single Less Switch	0.20
VC 2	Single D.P. Switch	0.40
VC 3	Tandem Less Switch	0.60
VC 4	1K Lin Less Switch	0.20
VC 5	100K Log anti-Log	0.60

HORIZONTAL CARBON PRESETS
0.1 Watt 0.09 each
100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M, 4.7M.

REPANCO TRANSFORMERS *
240V. Primary. Secondary voltages available from selected tappings 4V, 7V, 8V, 10V, 40V, 50V and 25V-0-25V.

Type	Amps	Price	P&P
MT50/½	½	£3.00	0.45
MT50/1	1	£4.00	0.48
MT50/2	2	£5.00	0.60

COIL FORMERS & CORES
NORMAN ¼" Cores & Formers 0.07p
⅜" Cores & Formers 0.09p

SWITCHES
DP/DT Toggle 0.28p
SP/ST Toggle 0.22p

FUSES
20mm, 100mA, 200mA, 250mA, 500mA, 1A, 1.5A, 2A QUICK BLOW *0.05p each
Anti-surge 20mm only *0.8p each

VEROBOARDS*
VB 1
containing approx. 30sq. ins. various sizes all 0.1 matrix *0.60p
VB2
containing approx 30sq. ins. various sizes all 0.15 matrix *60p

ELECTROLYTIC PAKS

Containing a range of miniature electrolytic capacitors assorted into the following values:
E1 18 mixed 0.47uf—10uf 60p
E2 18 mixed 10uf—100uf 60p
E3 18 mixed 100uf—680uf 60p

V.A.T.

ALL PRICES EXCLUDE V.A.T.

Please add 8% to all prices marked *. Remainder add 12½%. Do NOT add V.A.T. to prices marked †.

INSTRUMENT CASES

In two sections, vinyl covered top, sides and bezel, in black or blue.

No.	Length	Width	Height	Price
BV1	8"	x 5¼"	x 2"	*£1.25
BV2	11"	x 6"	x 3"	*£1.62
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

COMPONENT PAKS

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
C20		Sheets Copper Laminate. approx. 200 sq. ins.	*.60

Please add 20p post and packing on all component packs, plus a further 10p on pack nos. C1, C2, C19 & C20.

AVDEL BOND

SOLVE THOSE STICKY PROBLEMS!
with

CYANOACRYLATE G2 ADHESIVE
The wonder bond which works, in seconds. Bonds plastic, rubber, transistors, components, permanently, immediately!

OUR PRICE ONLY 70p *
for 2 gm phial

CABLES

			Per Metre
CP	1	Single lapped screen	*0.08
CP	2	Twin Common Screen	*0.11
CP	3	Stereo Screened	*0.12
CP	4	Four Core Common Screen	*0.21
CP	5	Four Core individually screened	*0.28
CP	6	Microphone Fully Braided Cable	*0.11
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

P&P

Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.00

ANTEX EQUIPMENT

SOLDERING IRONS

X25. 25 watt	*£2.95
Model G. 18 watt	*£3.25
CCN 240. 15 watt	*£3.25
SK2.Soldering Kit	*£4.60

BITS AND ELEMENTS*

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

ELEMENTS*

Model ECN	*£1.25
Model EG 240	*£1.60
Model ECCN 240	*£1.60
Model EX 25	*£1.40

SOLDERING IRON STAND

ST3 Suitable for all models	*£1.25
Antex heat shunt	*12p

PLUGS

			PRICE
PS	1	D.I.N. 2 Pin (Speaker)	0.10
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
PS	43	Phono Single	0.07
PS	44	Phono Double	0.09
PS	46	Co-Axial Surface	0.09
PS	47	Co-Axial Flush	0.19

P.C.B. KITS & PENS

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

Spare container of etchant for above, complete with instructions *70p

P.C.B. MARKING PENS

2 x quality market pens, specifically designed for drawing fine etchant resistant circuits on copper laminate. Complete with full instructions *£1.53 per pair

SLIDER PAK

Containing a range of slider pots.

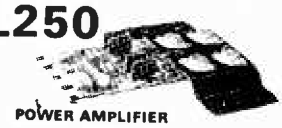
SP1	6	mixed values sliders	0.60
SP2	6	470R Lin. sliders	0.60
SP3	6	10K Lin. slider	0.60
SP4	6	22K Lin. sliders	0.60
SP5	6	47K Log. sliders	0.60
SP6	6	47K Lin. sliders	0.60

LOW-NOISE CASSETTES

C60	*33p
C90	*44p
C120	*56p

IT'S NEW—IT'S POWERFUL! IT'S THE AL250

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.

The unit is intended for use in many applications such as disco units, sound reinforcement systems, background music players, etc.

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: 0.1%
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

ONLY £15.95 + 8% VAT

BIB HI-FI ACCESSORIES

REF		PRICE
'D'	2 Hi-Fi Cable & Flex Tidy	*34p
'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
33	Splicing Tape	*38p
36A	Record & Stylus Cleaning Kit	*32p
41	8 Track Cartridge Head Carrier	88p
Model 42	Groov-Kleen	*£1.84
42/S	Roller & Brush for REF 42 & 2000	*24p
43	Record Care Kit	*£2.76
45	Auto Changer Groov-Kleen	98p
46	Spirit level	*72p
48	Record Dust-off	*26p
52A	Cassette Tray	*54p
53	Hi-Fi Stereo Test Cassette	*£2.40
56	Hi-Fi Hints & Tips Book	*48p
Model 60	Groov-Kleen	*£1.72
160/S	Replacement Brush Velvet Pad and Base Sticker for Model 60	*24p
62	Cassette Head Cleaner (Liquid)	48p
71	Record 'Dust Off' (Displays of ten)	*66p
71A	Record 'Dust Off' (Bubble Pack)	*70p
75	Indexa Record	*£1.50
76	Stylus Cleaner	*36p
78	Cassette Fast Hand Winder	*98p
83	Cassette Title & Container Labels (20 & 10)	*36p

AUDIO LEADS

S221	5 pin DIN plug to 4 phono plugs length 1.5m	£1.08
S222	5pin DIN plug to 5 pin DIN socket length 1.5m	.68p
S237	5 pin DIN plug to 5 pin DIN plug mirror image length 1.5m	£1.20
S238	2 pin DIN plug to 2 pin DIN socket length 5m	.68p
S268	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 length 1.5m	£1.00
S270	2 pin DIN plug to 2 pin DIN socket length 10m	.80p
S271	5 pin DIN plug to 2 phone plugs connected to pins 3 & 5 length 1.5m	.70p
S275	5 pin DIN plug to 2 phono sockets connected to pins 3 & 5 length 23cm	.68p
S318	5 pin DIN socket to 2 phono plugs connected to pin 3 & 5 length 23cm	.68p
S404	Coiled stereo headphones extension cord extends to 7m	£1.40
S217	3 pin DIN plug to 3 pin DIN plug length 1.5m	.80p
S219	5 pin DIN plug to 5 pin DIN plug length 1.5m	.80p
S474	3.5mm Jack to 3.5mm Jack length 1.5m	.68p
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

CERAMIC PAKS

Containing a range of miniature ceramic capacitors in mixed values, unrepeatable value.

MC1 24 ceramic capacitors: 22pF, 27pF, 33pF, 39pF, 47pF, 56pF, 68pF, and 82pF 0.60
MC2 24 ceramic capacitors: 100pF, 120pF, 150pF, 180pF, 220pF, 270pF, 330pF, and 390pF 0.60
MC3 24 ceramic capacitors: 470pF, 560pF, 680pF, 830pF, 1000pF, 1500pF, 2200pF, and 3300pF . 0.60
MC4 21 ceramic capacitors: 4700pF, 6800pF, 01µF, .015µF, .022µF, .033µF and .047µF 0.60

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APPROX. 200 PIECES

Assorted fall-out integrated circuits, including: Logic, 74 series, Linear, Audio and D.T.L. Many coded devices but some unmarked — you to identify.
OUR SPECIAL PRICE £1.00

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High quality modules for stereo, mono and other audio equipment.

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PUSH-BUTTON STEREO FM TUNER

OUR PRICE ONLY

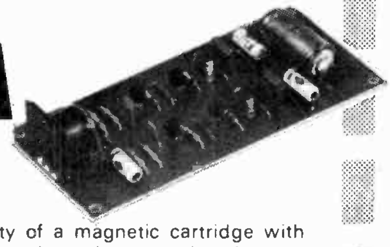
£19.95 **Fitted with Phase Lock-loop Decoder**

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 **T538.**
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.

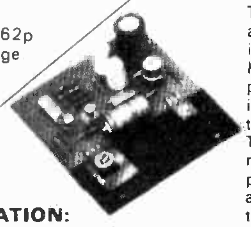
Frequency Response + 1dB 20Hz 20KHz Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

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.

AL-20-30 AUDIO AMPLIFIER MODULES



The 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 5 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**

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 AL 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 **AL20/30, 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

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ADVANCE
V.H.F. Square wave Generator SG21 10 KHz-100MHz. Max. o/p 2V **£35**

AIRMEC
Signal Generator Type 701 30 KHz-30 MHz (2 only) **£95.00**

GENERAL RADIO
Unit Oscillator 1209C. Freq. 250-920MHz. Accuracy 1% Drift. 0.2%. O/pin to 50ohms=150mW supplied with Power Supply Type 1201—CQ as illustrated **£215**
Unit Oscillator 1218A. 900-2000MHz. Power output of 200mW across band **£140**

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F.M./A.M. Signal Generator 202H. F.M. A.M. C.W. & pulse coverage 54 to 216 MHz R.F. o/p 0.1μV-0.2V 50ohms Impedance **£450**
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S.H.F. Signal Generator 618C 2.8-7.6GHz ±1% 50ohms **£550**
U.H.F. Signal Generator 616A 1.8-4.2GHz **£475**

MARCONI INSTS.
F.M./A.M. Signal Generator TF 995A/3S. Ministry type No. CT402 1.5MHz-220MHz. R.F. o/p 2μV-200mV. Internal & External Mod. Facilities. V. good condition **£385**
F.M./A.M. Signal Generator TF 995A/5 1.5-220MHz in 5 bands. 0.1μV-200mV. F.M. up to ±120KHz from 50Hz-15KHz. A.M. up to 50% from 100Hz-10KHz o/p (1) 2μV-200mV (2) with terminating unit 1μV-100mV. Int. mod. freqs 400Hz. 1KHz & 1.5KHz. Distortion (1) on internal F.M. ±25Hz. (2) on internal A.M. 6% at 30% mod **£300 to £450**
A.M. Signal Generator TF801D/1. Freq. range 10-470MHz. R.F. output 0.1μ-1V. Piston attenuator. 50ohms Impedance. Modulation Int. A.M. 1KHz. Ext A.M. 30Hz-20KHz. Low spurious F.M. & drift V.S.W.R. 1.2 or less **£400-£800**
A.M. Signal Generator TF801D/1S Military Version 10-485MHz **£450-£800**
R.C. Oscillator TF1370A 10Hz-10MHz. Square Wave up to 100KHz High Outputs up to 31.6V **£285**
Phase/A.M. Signal Generator TF 2003 0.4-12MHz **£150**
A.M. Signal Generator TF 801B/3S 12.485MHz 0.1μV-1V **£195**
R.C. Oscillator TF1101 Frequency range 20HZ-200KHz. Output. Direct into 600Ω0-20V 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**
U.H.F. & S.H.F. Signal Generator TF1058 1600-4000MHz. 0.1μV-445mV. 50ohms. Impedance **£295**
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Portable Receiver Tester TF888/3 Freq. 70kHz-70MHz Xtal check. 500kHz & 5MHz Output V.H.F. TF1064B/5M **£300**
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L.F. Decade Oscillator D880A 2 phase. 0.01Hz-11.2KHz **£295**
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VHF Signal Generator MS4/U. Freq. Range 9.6MHz to 230MHz. Turret Osc. for each band. Accuracy 1.2% o/p 30mV-1μV. Freq. Dev. 1KHz-100KHz. Amp. Mod. 0-100% **£175.00**

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HEWLETT PACKARD
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Single Channel 1 & 6" per hour
500μA Movement **£65.00**
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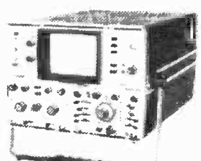

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Sampling Scope 661 c/w plug ins **£450**
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Ex Computer. Load regulation of 1% or better. Low ripple, fast response time. 220/240V I/P
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ICL Power Supplies (ex-computer)
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Contact Resistance Bridge AC 6000. Range 0-99 ohms ±2% Freq. 1KHz **£90**

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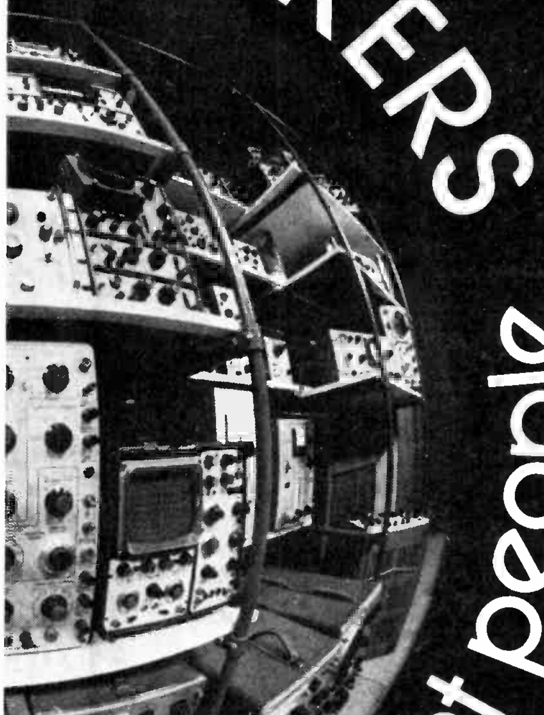

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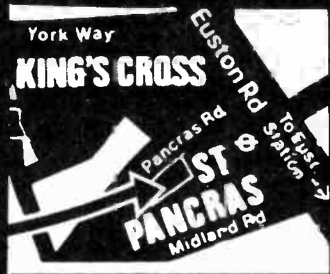

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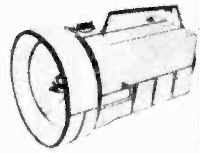

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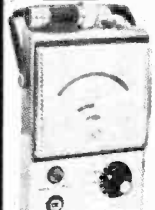

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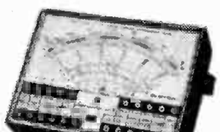

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7443	140p	74163	104p
7444	140p	74164	120p
7445	140p	74166	126p
7446	140p	74173	160p
7447	75p	74174	120p
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16A400V	Plastic		180p
16A600V	Plastic		220p
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C106D	4A/400V	Plastic	63p
★MCR101	0.5A/15V	TO-92	25p
2N3525	5A/400V	TO-66	99p
2N4444	8A/600V	Plastic	185p
★2N5060	0.8A/30V	TO-92	34p
★2N5062	0.8A/100V	TO-92	37p
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AC127	18p	BFY52	16p	★2N3702	12p
AC128	16p	★BU105	140p	★2N3703	12p
AC141	18p	BU108	250p	★2N3704	12p
AC142	18p	★MJE340	45p	★2N3705	12p
AC176	18p	MJ2955	110p	★2N3706	12p
AC187	18p	MJE2955	120p	★2N3707	12p
AC187K	25p	MJE3055	65p	★2N3708	12p
AC188	18p	★MPS6534	25p	★2N3709	12p
AC188K	25p	★MPSA06	30p	2N3773	250p
AD149	49p	★MPSA12	50p	2N3866	90p
AD161	36p	★MPSA56	32p	★2N3903	18p
AD162	36p	★MPSU06	62p	★2N3904	16p
AF114	20p	★MPSU56	78p	★2N3905	20p
AF115	20p	OC28	90p	★2N3906	16p
AF116	20p	OC35	90p	★2N4058	15p
AF117	20p	OC36	90p	★2N4059	10p
AF127	25p	★OC71	20p	★2N4060	13p
AF139	43p	★TIP29A	40p	★2N4123	22p
AF239	48p	★TIP29C	55p	★2N4124	22p
BC107/B	9p	TIP30A	48p	★2N4125	22p
BC108/B	9p	★TIP30C	60p	★2N4126	22p
BC109	10p	TIP31A	52p	★2N4289	20p
BC109C	12p	TIP31C	52p	2N4347	130p
★BC117	22p	TIP32A	58p	2N4348	160p
★BC147	9p	TIP32C	82p	★2N4401	27p
★BC148	9p	TIP33A	90p	★2N4403	27p
★BC149C	10p	TIP33C	115p	★2N5089	27p
★BC157	11p	TIP34A	115p	2N5296	60p
★BC158	10p	TIP34C	160p	★2N5401	50p
★BC159	11p	TIP35A	225p	2N6034	160p
★BC169C	12p	TIP35C	290p	2N6107	70p
★BC172	11p	TIP36A	270p	2N6247	190p
BC177	18p	TIP36C	340p	(Comp to 2N3055)	
BC178	17p	TIP41A	65p	40360	40p
BC179	18p	TIP41B	70p	40361	43p
★BC182	10p	TIP41C	70p	40362	45p
★BC183	10p	TIP42A	70p	40364	120p
★BC184	11p	TIP42B	76p	40409	65p
BC187	30p	TIP42C	82p	40410	65p
★BC212	11p	TIP2955	70p	40411	225p
★BC213	10p	★TIS93	30p	40594	81p
★BC214	14p	★ZTX108	10p	40595	92p
BC478	30p	★ZTX300	13p		
BCY70	18p	★ZTX500	15p		
BCY71	22p	★ZTX502	18p	FETs	
BD124	90p	2N457A	190p	★BF244	25p
BD131	36p	2N697	22p	★MPF102	40p
BD132	40p	2N698	30p	★MPF103	40p
★BD135	43p	2N706	20p	★MPF104	40p
★BD136	43p	2N708	20p	★MPF105	40p
★BD139	63p	2N918	40p	★2N3819	22p
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BDY20	100p	2N1131	18p	2N3823	57p
BDY56	160p	2N1132	18p	★2N5457	40p
BF115	22p	2N1304	36p	★2N5458	40p
BF167	23p	2N1305	36p	★2N5459	40p
BF170	23p	2N1306	40p		
BF173	25p	2N1307	40p		
BF177	26p	2N1308	40p		
BF178	28p	2N1309	40p		
BF179	33p	2N1613	25p	MOSFETs	
BF180	33p	2N1711	25p	3N128	85p
BF184	22p	2N1893	30p	3N140	85p
★BF194	10p	2N2219	20p	3N141	85p
★BF195	9p	2N2222	20p	3N187	180p
★BF196	14p	2N2369	14p	3N202	120p
★BF197	15p	2N2484	30p	40603	58p
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BF257	32p	2N2905/A	25p		
BF258	36p	2N2906/A	24p		
★BFR39	30p	★2N2926R	7p		
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★BFR88	30p	★2N2926G	9p	2N2646	45p
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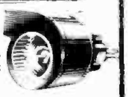

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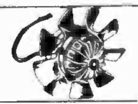

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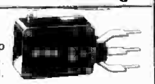

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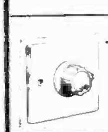

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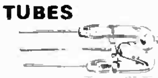

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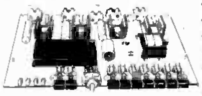
SQUAD LIGHT



A new conception in light control. Four channels each capable of handling 750 watts of spotlights, floodlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free.
Price only **£60.00**
Post 75p. S.A.E. (Foolscap) for further details.

TRIAC

Raytheon Tag symmetrical Triac Type TAG 250 500V 10 amp 500 p.i.v. Glass passivated plastic triac. Swiss precision product for long term reliability **£1.25.** Post 10p (inclusive of Date and application sheet). Suitable Diac **18p.**

COLOUR WHEEL PROJECTOR TYPE P150 INTACHANGE

200/240V a.c. 50Hz 150W lamp, complete with oil filled colour wheel and motor plate. Takes intachange accessories and full range of lenses. **£29.95.** Post £1.35. (Total inc. VAT & Post, **£33.70).**

INSULATION TESTERS (NEW)

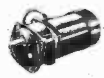
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L 8 in. W 4 in. H 6 in., weight 6 lb.
500 VOLTS 500 megohms **£40.00**
Post 80p
1000 VOLTS 1000 megohms **£46.00**
Post 80p

VAT VAT AT 8% MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED

ACCOUNT CUSTOMERS MIN. ORDER £10.00

GEARED MOTORS

100 R.P.M. 115 lbs. ins.!!



115 lb. ins., 110 volt, 50Hz, 2.8 amp. single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle Dia. 15.5mm. Length 145mm. ex-equipment tested **£12.00.** Post £1.50. Suitable transformer 230/240 volt **£8.00.** Post 75p.

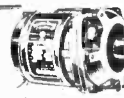
15 R.P.M.

Type SD48 15 r.p.m. 80 lb. ins. Input 100/120 volt A.C. Length incl. gearbox 270mm. Height 135mm. Width 150mm. Shaft drive 16mm. Weight 8.5 Kilos. BRAND NEW. Price **£10.00,** carr. £1.00. Suitable transformer for use on 220/240 volt A.C. **£3.85.** Post 50p.

60 R.P.M. REVERSIBLE

220/240 volt A.C. Small, powerful, continuously rated motor. Mfg. BERGER (Germany). Size 80mm x 65mm x 65mm. Spindle dia. 6mm. Length 15mm. Weight 725 grams. **£6.50.** Post 50p.

BODINE TYPE N.C.I. GEARED MOTOR



(Type 1) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 38 amp. **(Type 2) 28 r.p.m.** torque 20 lb. in. **Reversible** 1/80th h.p. 50 cycle .28 amp. The above two precision made U.S.A. motors are offered in as new conkvn. Input voltage of motor 115v **A.C.** Supplied complete with transformer for **230/240v A.C. input.**
Price, either type **£6.25.** Post 75p or less transformer **£3.75.** Post 65p

(Type 3) 71 r.p.m. 230 Volt A.C.
Continuously rated. Non reversible. £6.50 Post 75p

6/9 VOLT D.C. GOVERNED

40mm x 40mm. Spindle 10mm. Dia. 2 mm. **£1.00** Post Paid. Two for **£1.65** Post Paid

24 R.P.M.

230 volt A.C. Continuously rated. Mfg. Mycalex. Ex equip. Fully tested **£3.85** Post 75p

1 R.P.M. 230/240 VOLT A.C. SYNCHRONOUS!!

Ex-equipment. Thoroughly tested and guaranteed. **ONLY £1.50** Post 20p.

20 r.p.m. GEARED MOTOR

230/240 volt 20 r.p.m. motor **£1.00.** Post 20p

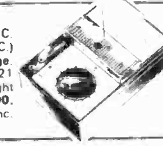
REVERSIBLE MOTOR 230V A.C.

General Electric 230v A.C. 1,600 r.p.m. 0.25 amp. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm x 95mm. Spindle 5/16" dia. 20mm long. Ex-equipment tested **£3.00.** Post 50p

METERS NEW 90mm Diameter

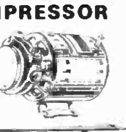
Type: 65CS D.C. M/C 2. 5. 10. 20. 50 amp. **£2.75.** Post 20p. 100 amp **£3.25.** Post 20p
Type: 62T2 A.C. M/I 1. 20. 50 amp. **£2.50** Post 20p. 0-300 Volt A.C. M/I **£2.75** and 300 Volt A.C. R/M/C **£3.00** Post 30p

WHY PAY MORE?!



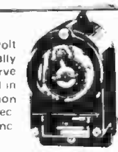
MULTI RANGE METER. A.C. volts 2.5-500 D.C. volts 2.5-500 (Sensitivity 2000Ω/V D.C. & A.C.) D.C. current 0/1/10/100 mA. Ohms range. Sturdy compact moving coil instrument with 21 ranges, dimensions 120 x 80 x 44mm. Weight 0.32 kg. SERVICE TRADING CO. Price **£5.00.** Incl. leads and battery. Post 50p (Total price inc. VAT & Post **£5.94).**

ROTARY VACUUM AIR COMPRESSOR AND PUMP



Carbon vane, oil-less 100/115V A.C. 1/12 h.p. motor 50/60 cycle 2875/3450 r.p.m. 20" vacuum 1.25 c.f.m. 10 p.s.i. (approx figures). New unused surplus stock with elect. connection data. Fraction of maker's price. **£12.00.** Post £1.00. Suitable transformer **£3.50.** Post 50p.

TIME SWITCH



Horstmann Type V Mk II Time Switch. 200/250 volt A.C. Two on/two off every 24 hours, at any manually pre-set time. 30 amp contacts. 36 hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case with glass observation window. Built to highest Electricity Board spec. Individually tested. Price **£7.75.** Post 50p (Total inc. VAT £8.91)

A.C. MAINS TIMER UNIT

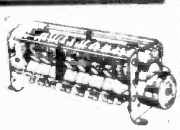
Based on an electric clock with 25 amp. single-pole switch, which can be preset for any period up to 12 hrs ahead to switch on for any length of time, from 10 mins to 6 hrs then switch off. An additional 60 min audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets etc. Attractive satin copper finish. Size 135 mm x 130 mm x 60 mm. Price **£2.25.** Post 40p. (Total inc. VAT & Post **£2.87).**

POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated

25 WATT 10, 25, 100, 150, 250, 500, 1k, 1.5k ohm **£1.90.** Post 20p **50 WATT** 1, 5, 10, 25, 50, 100, 500, 1k ohm **£2.40.** Post 25p **100 WATT** 1/10/25/50/100/250/500/1k/1.5k/2.5k/5k ohm **£3.70.** Post 35p
Black Silver Skirted knob calibrated in Nos. 1-9 1½ in. dia brass bush. Ideal for above Rheostats. **22p ea.**

PROGRAMME TIMERS



230 Volt AC Operation. 15 or 20 r.p.m. Each cam operates a c/o micro switch. Ideal for lighting effects, displays, etc. Ex equip tested. Similar to illustration.
9 CAM model **£5.00**
9 CAM model **£6.50**
12 CAM model **£7.50**
Post 60p. Also available for 50 volt A.C. operation. Prices as above

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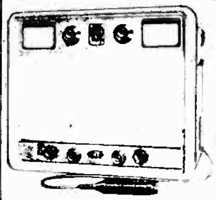


MARCONI TF 867 SIGNAL GENERATOR
Range: 15KHz to 30MHz Output 0 4μV to 4V at 13 or 75 ohms Impedance with termination (supplied). Built in crystal check facility with handbook. **£138** including carriage.

HEWLETT-PACKARD
AUDIO GENERATOR MODEL 206-A. Freq. 20c to 20 000c matching impedance 50, 150, 600 ohms Price **£85.00** carriage £4 00
OSCILLOSCOPES 175A with 1750A dual trace vertically plug-in and 1781B delay time base plug-in 50MHz mini-meter band switch at 50 Mv/CM Modes of operation Single, mixed, delaying Full spec and price on application.

DIVERSITY SWITCH TYPE MA168B. Solid state **£45.00.**
REDIFON SSB TRANSMITTER/RECEIVER TYPE GR410. Full particulars and price on request.
SOLOTRON REGULATED PSU MODEL SRS 152. 0.170v DC to 200mA, 160-340v 330-500v and AC 6.3v 5 amp **£35.00.** Carriage £5 00

RACAL RECEIVERS MODELS. RA17, in fully working and tuned condition Prices on application **RA98A ADAPTOR £85.00.**
RACAL FREQUENCY COUNTER SA 550. Measures freq up to 100MHz also period and time **£135.00** carriage £4 00
524B FREQUENCY COUNTER. Measures basically to 10MHz. Display on neon lamp 8 decibels P O A

PHILIPS AUDIO GENERATOR TYPE GM 2308. 0-16kc/s Attenuator 0 0001 0 0003, 0 001 to 1 with output asym & sum and matching impedance 5 250 600 & 1,000 ohms Price **£120.00** carriage £4 00
FERRANTI SWEEP GENERATOR LF Mk 2. 0-2 to 20 c p s Band sweep 1 5 10 15MHz Carrier freq 10-220MHz **£55.00** carriage £5.00

BOONTON AM/FM SIGNAL GENERATOR. TYPE 202E & 202H. 54-216MHz in 2 ranges **£275.00.**
SIGNAL GENERATOR TS. 497/URS 2-5Mz, 13MHz, 30MHz, 78MHz, 180MHz, 400MHz 0 1v-1uv **£150** carriage £3.00.

Open Monday to Friday 9-12.30, 1.30-5.30 p.m.

BRUEL & KJOER RANDOM NOISE GENERATOR TYPE 1402. Freq resp 20-20,000 c/s, time constant 0 5, 1 5, 5, 15 sec. Matching imped 6, 60, 600 6,000 ohms and attenuator 0 04, 0 12, 0 4, 1 2, 4, 4 000 output level 1 to 10 Price **£155.00** carriage £3 00
TRIGGERED VACUUM SPARK GAP TYPE ZR 7512. Capable of switching 15,000 joules at 45KV **£50.00** carriage £2 00
LOW RESISTANCE HEADPHONES TYPE CLR £2.50. 40p postage VAT 25%
CINTEL TYPE 1873 SQUARE WAVE & PULSE GENERATOR. Freq 5c/s to 250KHz Pulse 0 5 μsec 0 3 μ3 Output to 50v for 1000Ω & to 5v for 100Ω P O A
RADIOMETER TYPE MS111 SIGNAL GENERATOR. High quality Danish production. 10KHz-110MHz **£200** carriage £5 00
CT480 SIGNAL GENERATOR. 7 KMC/S to 12 KMC/S mod C W, F M Pulse **£160** carriage £5 00
AVO NOISE GENERATOR CT 410 **£30** carriage £2 00
BRIDGE IMPEDANCE No 5. 0.1Ω-10MΩ, 1pF-1μF, 1μH-1H **£85** carriage £4 00
EDISWAN STABILIZED POWER UNITS. To 100v 50MA Type R1280 to 300v-150MA and 300v-75mA
TEKTRONIX OSCILLOSCOPES 535, 545 & 545A. With plug in units CA (33MHz double beam) G(20MHz differential 50mV-20v) and D (high gain differential 1MV-50v)
Price on application

TECHNICAL MATERIAL CORP EXCITER/TRANSMITTER MODE SELECTOR. Freq 2-32MHz M D and 10 crystal positions Vernier tuning USB LSB var carrier insertion etc **£200** carriage £10.00
FSK EXCITER. Freq 1-6 5MHz 0-100Hz continued frequency shift up to 600Hz switched freq correction Modes FAX, FS, MSC, CW **£50.00** carriage £5 00
AMPLIFIER UNIT TYPE 1430. Dynatron Production Pulse amplifier with control "Differential" and "Integration" time constant 0 08μs to 8μs Attenuation to 20db P O A
PULSE ANALIZER. Made by Dynatron with discriminator all meter reads, channel width threshold level P O A

RHODE & SCHWARZ. Z-g DIAGRAPH TYPE ZDU 30-420MHz 50Ω Directly measures multiterminal net works phrase shift phrase angle with complimentary POWER SIGNAL GENERATOR TYPE SMLM high freq resolution, internal external mod up to 3v out **£750.**
FREQUENCY SYNTHESIZER TYPE XUA. 30Hz-30MHz with FREQUENCY INDICATOR TYPE FKM 15-30MHz, 30-100MHz **£1,000.**

SIGNAL GENERATOR NO 16. 8cm-11cm **£85** carriage 4 00
SIGNAL GENERATOR NO 13. 20MHz-80MHz AM, FM CW 1 μv-1v **£65** carriage £4 00
KAHN SSB ADAPTOR TYPE RSSB — 62 — 18. Designed for receivers with 455-500KHz IF at 100mV (max) input Features electronic AFC carrier freq diversity to combat fading 20 sce R C memory to maintain tuning during severe fading Individual carrier meters nuvishers, IOW distortion production demodulator **£65** carriage £5 00
TF 801B/2. Spec as for 801D but minor circuit differences Few only left **£120** carriage £5 00

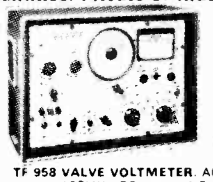
BEST PRICES PAID FOR TEST AND COMMUNICATION EQUIPMENT. Single items or quantities. Private or Industrial.

TF 801D/1/S SIGNAL GENERATOR. Range 10-485MHz in 5 ranges R F output 0 1 μV-1V. Source C M Dial calibrated in volts decibels and power relative to thermal noise. Piston type attenuator 50Ω output impedance Internal modulation at 1KHz at up to 90% depth also external sine and pulse modulation Built in 5MHz crystal calibrator Separate RF and mod meters P O A.
TF 1066 SIGNAL GENERATOR. Freq 10-470MHz with attenuator EMF from 50Ω square. —6dB Price on application
TF 1060 SIGNAL GENERATOR 450MHz to 1200MHz with attenuator Output for 0 1 μV to 4V CW Int A M & Ext Pulse **£200.00** carriage £5 00
TF 1041 B VALVE MULTIMETER. General purpose measuring DC voltage from 300mV to 1,000V AC voltage from 300mV to 300V at up to 1,000MHz and resistance up to 500Mohms Price **£65** carriage £3 00
TF 1370 R.C. OSCILLATOR FOR SQUARE & SINE WAVE. Freq —31 6V rms 10Hz-1MHz square wave 0-73 2pp, 10Hz-100KHz Attenuator range —50db to + 10db, impedance 75, 100, 600Ω **£145** carriage £5 00
EMI OSCILLOSCOPE WM8 AC/DC to 15 mc/s. Time base 0 15Msec-15Msec **£40** carriage £5 00
HR 23 TRIPLE DIVERSITY SSB RECEIVERS. Freq 3-275MHz V F O at 6 Xtal positions Reception of independent single or double side band transceivers Full spec on application **£350** carriage £35 00
TF 885A/1 VIDEO OSCILLATOR. 0-30KHz, 5MHz 1Mv-31 6v **£85** carriage £4 00
TF 934 DEVIATION METER. 250MHz **£55** carriage £3 00
TF 1400S DOUBLE PULSE GENERATOR WITH TM 6600 SECONDARY PULSE UNIT for testing radad nucleonics scopes, counters filters, etc **£175** carriage £5 00

500/250 MEDIUM WAVE BROADCAST TRANSMITTERS. Export only Price and details on application

VAT FOR TEST EQUIPMENT
8% PLEASE ADD **8%**

PLEASE SEND STAMP WITH ENQUIRIES



TF 995A/1 or A/2 or A/2M or A5 SIGNAL GENERATORS. Very high class AM/FM 1 5MHz to 220MHz Detailed spec and price on application

TF 958 VALVE VOLTMETER. AC voltage 1 5-150v at up to 100MHz DC voltage 1 5-150v **£25** carriage £1.00.

PLEASE NOTE
Unless offered as "as seen"
ALL EQUIPMENT
ordered from us is completely overhauled mechanically and electrically in our own laboratories

SOLOTRON CD 1220 OSCILLOSCOPE
With plug-in units up to 40MHz single beam or 20MHz double beam **£175.00** plus £6.00 carriage
SOLOTRON DIGITAL VOLTMETERS
LM 14202 2-2.5μv±1000v in 6 ranges. Accuracy 0 05% of range i e ±1 digit, sensitivity 2 5μv per digit **£320.**
LM 1426 25mV-1000V in 6 ranges. Acc range 1 in 0.02% **£170.**
Also available
CD 1420 £170.
CD 1440.2 £220.

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RF METERS. 0.8 amp 2¼" (USA) brand new **£1.50** P&P 25p
TELEPHONE TYPE "J" tropicalised
10 LINE MAGNETO SWITCHBOARDS
50 LINE AUTOMATIC PRIVATE TELEPHONE SWITCHBOARDS
CABLE LAYING APPARATUS No 11. New Production P O A

FOR EXPORT ONLY
RCA ET 4336 TRANSMITTERS
Also modified version of increased output to 700W
COLLINS TYPE 2310 4/5KW TRANSMITTER
10 channel, Autotone and manual tuning
C13 TRANSMITTERS 38.62 TRANSCEIVERS
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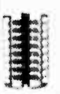
Build & test circuits as fast as you think!

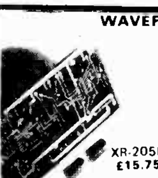
PB100	10 IC cap breadboard kit. 4.5 x 6.0 x 1.3"	£17.45
PB101	10 14-DIP cap. 5-way post. 940 solderless tie points, 5.8 x 4 5"	£26.15
PB102	12 14-DIP cap. like PB101 with 1,240 tie points, 7 0 x 4.5"	£34.90
PB103	24 14-DIP cap. 4 5 way posts, 2,250 tie points, 6 0 x 9.0"	£52.35
PB104	32 14-DIP cap, 3,060 solderless tie points 8.0 x 9 76"	£58.50



LOGIC MONITOR
Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size LM-1 **£55.00**

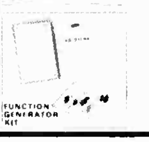
PROTO-CLIP
For power on/hands off signal tracing Bring IC leads up from PC board surface for fast trouble shooting
PC14 14 pin **£3.25**
PC16 16-pin **£3.40**

WAVEFORM GENERATOR KITS

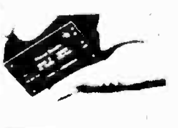


Here's a highly versatile instrument at a fraction of the cost of conventional unit. It includes two XR205 IC's data & applications PC board (etched & drilled ready for assembly) and detailed instructions.

XR-205K **£15.75**



The Function Generator Kit features sine, triangle and square wave THD 0 5% typ. AM/FM capability.
XR-2206KA FUNCTION GENERATOR KIT £12.50
Includes monolithic function genreator IC PC board, and assembly instruction manual
XR-2206KB FUNCTION GENERATOR KIT £17.50
Same as XR-2206KA above and includes components for PC board



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THE SMALLEST *REGULATED* AC/DC POWER SUPPLY EVER!
Only 1 70" x 1 00" x 0 85", output pre set ±5%, 9 models
£15.00 each

Volts	mA
5	140
8	115
10	100
12	90
15	70
18	50
20	35
22	25
24	15

7400 SERIES TTL.

	1	25	100+
SN7400	0.14	0.13	0.12
SN7401	0.14	0.13	0.12
SN7402	0.14	0.13	0.12
SN7403	0.20	0.18	0.16
SN7404	0.15	0.14	0.13
SN7405	0.15	0.14	0.13
SN7406	0.30	0.29	0.28
SN7407	0.30	0.29	0.28
SN7408	0.15	0.13	0.12
SN7409	0.15	0.14	0.13
SN7410	0.14	0.13	0.12
SN7411	0.23	0.22	0.21
SN7412	0.20	0.19	0.18
SN7413	0.30	0.29	0.28
SN7414	0.71	0.70	0.69
SN7415	0.30	0.29	0.27
SN7416	0.28	0.27	0.26
SN7417	0.28	0.27	0.26
SN7420	0.20	0.19	0.18
SN7421	0.45	0.36	0.27
SN7422	0.25	0.24	0.23
SN7423	0.29	0.28	0.27
SN7425	0.26	0.25	0.22
SN7426	0.26	0.25	0.22
SN7427	0.26	0.25	0.22
SN7428	0.39	0.38	0.37
SN7430	0.14	0.13	0.12
SN7432	0.32	0.30	0.29
SN7433	0.36	0.35	0.34
SN7437	0.27	0.26	0.22
SN7438	0.27	0.26	0.25
SN7439	1.10	1.08	1.06
SN7440	0.16	0.15	0.14
SN7441	0.70	0.68	0.56
SN7442	0.63	0.60	0.43
SN7443	1.00	0.99	0.90
SN7444	1.08	1.07	0.90
SN7445	0.85	0.83	0.75
SN7446	1.03	1.00	0.85
SN7447	1.03	1.00	0.85
SN7448	0.85	0.83	0.70
SN7450	0.14	0.13	0.12
SN7451	0.23	0.20	0.18
SN7453	0.14	0.13	0.12
SN7454	0.14	0.13	0.12
SN7455	0.40	0.39	0.38
SN7460	0.14	0.13	0.12
SN7462	0.45	0.44	0.42
SN7464	0.45	0.44	0.42
SN7465	0.45	0.44	0.42
SN7470	0.30	0.27	0.24
SN7471	0.60	0.59	0.58
SN7472	0.25	0.24	0.21
SN7473	0.35	0.32	0.30
SN7474	0.31	0.29	0.23

	1	25	100+
SN7475	0.40	0.39	0.32
SN7476	0.31	0.29	0.26
SN7478	0.65	0.63	0.61
SN7480	0.43	0.41	0.36
SN7481	2.99	2.95	2.93
SN7482	0.75	0.70	0.62
SN7483	0.81	0.80	0.68
SN7484	0.90	0.86	0.85
SN7485	1.25	1.15	1.00
SN7486	0.31	0.28	0.25
SN7489	3.50	2.97	2.35
SN7490	0.45	0.42	0.34
SN7491	1.00	0.95	0.78
SN7492	0.45	0.42	0.34
SN7493	0.45	0.42	0.35
SN7494	0.90	0.75	0.70
SN7495	0.75	0.70	0.65
SN7496	0.97	0.78	0.75
SN7497	2.50	2.35	2.25
SN74100	1.35	1.30	1.25
SN74104	0.45	0.40	0.38
SN74105	0.45	0.40	0.38
SN74107	0.42	0.33	0.28
SN74109	1.00	0.84	0.65
SN74110	0.55	0.50	0.45
SN74111	0.81	0.80	0.76
SN74114	1.00	0.97	0.95
SN74115	1.00	0.97	0.95
SN74118	1.00	0.95	0.90
SN74121	0.31	0.29	0.25
SN74122	0.44	0.41	0.35
SN74123	0.62	0.58	0.50
SN74125	0.49	0.39	0.30
SN74126	0.49	0.39	0.30
SN74128	1.40	1.35	1.30
SN74132	0.93	0.74	0.59
SN74136	0.95	0.90	0.85
SN74140	2.50	2.45	2.40
SN74141	0.90	0.87	0.85
SN74145	0.92	0.74	0.58
SN74147	2.15	1.70	1.33
SN74148	1.33	1.06	0.83
SN74150	1.35	1.30	1.07
SN74151	0.68	0.62	0.55
SN74152	1.55	1.50	1.45
SN74153	1.10	1.06	1.04
SN74154	1.55	1.50	1.45
SN74155	0.68	0.62	0.55
SN74156	0.68	0.62	0.55
SN74157	0.86	0.68	0.55
SN74158	1.50	1.45	1.40
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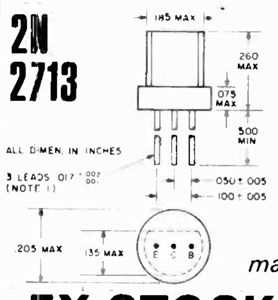

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TURNTABLE Popular BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and de luxe plinth and cover. **£24.00** + p & p £3.50 VALUE

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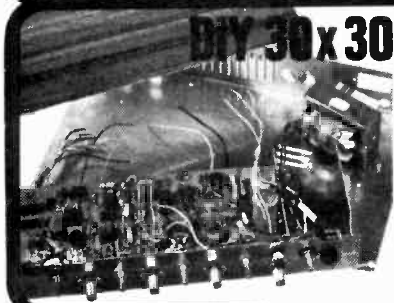

Specially designed by RT-VC for the experience constructor, this kit comes complete in every detail. Same facilities as Viscount IV amplifier. Chassis is ready punched, drilled and formed. Cabinet is finished in teak veneer. Black fascia and easy-to-handle aluminium knobs. Output 30+30 watts rms, 60+60 peak. **£29.00** + p & p £2.10

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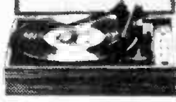
DIY STEREO SYSTEM



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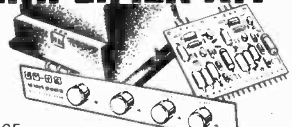
STEREO AMPLIFIER KIT



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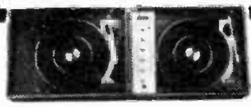

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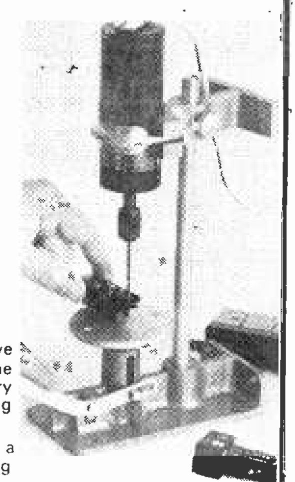

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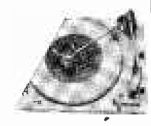

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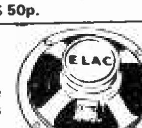

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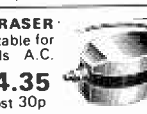

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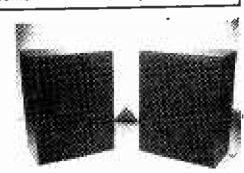

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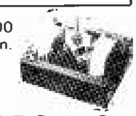

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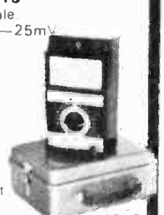

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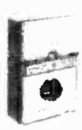

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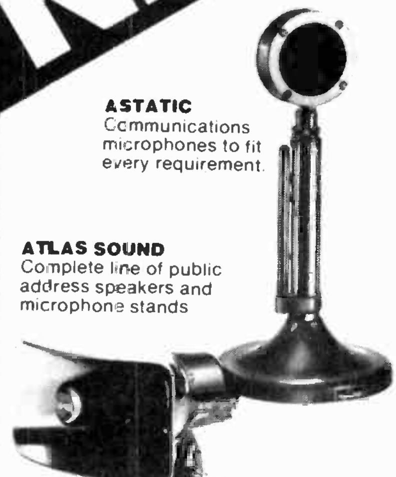

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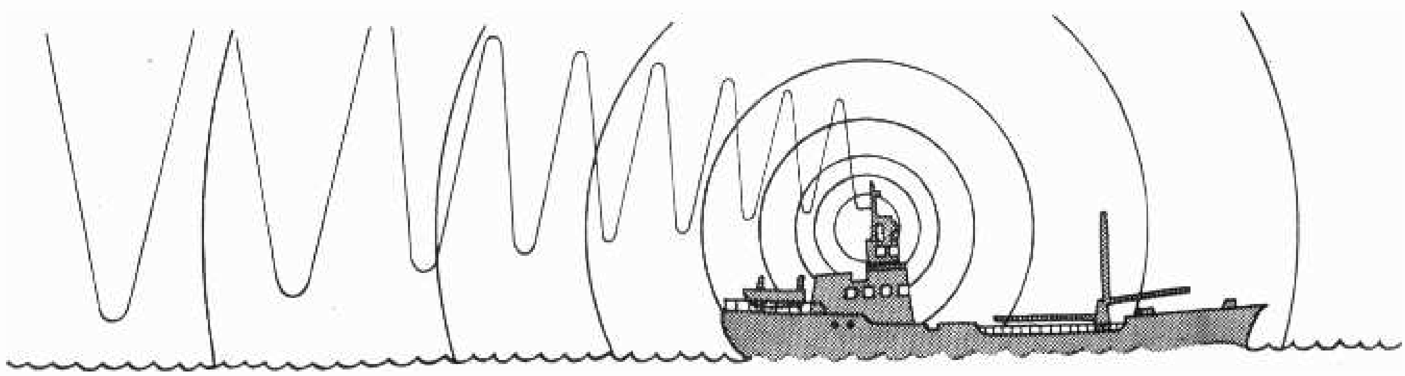

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We are seeking people with suitable experience either of analogue development work or of product engineering within the electronics industry, and who possess a high degree of motivation. In return for initiative we offer competitive salaries and generous Pension and Life Assurance schemes.

For application form or further details please contact Mr. G.N. Turner
Grampian Reproducers Ltd.,
The Hanworth Trading Estate,
Feltham, Middlesex TW13 6EJ
01-894 9141.

Grampian (6102)

UNIVERSITY OF SALFORD

ELECTRONICS TECHNICIAN

To work in the Electronics Workshop of the Department of Electrical Engineering. Work involves the repair and maintenance of a wide range of instrumentation (including minicomputers and their associated electromechanical peripheral equipment) together with the development and construction of special purpose electronics. Applicants should possess ONC or equivalent, together with some years' experience relevant to the work involved.

Salary scale £2751-£3207. Starting salary according to age, qualifications and experience. Local Government Superannuation.

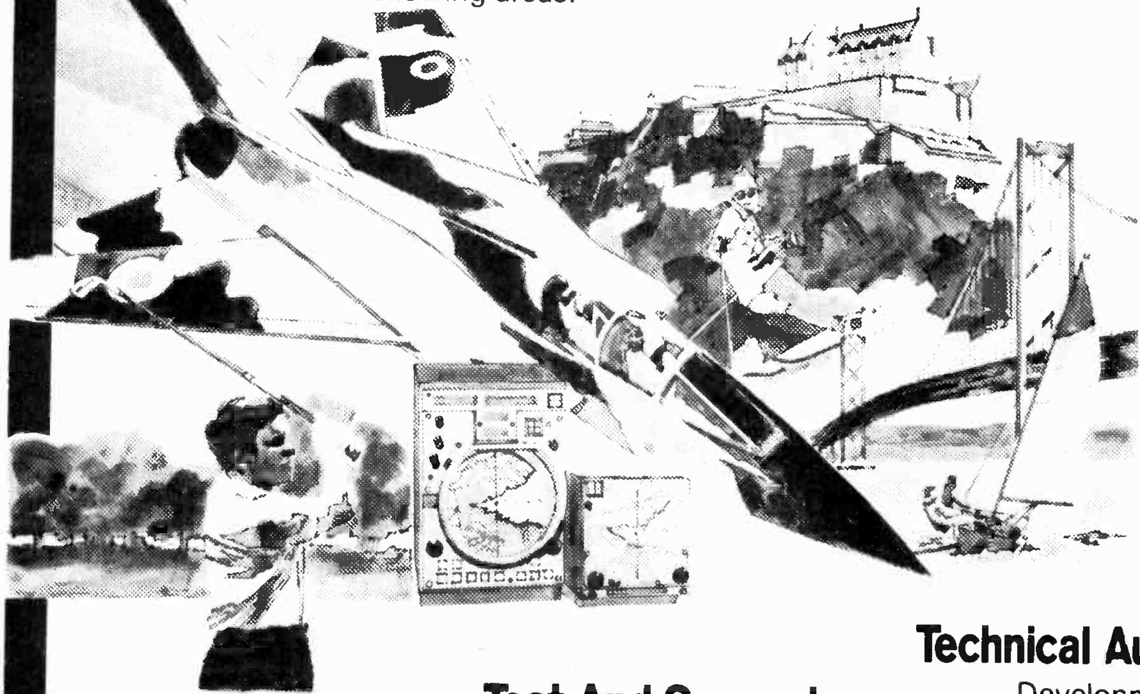
Letters of application stating age, qualifications and experience together with the names and addresses of two referees should be sent to the Registrar, University of Salford, Salford M5 4WT by 10 September, 1976 quoting reference E/176/WW.

(6120)

www.americanradiohistory.com

AVIONICS IN EDINBURGH

With contracts for a variety of advanced avionic projects in the Tornado (MRCA), Sea Harrier, Nimrod Mk2, Mitsubishi FS-T2, Jaguar and the naval Lynx helicopter, Ferranti in Edinburgh are in a position to offer career conscious engineers a wealth of technological experience. Planned expansion through this year and next now requires the appointment of engineers with experience in the following areas:



Design/Development

Opportunities exist for electronic and mechanical engineers with qualifications ranging from HND to Honours degree to join our design teams involved in airborne radars, laser range finding and target seeking equipments, inertial navigation systems and their associated test gear.

Test And Support

To support our design teams we need engineers with qualifications from C & G to HNC, preferably with Test and Quality Assurance experience.

They will become involved in a range of work covering automatic test equipment, fault diagnosis and building special-to-type test equipment.

Technical Authors

Development across all our projects requires parallel expansion in our Technical Publications Group.

Experienced technical authors will find the close association with project design particularly stimulating and for engineers keen to embark on such a career this is an opportunity to train in one of the most authoritative technical writing teams in the country.

Salaries are negotiable. The Company operates a contributory pension and life assurance scheme and incoming employees will qualify for housing under the Scottish Special Housing Association scheme.

Apply in writing, quoting reference WW/1, with particulars of qualifications and experience to:

Staff Appointments Officer,
Ferranti Limited, Ferry Road,
Edinburgh EH5 2XS.

FERRANTI

(95)

www.americanradiohistory.com

OMAN

Dhofar Region Television Service

We are recruiting on renewable one year contracts and have vacancies for

- Very Good Salary
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- Special End of Contract Bonus
- We pay Local Education Fees
- Comprehensive Free Insurance, Health, Dental, etc.
- Hard work is necessary

ASS. CHIEF ENGINEER

SECRETARY TO GENERAL MANAGER

SENIOR MAINTENANCE ENGINEER

THESE ARE IMPORTANT POSTS TO BE FILLED

Let us discuss with you your abilities for these interesting and important positions

Phone: Tony Owers, 01-573 8333 for more information

PERSONNEL & ELECTRONICS LTD.

www.americanradiohistory.com

INTERNATIONAL VIDEO SYSTEMS REQUIRE:

SENIOR SUPERVISORY ENGINEER

Experienced in operational TV systems. Knowledge of all colour systems, telecine, Ampex 1200 and video cassettes. Salary £3,000 - £6,000 depending upon experience and qualifications.

OPERATIONAL ENGINEERS

Technically qualified and experienced in operating with video tape and film. Salary approx. £2,500 - £3,500.

The above vacancies are in Mitcham, Surrey.

SALES REPRESENTATIVES

Experienced television equipment and systems, required to sell UK and abroad exclusive equipment and services. Salary approx. £3,000 basic plus commission (Total at least £5,000) based Central London.

Applicants send full details of qualifications, experience and age, to:

**G. White, Technical Director, I.V.S. (UK) Ltd.
Redan House, One Redan Place London W2 4SA
Tel. 01-727 2783**

(6131)

Junior Laboratory Technicians

BBC Engineering Designs Department -London.

A number of posts are available in Central London for enthusiastic and forward thinking young students to train as TECHNICIANS in the laboratories of the BBC's Designs Department.

The work will include assisting engineering and laboratory staff in the development, construction and testing of units of sound and television broadcasting equipment.

The successful candidates will probably be aged 18-20 and have a keen interest in, and possibly some experience of, electronics. They will have some 'O' levels two preferably will be scientific and will be either qualified to ONC or City and Guilds part II standard, or have recently commenced the final year of such a course.

Salary according to experience in the range £2514 to £2706 rising to £2994. Good promotion prospects. Pensionable. Good club and restaurant facilities.

Please write for application form to:

**The Engineering Recruitment Officer,
Broadcasting House, London W1A 1AA**

quoting reference: 76.E.2174 WW and enclosing an addressed envelope at least 9" x 4". Closing date for completed application forms: 14 days after publication

BBC

(6127)

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.

**TJB Electrotechnical
Personnel Services
12 Mount Ephraim
Tunbridge Wells, Kent**

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 ....

....

.... (90)

www.americanradiohistory.com

Anglian Water Authority

BEDFORD WATER DIVISION

MAINTENANCE ASSISTANT
(ELECTRONICS)

Ref W1G10 Grade 5

(£3,705-£3,996 + supplement of £6 per week

Applications are invited for the above post for the supervision and maintenance of the extensive Supervisory and Instrumentation System of the Authority's Grafham Water Scheme controlling the supply of up to 50 million gallons of potable water per day

Applicants should have a good electronics background, together with previous maintenance experience The existing system is programmed to be replaced in the near future and the successful applicant will be involved in this work

Relocation expenses are payable in appropriate cases

NJC for Water Service Staffs Conditions of Service apply

Applications with full details of career, including the names of two referees, should reach the Divisional Manager by 30 Sept., 1976

Bedford Water Division
Cambridge Road
Bedford
MK42 OLL

(6119)

EALING HAMMERSMITH AND HOUNSLOW AREA HEALTH AUTHORITY (TEACHING)

SOUTH HAMMERSMITH HEALTH DISTRICT (T)

Charing Cross Hospital

ELECTRONICS TECHNICIAN

Medical Physics Department

£2,970 - £3,891

The person appointed will act as an assistant to the Senior Electronics Technician responsible for the day-to-day maintenance and servicing in the Medical Electronics Section of the Medical Physics Department. The work will include calibration and safety checking of electronic equipment used in this and associated hospitals

A good knowledge of electronic equipment, particularly differential amplifiers, oscilloscopes, power supplies, chart recorders, tape recorders etc., is necessary

Applicants should have a minimum qualification of ONC in Electrical Engineering or equivalent, and have appropriate experience A knowledge of medical equipment is not essential but would be an advantage

Application forms from Heather Dann at District Personnel Department Charing Cross Hospital, Fulham Palace Road, London, W6 8RF Telephone 01-748 2040, ext 2997. Closing date for return of completed application forms, 3rd September, 1976

(6108)

emа

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 Ltd
Burne House, 88/89 High Holborn
London WC1V 6LR
01-242 7773

VIDEO SALES REPRESENTATIVES

Due to expansion, we require additional experienced representatives, with proven record of success in previous job, enthusiasm and self-motivation to work in the office and on the road.

We offer:

1) **an excellent salary negotiable**
2) **company car (where applicable) and expenses**
3) **permanent and assured future, plus job satisfaction with an established and expanding company**

VIDEO HIRE DEPARTMENT

Manager and Manager's assistant, required to work in busy department. Previous experience in video or allied field essential.

Please write in confidence to the **Managing Director, M. Murray, REW Audio Visual Company, REW House, 10/12 High Street, Colliers Wood, London SW19 2BE.**

These positions are available to either sex.

(6121)

WESTFIELD COLLEGE
(University of London)

ELECTRONICS TECHNICIAN

In the College Physics Department. Duties include construction and maintenance of a variety of electronic equipment. Applicants must be educated to A level/ONC/OND or equivalent level and have 3-5 years' relevant experience. Salary scale £2325 x £66 to £2655 plus £465 London Weighting.

Further details and application form from Dr. J. Buckingham, Personnel Officer, Westfield College, Kidderpore Avenue, Hampstead, London NW3 7ST.

(6087)

TECHNICAL TRAINEES FOR TELEVISION

Thames Television is seeking applications for appointments as Technical Operations and Engineering Trainees. The Technical Training Scheme is a one year broad based course which covers all aspects of television operations.

Candidates should be between 20 and 25 years of age, possess a degree, Higher National Diploma or similar qualification in electrical or electronic engineering and have a sound knowledge of television engineering principles. A keen interest in the field is also essential.

Applicants should give full details of age, qualifications and experience and must arrive not later than 28th August, 1976.

Training Organiser, Thames Television Limited, Teddington Studios, Teddington Lock, Teddington, Middlesex TW11 9NT.

THAMES

(6101)

AMPEX

SYSTEMS ENGINEER

We are currently seeking a first class systems engineer to fill a vacancy in our offices in Reading. The engineer appointed will be responsible for the execution of contracts for outside broadcast mobiles, which includes designing, planning, liaison with sub-contractors through to check-out and commissioning.

Acceptance usually takes the place on the customers site in the U.K. and abroad, and therefore the successful applicant will be required to travel.

Experience in television broadcasting would be an advantage. Salary commensurate with experience, generous overtime payments.

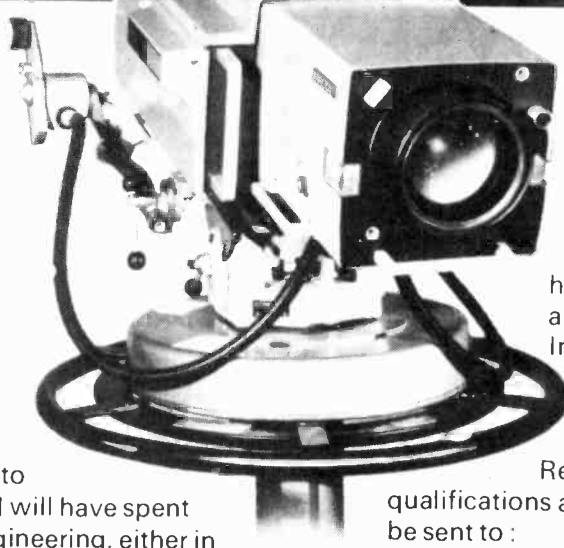
Applications with curriculum vitae should be sent to the Personnel Manager, Ampex Electronics Limited, 72 Berkeley Avenue, Reading RG1 6HZ, quoting ref. RVDL.

(6110)

www.americanradiohistory.com

Studio Systems Engineer

Exceptional opportunity with an international leader in TV Broadcast Engineering



Pye TVT is a leading supplier of professional TV and radio broadcasting equipment. Current contracts include TV outside broadcast vehicles for Denmark, Holland and Nigeria, a major studio installation in Indonesia and a complete radio and TV turnkey project in Oman. Our continually increasing broadcasting systems activity world-wide has created the need for a further Studio Systems Engineer.

You will be technically qualified to HNC or equivalent standard, and will have spent several years in TV broadcast engineering, either in design, installation or operation and maintenance of studios or outside broadcast vehicles.

As a member of the Marketing Projects Team, your main activities will be the design of TV studio systems together with responsibility for the preparation of technical quotations and tenders and related customer information. You will be based in Cambridge, but may be required to make short visits to any part of the world. Ideally, the position calls for someone dedicated to broadcast engineering, having the ability also to plan, and firmly maintain, target dates. In addition to the usual employee benefits, assistance will be given with relocation expenses.

Replies, giving brief details of qualifications and experience to date, should be sent to:

Alan Fergusson, Personnel Manager,

Pye TVT Limited

PO Box 41 Coldhams Lane Cambridge England CB1 3JU
Tel: Cambridge (0223) 45115 Telex: 81103

A member of the Pye of Cambridge Group

LKB INSTRUMENTS LIMITED

ELECTRONICS TECHNICIAN/ ENGINEER

required to be responsible for repairs and the general day-to-day running of our workshop. The position offers a wide variety of challenge and opportunity covering all types of modern electronics and small mechanical instruments.

The applicant should possess a good modern electronics background and a mechanical aptitude.

The Company is internationally renowned for the quality of its products and offers excellent working conditions.

Write for application form to:

Service Manager
LKB Instruments Ltd.
232 Addington Road
Selsdon, South Croydon
CR2 8YD
or telephone: 01-657 8822

LKB

THE INCENTIVE GROUP

(6117)

TELEVISION ENGINEERS

Doric Radio is a fast growing member of the Rediffusion group of companies, selling monochrome and colour T.V. receivers to the retail trade through an increasing network of dealers. A small but effective team is being established to provide a technical service to our customers at home and overseas. This team provides service back up facilities by direct contact with our Doric dealers, helping to solve their problems and completing the link back to our factories where necessary.

Attitude, ability, thoroughness, tact and a willingness to get involved are essential requirements for these positions. This is a challenging opportunity for experienced engineers who wish to become important members of a small successful team working on the latest receivers employing advanced electronic techniques. Prospects for promotion are excellent. Formal qualifications, whilst desirable, are not essential where adequate practical experience on modern colour television receivers can be demonstrated.

Successful applicants will be based at our Chessington laboratories, with their excellent facilities and equipment, but occasional visits to our factories in the North of England and to our dealers' premises, both at home and abroad, may be necessary.

Salaries will depend on ability and experience, but will reflect the importance of these new posts. Assistance with relocation expenses will be given where appropriate.

Interested? then write to:-

H. Brearley,
Head of Technical Services,
Doric Radio Ltd.,
Fullers Way South,
Chessington,
Surrey. KT9 1HJ.

Telephone 01-397-5411

DORIC RADIO (6049)

UNIVERSITY OF WARWICK

ELECTRONICS TECHNICIANS — GRADE 5

in the DEPARTMENT OF PSYCHOLOGY

(1) A Technician is required for a wide range of electronics work with particular emphasis on the ability to participate in the development of microprocessor systems for laboratory measurement and control applications. Extensive experience relevant to this field is required and applicants should be qualified to HNC or equivalent level. The post is permanent and pensionable and appointment will be made on the Technician Grade 5 scale: £2,751-£3,207 p.a.

(2) A Technican is required to work on a three-year, MRC funded research project into the relations between eye movement control and perceived movement and stability. The job will include the development, construction and maintenance of electronic equipment, and it is hoped that the successful candidate will also want actively to participate in other aspects of the project. We shall be using on-line computer analysis of eye movement responses and on-line control of experimental conditions. A knowledge of mini-computers and programming, and an interest in models of eye movements would be an asset. Starting salary up to £2,934 p.a. on the Technician Grade 5 scale: £2,751-£3,207 p.a.

Further details may be obtained from the Academic Registrar, University of Warwick, Coventry CV4 7AL, to whom applications in writing (no forms) giving full details and the names of two referees should be sent as soon as possible. Please quote Ref. No 51/J/76.

(6111)

UNIVERSITY OF EDINBURGH

SENIOR TECHNICIAN

—AND AUDIO VISUAL SERVICES

Duties include the operation and maintenance of a C.C.T.V. studio including telecine and helical scan video tape recording and editing facilities, provision of video and audio recording/replay facilities outwith studio and maintenance of University Department's video and audio equipment.

Applicants must be qualified and have worked for a minimum of 5 years in a C.C.T.V. or broadcast studio complex and have sound knowledge of electronics with diagnosing and repairing experience. The post is one of responsibility and requires drive, initiative and tact in dealing with technicians in the unit and academics using the facilities.

Salary on the scale £3666-£4122 p.a. Annual holidays, 4 working weeks and 4 days, plus public holidays. The names and addresses of two referees will be required. Applications, quoting post reference no. A196, should be addressed to the **Personnel Office, University of Edinburgh, 63 South Bridge, Edinburgh EH1 1LS. Telephone 031-667 1011, Ext. 4510-3.**

(6105)

Systems Test Engineer

Crosfield Electronics Ltd are leaders in the field of sophisticated electronic equipment for the printing industry. We need engineers to work on the final testing of systems using analogue and digital circuitry with a degree of photographic and optical involvement.

The right people will be aged 20 to 32 and either up to HNC standard with three to five years' relevant experience or with a service background. Knowledge and experience of computer software and hardware would be an important advantage.

Starting salary depending on experience will be attractive and benefits are commensurate with those expected of a member of an international group of companies.

For an application form please contact **Linda Geers, Crosfield Electronics Ltd, 766 Holloway Road, London N19 3JG. Telephone 01-272 7766.**

CROSFIELD ELECTRONICS

ROYAL COLLEGE OF ART

The Department of Environmental Media operates and maintains an information system of all work undertaken in this area.

Applications are now invited from suitably qualified candidates to fill the post of

TWO DAYS A WEEK TECHNICIAN

in the Department. Salary within the salary range £1448-£1690 p.a. according to qualifications and experience. Applicants should have a working knowledge of the following equipment and have the capacity to undertake routine maintenance of it, or familiarity with elementary information processing systems. 26mm cine projector; ½" Sony video recording and editing facilities; multi-screen encoder/decoder and cross-fade unit; sound recording, mixing and synthesising equipment.

Please write giving full details of age, qualifications and previous experience to **Mr. H. W. Denyer, Assistant Registrar, Royal College of Art, Kensington Gore, London SW7 2EU.**

(6124)

www.americanradiohistory.com

APPOINTMENTS

WEST SUSSEX COUNTY COUNCIL
FURTHER EDUCATION
CRAWLEY COLLEGE OF TECHNOLOGY
College Road, Crawley, Sussex

LECTURER

Grade 1, required as soon as possible for the following courses

RADIO, TELEVISION and ELECTRONIC MECHANICS (C & G 222)
BASIC ENGINEERING CRAFT STUDIES (C & G 200) and ELECTRICAL & ELECTRONIC CRAFT STUDIES (C & G 231)

Suitable applicants will have good practical experience at least a City & Guilds Full Technological Certificate and ability to teach craft students in practical and theoretical subjects.

Salary Scale — £2,469-£4,377 + £312 p a supplement + £150 L W

Further details and application forms available on receipt of foolscap s.a.e. from The Principal, Crawley College of Technology, Crawley, Sussex.

Applications to be returned to the Principal by 1st September, 1976

Grants towards removal and resettlement expenses payable in approved cases There is a possibility of housing (6086)

LOGIC ENGINEER REQUIRED

Able to troubleshoot digital and analog circuits. Must have working knowledge of solid state television and power supplies Good mechanical aptitude. Excellent salary and working condition.
Telephone: Ruffler & Deith Limited, 870 5238 and 870 5224 or write to 127 Wandsworth High Street, London SW18 4JB. (6138)

MANCHESTER POLYTECHNIC. Faculty of Art and Design, DEPARTMENT OF COMMUNICATION ARTS AND DESIGN. School of Film and Television. TELEVISION STUDIO ENGINEER. The post is one of responsibility and entails assisting the Senior Engineer with studio operations and maintenance in closed circuit television. Candidates should have experience of broadcasting or educational television operations and should be conversant with both television and sound studio production. Appropriate technical qualifications such as HNC or City and Guilds Certificate would be an advantage. Salary scale: Technician 4 £3,366-£3,702, plus £312 per annum supplement. For further particulars and application form (returnable by 31 August 1976) please send a self-addressed envelope marked "A/253" to the Secretary, Manchester Polytechnic, Lower Ormond Street, Manchester M15 6BX.

Electronic Engineers with marketable ideas or inventions to join well established company with development laboratory and production facilities on salary and profit sharing basis. Preference given to high quality instruments, avionics or telecommunications. Excellent opportunity for right man to build a future with a share in well established electronics company just south of London Airport. Write Box WW 6051.

U.S.A. OPPORTUNITY. Marine Electronics Field Service technician. Must be experienced in all phases of Marine Communications, Autopilots and radar. Work on world's largest luxury yachts. Please submit résumé and photograph to Electronics for Yachting, 1525 S. E. 16th Street, Ft. Lauderdale, Fla. 33316 U.S.A. (6054)

SOUND SYSTEM ENGINEERS

Join the APAE, the only official Association representing the P.A. Industry — further details:

The Secretariat
The Association of Public Address Engineers
47 Windsor Road, Slough, Berks., SL1 2EE (6039)

CAPITAL APPOINTMENTS LTD.

FIELD SERVICE ENGINEERS (ELECTRONICS)

If you're not earning over **£3,500 p.a. plus a car — then you had better contact us!** (5540)

34 Percy Street, London, W.1
01-636 9659 (day) or 550 0836 (evening)

DESIGN TEST FIELD SERVICE

Immediate vacancies exist in most areas for engineers qualified to BSc/HNC/C&G with analogue, digital or R.F. experience.

Phone or write

APEX PERSONNEL
800 FULHAM ROAD
LONDON S.W.6

01-731 4353 (6091)

RADIO TELEPHONE Service Engineer wanted for work-shops in South London. Must be reliable and experienced with Pye, GEC, and other mobile radio equip. Salary Neg. 680-1010. (5329)

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SOWTER TRANSFORMERS

FOR SOUND RECORDING AND REPRODUCING EQUIPMENT

We are suppliers to many well-known companies, studios and broadcasting authorities and were established in 1941. Early deliveries. Competitive prices. Large or small quantities. Let us quote.

A recent release:

SOWTER TYPE 3678
MULTITAP MICROPHONE TRANSFORMER

Primary windings for 600 ohm, 200 ohm and 60 ohm with Secondary loadings from 2K ohm to 10 K ohm. Frequency response plus/minus ½dB 20 Hz to 25 KHz. Contained in well finished Mumetal box 33mm diameter by 22mm high with colour coded end leads. Low distortion. DELIVERY (small quantities) EX-STOCK. HIGHLY COMPETITIVE PRICE. FULL DETAILS ON REQUEST.

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DIGITAL CLOCK MODULES, KITS
Further details free on request

'E' LED DISPLAYS		CLOCK CHIPS		SOLDERCON PINS	
DL-704E 0 3"	70p	AY-5-1224A	£3.50	100	60p
DL-707E 0 3"	70p	MK 50253	£5.50	1000	£4.00
DL-728E 2×0 5"	£1.80	**OP-AMPS**		**RED ACRYLIC FILTER**	
DL-727E 2×0 5"	£1.80	CA 3130 (COS/MOS)	£1.00	For L E D displays	
DL-750E 0 6"	£1.50	CA 3140 (BiMOS)	95p	157×92×3mm	70p
DL-747E 0 6"	£1.50	741 Minidip	25p	**DIL SOCKETS** 14/16 Pin	15p

PUSH BUTTON SWITCHES Type SW9 Min Push to make **15p**
CMOS WITH DISCOUNTS! (Any mix disc. 10% 25+, 25% 100+, 33⅓% 1000+)

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4007/14007	0.20	4049/14049	0.60	40107/—	0.66	14519/4019	0.57
4008/14008	1.07	4050/14050	0.60	40108/14580	6.18	14520/4520	1.39
4009/14009	0.80	4051/14051	1.04	40109/—	2.21	14521/—	3.77
4010/14010	0.50	4052/14052	1.04	40181/14581	4.30	14522/—	2.16
4011/14011	0.20	4053/14053	1.04	40182/14582	1.73	14526/—	2.16
4012/14012	0.20	4054/	1.29	40194/—	2.26	14527/4527	1.76
4013/14013	0.60	4055/—	1.46	40257/—	2.26	14528/4098	1.22
4014/14014	1.12	4056/	1.46	4700/—	1.75	14529/—	1.72
4015/14015	1.12	4057	29.81	7083/—	4.25	14530/—	0.95
4016/14016	0.60	4059/	6.20	14410/—	5.70	14531/—	1.74
4017/14017	1.12	4060/	1.24	14411/—	9.54	14532/4532	1.39
4018/14018	1.12	4061/	25.60	14412/—	17.07	14534/—	8.15
4019/14519	0.60	4062/	10.10	14415/—	7.35	14536/—	4.00
4020/14020	1.24	4063/—	1.22	14419/—	2.67	14537/—	13.17
4021/14021	1.12	4066/14066	0.89	14422/—	4.98	14539 —	1.24
4022/14022	1.07	4067/—	4.13	14435/—	7.93	14541/—	1.62
4023/14023	0.20	4068/14068	0.24	14440/—	11.58	14543/—	1.82
4024/14024	0.87	4069/14069	0.24	14450/—	2.67	14549/—	4.10
4025/14025	0.20	4070/14070	0.65	14451/—	2.67	14552/—	10.50
4026/—	1.92	4071/14071	0.24	14490/—	6.51	14553/—	4.66
4027/14027	0.60	4072/14072	0.24	14160/—	1.18	14554/—	1.67
4028/14028	1.00	4073/14073	0.24	14161/—	1.18	14555/4555	1.01
4029/—	1.27	4075/14075	0.24	14162/—	1.18	14556/4556	1.01
4030/14507	0.80	4076/14076	1.71	14163/—	1.18	14557/—	4.65
4031/—	2.46	4077/14077	0.65	14174/—	1.08	14558/—	1.26
4032/14032	1.19	4078/14078	0.24	14175/—	1.04	14559/—	4.10
4033/—	1.55	4081/14081	0.24	14194/—	1.17	14560/—	2.17
4034/14034	2.11	4082/14082	0.24	14501/—	0.20	14561/—	0.70
4035/14035	1.31	4085/—	0.80	14502/4502	1.38	14562/—	5.59
4036/—	3.09	4086/—	0.80	14503/—	0.75	14566/—	1.67
4037/—	1.06	4089/—	1.74	14505/—	4.38	14568/—	3.15
4038/14038	1.20	4093/14093	0.89	14506/—	0.57	14569/—	3.72
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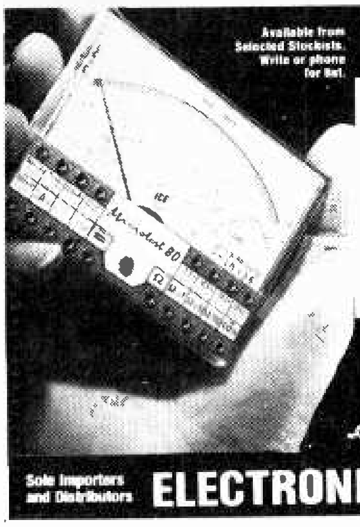

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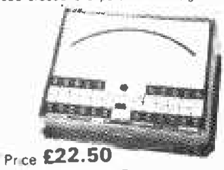

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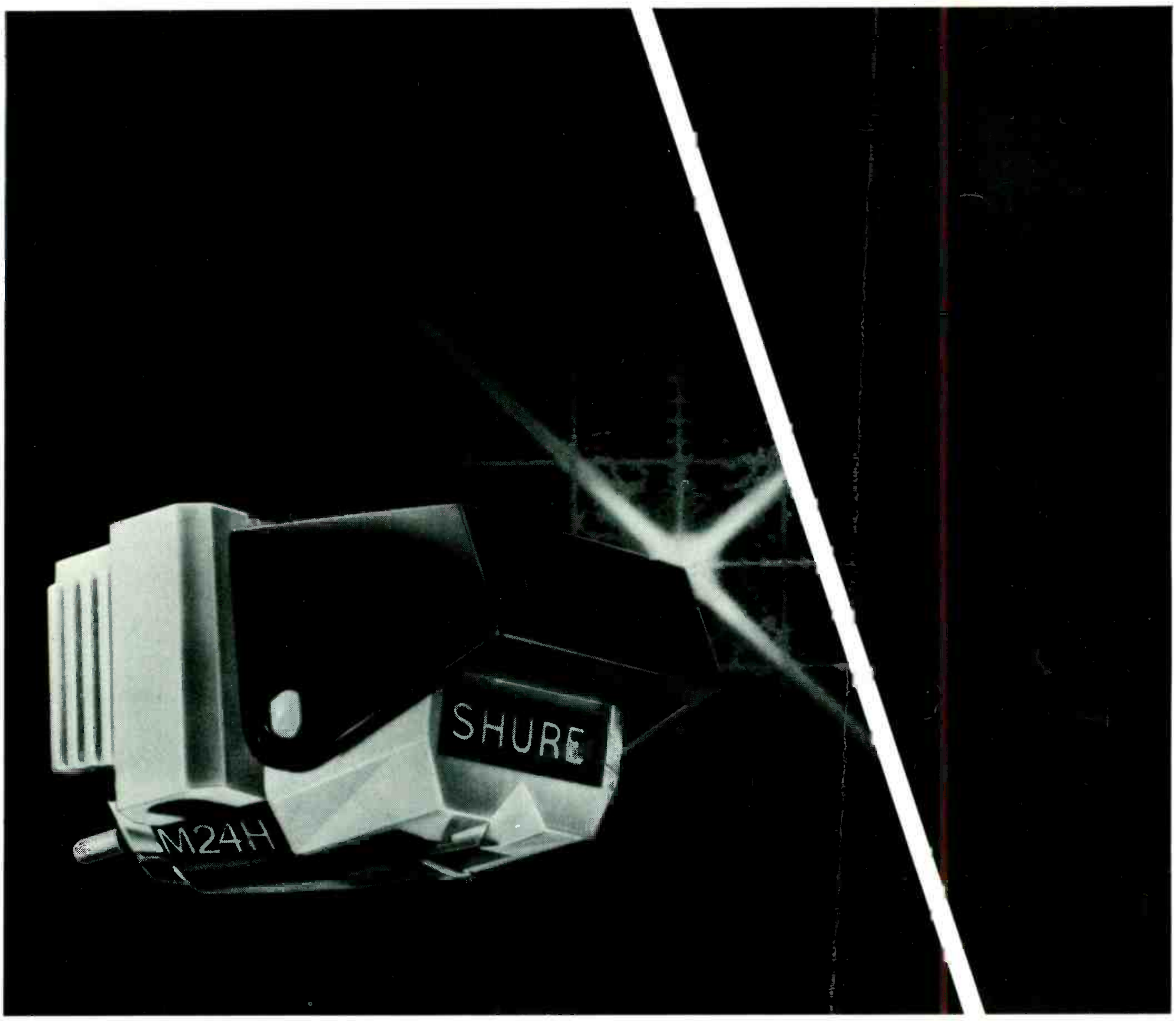

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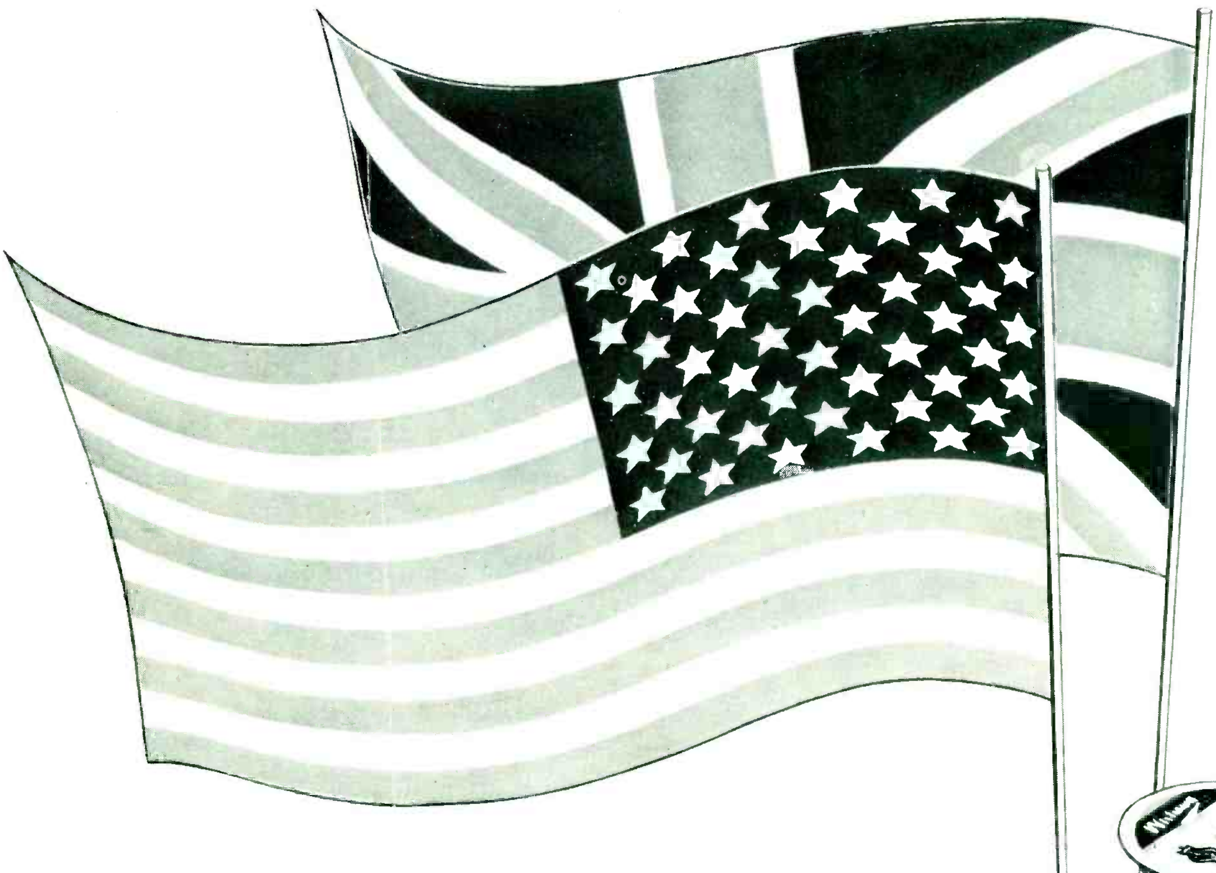

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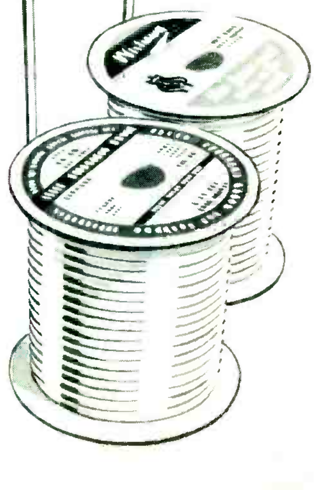

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