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ELECTRONICS/TELEVISION/RADIO/AUDIO

JANUARY 1980 Vol 86 No 1529

37 **Into the 'eighties**

38 **RADIO AND ELECTRONICS INTO THE 'EIGHTIES**

Land mobile radio by W. M. Pannell
Broadcasting by D. P. Leggatt
Consumer electronics by St John C. Jackson
Radio navigation and radar by D. W. G. Byatt
Audio by Adrian Hope
H.f. radio communication by R. F. E. Winn
Electronic measuring instruments by John L. Minck

61 **News of the month**
More v.h.f. broadcasting — Engineers want registration
Japanese make Prestel terminals

64 **World of amateur radio**

67 **Practical parallel-tracking pickup arm — 2**
by R. Cooper

73 **Circuit ideas**
Simple waveform generator — Amplitude modulator
Long duration timer

77 **Letters to the editor**
Sidebands as phasors — Digital filters
The Poynting vector

81 **More on the scientific computer**
by J. H. Adams

87 **S.s.b. and f.m. tranceiver — 4**
by G. R. B. Thornley

92 **Novatexts: astables — logic gate circuits**
by P. Williams

95 **New products**

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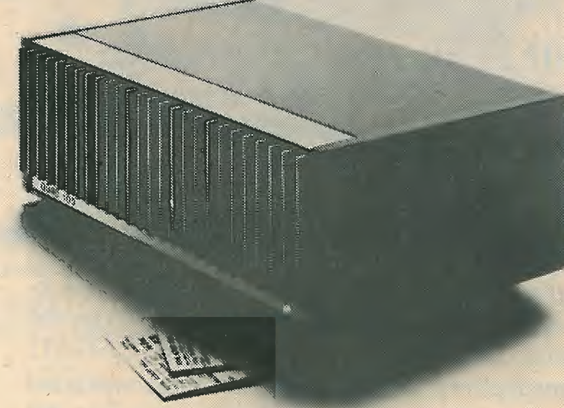

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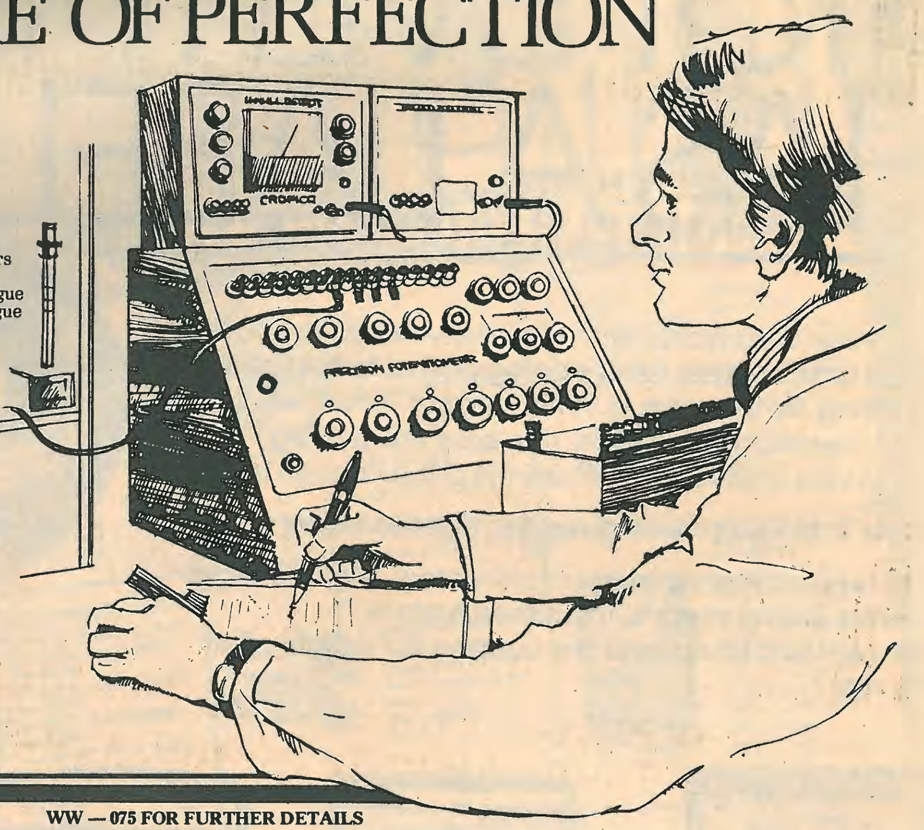

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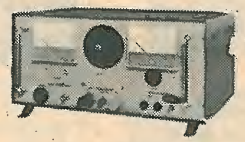

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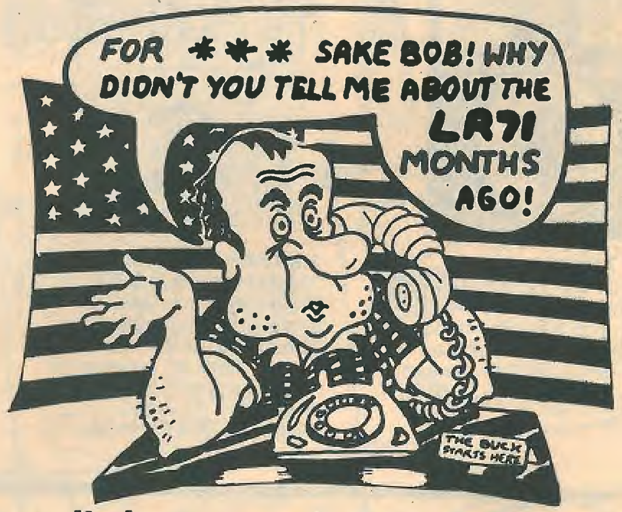

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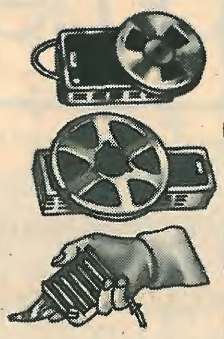

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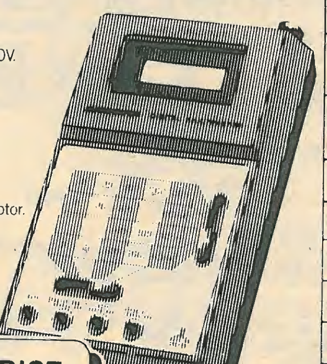

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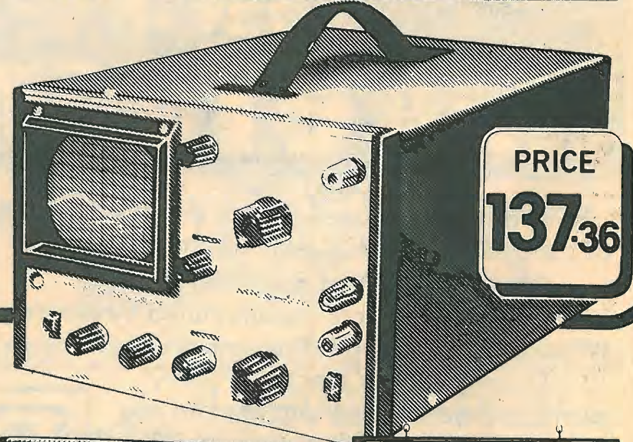

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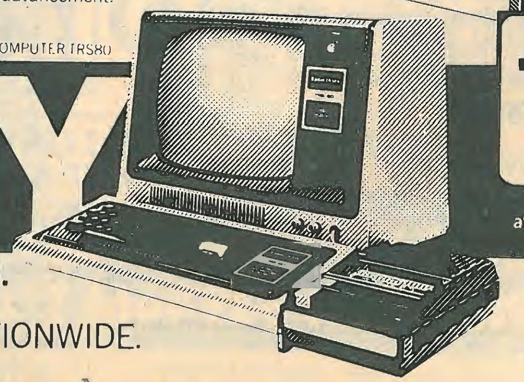

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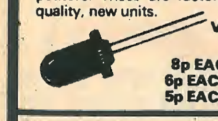

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Into the 'eighties

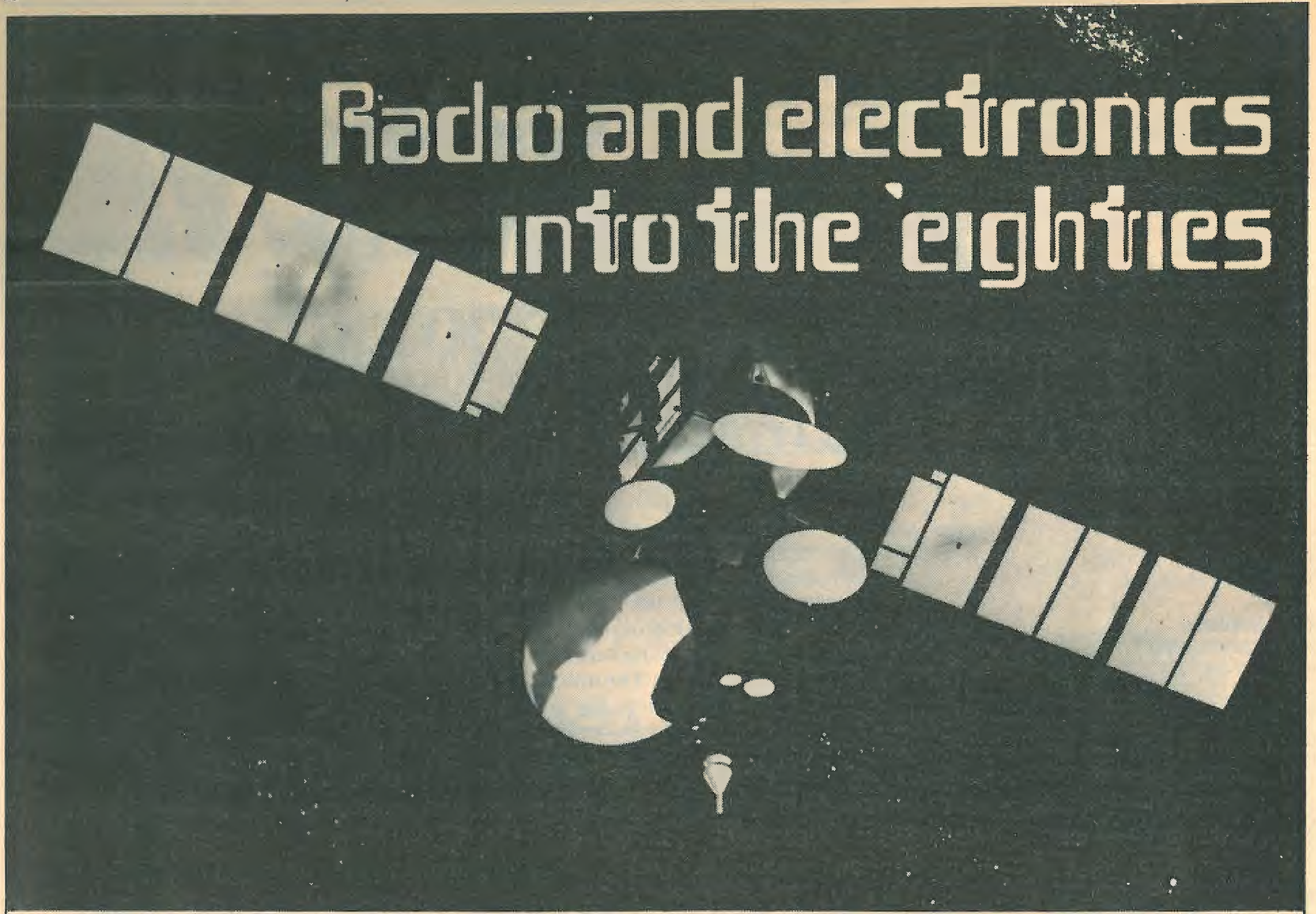
Our front cover this month, introducing the articles "Radio and electronics into the 'eighties", symbolizes man's increasing involvement with his technology. This is a two-way process. The more devices and systems he produces the more he changes his environment and this reflects back on him by modifying his customs, institutions and general way of life. And it may go deeper than this. According to the early sociologist Durkheim, a person's knowledge of himself — his self-image — is created by the society in which he lives. Not only does he exist in society but society exists in him. So in modifying the material basis of society and hence social relations by technology, he continually changes his concept of himself as an individual and all the imagined needs or wants that arise out of this concept. No wonder that modern man in industrialized society seems such a restless, anxious and dissatisfied creature.

This two-way process is very intense when the technology is electronics, for here we are concerned with transmitting and transforming information, and ultimately, if not directly, this information causes human beings to think, feel and act. What seems to emerge from the developments described in the following articles is that the 1980s will see a further intensification of the links between the human being and his electronic systems. The systems will become even more closely matched to the input and output capabilities of the biological organism and will make even greater demands on it. It's not simply a case of more communication channels conveying more information in a given time, but a continuing increase in the refinement and variety of the information put in by and presented to the human beings.

Higher quality sound and visual images, and higher performance in radar systems and laboratory instruments, for example, all demand greater attention and discrimination. In broadcasting the addition of colour and text to television and stereophony to sound have already given us more to perceive and cognize, and electronic tricks in sound and vision synthesis are stretching these abilities to the edge of confusion. In radiocommunication, voice messages are being supplemented by digital data transmission, often on the same circuits, to make possible greater detail and accuracy. And now the general public can retrieve useful facts from data banks over the ordinary telephone lines. Telecommunications are, of course, essential to organizations — especially large, far-flung organizations like multinational companies, airlines and political/military alliances — to enable them to respond quickly and appropriately to events in any part of their structure. Any message demands a decision, if only to ignore it, but with messages arriving quicker, and in ever greater quantity and detail, the mounting pressure on responsible people to be continually making decisions and deciding priorities is reaching inhuman proportions. Some individuals have found it too much and have left for a quieter life.

On the 50th anniversary of Bell Laboratories, the president, W. O. Baker, said of communications: "I see it also as a mission of importance involving great responsibility. Improving communications, more efficient and satisfying handling of information — these I deeply feel are essential to help solve economic and social problems and aid efforts to civilise the future". These are noble sentiments but it is already evident that we cannot solve such problems by technology alone. As humans we are limited in our powers to assimilate information and in our good will to act on it properly. Perhaps what we really need is less information and more wisdom.

Radio and electronics into the 'eighties



Intelsat V (above) the latest communications satellite, which will be launched at the turn of the year, marks dramatically the entry of radio and electronic technology into the 1980s, for it has double the communications capacity of its predecessor, Intelsat IVA. Equally important advances are being made in terrestrial radio and its related fields, and in the following pages we present articles by seven specialists who first look back at what has happened over the past decade and then project their thoughts and expectations into the 'eighties.

Land mobile radio

by W. M. Pannell, M.I.E.R.E. Pye Telecommunications Ltd

Technical progress in the electronics industry over the past decade has taken vast strides, with the land mobile radio sector certainly not lagging behind. The inevitable questions arise: What effect have all the changes in technique had on the mobile radio industry and its users? Which changes have made the biggest impact? And, what can we expect over the next decade?

Although the changes to the mobile and portable units, the fixed equipments and the peripherals have shown considerable innovation over the past ten years, many of the changes in technique have been brought about by the increasing complexity of overall system requirements.

One change that made a major impact on mobile radio in the UK, over a decade ago, was the decision to split the channel bandwidth at v.h.f. from 25 to 12½ kHz. This resulted in some immediate relief in the search for extra spectrum and a marked reduction in co-channel interference. The change improved the utilization of channels for many types of user.

During the 1970s we also saw the increasing use of personal portables in all types of system. This is, of course, a logical progression in view of communication being needed between people rather than vehicles in most cases — the main exceptions being where interrogation of vehicle status is desired or where vehicles are the essential tool, for example fire engines.

It was at this point that the move towards miniaturization became an essential requirement in all types of equipment, not so much because of the need for smaller equipments, although in portable design this was naturally a fundamental requirement, but more to enable equipments of increased complexity and versatility to be designed for the more sophisticated systems without increasing the total volume of individual units. So an upsurge in the use of integrated circuits took place: the ubiquitous light bulb was replaced by light emitting diodes: l.e.d. followed by l.c.d. displays became a recognised means of presenting information; while conventional components became steadily smaller to keep up with the new techniques. At the same time, higher stability frequency sources and better i.f. filters became necessary in fixed, mobile and portable equipments as the need for higher performance developed.

Meanwhile, in the systems control field, processors began to take over many of the functions which had previously involved complicated manual operations. More facilities and information became available to the system controller, while, in the mobile, actions could, for example, be initiated from control or other designated points without the need for intervention by the mobile user.

Signalling. Signalling over radio gained considerable ground during the 1970s. Previously such requirements as selective calling were often considered to be refinements and were avoided where possible, usually on the grounds of cost and size. Solid-state techniques changed this view and selective calling units employing relays and often mechanical selectors gave way to units of but a fraction of the size and power consumption.

Unfortunately during this period the variations in signalling techniques increased in an alarming way, each manufacturer tending to develop his own form of coding with the result that compatibility became almost impossible. At present there is however a trend to standardise on a few of the better systems, mainly of the sequential tone variety. Even with the reduced number of variants, compatibility is still a problem and further standardisation would be advantageous.

A lot of work has been undertaken in recent years in digital signalling, generally of the order of 1200 bit/s. Various error detecting and correcting codes have and are being investigated to obtain higher coding efficiency and provide a good throughput of data. Such techniques may help in providing data communication at signal levels which in the past have been considered too low for error free data transmission. Digital signalling will undoubtedly be the answer to providing channel assignment switching, sophisticated selective calling, alarms, identity, printer drive, data display and many other uses. However, the low signal threshold achieved with tone signalling has yet to be equalled by any but very low speed digital signalling.

Microprocessors have enabled "intelligence" to be added to systems. The era of manual press-to-talk and the occasional channel change accompanied, where needed, by a selective call operating an electronic 'door bell' is now often superseded in the larger systems by intelligent switching functions where channel and routing procedures are performed automatically; hand shaking/identity routines are undertaken with complex control functions being processed, as well as many other technically complex operations. At the moment, microprocessors, although cheap, tend to be greedy in power consumption (n.m.o.s.). This may be improved in the near future by the use of c.m.o.s. and ultimately silicon on sapphire (s.o.s. m.o.s.). Microprocessors in portables where low consumption is critical may thus become practical.

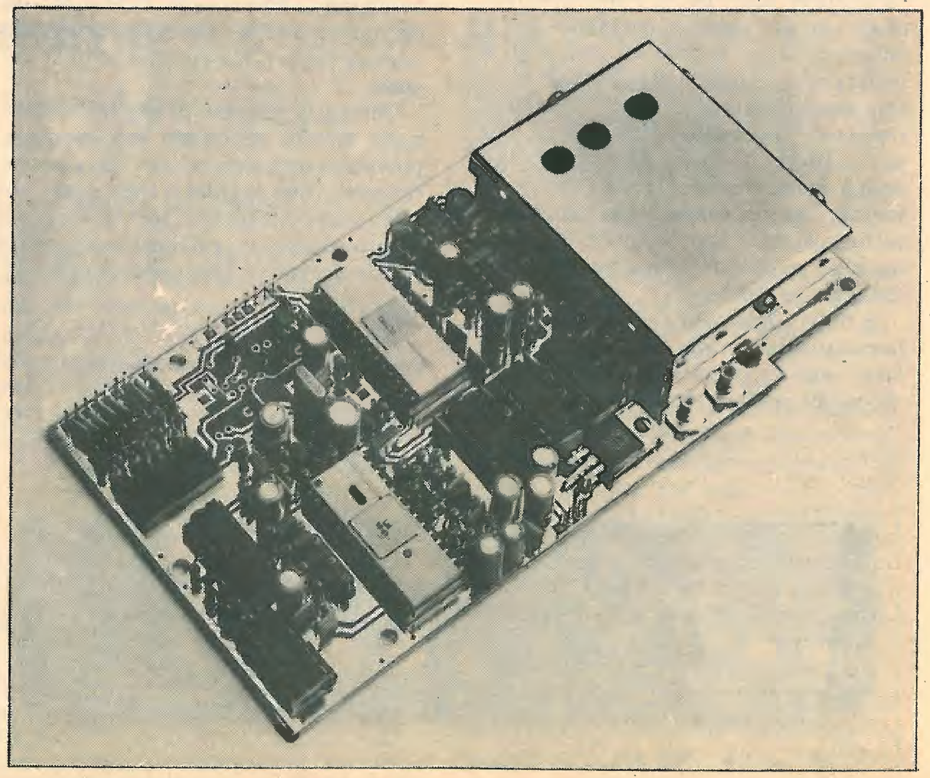
Trunking. Trunking in land mobile systems is a technique which has grown during the past few years with the help of the microprocessor. While the full advantages of such systems in frequency spectrum economy have yet to be seen, undoubtedly first indications are favourable. The use of trunking, however, can raise an operational problem concerning the ownership of the base complex, and this may limit its use to definite types of system where single ownership or the radio common carrier type of operation prevails.

Quasi-synchronization. System techniques evolved during the 1970s included the use of a quasi-sync — a method whereby a number of transmitters carrying the same intelligent radiate simultaneously without interference in a number of overlapping areas. Although as early as 1946 J. R. Brinkley proposed the use of staggere carrier techniques, this method ultimately became unworkable as the channel habdwidth was reduced down to 12½kHz. At these narrow bandwidths much closer staggering, of the order of a few hertz, is required, so that a need arose for high stability, low noise oscillator sources. The technique of quasi-sync is generally applicable to a.m. and f.m. at frequencies up to 500MHz although at v.h.f. the use of f.m. quasi-sync is subject to some reservations.

Frequency sources. The development of frequency synthesisers for mobile radio also shows signs of increasing in tempo as the need for greater frequency agility grows. Several designs have been announced using various custom built chips. It is just a matter of time before the cost of such devices is comparable with conventional crystals, even for one channel. Meanwhile frequency control has improved considerably by the use of a phase lock loop system and this is often standard on present day fixed receivers in the land mobile bands.

Modulation methods. Overshadowing many of the developments during the past few years has been the obvious rapidly diminishing spectrum space available for each new land mobile radio system. Much has been written on the,

This microprocessor controlled equipment generates and decodes selective calling tones. Providing alert, identification, status, alarm and other operating functions, it is compatible with all known selective calling systems.



Synthesizer board in the Pye M206X two-way radio can be supplied for anything from 16 to 128 channels.

subject and at the recent World Administrative Radio Conference in Geneva much was undoubtedly discussed.

Even if, as a result of all the decisions made, extra spectrum is handed to mobile radio, the rate of growth is such that economies must be made. To this end techniques are already being investigated to achieve spectrum savings and further bandwidth splitting by the use of s.s.b. is but one method currently under review. Others include spread spectrum methods, stored speech and the virtual elimination of speech by the total use of data in those applications where standard forms of message predominate. The latter methods are still in the early stages of investigation, but the development of s.s.b. is quite advanced and shows considerable promise.

Cellular systems. Much has also been written on the use of small cell techniques in urban area radio systems. In the United States, where a lot of work has originated, several systems are being put into operation at 900MHz using this principle. Although the cells involved initially in these systems cannot really be described as 'small cell', the possibility of sub-division exists and will undoubtedly be the subject of further investigation. Small cell systems are necessarily oriented towards processor control if all the functions proposed are to be implemented. Cellular systems and trunking have a great deal in common in many design aspects.

Energy sources. In spite of the huge variety of systems which have been devised over the past decade, one common denominator remains — that of the energy source required to drive the equipments. Vehicle units are generally no problem, there being a ready source of d.c. in the vehicle. Portables are a different matter insofar as, although a battery of a suitable type is included in the assembly, this must be either replaced or recharged after a period of work. There has been no outstanding design change during the past ten years which has increased the portable battery capacity appreciably or reduced its size, so this is one aspect where changes are required.

In fixed equipment the tendency has been to use secondary batteries charged from sources of energy ranging from the public power supply through diesel generating sets, wind and water driven generators, thermal generators to solar cells. All methods have their place in providing power to radio equipment. With the present energy crisis, further work is indicated, not only to find means of providing power in relatively inaccessible places but to do so using the minimum resources at present in great demand.

The next ten years

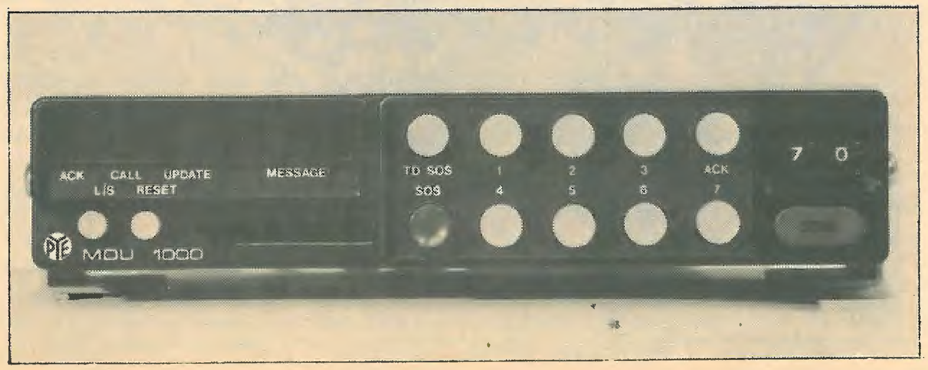
In view of the vast changes which have taken place over the past decade one is tempted to forecast the future almost in terms of science fiction. It is not my intention to examine such possibilities but rather to consider the more down-to-earth developments of existing techniques.

Data will undoubtedly appear as one of the main contenders for optimising usage of the frequency spectrum. While speech will be with us for some considerable time, particularly in the simpler systems, the efforts being made in the data field must be recognised. For example although there is a lack of economically viable vocoders suitable for digital speech at the moment, they will undoubtedly appear. Alternatively, stored speech controlled by a digital bit stream could well be a relatively inexpensive method of spectrum conservation. Speech synthesisers driven directly by computers are also likely. Good speech quality at real time digital speeds of 2 or 3 kbit/s now appears probable in the next decade. Bubble memory techniques permitting occupancy time reduction are, even now, a possibility, with available bubble memories capable of 10^6 bits/chip, one square centimetre in size, already available.

At present the rate of growth of data by digital methods is in excess of 20% per annum and is expected to maintain or even exceed this during the next ten years.

Obviously the use of digital techniques, spread spectrum for example, provides a high degree of privacy and at the same time enables a high degree of large scale integration to be employed — all leading to smaller equipments and, one hopes, greater power economy.

Two-way mobile data unit for use in a vehicle availability system.



The use of data processing methods to impart "intelligence" to a system is of course one of the most important aspects. Already microprocessors play a major role in the more sophisticated systems, as indeed they are beginning to do in many other areas of present day activity. The future holds an almost unlimited range of possibilities. Dynamic channel allocation, automatic transmitter power level adjustment to suit the propagation conditions and local interference level, automatic call routing, and many others are already in the pipeline, and every day sees a new requirement.

In spite of the digital revolution we must not forget the more conventional forms of mobile communications — forms which will undoubtedly remain in use for a long time, particularly in the simple system and in many of the overseas areas where sophistication is not necessarily needed at present. Here single sideband at frequencies up to at least 500 MHz could well provide all the channels needed until the end of the present century even in areas of international congestion — where, for economic reasons, several countries merge into a single overall area. It should also be emphasised that s.s.b. can also carry the simpler forms of data on equal terms with the more conventional a.m. and f.m. systems.

Portables will tend to become the more normal form of unit, although generally adaptable also for mobile use. Here again the use of data may modify the portable as we see it. For example, display methods may be incorporated to minimize standard speech messages. Key pads to send alpha-numeric messages will be of greater convenience than speech, in many cases, for example, in crowded environments where privacy is required. Similarly key pads will be used for routing the call.

The low efficiency of the portable antenna is another area for further development. However, it could well be that, rather than improving the ranges possible with portables, cell type systems will predominate and most fixed networks will consist of many low power stations closely spaced. Typically, if operation into the telephone is envisaged, the existing telephone call box could be used to locate individual fixed stations, the present physical spacing being close enough to permit very low power to be used. available power and easy connection into the telephone system favours such an approach.

All these innovations will inevitably increase the complexity of the portable, requiring more compact packaging if only to maintain the same size. Work must be undertaken on battery design if sizes are to remain as at present or preferably reduced in volume, while the extra consumption of the ancillary equipments means that increased battery efficiency is a 'must'.

With the ever increasing use of integrated circuits it is not impossible that the design of much of the radio circuitry will move from largely discrete components to both hybrid and monolithic i.cs. With this approach the basic radio equipment will tend to become stereotyped in design and specification, with only the overall packaging being different. The ancillaries, which will be determined by the system, will then be the part of the package which will highlight the individual units.

It is for these reasons that, although there is a desire to harmonize specifications in as many aspects as possible future advances may be inhibited by too great a degree of commonality as integration becomes more involved. The use of common designs, however, show up some advantages. Already we are at the point where 'throw-away' modules are often more economical if and when a fault develops. This practice could even extend to the complete unit, especially where the simpler type is in use. Even now for example, it is cheaper to buy another medium wave pocket broadcast radio than to repair it. It is only a short step to the more complicated mobile/portable transmitter/receiver unit.

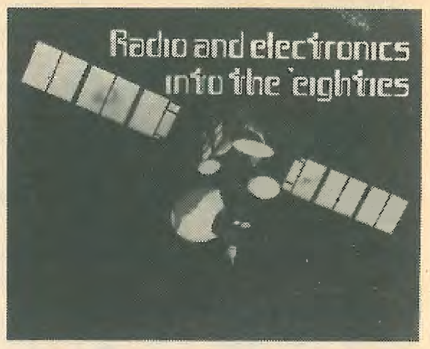
In the realm of power supplies, one hopes that there will soon be some breakthrough in the overall efficiency of batteries relative to size. Ultimately the size of portable units — in spite of increasing electronic complexity — must be reduced to a point where they can be 'worn' in an inconspicuous manner by the average person. Nevertheless, *very* small units are not really practicable at this moment for a number of technical and functional reasons.

Possibly a packet of 'king' size cigarettes is about optimum, although the present day 'credit card' calculator seems to be popular, and this format could well be considered in future personal radio designs. The 'king' size package has already been achieved in many types of pager, but of course the battery requirement here is quite different as there is no heavy transmitter drain.

Methods of charging batteries, whether the batteries are small in size and number, or are the larger types feeding a fixed station, are important aspects requiring further attention. In many parts of the world solar energy is the obvious immediate answer for powers up to a maximum of 500 watts. If efficiency could be improved, many other types of station could benefit, quite often saving expendable fuel.

In suitable areas the wind is already utilized as a source of electrical power and work on optimizing the energy conversion has produced good results. The energy in water movement, whether wave motion, tidal changes or just flow, also offer large scope for investigation.

Without any doubt, the future of mobile radio looks exciting. We must however, keep a firm grip on future developments to ensure that they do not fall into 'nice to have' category, but perform a real service to the world. Improved communication, saving of energy and all the other advantages likely to accompany the microchip era will undoubtedly gain momentum as we move through the years towards the next century. It is up to the engineer to ensure that the steps taken follow an ordered path. □



Broadcasting

by D. P. Leggatt B.Sc., F.I.E.E.

Engineering Information Department, BBC

One of the most striking features of the last decade has been the public appetite for high-quality audio. The 'hi-fi' was becoming a must in any modern household in the early 'seventies and by the end of the decade this had developed into the 'stereo.' While this movement has been led by the gramophone record, it represents a gratifying conversion to the gospel preached by the broadcasters since the introduction of v.h.f./f.m. broadcasting in the 'fifties, with the addition of stereo in the 'sixties. Public acceptance was slow to develop but at last there is wide appreciation of high-quality reproduction. Much recent development in radio broadcasting has been spurred by this public expectation: in the studios, stereo origination is becoming standard; on the distribution networks, high-quality digital p.c.m. systems are spreading stereo broadcasting throughout the country; the v.h.f. transmitter network is being extended; and experimental transmissions of quadraphony or surround-sound systems have been mounted. Although the majority of the radio audience still uses medium and long waves, the congestion and limited quality of reception on these bands has added further impetus to the swing towards v.h.f.

Another reflection of the healthy activity of radio in the last ten years has been the development of local and regional radio services. BBC Local Radio started in the late 'sixties, followed by Independent Local Radio in the early 'seventies. These did not bring new technical problems, but they did increase pressure on available frequency channels: indeed, we have now reached the point where the v.h.f. Band II is badly congested and frequencies have to be shared by programme services which really require channels to themselves.

Turning to television, the main areas of development in the past decade can be categorised as improvements in transmitted quality; extension of programme services; and improved facilities for programme makers. Improvement of picture quality is, of course, a continuing process as each generation of equipment succeeds the last, but one very obvious advance has been the spread of colour into the majority of all programmes with steady development in clarity, fidelity and consistency of colour picture generation and reproduction. Two other examples of technical quality improvement are worthy of mention: the introduction of almost distortion-free digital standard converters has brought significant quality improvements in the international exchange field; and the video noise reducer, a recent digital development, offers considerable benefits for programme material in general.

Programme services have been actively extended in the 'seventies. Notable developments have been the extension of u.h.f. transmitter coverage; the introduction of the teletext information services, Ceefax and Oracle; increasing use of satellites for international exchange; computer-based subtitling services for the deaf and for foreign films; the simultaneous transmission (on radio) of stereo sound with selected television music programmes; and, in the home, the availability of video cassette recorders for catching programmes which would otherwise be missed.

Improved facilities for programme makers should, and do, result in a wider range of better programmes for the viewer. The decade has seen much progress, including improved videotape recorders with sophisticated editing systems; instant replay and slow motion facilities; really portable cameras and video recorders for electronic news gathering; full-facilities outside broadcast cameras requiring only a single coaxial cable; zoom lenses of increased range and aperture; digital timing correctors and synchronisers for automatic signal timing; and digital picture stores for special effects and graphics work.

What, then, is the *zeitgeist* which has characterised the 'seventies? I suggest it is the realisation that with

transistors, large-scale integration and computer techniques, technical solutions can be devised for most problems. Increasingly, as time goes on, it will be economic, political and social factors which determine the course and pace of development. The questions for the future will more often be "how much do we want and what can we afford?" rather than "is it technically feasible?"

The next ten years

You want '100 Best Tunes' in the kitchen, so you pull out the telescopic aerial in your v.h.f. portable. For good results you need the aerial horizontal and angled for best reception; and in doing so you sweep three cups onto the floor! Then you find Radio 1 is taking its turn on the v.h.f. channel so you switch to medium wave. You find three or four stations transmitting serious music, so which is Radio 2? Eventually you hear Alan Keith's voice, but with an excitable Frenchman in the background plus crackles from your neighbour's electric drill. So there's nothing for it but down to the pub again!

This points the way to some main tasks for the 'eighties. We need more radio channels, signals which can be more easily received, and something to help us find the programme we want.

It is to be expected, following the World Administrative Radio Conference in Geneva, that more broadcasting channels will become available in the v.h.f. Band II. This will enable us to re-engineer the existing v.h.f. transmitting networks to avoid the necessity for sharing between BBC Radio 1 and Radio 2; to reduce the need for displacement of some Radio 3 and Radio 4 programmes by educational material; to cater for significat extensions of local radio services, ILR and BBC; and to increase the number and power of transmitters so that adequate signal strengths for reception on portables and in cars become available throughout most parts of the country. Further extension of the p.c.m. signal distributuion system will be a necessary ancillary to this transmitter development.

Experimental BBC radio receiver allows programmes to be selected digitally by a sensing pen drawn across bar codes printed in the Radio Times.

IBA's transportable 14GHz up-link to OTS satellite used for ITN broadcast from Wembley conference centre.

Towards the end of the 'eighties we may see the start of some direct transmission and reception of sound programmes in digital form. Although this may become the norm in the long-term future, current investment in conventional analogue systems is such that change to digital methods is not likely to be rapid.

Choosing a programme from the published schedules, selecting the right channel at the right time and tuning the receiver for optimum reception are becoming increasingly difficult for the average listener. Ideas are now developing for radio transmissions to carry coded identification signals inaudible to the listener but detectable by a suitable receiver. Given such codes, a receiver could be pre-programmed at the listener's choice to search for any desired programme — or type of programmes such as news, light music — and switch on at the appropriate time without the need for any manipulation or control by the listener. Such coded signals could also be used for automatic control of cassette recorders and to carry time information for electronic clocks.

New radio services we can expect in the 'eighties may include whatever form of surround-sound is finally agreed; and a dedicated channel of motoring information such as the BBC's Carfax development.

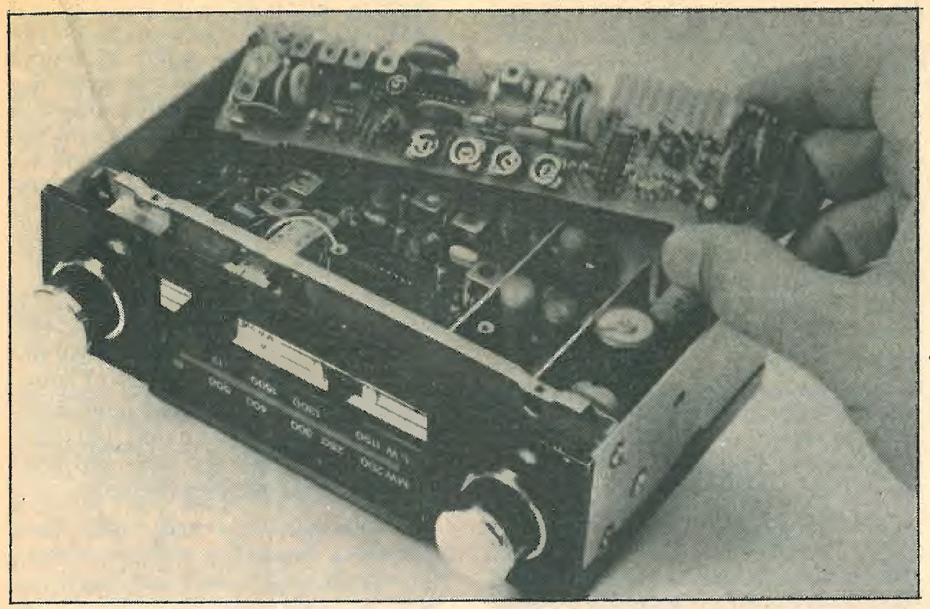
At the programme origination end, digital sound recorders will fairly soon be with us and will offer quality good enough for multi-generation work with little need for the careful alignment and maintenance which analogue recorders demand. Digital sound mixing desks will also appear, together with computer control of complex mixdowns from multitrack recordings which is already a facility in some recording studios and television sound dubbing areas.

Television. Although the solution to many technical problems can be foreseen, there are in television one or two areas where we need to tell our inventors "go away and make a breakthrough!"

The limited sensitivity of colour cameras is a case in point. Existing sensors are already approaching the region where photon noise — arising from the quantum nature of light — becomes the limiting factor. No new sensor, however revolutionary, can cross this fundamental barrier nor can we foresee optical devices of manageable size which would gather in many more of the limited number photons emitted by an ill-lit scene. The apparently much greater sensitivity of the human eye/brain combination is achieved by physical and subjective integration processes and it is down this road that useful investigation may proceed: the current development of integrating noise reduction equipment perhaps points the way.

In another area, colour camera sensors and receiver display devices employ rather cumbersome three-colour superimposition techniques with attendant disadvantages in terms of size, complexity and cost. A single colour pick-up device is wanted with outputs directly related to hue and luminance and no need for optical colour separation filtering; correspondingly a large area, flat display device is needed, responding to hue and luminance signals rather than relying on superimposition of three separate colour images. We must hope that the 'eighties will see a breakthrough in this area also.

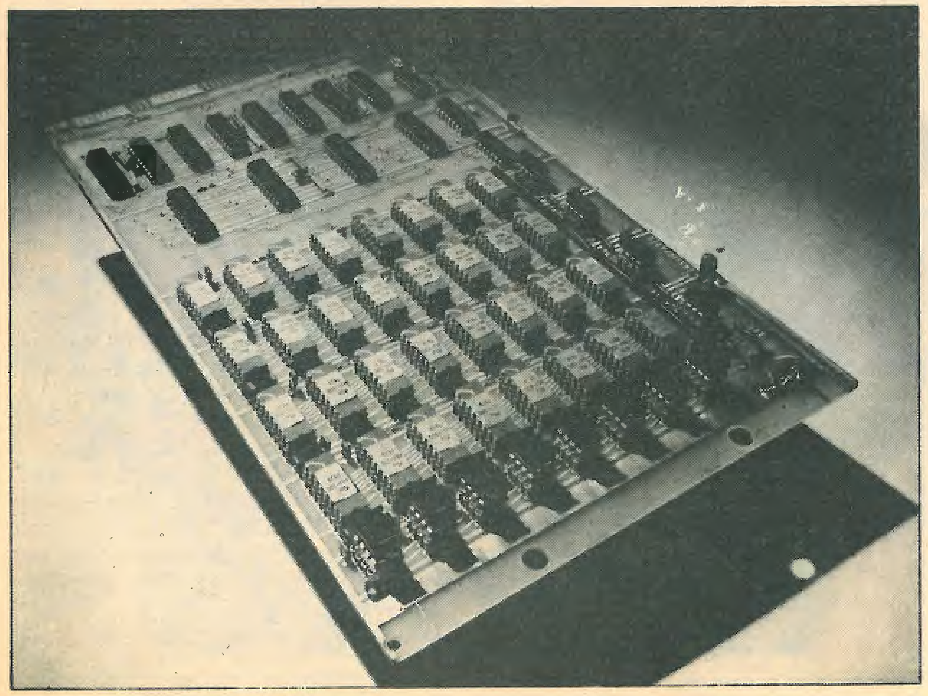
Turning to more foreseeable developments, work will continue through



Prototype Carfax receiver module. ▲

Teletext hard copy printer. ▲

2Mbit television field store based on c.c.d. devices, as used in digital standards converter and digital noise reducer. ▼



the decade to extend relay station coverage to yet smaller population groups in the UK, with community aerials and local wired distribution systems playing an important part. The fourth television channel will be with us and there may be increasing pressure for local television services. More channels will be needed and the u.h.f. bands may be extended to accommodate this; 405-line services on v.h.f. Bands I and III will be closed down and Band III at least is likely to be re-developed for extended, or new, television networks. Band I is not ideal for television and could be used for mobile services displaced from Band II and perhaps for the start of direct digital radio broadcasts. Television broadcasting via satellites — for direct reception at home or with local distribution from a number of ground stations — is being actively planned for some European countries, but seems less needed in the UK where conventional transmitter coverage is fairly comprehensive.

An alternative source of television programmes is the video cassette recorder. Already well launched in the 'seventies, its use for replay of pre-recorded material will become a significant factor in programme distribution in the 'eighties.

In the studios, programme makers will be looking for increased flexibility and reliability. These qualities are offered by digital techniques, by which signals may be stored, manipulated and passed between areas with little degradation or need for manual intervention. Already we have digital systems for special effects and graphics, standards conversion, noise reduction, source synchronisation, sound distribution, teletext services and numerous routing control functions. We can soon expect to see digital video recorders and editing systems, digital vision mixers and digital camera processing chains. Digital PAL coding will reduce very significantly the cross-colour effect which is perhaps the most obvious shortcoming of present-day colour television. For outside broadcasts we can look forward to compact cameras using highly integrated digital circuitry (and a single colour sensor?) with digital transmission via transportable satellite links into the network control centre.

The islands of digital operation now appearing in the chain will steadily be merged during the 'eighties. Once a signal has been converted to digital form there are many good reasons for keeping it that way until final conversion at the transmitter to the PAL coded analogue signal required by the domestic receiver.

For international exchange we shall find signals distributed in digital form, very possibly as luminance plus colour difference components; final coding into PAL, SECAM, etc. will be left to the individual customer countries. Accompanying sound will be digitally multiplexed with the vision signal, several sound channels being available for multilingual requirements. All this will require comprehensive national and international standardisation of digital coding methods, and much work in the 'eighties will be devoted to negotiation and argument on this front.

Teletext and similar services can clearly be expected to advance rapidly in the next ten years. The scope of the information provided can increase almost indefinitely, reasonably short access times being maintained by allocating an entire television channel to this purpose and by provision of further storage and processing in receivers. High-resolution graphics, still and animated pictures of full television quality, and increasing sophisticated subtitling services will become available. Telesfotware, the transmission via teletext of computer programmes, will greatly extend the variety of tv games and will provide the non-specialised computer services which increasingly we shall make use of in our domestic lives. Hard-copy printers will become available to give us permanent records of any desired teletext information and (though not perhaps in the 'eighties) this may become the medium by which we receive our copy of *Wireless World*.

As we move towards the 'nineties, we may see the first optical fibre data circuits run into private homes. In the longer term all radio, television, information and communication services will come to us 'on the fibre,' radiated transmissions being reserved for mobile applications where wireless communication is essential. Once we have our domestic wide-band circuits and high-quality large screen displays, the way will be clear for 'hi-fi' television on new standards. But it will not be in the 'eighties that we shall be closing down the 625-line services. □

Consumer electronics

by St John C. Jackson, Thorn Consumer Electronics Ltd.

The last decade has been one of rapid development in the different design areas of consumer electronics products making use of advances in electrical component availability and electrical engineering to entertain or make life easier for the majority of people, whose interest lies mainly in what such products will do rather than how they work.

There is perhaps one feature which, on looking back, makes consumer electronic products unique when compared with any other manufactured product. It is the fact that, despite the very real improvements and the ravages of inflation at the end of the 'seventies, on a like-for-like basis, products were cheaper at the end of the decade than they were at the start — in many cases in cash terms but without doubt in real money terms. A comparison of consumer electronics products shows that a 12in mains/battery monochrome portable tv cost around £55 (or 2 weeks average earnings) in 1970 and nowadays even with v.a.t. at 15%, the same two weeks' average earnings will almost buy a 14in portable colour tv. Similarly, the first electronic calculators retailed at over £200 — now for less than £10, a pocket calculator is commonplace and includes all or more of the functions of the earlier £200 machine. But the 'seventies also had their casualties — remember the 8-track cartridge, remember quadraphonic sound, remember Elcaset? Just to dwell on quadraphonic sound for a moment, possibly for the first time, technological advance overtook the ability of the market place to accept it. Whilst the electrical engineer could point to the benefits of quad, the same engineer forgot that the user didn't have four ears or, perhaps more to the point, his girl friend, mistress or wife was not prepared to accept four separate loudspeakers in the living room.

There was also a more fundamental point; the competing quadraphonic systems each required their own prerecorded software and because more time and effort was spent on selling the advantages of one system against the others, confusion reigned. For the future, it is important that product development is based on agreed international and common standards, but let's look at specific pocket areas and how they developed in the 'seventies.

* * *

With tv receivers now in 97% of UK homes (70% colour) it's right and proper to consider television first. In the early 'seventies, the transition was being made from hybrid chassis with a mixture of valves and transistors to all solid-state. With moves in this direction, styling improvements were made possible to reduce the overall size of the average television cabinet and chassis engineering moved towards modular construction.

Ultrasonic remote controls made their appearance, and were quickly accepted only to be gradually replaced by quicker-acting infra-red control systems. Whilst ultrasonic controls were more than adequate for the typical viewer of the late 'seventies who wanted to send simple commands to his receiver, the introduction of infra-red microprocessor-controlled systems is particularly relevant to the customer requirements of the 'eighties when

Music centre with digital frequency tuning (Ferguson 3951)

Teletext and Prestel are likely to be in widespread use.

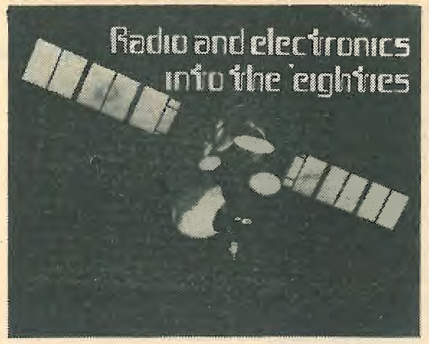
However, both of these great British developments with their data display capabilities are still in their infancy and the lack of average consumer awareness about their existence and what the services offer is an indication that it is not enough for the engineers to apply their minds and develop such powerful means of communication. Marketing people must do more to promote their benefits.

Probably the product area of the 'seventies which will have the greatest impact in the 'eighties is domestic video, both cassette recorder and disc. The late 'seventies saw the introduction of domestic video cassette recorders not much larger than conventional audio cassette recorders and almost as easy to install and use. The early recorders (of any format) relied heavily on mechanical control functions but already we are beginning to see mechanical operations replaced by electronics and especially microprocessor controls, but more of this later. The audio scene saw one overriding development — the growth in importance of the conventional audio cassette, aided by the world-wide acceptance of a common standard. Ten years ago, the available cassette hardware and software was still regarded as something of a novelty and not a serious contender to the established position of the quality record player and audio disc or open reel recorder. Developments such as noise reduction systems, improved drive systems and record/replay heads, software developments improving overall performance standards (with first of all CrO_2 tape and more recently the introduction of metallic tapes) have elevated the performance of cassette equipment and cassettes of ten years ago to a replay medium generally accepted even in serious hi-fi circles. Certainly the public have also accepted the cassette. At the close of the 'seventies, UK homes owned more cassette playing equipment than disc playing.

The development of low price, good quality cassette mechanisms made the music centre a practical proposition and without doubt this particular item was the audio home entertainment product of the 'seventies. The audio cassette is also the common denominator amongst those other products that during the period had greatest appeal for the public. Cassette and radio cassette recorders now sell at an annual rate of more than 2-million units per annum in the UK. The biggest growth area in the late 'seventies was quality stereo radio cassettes with automatic programming facilities and even Dolby Noise Reduction.

Cassette-based products have been so successful because they have two overwhelming advantages over their disc counterparts; the cassette can be re-recorded and the machine is easily portable, satisfying today's demand for music on the move. In-car entertainment products have also adapted to the higher ownership levels of home based cassette equipment so that today it is possible to have better quality audio sound in a car than was possible in most homes ten years ago.

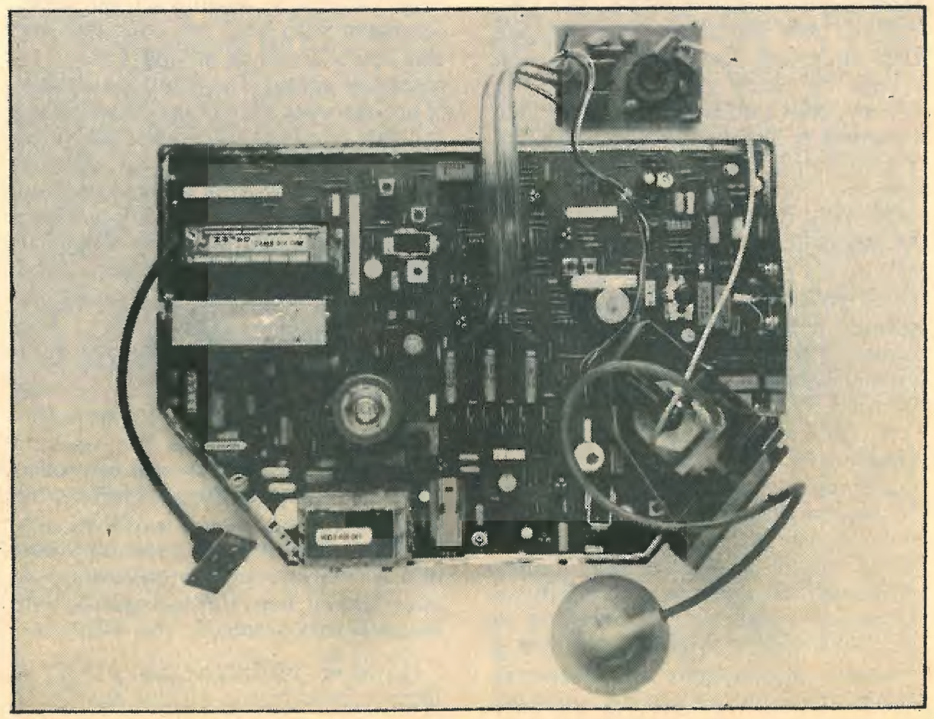
But enough of the past; it seems that the 'eighties will see most of the colour televisions acquired during the 'seventies replaced by receivers which, on the outside, may look similar (apart from the reduced number of function controls) but on the inside will bear very little likeness. The modular chassis of the 'seventies will increasingly be replaced by single board chassis de-



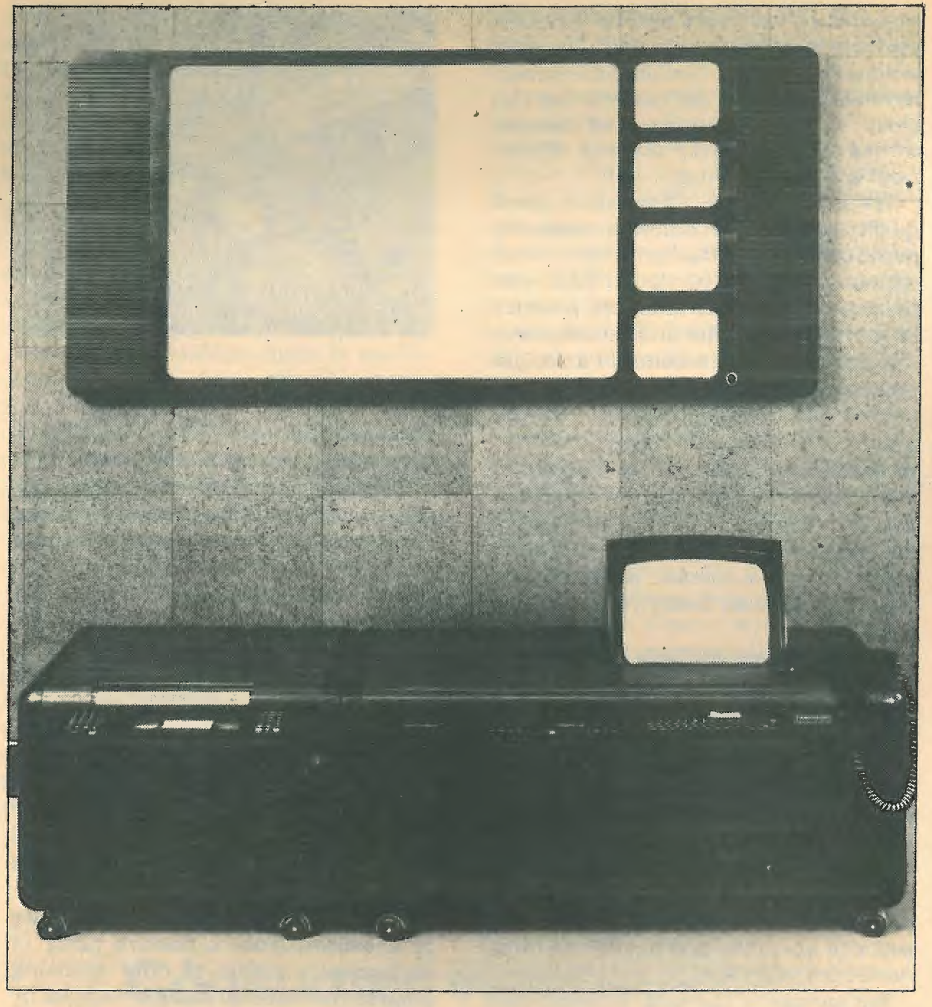
signed to optimize the availability of large scale integrated circuits (l.s.i.) and the application of microprocessors, remote control teletext and viewdata displays. The introduction of single board chassis will revolutionise not only product reliability but also the approach to servicing so that the service department of the 'eighties will look vastly different to that of the 'seventies. Today's cathode ray tube tehnology means that the television viewers of tomorrow will see demonstrably better pictures and data displays than have been seen to date.

Increasingly, tv receiver design will have to accommodate the requirements of home computers, video games etc. which are rapidly changing the nature of television from a passive piece of equipment capable of only showing programme material being broadcast by the BBC or IBA to a two-way, interactive display medium at the centre of a communications network. By the mid 'eighties, satellite broadcasting could become a reality, allowing the viewer a much wider choice of programme material. It is also reasonable to predict that voice-activated controls will begin to make their appearance, freeing the

Ferguson TX9 single circuit board colour tv chassis ▶

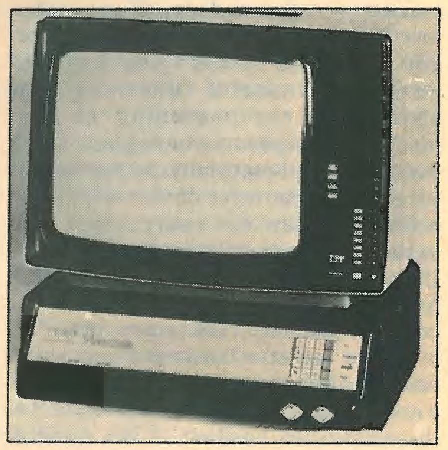


Personal computer by ITT is contained in the keyboard unit with floppy disc drive on left. Memory is up to 48K bytes of r.a.m. and 8K bytes of r.o.m. holding BASIC and a system monitor. ▼



◀ *Ferguson's forward-looking flat screen (with other station monitors) receiver, called "Total Television." Although this is just a dummy, most of its component parts are available as production items or on the development horizon.*

ITT TXV 16 viewdata terminal. The lower section contains an isolated power supply and the viewdata equipment while the upper section can function as either the viewdata display or as a "straight" 16in black and white tv receiver. ▼



viewer from the arduous task of having to press the control buttons of a hand-held remote unit!

But, as previously mentioned, the 'eighties will more than anything else be the decade of the widespread introduction of domestic video products. The VHS (Video Home System) format has quickly established itself as the best-selling video system in the world in all the major developed markets – the UK, Europe, USA and Japan – but despite this, other video formats are likely to be around for many years to come. The conventional format of the early video recorders is likely to change with the accent being on the portability of a recorder unit linked to a separate programmable tv tuner/timer which could be indispensable when satellite broadcasting is a reality. Indeed the situation could well arise that despite the increased leisure time available, video owners will be so busy recording programmes they will never have the time to replay them!

Already the introduction of the vidicon tube has made low-cost, good quality colour video cameras a reality. No one can doubt that the already high performance standards of today's products will be improved, real money prices will fall and the cameras themselves will weigh less and diminish in size. No wonder that with the arrival of electronic photography manufacturers around the world are getting out of the conventional cine 8 camera business as quickly as possible – they have seen the writing on the wall.

It is forecast that the ownership of domestic video cassette recorders will parallel the early growth of colour tv in the UK. By 1984 at least 7% of UK homes are expected to have acquired one. They will be used mainly for time-shift recording and the replay of home-made video movies at around £5 per hour, compared with £100 per hour plus for cine, the difference adding greatly to consumer appeal. The additional appeal of pre-recorded video cassette software will pale into insignificance when video disc players with their lost cost software become a reality. One thing is certain; the incompatibility of the various video disc standards that are likely to appear will be a much more serious factor than with the present ones surrounding video cassette recorders. The availability of disc software will be a critical factor on three counts:

a. without the appropriate software the disc player itself is useless.

b. questions related to the low cost production of video discs still have to be resolved.

c. material for reproduction on video disc is likely to be surrounded by a minefield of copyright issues which have still to be resolved.

However, the video disc player is likely to lead to the further demise of the conventional audio record player because despite the name "video disc," all video disc players give the capability of very much improved audio-only replay, making possible a signal-to-noise ratio in excess of 90dB through the use of p.c.m. recording techniques. So looking ahead, any audio disc system that does not include a video replay mode is likely to find the going a bit tough.

So far no reference has been made to monochrome television receivers which, as the years pass, are likely to become increasingly less attractive as potential purchasers accept colour tv viewing as the norm. On the other hand it is not unreasonable to suggest that the youth of tomorrow will look at television in the same way that today they look at radio and the cassette. That is, they will want to take it with them wherever they go. Therefore (and with continuing miniaturization) today's combination tv products either with radio, or radio and cassette, are likely to become more and more popular. Audio products either mains-only, portable or "in-car" will become increasingly cassette-based as the youngsters of today become the purchasers of tomorrow. This is a generation to whom the cassette is not something new and the majority look upon their parents collection of 78, 33⅓ and 45 r.p.m. discs with the same degree of interest that Arthur Negus looks at 17th century

antiques. Further improvements in cassette hardware and software, because of the introduction of p.c.m. recording techniques, will be readily accommodated on the conventional audio cassette format.

In looking at the 'seventies, little was mentioned about radio, not deliberately, but because with the expansion of f.m. stereo broadcasting that has already taken place, no great changes are anticipated. Certainly, in looking ahead it is expected that pre-set tuning facilities will appear in all but the most basic of radio products. Synthesized tuning systems will undoubtedly make their way down the market into more basic products and digital tuning frequency displays will become standard.

To many people, the radio is still a very important vehicle for keeping in touch with the outside world and with broadcasting putting the emphasis on news and general current affairs, the radio will increasingly take the place of more conventional sources of information, for example, newspapers. News is of great value in the car, and travel information systems, such as the BBC's pilot testing of Carfax, will be a practical expression of advances in electronics applied to real consumer applications, particularly as such systems can lead to real time and energy savings. Citizens' band radio has received enough recent publicity and (regardless of its merits or drawbacks) at the end of the day the outcome will be decided by politicians and civil servants rather than engineers, marketers or even public demand.

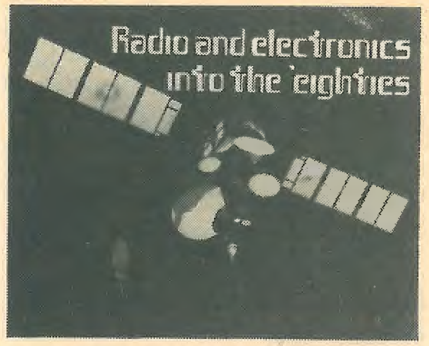
Home video computers and programmable video games will be areas of dramatic growth in the 'eighties but initially confusion about base technologies could prove a deterrent factor. Certainly one of the best money-making opportunities in the 'eighties will be in providing the software programming facilities in support of the expanding range of hardware in these two product areas.

So where does this quick review lead us? Very simply, to many new and exciting product areas capable of providing new business opportunities and the ability to keep a continuous flow of new products available to customers to help and entertain them. Not all of these new products will be instantly accepted and one major problem will be in the retail store where the salesman will have to assimilate a lot of new technology if his or her traditional role is to continue.

The degree of product knowledge needed to demonstrate and sell a home computer calls for a different person to the one currently selling a mains/battery cassette recorder. Service engineers too, are going to come across a lot of advanced new technology in the products they will be looking at on a day-to-day basis.

Beyond the 'eighties?

Quite recently Ferguson had an experimental look at the home entertainment centre of the early 1990s. The result was a concept called "Total Television" which included in a domestic console unit, a VHS electronic cassette recorder, floppy disc machine, electronic audio cassette, Prestel/home computer keyboard and videophone with remote control of all viewing functions. The conventional c.r.t. was replaced by a wall-mounted flat screen including four monitor screens to take account of the multiple screen viewing that might be a requirement of the future. A dream? Well apart from the sorting out of problems related to the flat screen the other features of the unit



are either with us today or at least a large scale manufacturing possibility.

Only time will tell how close to reality the ideas of the late 'seventies will be at the end of the 'eighties. □

Radio navigation and radar

by D. W. G. Byatt, B.Sc., F.Inst.P., F.I.E.E., GEC Marconi Electronics

The fields of radio navigation and radar cover a broad range of constantly changing techniques, and are influenced by advances in computers and military systems.

With both these topics, we are interested either in where we are, or where someone else is. The system may rely on transmitting or receiving signals at a known location or vehicle in question (ship or aircraft). Almost every permutation and combination of these alternatives has been investigated over the past fifty years or so.

In moving a vessel from A to B some basic form of dead reckoning and position plotting should be maintained and in ships in particular, traditional methods using the sextant, chronometer and compass are fundamental to good navigation. In the air, long-haul aircraft frequently rely on inertial navigation, again based upon the gyro, and indeed ships also use this type of navigational aid. However, we are here primarily concerned with radio aids and radar, and in very many ships, in aircraft and at airfields, the ubiquitous direction finder (d.f.) is used, and is sometimes the only form of aid. In fact, both radar and radio navigation can trace their ancestry back to the simple d.f.

The adoption of new equipment in civil aircraft and ships is inevitably limited by financial constraints; every piece of new hardware proposed for a ship or aircraft must be justified in terms of cost effectiveness. This means that adequate, well-proven techniques and systems tend to have a very long operational life. Nevertheless, if rapid, accurate position-fixing can shorten journeys and minimize delays, then in a period of increasing fuel costs, new equipment capable of providing this must become more readily acceptable.

Safety at sea and in the air is, of course, vitally important. At sea, minimum safety requirements are recommended by the International Maritime Consultative Organization (IMCO) primarily for vessels above 300 tons, although the country in which the ship is registered legislates for this – in the UK, it is the responsibility of the Department of Trade. In the air, the equivalent authority is the International Civil Aviation Organization (ICAO).

Direction finding

Before dealing with some of the more recent developments in navigation aids, the current state of d.f. is worth examining. There are three major areas of common commercial usage, air-to-ground, ship-to-shore and ground-to-air. There are other military applications, but for general navigation the major advances have been in improving the equipment. A typical marine automatic direction finder, in common use, covers the m.f. beacons in the band 250-550 kHz and also operates on the international distress frequency of 2182 kHz. This equipment is as simple to use as a domestic receiver, gives automatic ambiguity resolution, the bearing of the station being read directly from a compass-type scale, typically to within ±1°. Because of the relatively short range of reliable bearings, ship navigation by d.f. is mainly confined to coastal waters; in the consumer field, many thousands of simple direction finders are in use in modest sailing boats and motor cruisers. The situation with airborne d.f. is similar to that for ships: most aircraft carry one and the accent is on automatic operation. The frequency band is typically 190 to 1800 kHz. The size of the antenna loops have been reduced and contained in stream-lined bumps to reduce air drag. In many parts of the world a.d.f. is still the primary source of navigation information, which in areas with good reception can provide a bearing of ±1°.

Ground-based direction finders require only the minimum of a communication set in the aircraft to provide a position line, so that if all else fails, navigation assistance can still be provided. These direction finders mostly operate on v.h.f./u.h.f. and in order to minimize the bearing errors from all causes, antenna arrays are multi-element, frequently wide aperture and automatic in operation, with direct-reading bearing presentation. Most locations can provide ±1° accuracy on signals of reasonable strength.

A short-range navigational aid closely allied to d.f. is the v.h.f. omni-range (VOR) which, when associated with a distance-measuring equipment (DME), gives aircraft a precise location. The range limitations caused by operating at v.h.f./u.h.f. (108-118 MHz for VOR and 960-1215 MHz for DME) make this system unattractive for ships.

Hyperbolic systems

Measuring distances from known ground radio stations is a well established navigational aid. Hyperbolic systems are so called because the position lines they provide from such measurements are hyperbolic curves. Referring to Fig. 2, if T_1, a transmitting station, emits a short pulse, and transmitter T_2 simultaneously emits a second pulse, then any receiver on line A-B will receive these pulses together. Positions at which one pulse is delayed by a given time with respect to the other lie on one of the hyperbolae. The association of a third transmitter would provide two position lines and therefore a fix.

One of the best known pulse systems is Loran 'C' which operates on a frequency of about 2 MHz and covers large areas of the Pacific, Atlantic and Europe. During the last war, a similar British system known as GEE operated at v.h.f. With a good ground-wave pulse, position accuracies of better than one mile in 100 miles are possible but, as with many long-range navigational aids, ionospheric sky-wave propagation can produce errors an order of magnitude larger, and considerable skill is needed to interpret results in adverse conditions. The Decca system, operating at around 100 kHz, also became established during the second world war. This uses c.w. signals and phase measurement to provide position lines and fixes. Very many ships and aircraft carry Decca, which has been considerably refined over the years to overcome propagation and ambiguity problems, so that automatic plotting on route maps is now generally in use,

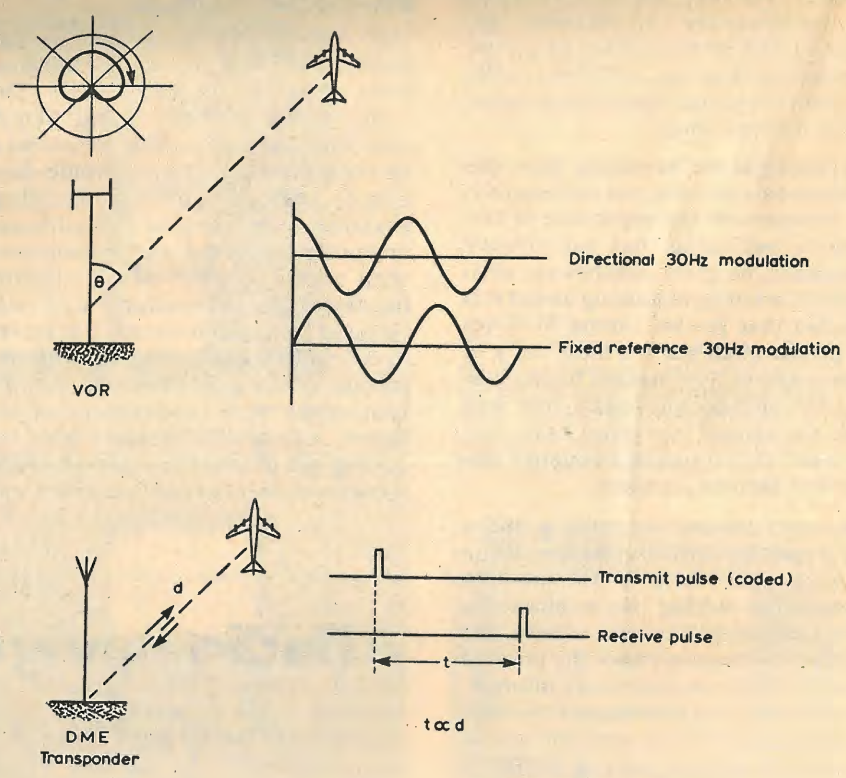


Fig. 1. V.o.r./d.m.e.

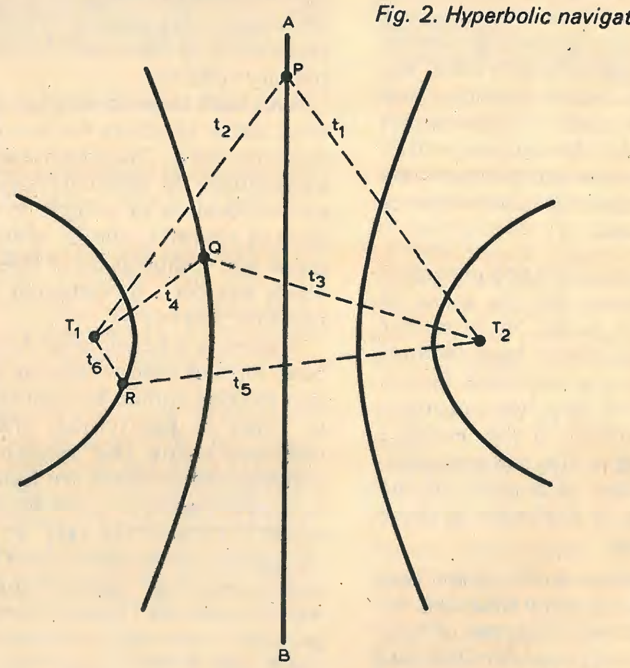


Fig. 2. Hyperbolic navigation

giving accuracies of fractions of a mile.

A system of increasing importance, which is designed to minimize range and propagation problems, is Omega. This operates on very low frequencies (v.l.f.)—typically 10-14 kHz—with inter-station baselines of around 5,000 miles. The very low frequency provides long range, stable and predictable propagation characteristics and the large separation between stations means that position lines are almost parallel over very large areas. Omega is a c.w. phase-comparison system and is virtually the only radio navigation system that can be used by completely submerged submarines.

A typical marine Omega receiver incorporates four channels for continuous monitoring of four transmitters, each channel measuring the phase of the signal relative to an internal high stability reference oscillator. Phase difference can be measured to one-hundredth of a cycle, defined as centi-lanes. In use, the receiver is run continuously from leaving port, automatically logging the lanes. It takes about half an hour to cross one lane, and modern equipment provides direct

Fig. 3. Doppler navigation — airborne equipment — 1980 model AD660 compared with designs of the '50s (left and '60s (right).

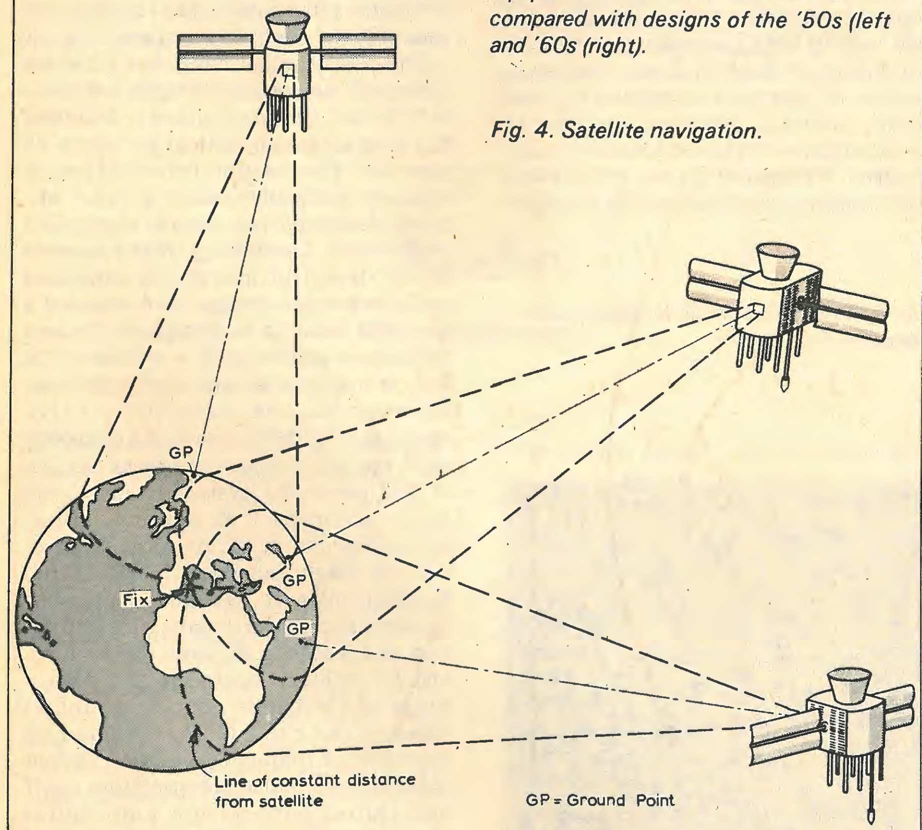


Fig. 4. Satellite navigation.

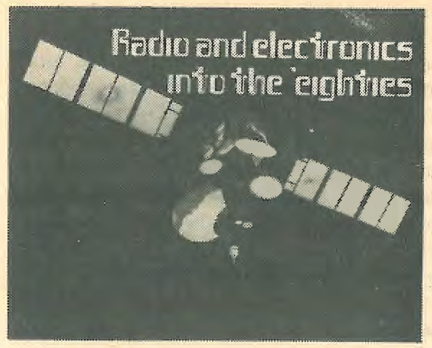
read-out of position. World cover is achieved with eight Omega stations.

For aircraft use, initial problems arose with antenna design for such low frequencies: a further difficulty was the high speed of lane crossing. However, advances over the last few years have led to an increase in the use of Omega for aircraft, current equipments providing automatic operation with 95 per cent errors less than 3 nautical miles.

Terrain-reference navigation

The Doppler navigator provides an aircraft with means for measuring the frequency shift of a radio signal reflected from the ground. With no drift and for a radio beam transmitted at a forward angle θ to the aircraft horizontal axis, the Doppler frequency shift $= (2V/\lambda)\cos\theta$ Hz. Thus, the Doppler shift can provide an accurate measure of the aircraft ground speed, V.

If two beams are radiated downwards at an angle to the forward direction then it is possible to measure the sideways motion or drift of the aircraft. Note that the Doppler shift is also proportional to the cosine of the vertical angle of the beam, hence antenna sys-



tems must be horizontally stabilized or a further pair of beams arranged to point aft to provide a differential signal, independent of attitude.

The Doppler itself gives ground speed and drift angle: to determine location, accurate heading information must be provided to the navigation computer. Most Doppler systems operate at microwave frequencies around X-Band (3 cm) and are sufficiently refined to drive an automatic map reader, or feed an integrated navigation system. Overall accuracies of one or two per cent of distance flown can be expected.

Sonar Doppler operating on similar principles is increasingly used by larger ships, and mariners also use depth sounding to augment their position fixing, particularly near harbour.

Airborne radar systems giving very high azimuth resolution and known as synthetic aperture radar (s.a.r.) can be used for navigation by map reading the high quality returns. The high resolution is obtained by simulating the radiation as from a wide aperture antenna by storing and recombining the individual signal elements from a small antenna as the aircraft carrying this small antenna moves along its track.

Similarly, by storing the height of the terrain along or adjacent to your own desired flight path, and comparing actual height from a radio altimeter, positional information may be obtained using correlation techniques.

Satellite navigation

NAVSTAR or Global Positioning System (G.P.S.) is designed to give very accurate position and velocity information anywhere in the world. The full system is intended to include 24 satellites in three orbits, giving visibility of 6 to 11 satellites at 5° or more above the horizon from any location on the earth's surface.

The basic method of position fixing by means of satellites is similar to celestial navigation except that distance, rather than angle provides the basic data. Fig. 4 shows the essential components of NAVSTAR. The height of the satellite is accurately determined, the earth's radius is known and the range is measured by timing radio signals from the satellite. In three dimensions, the range line traces a circle upon the earth's surface giving an observer position line. Two such lines give a location fix, and three are needed for an aircraft to include its height.

Signals are transmitted on two L-band frequencies, 1227 MHz and 1575 MHz, containing identification and the navigation data for the user to compute his position. This includes information on the status of the satellite, orbit details to enable the user to calculate the position of each satellite at the time of transmission, time corrections and propagation delay corrections.

High accuracy can only be achieved by precise synchronization of the satellite clocks with each other and the user clock error must be known or corrected; each space vehicle carries an atomic frequency standard which is corrected at least daily with a caesium clock at the master control ground station. In terms of accuracy one nanosecond of time error is equivalent to 0.3m range error.

The concept of navigation by satellite is simple. In practice however, for a worldwide system, a number of space vehicles must be maintained in accurate orbit, constantly updated for time and position. The user equipment includes a microwave antenna and receiver, together with a comprehensive navigation computer. Nevertheless, advances in microwave and microprocessor devices have made possible a range of receivers for ships, aircraft and missiles, and even a 10kg manpack, which will locate position to within about 10m. At present, GPS is in the validation phase I – about six satellites are in operation. Phase II is the period of development for military use, primarily in the USA, and this phase will end in 1982. True production of an operational system will take place between 1984 and 1987. Thus, one can expect that it will be the latter part of the '80s before NAVSTAR can be considered a truly universal worldwide navigational aid.

Radar systems

There is an enormous variety of radar equipments and techniques, ranging from small boat sets, to large ground military complexes.

Radar is frequently used for navigation, especially by ships, but here I would like to discuss a few recent innovations affecting the big system design philosophies.

A simple, basic, airfield-based surveillance radar locates an aircraft by rotating a continuous train of pulses in a transmitted radio beam, narrow in azimuth, and measuring the time of flight of the pulses reflected from the aircraft. The aircraft position is usually displayed on a cathode ray tube or plan position indicator (p.p.i.) in the form of range and bearing from the radar antenna.

There have been considerable developments in radar techniques since the last war to help controllers cope with increased air traffic. Early improvements integrated computers and alpha/numeric labelling systems to automatically track and identify target returns. Extensive signal processing and moving target indication circuitry

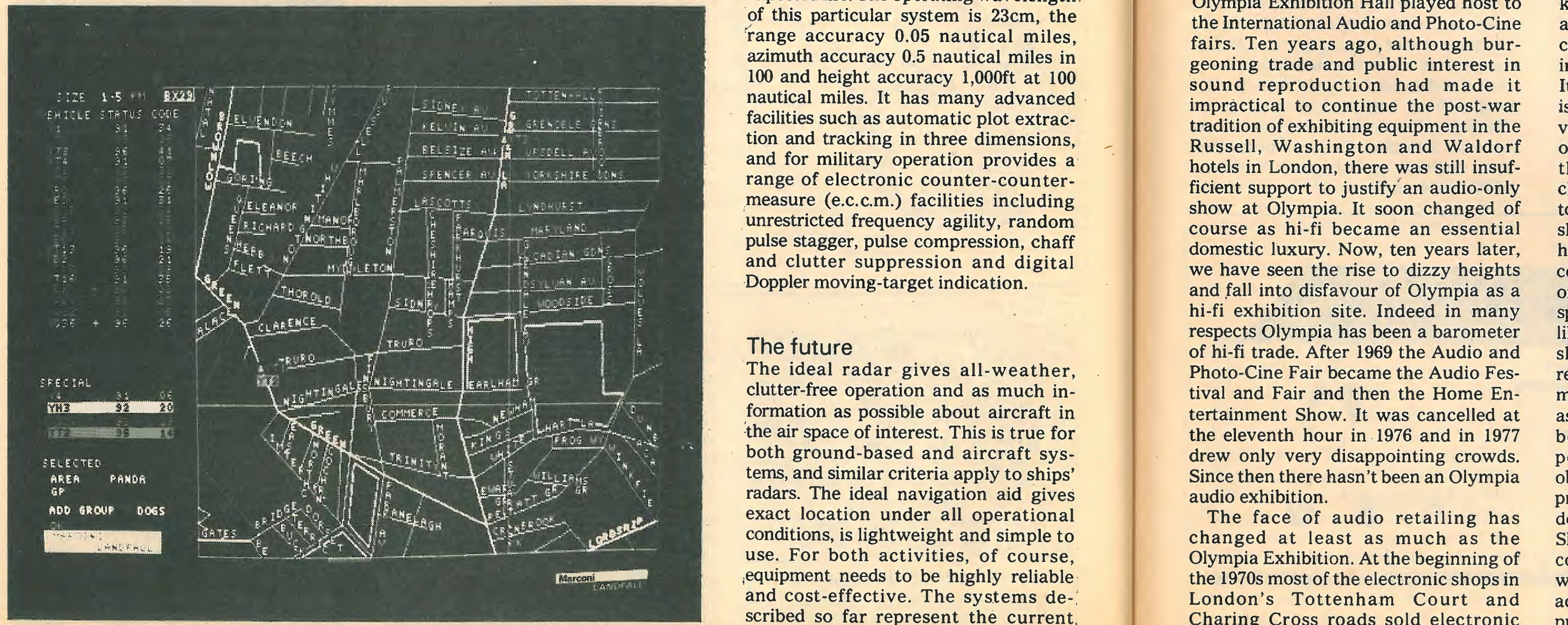


Fig. 5. Automatic vehicle location, base station v.d.u.

(m.t.i.) have overcome many problems of false returns and clutter obscuration.

Perhaps two of the more recent major improvements in ground radar have been the growth of secondary radar for air traffic control and the evolution of the 3-D radar for military use.

In hostile conditions the ability to observe enemy aircraft without their co-operation is obviously useful, but for aircraft which are both co-operating and controlled, the addition of a transponder confers useful advantages.

Secondary surveillance radar (s.s.r.) is similar to the military Identification Friend or Foe (i.f.f.) developed during the war to protect friendly aircraft. S.s.r. works by sending a radar pulse from an interrogating transmitter. This pulse is received aboard the aircraft by a transponder and retransmitted on a different frequency as a group of coded pulses, which include aircraft identity and a height reading from the aircraft's altimeter. The equipment is normally mounted on the primary radar and the signals from s.s.r. are either displayed directly on the radar p.p.i. for identification purposes or separately processed in the computer system.

The classic radar with the rotating beam will not provide height information; in fact, the beam shape is designed to cover as much vertical air space as possible. For height information, a separate vertically-scanning radar antenna was employed, usually controlled on demand. Continuing improvements in the design of microwave antennas and component design have enabled a new 3-D radar to be designed. Modern techniques enable such a system to be fully transportable and highly reliable; for example, the transmitter valve operates at 3.3MW to provide a 10,000h expected life. The operating wavelength of this particular system is 23cm, the range accuracy 0.05 nautical miles, azimuth accuracy 0.5 nautical miles in 100 and height accuracy 1,000ft at 100 nautical miles. It has many advanced facilities such as automatic plot extraction and tracking in three dimensions, and for military operation provides a range of electronic counter-counter-measure (e.c.c.m.) facilities including unrestricted frequency agility, random pulse stagger, pulse compression, chaff and clutter suppression and digital Doppler moving-target indication.

The future

The ideal radar gives all-weather, clutter-free operation and as much information as possible about aircraft in the air space of interest. This is true for both ground-based and aircraft systems, and similar criteria apply to ships' radars. The ideal navigation aid gives exact location under all operational conditions, is lightweight and simple to use. For both activities, of course, equipment needs to be highly reliable and cost-effective. The systems described so far represent the current state of development and undergo continuing refinement towards these objectives.

One must, however, differentiate between military and civil use. Co-operation-dependent systems, such as those based upon satellites or global transmitters, could well be vulnerable in times of national conflict. Probably the self-contained navaid is least open to this sort of criticism if high accuracy at reasonable cost can be sustained.

One can fairly safely predict that semiconductor microcircuit advances will continue to affect radar and radio navigation developments in a very significant manner. Digital processing and storage are already leading to new concepts in system organization and complex error corrections not previously feasible.

Miniaturization of the newer solid-state, microwave power sources and other components leads to new applications. One example is for location and control of road vehicles, increasingly important for large, commercial fleets or public utilities in these times of energy problems and rising fuel costs. The display shown in Fig. 5 us of part of the area of a map of London, where the characteristics of each road junction are stored in a computer in the boot of a car for automatic position fixing.

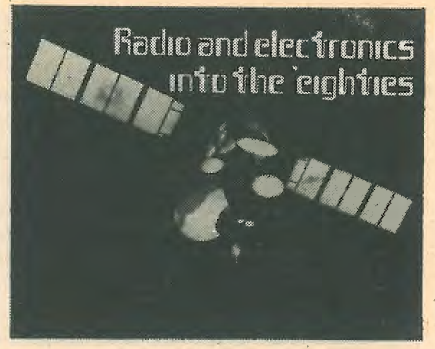
A further example is in radar developments which are making feasible static antenna arrays where each element of the array is effectively a miniature transmitter/receiver and the beam is electronically rotated or selected. One such system, known as bi-static, can use a separate transmitter as an illuminator, with several spaced receiving systems using multi-beam static arrays. Such a system could provide enhanced protection against noise, interference and signal fluctuation.

The US Air Force hopes to deploy a 600ft diameter radar in earth orbit by 1985, using the space shuttle. This could be used for tracking ships, aircraft, cruise missiles, inter-continental ballistic missiles and even armoured vehicles on the ground.

The author thanks the technical director, GEC-Marconi, for permission to publish this article.

Further Reading

"Navigation Systems" G. E. Beck. Van Nostrand Reinhold 1971. *Journal of Inst. of Navigation* Vol. 25 No. 2 1978. "Radar Handbook" M.I. Skornik, McGraw-Hill. □



Audio

by Adrian Hope

BACK IN the early winter of 1969 the Olympia Exhibition Hall played host to the International Audio and Photo-Cine fairs. Ten years ago, although burgeoning trade and public interest in sound reproduction had made it impractical to continue the post-war tradition of exhibiting equipment in the Russell, Washington and Waldorf hotels in London, there was still insufficient support to justify an audio-only show at Olympia. It soon changed of course as hi-fi became an essential domestic luxury. Now, ten years later, we have seen the rise to dizzy heights and fall into disfavour of Olympia as a hi-fi exhibition site. Indeed in many respects Olympia has been a barometer of hi-fi trade. After 1969 the Audio and Photo-Cine Fair became the Audio Festival and Fair and then the Home Entertainment Show. It was cancelled at the eleventh hour in 1976 and in 1977 drew only very disappointing crowds. Since then there hasn't been an Olympia audio exhibition.

The face of audio retailing has changed at least as much as the Olympia Exhibition. At the beginning of the 1970s most of the electronic shops in London's Tottenham Court and Charing Cross roads sold electronic components, along with construction kits and a smattering of ready-built audio equipment. Almost all had one characteristic in common: undisguised impatience with the average customer. It was, I suppose, understandable. There is little profit to be had from testing a valve or advising an amateur constructor on why a resistor has burned out. Soon the names of the shops started to change, for a while almost exclusively to Lasky. Profits increase because the shops started to concentrate on selling hi-fi equipment, to the exclusion of components. By the mid-seventies anyone asking for a fuse, a resistor or a spare part could expect to be treated like a mad leper in all but a very few shops. Gradually the public became reconciled to the idea of buying equipment in a cardboard box from a shop assistant who might just as well have been selling washing powder or potatoes. The main culprit, some observers argued, was the end of resale price maintenance and the consequent declaration of a competitive price war. Shops selling at cut-to-the-bone prices could not hope to offer anything in the way of before and after sales service or advice. Some dealers stuck to higher prices but offered service into the bargain. Inevitably some customers took free advice from the high price dealer and then bought the recommended product at cut price in a cardboard box from a warehouse dealer. Between these extremes some dealers, both in London's golden mile and elsewhere in the UK where the golden mile image had spread, offered intelligent advice and reasonable service at a low price. Others offered neither service nor advice but at high price.

It was inevitable that the bubble would eventually burst. There comes a time, especially when money is short, when a householder with an adequate sound system will no longer go out once a year and buy a replacement. There comes a time too when the public, working hard for their money, start to resent the need to junk relatively new equipment for the want of a single spare part that proves unobtainable, or at least an expensive nightmare to procure. It is no secret that now, at the end of the decade, the audio trade is in bad trouble. Spare cash now, and there is clearly less of it around, goes toward a video recorder or a second colour tv, not a new stereo amplifier, record turntable or cassette recorder to replace a perfectly adequate system which is still giving faithful service.

The Olympia barometer of hi-fi is not however to be taken as gospel. Although Olympia is no longer the site of an annual audio exhibition in London, other shows flourish. The sad truth is that Olympia now has a bad name in the audio world. Exhibitor firms have suffered once too often from what they euphemistically refer to as "union problems," but which in less euphemistic terms means spending many tens of thousands of pounds to exhibit and finding the stand unfinished on opening day. It's also a barn of a place, in many respects the unideal venue for audio demonstrations. But smaller shows in hotels in and around London have always left some exhibitors or visitors dissatisfied. One year in the mid-seventies there were two rival shows at two Heathrow hotels running in parallel. An autumn 1979 show in London was cancelled at the last minute through lack of trade support. Currently, perhaps rather curiously, the major UK show is the annual exhibition held at Harrogate in Yorkshire. The fact that so many of the trade, press and public are prepared to venture so far north into the provinces as to make Harrogate an annual success, while declining to give sufficient support to make a London show viable, is surely the audio phenomenon of the decade.

Another phenomenon of the decade has been the rise, and occasional fall, of so many audio and hi-fi publications. At the beginning of the decade there were just two specialist hi-fi magazines. Both had a fairly staid outlook. Then the first of the breakaway "glossies" appeared followed by a string of several more. After various changes of ownership, a few bankruptcies, and several changes of title and direction the market now appears stable.

One theory is that the current misfortunes of the trade are partly due to the boom in hi-fi journalism. The argument is that enthusiasts, with limited money, are now content to read about new developments and leave buying them to someone else. Whereas magazines like *Playboy* and *Penthouse* work on the assumption that readers are interested mainly in vicarious thrills, the hi-fi industry has so far assumed that a stimulating article on audio will stimulate sales of the product described. As a result they have continued to keep the magazines in business by using them as an advertising vehicle. (It is easy for the lay reader to forget that although reputable magazines try hard to ensure that editorial content is not influenced by advertisers, every magazine relies on advertisements for commercial viability). Although the hi-fi magazine market now seems to have stabilized, with all those publications currently on sale likely to remain so, it is highly unlikely that any new hi-fi magazines will now appear.

Perhaps the most notable overall trend of the last decade has been the massive influx of Japanese electronics equipment, moving towards almost a total market domination in some areas. At the 1969 Audio and Photo-Cine Fair there was just a handful of USA exhibitors, notably ADC, Shure and Koss. From Europe (excluding Britain) there were 15 exhibitors, including Agfa, Arena, B & O, BASF, Dual, Grundig, Luxor, MB, Mikrofonbau, Ortofon and Peerless. From the UK (excluding the BBC, and several magazine and book publishers) there were over 40 companies of which only a very few were importers. Among the British names showing were Brenell, Bush, Colton, Decca, EMI, Ferguson, Ferrograph, Ferranti, Garrard, Hacker, HMV, Leak (then still of Brunel Road, London, W3), Lowther, Lustraphone, Mullard, Dansette, Philips and Sinclair. These were in addition to currently famous names such as Armstrong, B & W, Celestion, Connoisseur, Goldring, Goodmans, KEF and Quad who were all already well established. From Japan, and often with very low profile, came just 14 exhibitors. Of the Japanese firms, Yamaha was showing just loudspeakers and cabinets but Trio offered a full range of amplifiers and tuners and Toshiba, Sony and Sanyo offered tuners, amplifiers and turntables. Teac offered just tape recorders. It is sobering to compare this list with the catalogue for the 1979 Harrogate Audio Exhibition. For the European electronics industry ten years has been a very long time.

The last decade has seen any number of new developments and offered, often foisted on the buying public. But a few have stood out head and shoulders from the rest either as a result of value which has been subsequently proven or because the passage of time has underlined their lack of consequence. But some ideas of consequence have failed, at least first time round. And some ideas of no consequence have succeeded, at least temporarily.

From a considered and selective recap on the technology seen in the 'seventies, likely trends for the 'eighties become clear.

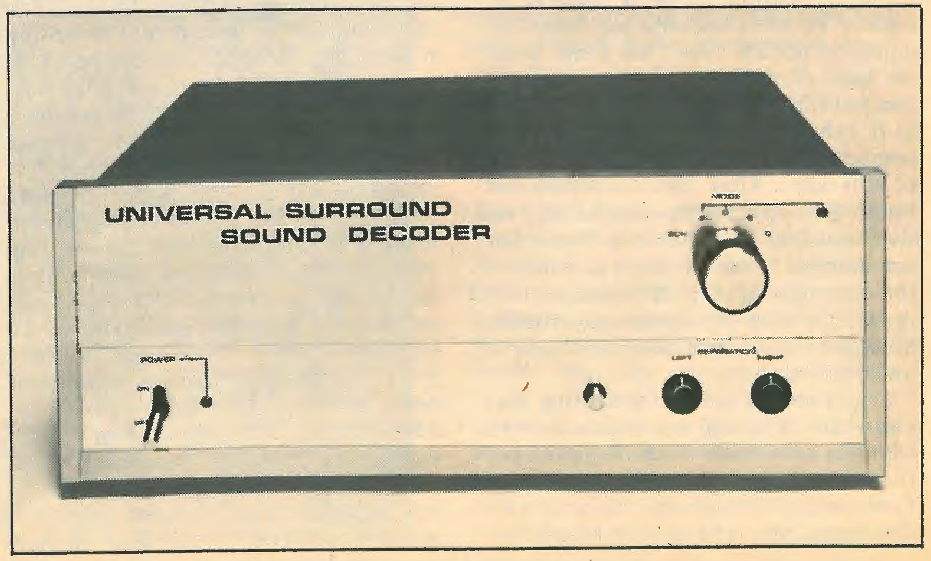
The 1970s must surely go down in history as the decade in which surround sound didn't happen. In the late 'sixties engineers in the USA started to show interest in improving the reproduction of music in a relatively small domestic room by adding reverberation to simulate the sound of concert hall or large room. Early workers soon recognised that it was not sufficient merely to remove all sound absorbent furnishing and furniture from a small room, with short reverberation paths. An artificial long path reverberation signal had to be generated and reproduced from loudspeakers behind or around the listener. The 'sixties experiments sought to record and reproduce natural hall ambience, rather than simulate it at the reproduction stage.

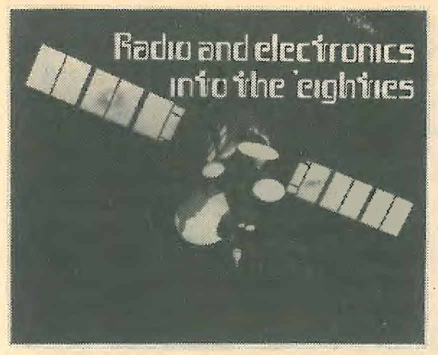
The then-new breed of multitrack studio recorders provided the ideal tool to record ambience along with the main, front, sound stage. An eight-track tape cartridge or four-track tape-recorder provided the ideal medium for selling the resultant multichannel surround sound to the public. The record companies, forseeing a drastic drop in two-channel stereo disc sales, panicked. At the turn of the decade numerous engineers around the world beavered away to produce a multichannel surround sound disc that would also offer good stereo and mono.

Not to be outdone, the broadcasters addressed themselves to the same problem. At first there was excitement that the apparently impossible had been achieved; a quartet of loudspeakers around the room could be fed with four sets of signals derived from a two-channel stereo source. But as the inevitable trade-offs and compromises became better understood, thinking engineers became disillusioned. So did the public not so much because of the various system deficiencies, but because of the lack of standardisation between so many competitive systems.

With the benefit of hindsight we now know that lack of standardisation on any one system was probably the best thing that ever happened to domestic audio. If any one early 'seventies system had become a world standard we would now be stuck with it — and all its inherent inadequacies. But early in the 1970s surround sound reproduction (or quadraphonics as it became known when four loudspeakers in the four corners of a room became tradition), looked to the marketing men like potential big business. The 1972 Consumer Electronics Show in Chicago saw private discontent flare into public squabbles. While the manufacturers tried to produce reproduction equipment capable of playing any or all of the competitive systems then available or announced, the record companies hedged over which system to adopt. "They ought to be locked in a room and kept on bread and water until they come out with an agreement" said one frustrated manufacturer.

When broadcasters finally agree a surround format we might get multi-channel surround sound records from the industry again.





At around this time a compromise offered by American engineer David Hafler started to find favour. This was the now familiar "Hafler circuit" which feeds a rear pair of loudspeakers with the difference information available across the outputs of a conventional stereo amplifier.

This simple connection provides signals for the rear, from almost any programme material. Readers of hi-fi magazines, puzzled over which quadraphonic system to buy, were repeatedly advised to compromise with a Hafler set up, at least temporarily until a standard was agreed. Even now, long after the quadraphonic bubble has burst, many enthusiasts retain a Hafler connection to feed rear loudspeakers because, especially with programme material recorded with a simple crossed pair of microphones, the results can be highly acceptable. There is now little doubt that every quadraphonic system marketed during the last decade is dead in its present form.

But the last years of the decade has seen the progressive acceptance of Ambisonics surround sound technology. This of course stems from the work of Michael Gerzon and Professor Peter Fellgett.

It is also embraced, albeit to a fluctuating extent, by the BBC and IBA. The recent patent pool agreement between Ambisonics-NRDC, Nippon Columbia and Duane Cooper (joint holders of most of the crucial patents covering a hierarchical approach to Ambisonics surround-sound technology) will almost certainly prove a significant influence in the next decade. In the USA the Federal Communications Commission is currently debating, yet again, the future of surround-sound broadcasting. The signs are that the final FCC choice will be between Ambisonics and the CBS SQ system, or modern variants thereof. Until recently there has been a fairly unified approach from the Ambisonics faction. But now the IBA has raised a question mark over the validity of the hierarchical approach. Essentially the IBA argues that the best compromise is a three channel system, which offers good surround sound to listeners with a three-channel decoder, and good stereo and mono with existing equipment. This conflicts with the Ambisonics-NRDC approach which seeks to offer the surround-sound listener the choice of using either two or three channel (the third with or without limited bandwidth) reproduction equipment in hierarchical fashion. The IBA now describes the two approaches as "irreconcilable" so it is clear that if surround sound is to progress in the 'eighties past the laboratory stage the IBA, BBC and Ambisonics-NRDC engineers must reconcile their differences. This will require the cooperation of all parties in extensive on-air transmission tests. Unfortunately the BBC and IBA have not been noted for their mutual cooperation and have instead appeared more inclined to generate competition even where none naturally exists. Although independency of technical research at the development stage is admirable and in the public interest, rivalry at the early stages of commercial development can only hamper the spread of a new technology. Witness the public ignorance over teletext. In fact cooperation of the two British broadcasting authorities is essential if ever the public are to be educated into what teletext and surround sound are all about. Is it too much to hope that the 'eighties may see British broadcasters thinking and speaking of new technologies as a common vehicle for competitive programming, not as a source of competition in their own right?

The 1970s saw not only the emergence of the Philips compact audio cassette as a serious recording medium, but also the parallel emergence of Dolby noise reduction as a standard. Indeed the parallel progress of the cassette and Dolby system is no coincidence. Without one the other would not be where it is now.

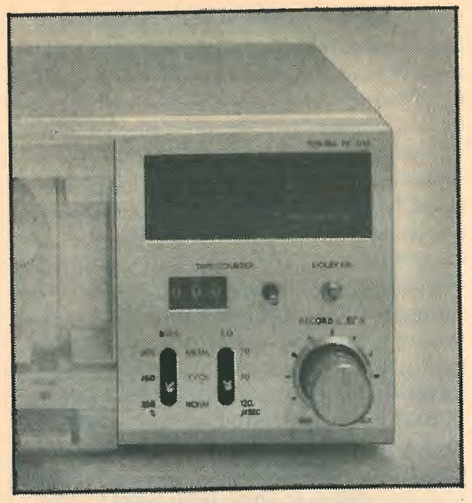
It took three years into the decade before Philips finally agreed on a licence to incorporate Dolby circuitry. Until then Philips had tried vainly to interest the cassette recording world in the Dynamic Noise Limiting playback-only system. The pity of it was that DNL was a useful noise limiting tool, but certainly not an alternative to the Dolby encode-decode system. Now, at the end of the decade, DNL is reappearing as an addition to Dolby noise reduction on some cassette decks. Despite the emergence and marketing of rival noise reduction systems, Dolby B has become an integral part of cassette recording. Another Dolby proposal, the use of Dolby encoding on f.m. broadcasts with modified pre-emphasis to suit the frequency content of modern music and aid compatibility, has not however taken off in Europe. Another slow starter, Dolby's work in film sound encoding, is however starting to boom. The words "Dolby stereo" now often feature as large on the publicity posters outside the cinema, as the names of the stars or director of the film.

Throughout the last ten years tape manufacturers around the world have offered every imaginable modification of the basic iron oxide magnetic coating, plus a few more besides. Following work by Dupont in the USA magnetic oxides of chromium have also become popular with some tape manufacturers. Others mainly in Japan have eschewed the use of chromium and concentrated instead on a range of cobalt-modified iron oxide particles. The newest innovation, of which a few samples may reach the retail shops before the end of the year, is tape coated with pure iron particles. Although the original pre-war pioneering work in magnetic recording relied on iron-coated tape, this material is a brute to handle at the manufacturing stage. It is only now that a few tape makers feel the time is ripe for a full circle return to this original technology. Philips and 3M were the first to make public noise over their new metal tape formulations. But their announcements have backfired. Philips has at least temporarily pulled out of commercial production of the tape and 3M, after proudly announcing the product in June 1978, is still unable to supply more than a few cassettes to a few selected dealers for retail sale. It is likely however that the first years of the 1980s will see pure metal tape come into plentiful supply. Certainly within a year or so virtually every respectable cassette recorder will be equipped with recording heads and circuitry capable of coping with the new high coercivity material. But all the manufacturers involved in tape production are agreed that the cost of pure metal tape will always be higher than oxide tape (currently around four or five times as expensive) and it remains to be seen whether the public will actually pay the extra for the new wonder medium when it is on open sale and readily available.

Pure metal tape is counted as the short-term answer to digital recording. But in the long term, and at today's current accelerating pace of development, this may mean only a year or so. There is no doubt that the days of analogue recording are numbered. The idea of digital encoding is not new; it was Alec Reeves of course, at STC, who proposed and patented a workable system shortly before the last war. But without solid-state switching equipment Reeves could only theorize. By 1972 the BBC, after experimenting with digital sound links between London and Scotland, was regularly distributing p.c.m. sound for television and stereo radio around Britain using microwave links. The BBC has continued through the last ten years to develop digital sound encoding techniques both for the transmission of sound signals around the country and for digital audio tape recording. The IBA has meanwhile devoted considerable effort to the development of digital recording techniques applicable to colour video.

In the domestic area interest in digital sound has been stimulated by snowballing developments in video recording. Indeed only a closed minded fool would not attempt to delineate between audio and video. The two technologies are now so closely and inextricably linked that the future of one is dependent on the other. It was in 1972 that Philips first announced a video cassette recorder capable of recording colour tv pictures and sound on a cassette of half-inch tape. Although the original N1500 machine was intended for the industrial and educational market, by 1974 it was launched for — albeit limited — open sale to the general public. This started not only the domestic video revolution but also the inexorable move toward digital sound. Any recording system capable of handling the four or 5MHz necessary for colour video is more than capable of handling the bit stream necessary for stereo or multichannel sound in digital form. Moreover a decade of work into video reproduction from discs, which culminated in the USA test marketing launch of a practical video disc system by Philips-Magnavox in 1979, brings the digital audio disc a step closer. Philips has of course already shown the compact disc, or digital audio version of the Philips VLP video disc, and toward the end of 1979 announced a patents liaison with Sony. Sony had independently developed a laser-optical disc system similar to that proposed by Philips. With the union of Philips and Sony standardization of a laser-read optical video disc comes a step closer. Almost certainly the Philips-Sony union will bring agreement on a digital Compact Audio Disc smaller than the 30cm proposal made by Sony and larger than the 11.5cm diameter chosen by Philips for the compact disc. Very probably a digital "compact audio disc" of around 15cm will emerge from the union. But this will almost certainly *not* herald world standardization. JVC still sticks hard with its different, and quite incompatible, capacitance-read grooveless disc and RCA argues in favour of a grooved capacitance disc. Matsushita has proposed a grooved disc which is read by a mechanical pressure-sensitive stylus similar to that developed by Telefunken and Decca early in the decade and briefly marketed at the Teldec TeD video disc. It is now known that Teldec has a miniature digital audio disc version of TeD. This Teldec Mini Disc is ready to launch in Europe if and when the time is adjudged commercially right. Without doubt there are many bitter battles ahead before there can be world standardization on the digital audio disc. These battles will delay standardization and give impetus to the short term stop gaps such as metal tape. There is also a move toward 45rev/min long-playing analogue discs. It is argued that their higher rotational speed, coupled with the long playing time per side offered by computer-assisted cutting techniques, offer the analogue album a shot in the arm.

Casual observers talk vaguely of some wholly new, as yet undreamed of, storage medium to replace the tape or disc. Without doubt it would be possible to encode programme material in holographic form. But the idea of a chip or memory, storing an hour of programme in solid state, must surely remain a dream for at least the next decade. Although high density memories with fast access time are available, a few moments calculation is sufficient to show that solid-state memories have a long way to go before they can offer the equivalent of an LP record in real time. Prophesies, especially in such fast-moving times, are always dangerous, but it seems a safe bet that for the next ten years sound and vision in the home will be stored on, and reproduced from, a moving strip of magnetic, capacitive or optical material or a rotating disc of similar characteristic.



Cassette recorders for the 'eighties will have bias and equalization for metal-particle tape but will the public pay the extra price?

The speed with which a new storage medium becomes a commercial success and gains acceptance as a household norm, will depend entirely on the behaviour of the companies involved in the development and promotion of such a new medium. Rapid agreement on digital encoding standards and storage techniques could bring a new record medium into the home within a couple of years. But behind the scenes squabbling, similar to that which killed off the quadraphonic systems could delay even the start of a transition from analogue reproduction until at least the mid-eighties. But as we learned from the quadraphonics fiasco this may not necessarily be a bad thing. Currently the signs are that the strong US and Japanese influences may impose on us world coding and sampling standards for digital sound reproduction which are tied to local tv standards. These could well prohibit or make expensively difficult, the exchange of recorded audio material between continents. Certainly it would be an appallingly retrogressive step. Moreover in their enthusiasm for a new generation of recording and reproduction techniques, engineers at laboratory level appear to have overlooked, or at least brushed to one side, the very real problems of mass producing high-density storage programme material in reliable quality as well as quantity. After one hundred years of analogue disc recording, there are still all too few record pressing plants capable of producing a respectable audio disc pressing. With track spacing between 50 and 100 times tighter in digital or video programme storage the importance of producing blemish-free pressings becomes paramount. The video and digital audio systems that succeed in the long run may well be the system for which it proves easiest to mass produce programme material. □

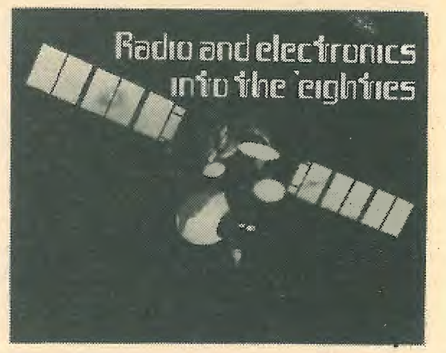
H.f. radio communication

by **R. F. E. Winn** B.Sc.(Eng.), F.I.E.E. Racal Communications Ltd

Advances in component technology and new design concepts during the past decade, together with projected future developments, ensure that h.f. radio communications will retain importance well into the twenty-first century. In particular this is true of the maritime mobile service where satellite communication is still in its embryonic stage, in developing countries where the economics of h.f. point-to-point working with low traffic density are attractive, in defence (as a back-up if not always primary system), and in emergency use where air-transportable containerised stations can be rapidly deployed. As well as advances in technology in recent years there has been a better understanding of the vagaries of propagation. This has resulted in greater precision in predicting maximum usable frequencies over various paths during the 24-hour day at different seasons and during sun-spot cycles.

For medium and long-haul communication h.f. radio today is still an economic, efficient and reliable solution.

Receivers of the 1970s. The most significant technical changes have been in receiver design in which a number of ideas, coupled with newly available



components, converged to provide by the early 1970s a completely new order of excellence in terms of overall performance and ease of operation. Before discussing the "breakthrough" of the 1970s it is helpful to look briefly at two previous generations of receivers.

In the immediate post-war years the most exciting development was the drift-cancelling technique known as the Wadley Loop. Although a tricky concept, demanding skilled mechanical as well as electrical design, it was successfully implemented in the now classic RA 17 receiver, made by my company, of which some thousands are still in daily use throughout the world. For the first time it had become possible to tune to a given frequency and leave the receiver unattended with reasonable confidence in its frequency stability over extended periods.

The next big challenge came in the 1960s with the change from thermionic valves to solid state devices. Early examples were heavily influenced by the previous valved designs, and although greater ingenuity was sometimes achieved they were little more than an exercise in re-engineering using transistors in place of valves. The advantages were reductions in weight, size and power consumption and an increase, at least in theory, in reliability. Overall performance, however, was disappointing and, in general, the best of the first generation of solid state receivers were inferior to the best of the valved sets. There was not even an advantage in price.

A parallel development in the 1960s was the frequency synthesizer, which generated a wide range of frequencies each with a stability equal to that of a single master crystal oscillator. This was seen as an elegant substitute for the often troublesome free-running local oscillator in superhet receivers and as a simpler solution to drift than the Wadley Loop. Unhappily the early synthesizers brought their own problems in the shape of unwanted intermodulation products generated by the internal mixers, adders and dividers. The advent of the digital synthesizer provided a cleaner output and today's units are capable of excellent spectral purity. The early synthesizers also suffered from the operational disadvantage in that frequency was selected through decade switches. Excellent if the exact frequency of a wanted signal was known, but hopeless for "searching". This problem was overcome later.

With so much new technology becoming available, engineers in this field came to the conclusion that a radical re-think on receiver design was overdue. Not only on how newly available technology and components could be implemented to advantage but also all aspects of performance and operation in modern conditions. The starting point was a statistical analysis of their occupancy of the h.f. frequency spectrum in terms of density and types of signals, their distribution and relative strengths, which would give a clearer indication of how a receiver needed to perform in order to use efficiently the 9,000 or so 3kHz channels available. An analysis was made by a computer in my company and, independently, a similar exercise was carried out by B. M. Sosin of Marconi Communications Systems.

It had been realised that the most significant limiting factor in receiver performance was linearity. Selectivity was as important as ever but the emphasis on front end sensitivity which had been a paramount feature of design for the past 50 years had come to the end of its usefulness and no further gains were necessary or indeed possible in this area.

It was found from the analysis and measurement that high powered broadcast and commercial stations were generating tens, in some cases hundreds, of millivolts at the antenna terminals when received on large collecting systems. The strong signals were generating a large number of intermodulation products strong enough to give the appearance of liveliness in the receiver yet masking weak wanted signals. What was required was a big increase in dynamic range together with extreme linearity, and the key to the problem of intermodulation products was to work out the linearity of previous receivers and to discover where the products were formed and at what level.

The first range of solid state receivers to incorporate the new principles in the 1970s was the RA 1770 series, of which the RA 1772 general purpose receiver will be discussed. The block diagram of this receiver (Fig. 1) shows it to be a straightforward double conversion superhet but with a number of novel features which provided a performance with respect to dynamic range, intermodulation products, reciprocal mixing, cross modulation, blocking and spurious response far superior to any other receiver then in production. This

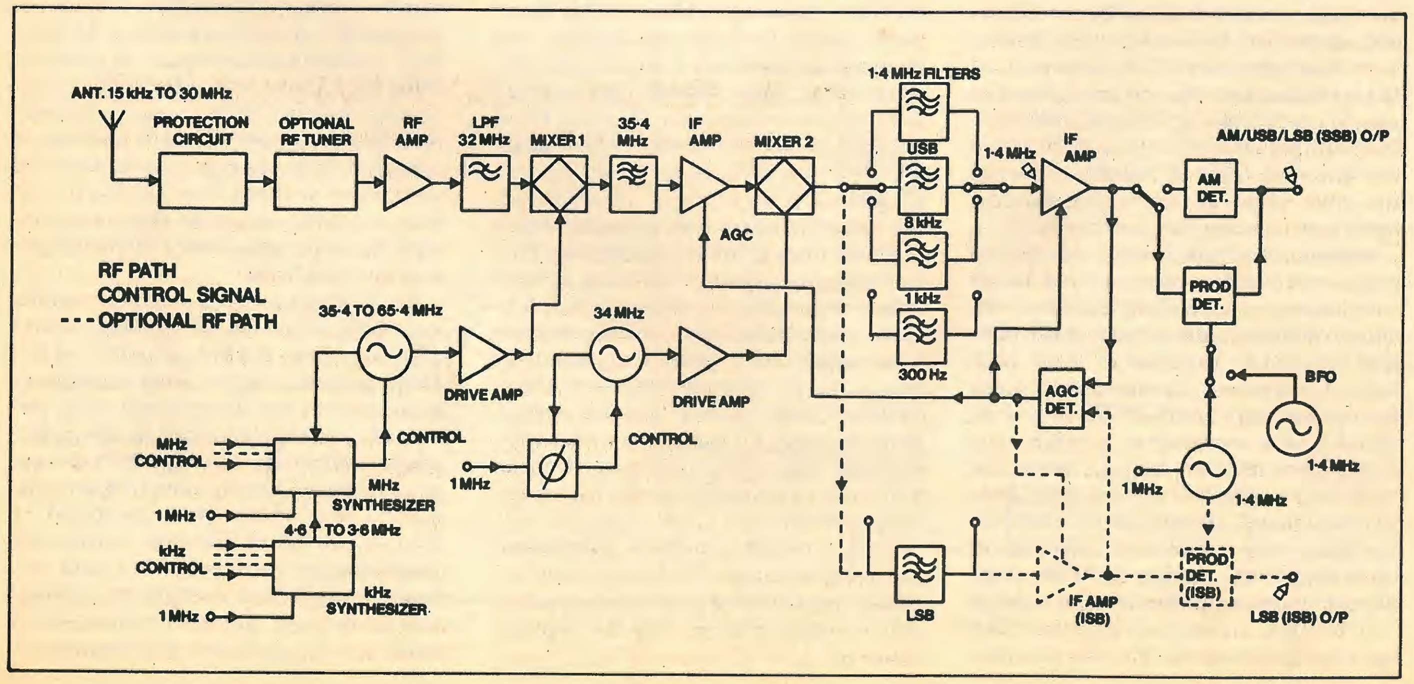


Fig. 1. *Block diagram of the RA 1772 general purpose receiver.*

was achieved through using a single linear broadband r.f. amplifier, a double-balanced hard-driven fast-switching m.o.s.f.e.t. first mixer, only moderate gain at the first i.f. of 35.4MHz with the main gain in the second i.f. amplifier operating at 1.4MHz.

The new order of performance at first caused some confusion. First comments on the development models, later echoed by the first customer, were apparent lack of sensitivity because there were far fewer signals. Repeated tests with a signal generator were necessary to convince ourselves that the design sensitivity had indeed been achieved and that the "emptiness" of the h.f. band was due to the elimination of spurious signals and not lack of band activity or insensitivity.

Apart from the redistribution of gain throughout the receiver the most notable advance in achieving the new performance was the use of a high first i.f. of 35.4MHz. This became possible through using a high stability digital synthesizer which also provided additional advantages. It was now no longer necessary to employ the traditional tuned r.f. preselector amplifier ahead of the first mixer to eliminate image signals. There were no tracking problems associated with a linear broadband amplifier so the front end was greatly simplified and this, in turn, helped open the way to remote control.

As a general purpose receiver, the set needed a free-tune facility and this was achieved by using an optical shaft encoder on the tuning knob which provided electrical pulses and directional information to step the synthesizer in 100 Hz (fast) or 10 Hz (slow) intervals up or down giving the operator all the "feel" of the familiar v.f.o. but with synthesizer stability. The tuning knob could be disengaged electrically to hold the receiver on any particular frequency. The digital frequency readout, derived from the local oscillator, although at first disliked by operators accustomed to dial and pointer indicators, was necessary if the accuracy of the synthesizer was to be exploited operationally. No traditional mechanical analogue dial could achieve a resolution of 10Hz at 30MHz and even the most conservative of the old-time operators now see its advantages.

Another innovation was to provide a complete receiving terminal in a single case instead of extending facilities with add-on adaptor units, which, in the past, had frequently resulted in a 6ft high rack of equipment. Provision was made for six internal filters which could be fitted at the customers' choice. The filters were selected through transistor switching controlled by d.c. only from the front panel. This not only eliminated the potentially troublesome mechanical switching of r.f. circuits from the front panel but also simplified remote control.

Although an earlier receiver had been developed using plug-in modules

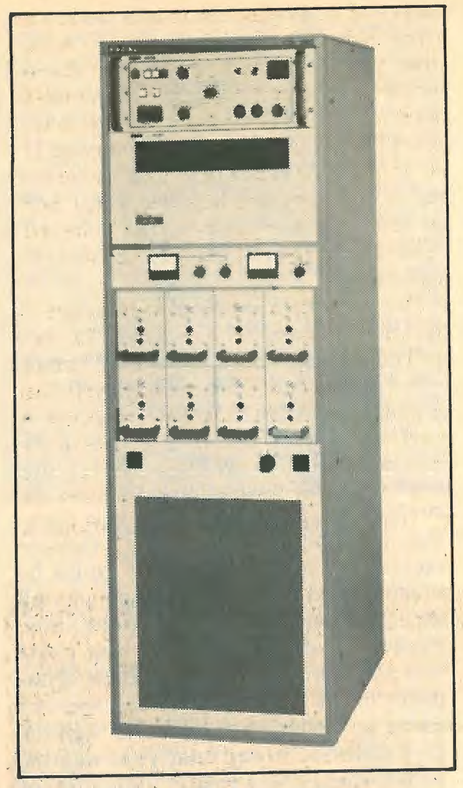


Fig. 2. *Solid state 1kW transmitter comprising eight 125W modules.*

it was decided in the interests of economy to use conventional construction in the RA 1770 series but the physical configuration allows all circuits and components to be accessed by test gear for fault diagnosis while the receivers are in an operating condition.

By the mid-1970s the series had been extended to include programmable and remote control receivers. The programmable set, in addition to continuous tuning at three selectable rates (10 Hz, 20 Hz or 1 kHz), had twelve programmable channels selected from a front panel switch.

The receiver for extended or full remote control is in two units, the receiver itself with blanked-off front panel except for local test facility, and an associated remote control unit with all the front panel controls. The receiver is triple conversion with the third i.f. at 100 kHz. Apart from a spin-wheel tuner and rotary controls for b.f.o. setting and i.f. and a.f. gain, all other functions on the remote control unit are selected by push-buttons. Control is exercised by a time-sharing data-multiplexing system which converts parallel control information into serial form for transmission over single wire lines. For extended control of all receiver functions three cable pairs are required. For full remote control over virtually any distance standard data modems are used on an ordinary unconditioned four-wire telephone circuit.

The system enables complete receiving systems to be built in which a single operator with one remote control unit commands several remote receivers.

The advent of such remote control systems resolved a social as well as a technical problem. It now became possible to establish the receivers at the best or alternative sites without having to move the operators. Assuming three shifts for round-the-clock surveillance, considerable savings are effected in re-housing, quite apart from the natural reluctance of operators to move to an unfamiliar and very often isolated environment.

This, then, was the measure of progress in receiver technology in the 1970s. The order of excellence was henceforth to be expressed not in sensitivity, selectivity or long-term stability, although all of these are still important, but in terms of third order intermodulation performance with a figure better than —90dB for two 30mV signals as the new industry standard.

Transmitters of the 1970s. Transmitter development in the past decade has not been as spectacular as in receivers. The digital synthesizer came into more general use for frequency control in drive units and remote control systems provided flexible extended and fully remote control. The most dramatic development was a solid-state power amplifier delivering up to 1kW of power (Fig. 2). This presented a great technical challenge, the problem as with solid state receivers being the inherent non-linearity of bipolar devices which demanded careful balance at every stage. No single device could produce significant output and my company's approach was to employ eight modules, each of 125W output with combiners summing through hybrid units to 250W, 500W and finally 1kW. The system had to survive a module failure which necessitated some complexity in design to provide protection over a large frequency range.

The advantages of the solid state design were mainly in reliability and ease of servicing. The 30V supply rail was non-lethal (although it is of course still possible to receive a serious r.f. burn from the antenna terminal). In terms of reliability there was adequate redundancy, failure of a module merely reducing total power output and any of the eight modules could be replaced or worked on without interruption of service. A 500W version on the same principle but with only four 125W modules was also produced.

For higher powers the valve remains supreme in terms of economy and efficiency. One 10 kW transmitter of the 1970s period, still in production, was solid state in the drive stages with air-cooled ceramic electrodes in the power stages. Automatic tuning, servo-driven, gave a typical tuning time of 8 seconds with a maximum over the band of frequencies of 20 seconds. Automatic level control was provided and the power supply had automatic overload protection with automatic re-set which would not finally lock out the supply in

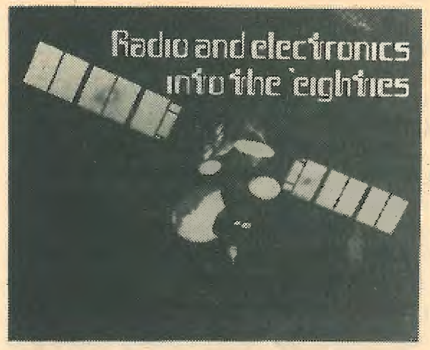
the case of a transient fault until four unsuccessful attempts at reconnection had been made.

The next ten years

Both technical and economic gains are anticipated in the decade ahead and in fact are already being realised. The market is highly competitive and it is clear that design trends will be towards better specification and more facilities per unit cost.

A positive example is an m.f./h.f. receiver which made its public debut in London in October 1979. It is a joint Anglo-American development and substantial orders have already been received from the US Air Force. The receiver (Fig. 3) has the overall performance of its predecessors at a far lower price, achieved largely by more functions per integrated circuit and therefore a smaller number of components. It is a double conversion superhet with the first i.f. at 40.455 MHz and the second i.f. at 455kHz. Frequency and receiver status displays are liquid crystal and all functions are push-button selected, control being through a microprocessor.

The important innovative advance is the synthesizer. In the RA 1772, described earlier, there were five circuit loops constructed on four printed circuit boards. In the new receiver a single loop synthesizer occupies only one board and as well as generating the local oscillator frequencies at intervals of 1Hz (previously 10Hz resolution) it



also generates the b.f.o. output in 10Hz steps. Because of the single loop design the new synthesizer has even greater spectral purity because all mixing has been eliminated and thus fewer frequencies are being generated. The unit is based on an l.s.i. m.o.s. chip developed by Racal Microelectronics Ltd which achieved 1Hz resolution by synthesizing phase as well as frequency. The UK version has a 100-channel frequency store and an interface for a remote control system. The US version has IEEE 488 input/output interfaces as standard, but both versions can be adapted for other interfaces by software changes.

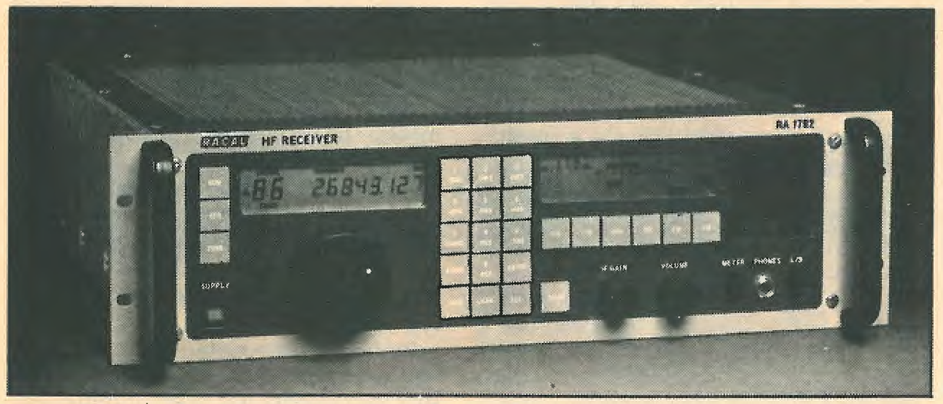
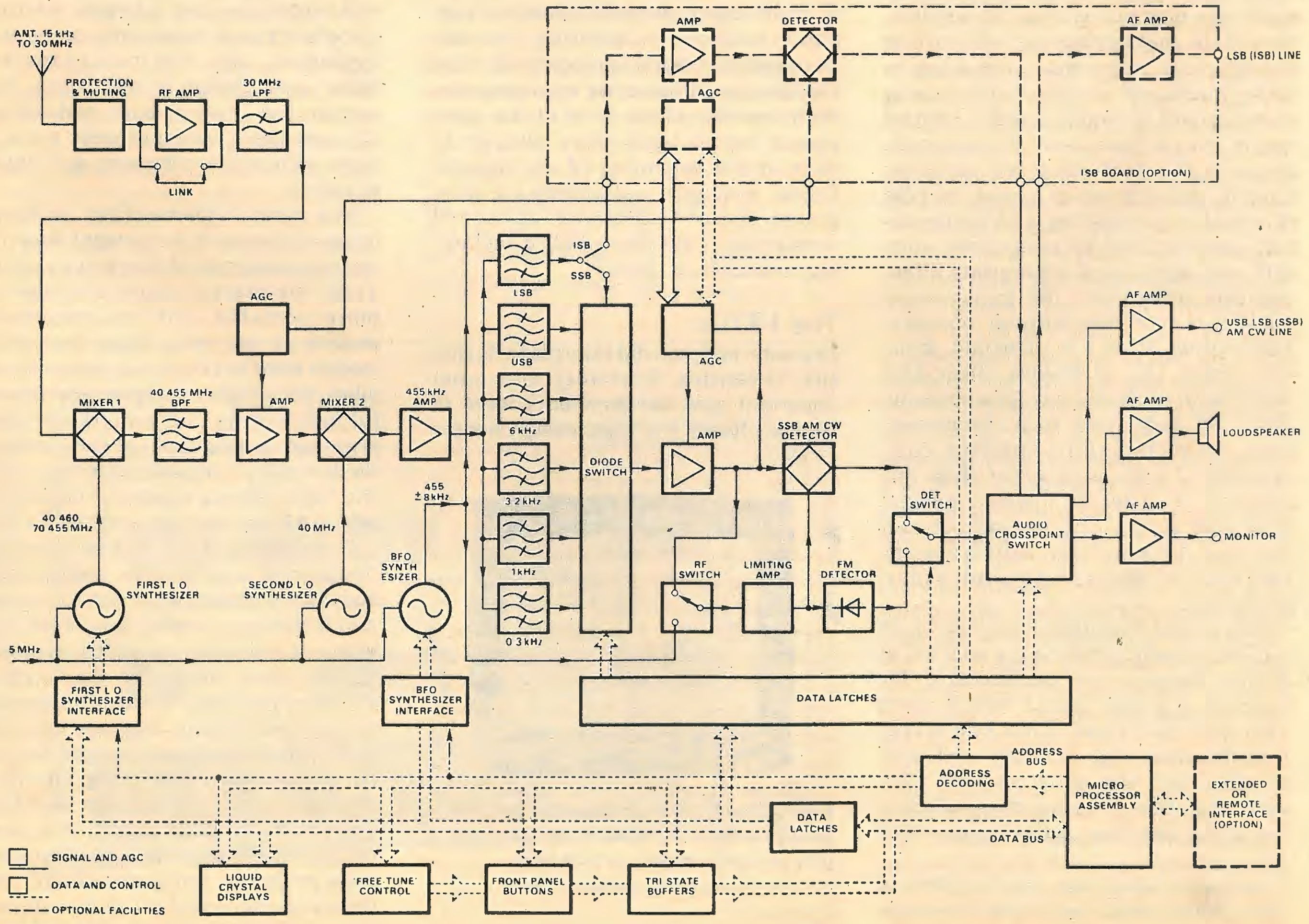


Fig. 3. *Anglo-American m.f./h.f. receiver. This recently introduced model uses a microprocessor for control and a new synthesizer.*



The synthesizer mentioned above is also employed in a military wide-band receiver where it is used to cover the h.f./v.h.f. spectrum continuously from 2MHz to 512MHz.

On the transmitter front the advances that one will see in the 1980s are less spectacular but none-the-less worthwhile. A second-generation 1kW solid state amplifier uses four 300 W modules which, allowing for losses in the combiners, delivers a full 1kW to the radiating system. Linearity has been further improved so that for the first time the CCIR recommendations for intermodulation products have been met over the whole of the h.f. range.

Looking further ahead there are two great hopes. One is v-m.o.s. devices which could provide much greater linearity than current bipolar devices, and of greater efficiency. The second is the feed-forward or polar loop concept on which research is being conducted at Bath University. If successful, there is a promise of solid-state transmitters comparable in efficiency and linearity with current class AB vacuum tube amplifiers.

On a more immediate note the world demand for low-cost channelised transmitters continues unabated, and it is now becoming apparent that the conventional channelised drive unit may well be displaced by a programmable synthesizer on economic grounds. With modern technology a synthesizer is already comparable in cost with a 10-channel crystal drive unit.

Receiver performance has now reached a new plateau but the application of the microprocessor will provide considerable refinement, resulting in more "intelligent" units in both systems management through remote control and in the receiver itself. For example, there is the self-adaptive receiver already realisable which senses the type of signal it is receiving and automatically adjusts itself by minor frequency shift and selection of appropriate filters and demodulators to the transmission mode it is receiving without operator intervention. If on c.w. it would probably select the narrowest filter and adjust the b.f.o. frequency for a pleasant tone, and audio gain to a convenient level, for recording or operator convenience. If s.s.b. is detected then the appropriate upper or lower sideband filter, and so on. The microprocessor will also be used for routine self-checking of sensitivity and other parameters.

The newer techniques pioneered on h.f. are already producing a spin-off at higher frequencies, particularly the concept of a high first i.f. which opens the door to broad band pre-mixer amplification. High stability v.h.f. synthesizers will also allow s.s.b. on v.h.f. and u.h.f., thus enabling more efficient use of the spectrum as has happened on h.f.

We may also expect new forms of modulation which will help overcome the inherent limitations of ionospheric propagation. There could be re-births such as the Piccolo system, where the advent of solid state circuitry has made the system economic enough to attract much wider application.

Work is currently being conducted on topics such as time encoded digital speech at 2.4 kilobit/s and, though presenting considerable technical difficulties, few professionals doubt that such developments will eventually prove successful and further enhance communications at h.f.

Although for purposes of illustration the practical examples quoted are all from the author's own company, he gladly acknowledges parallel work in other countries which, through professional cross-fertilisation, will continue to advance the art and science of h.f. radio. □

Electronic measuring instruments

by John L. Minck Hewlett-Packard Company

Progress in instrumentation is a result of at least three driving forces: the on-rush of new system requirements such as fibre-optic communications and satellite technology; 'breakthroughs' in component technology, such as microprocessors or microwave, hybrid microcircuits; extensions and combinations of present instrumentation, such as the remarkably successful IEEE-488 interface bus for programmable systems.

Very often, progress is really an intricate combination of all of the above. In so many cases successful instruments don't involve technology 'breakthroughs', but merely embody the right combination of customer requirements. With few exceptions, most of the component technologies were already in place at the beginning of the decade. Digital, analogue, and microwave integrated circuit techniques advanced substantially, but the primary technology was already there.

The 1970s

Dramatic progress did take place during the 'seventies. Probably the most important new developments were of logic analysers and logic design instruments. The earliest of these, typified by the HP 1601L introduced in 1973, was nothing more than a standard oscilloscope display with columns of 0s and 1s. An early serial data analyser, the HP 5000A, permitted diagnostics on long streams of data captured and displayed on rows of l.e.ds.

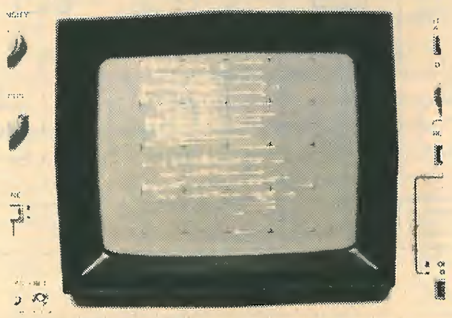


Fig. 1. Modern logic analysers can show timing waveforms, logic states, and some provide logic "maps" which help engineers diagnose malfunctioning processors.

In the six years since, the progress in logic analysers and microprocessor design instruments has been nothing less than breathtaking. And none too soon either, because relentless marketing pressure is pushing microprocessors well beyond the obvious applications in calculators and communications into appliances, toys, electric organs and motor cars. Design, qualification, production test, maintenance and service all need these measurement tools to work with microprocessors and digital circuitry.

One common theme of the 'seventies for most classes of instrument was that requirements moved two ways at once. Thus, the market called for smaller, more portable and less expensive models at the same time that other models went as far as technology would allow, with highly complex and powerful instruments and remarkably high price tags. An example of the former is the low-priced, digital voltmeter, while the high-priced example is the HP 3455A, a high-precision, system d.v.m.

Oscilloscopes handled higher frequencies and became both smaller and more portable, while others became much more powerful and complex, using microprocessors to measure digital time delay or rise times. Waveform, pulse and function generators tended to go in only one direction — towards smaller and cheaper designs, but with remarkably strong specifications. It's amazing how much waveform performance can be packed in a small package these days. The more complex pulse-generator products usually were the word and coded-pulse instruments required by new digital communications technology and fibre-optics.

R.f. and microwave. R.f. and microwave instruments entered the 'seventies with great promise. In 1970, hybrid microcircuit technology and the design processes using scattering parameters were in place, ready to supply the building blocks; G.a.s.f.e.t. devices were coming. The results were truly astounding. The microprocessor has made the difference — about half the circuits in many microwave instruments are now digital and it comes as no surprise that about half of our microwave design teams are digital and software designers.

A typical result is a newly-introduced synthesized signal generator. The 10kHz-1280MHz signal spectral purity of this generator rivals the best cavity-type generator of previous years, but it is also fully programmable and frequency agile (500μs switching time). The real contribution of this very expensive generator is in the design of the front panel controls. The mostly digital keyboard communicates only to the microprocessor, which does all the circuit and signal control, making things extremely easy for the operator. For example, he can set up ten completely different front-panel signal conditions, store each, and recall them at the push of a button.

Another example of this "smart" type of microwave instrument is a recent 1500MHz spectrum analyser. Starting from power switch-on, the machine runs through 30 self-tests and draws its own graticules and titles, and provides powerful measurement routines which are far beyond usual manual testing. Self-tuning routines bring identified signals to the centre of the screen and read out frequency and amplitude digitally. Sweep speed, bandwidth and resolution are automatically selected in program to prevent errors and ease the job. Peak detecting and hold and store functions capture information digitally to show historical peaks. Six sets of user-defined front panel set-up conditions can be stored and recalled. Powerful diagnostic routines and displays aid maintenance people. This new measurement capability can't be appreciated by reading about it. One must sit down in front of such a machine for about an hour to grasp its significance. For example, if the spectrum analyser is connected to a receiving antenna, all background spectrum accumulated for a given period can be used to cancel a given signal environment and the display will then show only new signals which show up later.

R.f. network analysis finishes the 'seventies with a typical instrument, covering 500 kHz to 1.3 GHz, which measures, calculates and displays complex impedance transfer functions, group delay, deviations from linear phase, etc. It's about all the design power an r.f. design engineer needs.

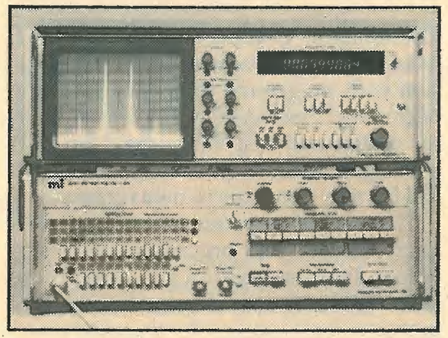
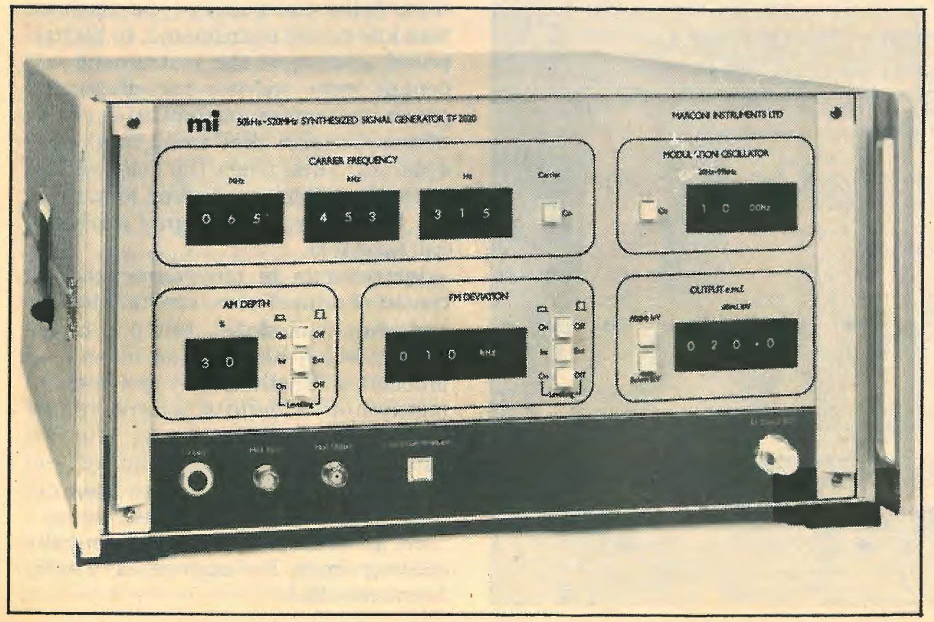
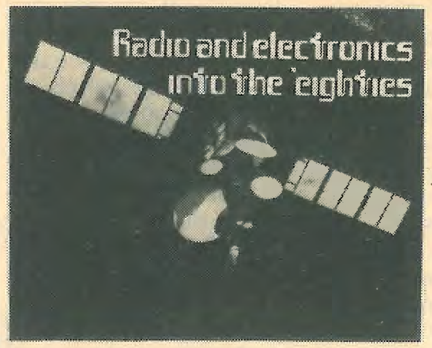


Fig. 3. 110MHz spectrum analyser employs digital storage, a television type display and automatic operation to give accurate spectral information quickly and easily.

Fig. 2. Synthesized signal generator provides precision r.f. signals and, being bus-controllable, may be incorporated into a fully automatic test set up.





In instrumentation, the 'seventies brought one development which probably overshadows all other advances in instrument techniques — the IEEE-488 bus. Interestingly, the IEEE bus was not a technological breakthrough; it was really more of an organisational and political advance. A simple data party line allowing automatic control of instruments and resulting data computations has revolutionised measurements already: over 700 instruments and controllers from over 160 manufacturers throughout the world now operate on the bus. Engineers now *think* in terms of automatic measurements for labs and production and maintenance uses.

Servicing. Finally, in the late 1970s, a more coherent strategy for dealing with service and repair of digital circuits was emerging. Early attempts at field diagnosis and repair of 'digital' boards placed the emphasis on changing the board. When the total number of instruments in service was small and widely scattered, the organisation to make this feasible was difficult.

One solution gaining rapid acceptance now is a design strategy based on signature analysis of digital circuitry. Instruments with a high content of digital components are designed with a certain portion of the microprocessor set aside to be used in fault diagnosis. In that test mode, the instrument circuitry is forced through a switching procedure which causes each digital circuit node or pin on a digital logic pack to produce a sequential stream of 0s and 1s. That repetitive pattern is unique to that pin of a good instrument. Thus a signature analyser like the HP 5004 takes a bit stream as long as 2^{16} bits and compresses it into a 4-digit alphanumeric display. Instruction manuals and test procedures are written to measure and assign a unique 4-digit signature number to every digital circuit pin. Technicians can quickly troubleshoot right down to a component level, picking out faulty i.c. packs with little trouble and alleviating the serious problem of stocking complete p.c. boards.

The future

Forecasting the future is always risky, but the clues to the next five years of instrumentation are already apparent from the most recent offerings.

Alternative digital methods will continue to invade analogue and r.f. techniques. For example, instead of a super-accurate, flat-frequency-response r.f. attenuator for use in signal generators, a signal generator will use a moderately-accurate but highly stable one: a highly-precise calibration table stored in memory then corrects the output signal. This is effective and inexpensive so long as there is already a microprocessor available.

It seems quite clear that analogue and radio-frequency circuit techniques will be further eroded by digital methods. As faster analogue-to-digital converter components come along, instruments will sample and convert signals to digital form further forward in the measurement process. Output signals may be more commonly generated by digital waveform synthesizers. For example, oscilloscope sweeps would be much more accurate if generated digitally by a clock whose frequency was referred to a crystal standard.

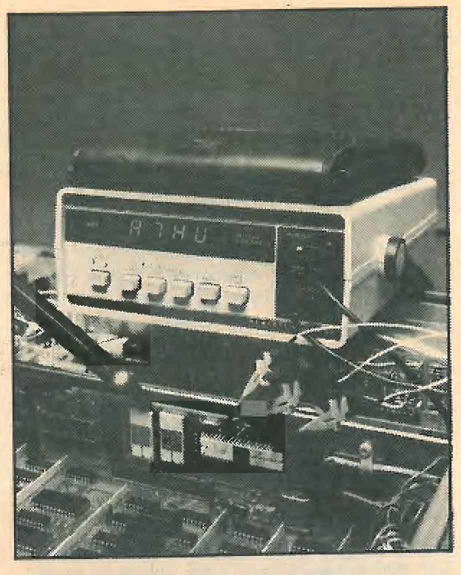


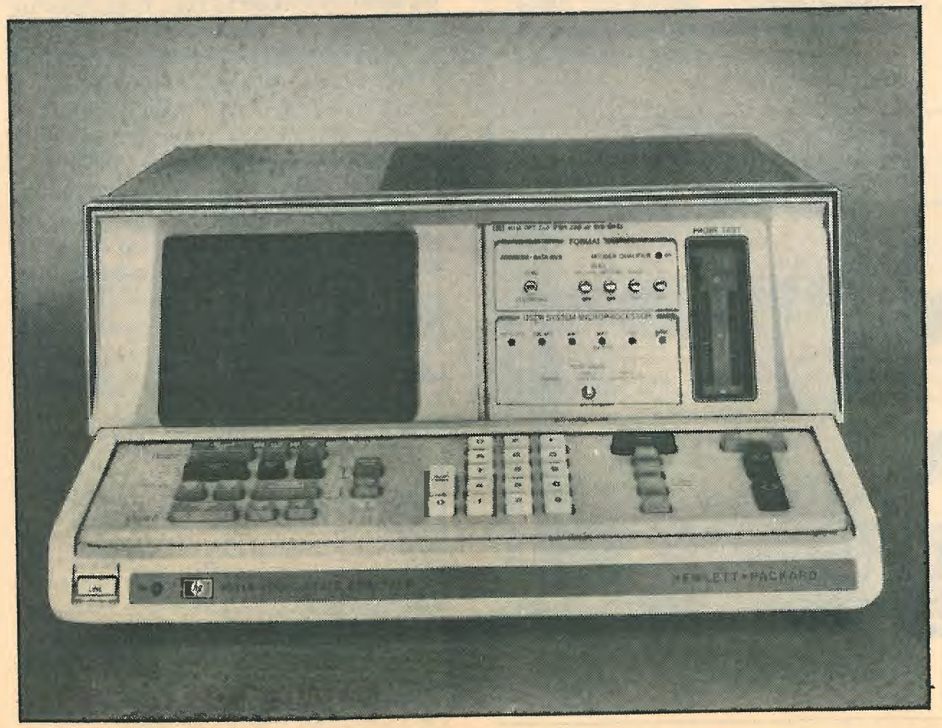
Fig. 4. Each pin of a digital i.c. pack has a unique 4-digit signature displayed and referenced in the repair manual, allowing diagnostics down to a component level.

Systems. Systems engineering will call for new initiatives in measurement which will create new instrument concepts. Communications systems are moving rapidly to digital modulations. Signal simulators will be needed for generating phase-shift-keyed modulations for satellite work as well as frequency agile signals for the new military communications and the cellular mobile telephone technology.

Fibre optics technology's on-rush into communications, in spite of its highly optimistic projections, has been underestimated: few people really see its impact clearly. The bandwidths of communication power to be unleashed by fibre optics will revolutionise not only the system business but will change instrumentation. Fibre optic data links can already link IEEE-488 bus instruments. Computer and terminal links as well as medical data transmission with no ground loops are just the beginning. These technologies will call for design and test equipment not yet envisaged. More importantly, they will call for new concepts in measurement.

The computer system technology will have memory and processors in every corner. Instrumentation will more than adapt: there is very heavy interaction between logic design instrumentation and the semiconductor revolution itself.

Fig. 5. Logic analysers for design of microprocessor-based everything will proliferate into many companies and industries outside electronics.



Certainly, computer-aided design for assistance in lab. projects becomes crucial. Engineering productivity is the key: in the 'seventies, automatic test equipment found willing ears for production test and for lowering costs — it was easier to justify.

The 1980s must attack the design side of things. Technology moves so fast that any lab. project which lasts longer than three years is going to produce a product with old or obsolete technology. As a result, there will be a steady proliferation of IEEE-488 bus mini-systems in laboratories. New instruments will appear with more operator-interactive controls and displays which interact, compute, correct and translate into your terms.

Complicated measurement procedures will be captured in software so the same tests can be re-run two weeks later. Suppose you run a particular test as you complete your circuit breadboard. Two weeks later, after modifications, you would like to recall the same procedure, set up all front panel settings as they were, run the test and compare the data to the previous test. This may sound a little like the HAL computer from the movie 2001, but it isn't; the technology to do that is here now in IEEE-488 bus systems. Now just contemplate individual instruments doing much of the same.

How will we maintain all this equipment? One computer maker recently proposed throwaway p.c. boards as a repair strategy; that might happen. Super-integration and high-reliability test programs could well give a substantial advance in reliability. But the usual reaction to that is to pack even more complexity into the instrument functions, putting instrument reliability back where it started. Smaller, lower cost, highly digital instruments will get more reliable. Larger, more complex, high priced instruments will hold their own on reliability. The most likely course will be a combination. With maintenance labour rates bound to increase, there may be some trends towards the throw-away-type repair on very low-priced instruments. In higher-priced equipment the instrument will contain more self-test and diagnostic capability, under control of its own microprocessor: that trend is already apparent. Then when the self-test has isolated problems to a given module or p.c. board, the digital signal analysers will take over.

Instruments in ten years will still consist of printed-circuit mother boards and plug-in modules. But p.c. board testing which has focused mostly on production functions may gravitate to maintenance depots where repair quantities can justify the cost. The new super-flexible automatic board-test systems are becoming attractive because of their remarkably low prices.

So, get ready for some technically exciting times. The surface has barely been scratched. □

NEWS OF THE MONTH

"Make way for engineers"— IERE president

The normal fabric of British life will have to be substantially changed, claims Professor William Gosling of the University of Bath, if we are to create an engineering profession adequate to the needs of our society. Giving his inaugural address as new president of the IERE, he said that we urgently need "an elite corps of engineers, particularly electronic engineers, who will be as able, perhaps abler, than any others in the world. To induce the most talented people to seek such a life, society will need to use the only inducements which have ever been known to work, namely honour, prestige and wealth. They will also need a good 'second division' of supporting engineers, of technician engineers and technicians. At each level of employment the appropriate rewards – tangible and intangible – to secure the quality and numbers to meet our social needs must be forthcoming. Such things are not achieved cheaply, but only by the diversion of resources in the appropriate direction. Since the wealth of society cannot immediately increase, even with the most favourable industrial policies, we are faced with a stark logic. If we need better engineers, more able to facilitate the creation of wealth by industry, we must make that career more attractive to the ablest of our children. To do that the rewards must be markedly improved. But if the very best engineers grow richer, everybody else, including all the other engineers, the trade union members and the arts graduates, must for a time see their prosperity grow less rapidly than would otherwise have been the case. This is a high hurdle for us all to get over, particularly in a society largely run by a collusion of arts graduates and trade unions, which has developed a marked predilection for living on its seed corn."

In a reference to the Finniston inquiry into the engineering profession, Professor Gosling said that nothing that could conceivably come out of this will change overnight the whole status and remuneration of engineers. "Maybe if engineers could be organised into a tight and monolithic union, and if they exploited their power ruthlessly and without regard for others, a change of that magnitude could be achieved. So far, engineers have for the most part not shown that willingness to unionize themselves, nor yet to their credit the extreme degree of ruthlessness and militancy. We may be sure that what they have not been prepared to organize themselves for and force from society, they will not be given unasked, from some kind of altruistic recognition of merit. We do not live in that kind of world."

"Engineers want statutory registration"—survey

A survey has revealed that professional electrical and civil engineers are overwhelmingly in favour of a statutory registering authority for the profession. The survey, carried out by NOP Market Research Ltd for the Institution of Electrical Engineers, questioned IEE and ICE members on their attitudes towards their professions, standards, and the way qualified engineers were perceived by society. It found that 92 per cent of IEE members favoured registration while the figure for the Civils was 87 per cent. The registering authority should be responsible for the registration of professionally qualified engineers (said 92 per cent IEE, 93 per cent ICE) as well as exercising control over the standards of education, training and qualification (80 per cent IEE, 72 per cent ICE) and professional conduct and discipline (78 per cent IEE, 79 per cent ICE). Virtually all members questioned believed that the registering authority should have the right of sanction against an individual if professional standards were not maintained.

It should be compulsory for all professional engineers to become registered (said 58 per cent IEE and 65 per cent ICE). A further fifth thought registration should be compulsory above a certain level of responsibility. However, if registration wasn't made compulsory then 79 per cent (IEE), 71 per cent (ICE) said they would apply anyway.

Not only did the majority favour registration but 67 per cent of both institutions believed that work requiring a high degree of responsibility should only be undertaken by registered engineers. When it came to the way the profession was perceived by the public, 97 per cent (IEE), 98 per cent (ICE) stated that "the public have little knowledge of the engineering profession." On the question of pay, 91 per cent (IEE), 88 per cent (ICE) said that they believed they were paid less than others in similar professional occupations. An overwhelming majority stated that engineers had achieved a higher professional status abroad than in the UK.

The questions were posted to a random sample comprising 4,400 corporate members of the IEE and 600 of the ICE, and the overall response rate was 52 per cent.

Japanese see opportunity in Prestel

Only a month after Prestel, the Post Office's viewdata system, started as a full public service (December 1979 issue, p55), the Japanese firm Sony displayed in London some equipment it has specially developed and manufactured for this information retrieval service. Shown by Sony (UK) Ltd at the Professional Viewdata Exhibition in November, it consists of two 14-inch colour television terminals using the famous Trinitron tube (December 1971 issue, p.587), one with a simple keypad and the other with a full alpha-numeric keyboard. Editing will be possible on these terminals. The equipment was developed at Tokyo and at the Sony (UK) manufacturing plant at Bridgend, Wales, and is assembled at Bridgend.

Speaking of his company's involvement in Prestel, Mr Kazuo Imac, of the Commercial and Industrial Division, said: "As well as being the first Japanese company to develop Prestel equipment, we have considerable investment in viewdata technology and this Prestel equipment is only the first of many developments to come." It will be remarked that this Japanese company seems to show considerably more enthusiasm for the system than the television set manufacturers in the country where Prestel was born. The British set makers have been well behind schedule in supplying viewdata receivers ordered for the test service started in September 1978.

• Four companies, Mullard Ltd, General Instruments, Texas Instruments and VG Electronics, demonstrated the British teletext/viewdata system in Tokyo on December 10 and 11. The object of the presentations was to show the advantages of the system's components and sub-assemblies to Japanese setmakers who undertake, or plan to undertake, the manufacture of suitably-adapted tv receivers in the UK or Europe. The presentations were organised by the British Overseas Trade Board. The Sony terminals mentioned above in fact use Mullard viewdata integrated circuits.

Arts competition

The Royal Society of Arts is including an audio-visual presentation in its 1979/80 Design Bursaries Competition, which this time will offer awards to the value of £50,000. In the audio-visual presentation section, students and young designers are given the opportunity to develop their technical skills and to apply their visual imagination to animating a sequence of ideas by means of lasers, holograms or any other audio-visual method.

Further information may be obtained from the Royal Society of Arts, John Adam Street, Adelphi, London WC2N 6EZ.

Hospital paging using synthesized speech

A new microprocessor-controlled radio paging system, recently installed by Multitone Electric Company Ltd at Frenchay Hospital near Bristol, includes synthesized speech. Multitone's ACESS 1800 paging terminal has enabled the hospital to organise several group alert sections of staff and considerably speed up the connection of one member of staff to another by telephone without using the switchboard staff.

ACCESS 1800 enables simultaneous calls to be made to as many as 12 team members in up to ten teams including the cardiac arrest team, a mobile resuscitation unit, and major accidents and fire teams. A member of staff can locate any receiver holder by simply dialling an access digit on any telephone, followed by the receiver number and the caller's extension number. He may then hang up the phone. A "bleep" will be heard by the receiver holder who, upon pressing a button, will then hear a synthesized speech message giving the caller's extension number. The switchboard is not involved in this at all. The cardiac arrest team can be alerted and mustered within seconds to a particular ward by a verbal message over their receivers. Similarly, the mobile resuscitation unit can usually be mobile in about 30 seconds from the origination of a call from the switchboard.

An operator on Frenchay Hospital's busy switchboard using the control panel for Multitone's ACCESS 1800 microprocessor-controlled speech-synthesized paging system.

Thirty calls may be stacked in the computer's memory and automatically processed in sequence, even when interrupted by a priority call. Any temporary change of receiver number, for staff on call, can be programmed into the memory, which will automatically call the alternative number when the original, unobtainable number is dialled. If one doctor is unobtainable, a second on-call doctor can be summoned automatically in his place. This call transfer system eliminates the need to inform all staff of the change of number when any receiver is exchanged.

Pseudo-direct satellite speculation

Mr Pat Hawker of the IBA, speaking as a 'devil's advocate' – his own words – at a meeting of the Society of Cable Television Engineers on October 16, posed the question "What would happen if say a commercial company in Luxembourg were to use a lower-power satellite positioned at 19°W (the orbital position allocated to Luxembourg, France, West Germany etc.) on the appropriate 12GHz channels and carrying a stream of bought-in programmes in the English language?" Speculating, he said, "Such transmissions would be picked up in the UK."

A small number of enthusiasts, according to Mr Hawker, would undoubtedly be capable of making their own equipment to receive these transmissions, either directly or for community distribution. For good quality reception, he said, they would need efficient satellite receive-only terminals with – for 12GHz – possibly 1.5, 2 or at most 3 metre dish aerials and these, while requiring greater profile accuracy, would not necessarily be any more expensive than the 4.5 metre dishes used in the USA. According to a recent press report, he said, enthusiasts in North America had managed to receive tv from Westar and Satcom Systems, mainly to mining and timber camps. The report said that Canadian government officials had estimated that 50 unlicensed stations were involved, but their operators were not shut down because the government had difficulty in locating them and there was a genuine danger, according to an official, that the lumberjacks and miners would resist with force.

Reminding his audience that Radio Luxembourg had been carried on cable, Mr Hawker posed a second question, "Would British cable networks be permitted to distribute programmes from France, West Germany or Luxembourg?"

"It would need Home Office approval," he said, "but as Erik Jurgens, chairman of the Netherlands Broadcasting Corporation has pointed out, there is Article 10 of the European Convention. This states: Everyone has the right to freedom of expression. This right shall include freedom to hold opinions and to receive and impart information and ideas without interference by public authority and regardless of frontiers. This Article shall not prevent States from requiring the licensing of broadcasting, television or cinema enterprises." Mr Hawker suggested that such an Article posed legal questions which only experts could answer, and that it was possible that no two experts would agree on how this might be held to effect the distribution of programmes from other members of the EEC and where no copyright protection was sought. If cable operators could distribute programmes in such a manner, it would open the way for programmes and advertisements which did not conform to BBC or IBA conventions, guidelines and regulations – de-regulation of broadcasting.

Pat Hawker made it clear that the views expressed were entirely his own and not those of the IBA.

CA for CB

The Consumers' Association have come out in favour of introducing a citizens' band radio service in the UK. In a one-page summary of the arguments for and against in the November issue of their magazine *Which?* they conclude: "Citizens Band radio in this country may not save many lives, nor may it be the best way of relaying traffic information. But it could provide an easy-to-use, relatively cheap method of communication that many people would find useful to have on occasions. We'd like to see it available here, if the problems of interference can be overcome."

The Association maintains in fact that the possibility of interference with other electronic equipment is the only serious argument against the introduction of c.b.: "The system of transmission used in most other countries would certainly cause interference, and shouldn't be used in the UK. There are other systems (e.g. v.h.f./f.m.) that would be much less troublesome – but the problem of interference is undoubtedly important, and more research is needed to ensure that any chosen system would be satisfactory."

SERT move

The Society of Electronic and Radio Technicians moved to larger offices on November 10, 1979. Its new offices are at 57-61 Newington Causeway, London SE1 6BCL. The Society occupied its previous offices, in Faraday House, since 1968.

German press considers higher frequencies for c.b.

Conditions on the 27MHz citizen's band are giving users cause for concern and every day there are new calls for better operating conditions. The German electronics journal, *Funkschau*, therefore carried out tests and compared some alternative bands to get acquainted with the advantages and disadvantages of each one as far as c.b. was concerned. Their findings showed that shifting c.b. into the v.h.f. or u.h.f. region could produce considerable advantages. It would cause much less interference to home-entertainment equipment, and the substantial increase in the channels which could be used would put an end to the present over-crowding.

Because special permission is required in West Germany to use frequencies around 900MHz, this band could not be included in the tests. Instead the 23cm amateur band (1295MHz), which has similar propagation characteristics, was considered, together with the 70cm (435MHz) band and the current 11m (27MHz) band. On the 11m band they found that there was always heavy interference from stations in countries further south and from industrial generators, while on v.h.f. and u.h.f. only noise could be heard. The tests were carried out using omnidirectional antennas with no gain and powers of less than 1W.

For propagation comparisons the different types of terrain were considered. Munich was chosen as a heavily built-up municipality, the Upper-Bavarian lakes were used for propagation over areas of water, and the hilly country in the north of Munich enabled trials to be done over undulating terrain. As expected, the poorest ranges were observed in the 23cm band, and usable ranges could not be achieved until a station arrived at an exposed location. Penetration was good on this band and radio contact was not even lost when one station moved into a garage. In the city, however, the "phase wipeouts" from passing vehicles proves a great nuisance, and it was concluded that diversity reception could help in this case. It was the journal's experience that the 23cm band could only be of value for c.b. radio if repeater stations were set up on high buildings or mountains, and it would also be necessary to obtain approval for high-gain antennas.

More v.h.f. broadcasting likely

The v.h.f. sound broadcasting band in Region 1, at present 87.5 MHz to 100 MHz, will almost certainly be extended upward to 104 MHz as a result of a decision at WARC 79, we understand. In Britain, for example, this will allow an extension of BBC and IBA local radio services, will avoid the necessity for sharing between BBC Radio 1 and Radio 2, and will reduce the need for some Radio 3 and Radio 4 programmes to be displaced by educational broadcasts (see article by D. P. Leggatt in this issue). To permit this extension of broadcasting, the police radio communications at present occupying 100-104 MHz will have to be moved elsewhere but it is not yet known what frequencies are likely to be used.

Apart from this loss, mobile radio in Region 1 has benefited overall from the decisions at WARC 79. At the time of going to press we understand from unofficial sources that this service will be allocated sections of the spectrum which it has not had the use of before. In Britain one of these sections could well be part of Band 1 (47-68 MHz) which is at present used for 405-line television broadcasting by both the BBC and IBA, but what happens here will in fact be an internal UK decision made by the Home Office. The BBC hint that the remainder of Band 1 could perhaps be used for the new direct digital radio broadcasts.

It seems there has been something of a conflict at WARC 79 between the USA and Canada over the allocations for services in the u.h.f. bands in Region 2. Because the heavily populated areas of Canada are close to the US border it is obviously necessary that the two countries use these bands in the same manner in an integrated way to avoid interference. Canada wants to use the u.h.f. bands exclusively for television broadcasting (the present exclusive allocation for this service being 470-890 MHz), partly because it has a large number of language groups to cater for both native peoples and immigrants, while the USA wants a more flexible arrangement in which they are shared with mobile radio. For example, the land mobile radio community in the USA recommended a co-equal mobile and broadcasting allocation between 470 and 806 MHz to provide flexibility in the international table of allocations and leave the domestic u.h.f. television allocations intact to the degree that is necessary. At the time of going to press we understand that the Canadian case is getting strong support from other delegations, but the issue is not yet settled.

Impulse buying by hi-fi customers

A consulting firm, Venture Development Corporation, from Massachusetts, claims that there is a link between the time spent by a customer selecting a hi-fi product and the amount of money spent by the manufacturer. The Corporation says that hi-fi buyers sometimes have a lot in common with new car buyers in that they need a lot of information, they often price shop, and they frequently require substantial psychological support. At other times, it says, the hi-fi buyers behave like chewing-gum buyers, needing very little time to make a brand selection and being completely pre-sold on a particular product. Price did not seem to be a critical factor as long as the merchandise was available.

The consulting firm compared the owners of systems costing $1400 or more with owners of systems costing less than $800, and found that 72.7% of the owners of high-priced systems spent at least a month selecting component brands, but only 37.2% of low-priced systems owners spent that long. Two factors accounted for this, according to the firm. Firstly, the larger the purchase, the more time the people were willing to invest to guarantee an optional selection, and secondly, the more expensive systems had more features requiring consideration, making the final choice more complicated. 20.7% of the owners of systems worth less the $800 decided on their components within one day or less, and only 4.2% of the owners of high-priced systems were able to make a purchase in the same time.

The Corporation claims that the implication for retailers is clear. They should not rush the sales of high-priced merchandise. Product literature, specification sheets and reprints of reviews should be readily available for customers to consider at their leisure, and the higher the price, the more information should be offered.

US noise jammer simulator to be made by UK company

A contract, valued at more than $4 million, to build the US Navy a noise jammer simulator, has been awarded to Watkins-Johnson the Windsor-based electronics company. The order, which comes from the Naval Weapons Centre at Dahlgren, Virginia, gives the company the responsibility of designing, manufacturing, installing and activating a computer-controlled system capable of emulating hostile jamming environments. When completed in 1981, the simulator will be used at the Atlantic Fleet Weapons Training Facility to provide electronic counter-countermeasures training for Navy radar operators.

V.o.r. computer

Walter Freter, who is a member of the Munich gliding club and the Siemens (Munich) amateur electronics group, has developed an automatic v.h.f. omnirange (v.o.r.) receiver, using a microprocessor to calculate and display the required compass bearing. Normally, the pilot of an aircraft is required to look up the frequency of the selected v.o.r. beacon, tune his navigation receiver and set the omni-bearing selector, observing the left/right indications of the display and adjusting the heading to keep the needle centred.

Freter's design avoids all this by virtue of its programmed table of all European frequencies, and the power of its microprocessor to tune the navigation receiver to the beacon transmission. The processor will calculate the required compass course to fly, using the left/right information which would normally be displayed, and will show the continuously up-dated compass course on a numerical display on the control panel.

Siemens say that several manufacturers (not Siemens?) have shown interest in the equipment.

WORLD OF AMATEUR RADIO

Past the peak?

By the time these words are published it seems likely that the peak of Solar Cycle 21 may have passed — although this will not be known for certainty until mid-1980. Long-distance paths on frequencies up to and above 50MHz reappeared in mid-October with many cross-band (50MHz/28MHz) amateur contacts between Europe and North America. The season appears to have opened on October 18 when American 50MHz signals were received in West Germany. The amateur station, G3SSO, operated by personnel at GCHQ, Cheltenham is thought to have been the first British station to make such a contact this autumn, working Canadian VE1AVX on October 19. RSGB advises that 28.875 — 28.895MHz has become established as the frequencies for cross-band s.s.b. operation with 50MHz North American stations.

The sunspot peak has been reached sooner than expected, although if the cycle follows the usual pattern, the decline will be considerably slower and several more seasons of 28MHz (and possibly 50MHz) long-distance "openings" appear likely. The past decade has shown once again the great difficulties experienced by radio physicists in accurately predicting, except in the short-term, the dates of maxima and minima and the level of maximum sunspot activity. Perhaps the most interesting new theories to emerge recently are those of Professor R. H. Dicke of Princeton University who believes that the cycles are accurately timed deep inside the sun by a form of magneto-fluid oscillator but take varying times for the magnetic fields to reach trhe surface; he also espouses the theory that the true solar cycle last 22 years with a reversal of magnetic field polarity at 11-year intervals.

Foxhunting

One of the aspects of amateur radio that continue to attract a small but faithful and enthusiastic following is the art of locating hidden stations by the use of direction-finding receivers. For many years the RSGB has organized a series of "qualifying events" leading to a "national final" based on transmissions in the 1.8MHz amateur band. For the qualifying events, competitors are expected to locate two different hidden transmitters within about a ten-mile radius of the starting point, but for the national final it is a question of finding three stations in a matter of a few hours. The 1979 winner, Eric Mollart of the Mid-Thames Club, took only just over two hours to do this, in spite of the many ingenious difficulties that tend to get built into the course as a result of past experience. For example, a technique which has been used at several events is to have an extremely long aerial which even when located may apparently lead nowhere. At Wolverhampton, in one of the 1979 qualifying events, for instance, one transmitter had several hundred yards of fine wire suspended in the trees as aerial, but with a final length tacked under the horizontal rails of a fence, eventually leading to gorse bushes in which the operator and his transmitter were concealed. The d/f bearings thus led the competitors only to a wooden fence with no sign of the concealed station.

A rather different form of 'foxhunting' using the 144MHz band, is also organized, for example, by the UK FM Group (London), though one gains the impression that care is taken to ensure that it can be combined with the objectives of the Campaign for Real Ale!

The first G/YL

Miss Barbara Dunn, G6YL, who died recently, is generally believed to have been the first licensed 'YL' (young lady) amateur operator in the UK and held her licence for over 50 years. Throughout the 1930s she was one of the small group of British 'YL' operators who were tremendously active on the long-distance bands and in pioneering both 28MHz and the old 56MHz bands. Even in 1937, ten years after she took out her licence, there were only five 'YL' amateurs in the UK: Nell Corry, G2YL; Constance Hall, G8LY (still licensed); A. J. Burns, GM2IA; G6SF; and Barbara Dunn — though these were joined soon afterwards by Catherine Myler, G3GH, who later was one of the very few amateurs to receive official recognition for their work as Voluntary Interceptors in the Radio Security Service.

Barbara Dunn became interested in radio communication as early as 1923 when she heard spark signals from ships breaking through on top of the old London 2LO broadcasts. She taught herself 20w.p.m. Morse by listening on a crystal set to the FL (Eiffel Tower) time signals on 2600 metres and ships on 600 metres before becoming interested in short waves at the end of 1925, acquiring her licence in 1927 and using initially an LS5 power oscillator with a rotary converter powered from 6V accumulators. Next year, moving from Stock, Essex to Northumberland, she was still limited (like many other amateurs of the time) to using 100V d.c. mains but worked all over the world with a maximum input of 8 watts to t.p.t.g. oscillators and, using a bent 60-ft 'AOG' (Act of God) aerial; with her rotary converter mounted on a block of sorbo rubber under the table. Her interest in ships continued and she made contact with many of those equipped with h.f. radio, although at that time British ships were not permitted to operate in this way.

The amateur radio market

Throughout the 1970s, the amateur radio equipment market has been increasingly dominated by Japanese firms whose products are now used by the majority of amateurs in most parts of the world (including many of the Eastern European countries although not in the USSR where much of the equipment continues to be described as "home made"). Although during the decade the total amateur market for equipment has risen sharply, few of the old-established British or American firms have come through unscathed from the torrent of equipment from Yaesu, Trio (Kenwood), Icom (Inoue), FDK etc. Some firms have adopted the policy of continuing to manufacture established designs but without introducing new equipments involving heavy development costs; others have attempted to keep ahead of the Japanese designs, although this is proving an increasingly difficult and hazardous policy and there are unconfirmed rumours that one of the more innovative American firms may soon be a further casuality of the trade war.

In brief

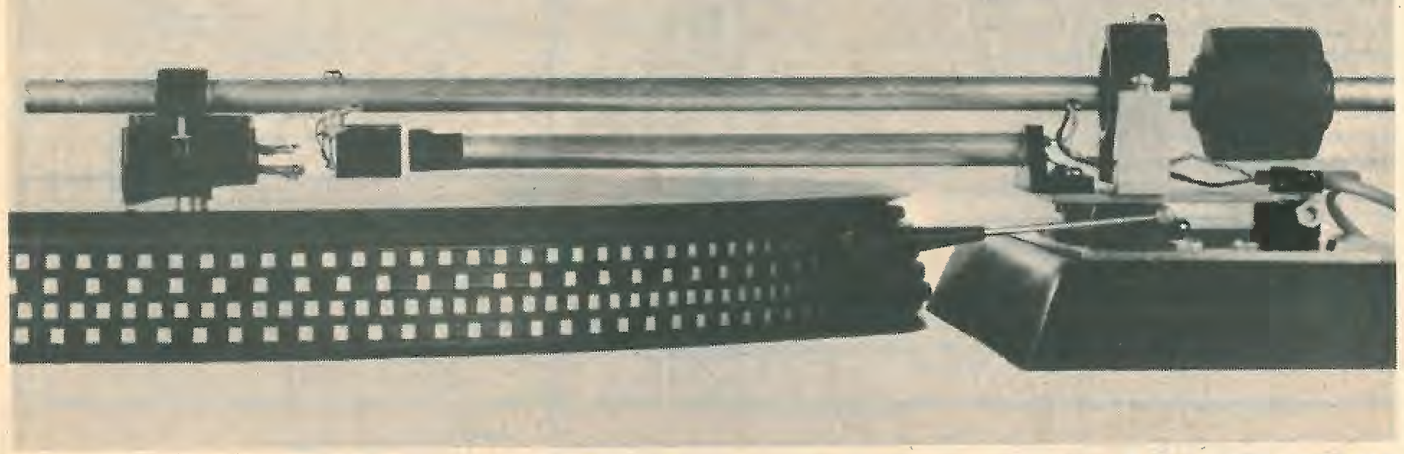
The USSR is planning to launch an RS3 amateur radio satellite during spring or summer 1980 .... King Hussein of Jordan (JY1 and G5ATM) recently met 45 members of the Radio Society of Harrow at a reception given by the Mayor .... Richard Thurlow, G3WW has become the third amateur in the world to obtain a CQDX award for working 100 different countries on slow-scan television (No. 1 was W8YEH, No. 2 G3IAD) .... Japan is now issuing amateur callsigns in the JM prefix series .... The VHF Committee of the RSGB has recommended 145.650MHz as a "calling frequency" for amplitude-modulated transmissions.

PAT HAWKER G3VA

Practical parallel-tracking pickup arm — 2

Optoelectronic servo control gives low-inertia, fail-safe operation

by Rod Cooper



Despite the many advantages of the parallel-tracking record deck, the high cost of owning one deters all but the well-heeled few. This prompted the design and construction of a pick-up arm and control system with simplicity of construction specifically in mind. By avoiding complex engineering it is possible to construct the design with non-specialized tools in about 40 hours and for a fraction of the cost of a commercial item.

WHILST ACCESS to a lathe makes construction quicker and easier, it is quite feasible to make all the parts with tools normally found in a small workshop. An electric drill and stand, some BA taps and dies and a selection of metal cutting files and saws are however essential.

Both the tracking arm and reference arms are made of thin-wall Duralumin tube, readily available from aeromodel shops. One end of the tracking arm is plugged with a tight fitting brass rod and glued into place with Araldite. This serves to strengthen the fragile tube where the vertical pivot goes through, and provides some degree of counterbalance.

Constructors will notice that the positions of horizontal and vertical pivots have been transposed, compared with the conventional arrangement. Having the vertical pivot on the tracking arm is not good practice on a conventional arm of course, but is permissible here because the tracking arm on a parallel-tracking machine does not swing on the pivot more than half a degree, whereas the conventional must swing through a wide angle. The change enables an unusual design of horizontal pivot to be used — one that allows the tracking arm assembly to be easily taken off for transport or adjustment without having to dismantle anything, and allows replacement without having to re-align it with the reference arm. There are other advantages to this design, namely: it is much easier to make than the usual spindle type, it is virtually friction-free, needs no lubrication, has no play due to bearing clearances and does not introduce play due to wear.

Avoiding play is important because the control system cannot distinguish between play and tracking error. It is for this reason too that the sliding platform is spring loaded, so that any running clearance in the track is taken up. Diagram 3 shows the horizontal pivot design. Two adjustable screwed pivot points rest on top of two support pillars, one in a slot and the other in a conical cup on the opposite side of the gimbal ring. The arrangement is quite stable, provided the two pivots are far enough apart.

The vertical pivot is straightforward. Adjustment for inclination is by means of the brass plate which forms the upper bearing, and which can be moved around on the flat top of the gimbal ring to the correct position.

The track in Fig. 4 can be cut with a small hacksaw and then filed to the exact dimensions. It is worth spending some time ensuring the track is straight, as the whole concept depends on the reference arm maintaining a constant angle to the tracked radius of the record. Also, it is essential that the carriage slides without any hard spots. It is not necessary to produce a perfect fit, as a small amount of slack will be taken up by the spring-loading.

To reduce wear, a few drops of clock-oil (which has good non-gumming properties) can be applied to the vertical pivot, the lead screw and the running surfaces parallel track. Don't use mineral oil sold as general-purpose or light machine oil because it thickens to a gum after a while.

The hinge pivot holder part 14 is soldered in position to the lower plate, part 11. The best way of doing this is to pre-solder both plate and holder; with a length of 6BA rod through both holders, position them the correct distance apart and place them on the plate, and gently heat the plate from below. It is then quite easy to move the two holders into the exact position while the solder is molten; excess solder will cause holders to float out of place, so use the bare minimum.

For the sake of simplicity, the counterweight on the prototype was made from a piece of 1in diameter brass bar drilled through the centre and decoupled with a foam rubber insert. However, the comments by Randhawa on counterweights (*WW* April 1978 pages 63-8) should be noted by constructors as a better design is probably possible. The main requirement for the counterweight is that it should give neutral equilibrium with the chosen cartridge when the tracking arm is positioned about half way up the vertical pivot.

The photocell holder was filed from a piece of solid engineering-grade p.v.c. which is particularly easy to use, but other reinforced or filled plastics such as Tufnol would probably be suitable. The two photodiodes were cemented to the holder with Araldite. An aluminium shim separated the diodes, this being necessary to prevent light from one diode reaching the other by reflections via the transparent sides of the BPW34. The size of the shim is not critical but for good light cut-off between the diodes it should project ⅛in or so all round.

A shroud was made from the same shim material to clip onto the holder. It is best if this is eventually fixed in place with Araldite when the system has been proved to work satisfactorily. Beer and soft drink cans are a good source of strong, thin aluminium. It is important that the weight of the holder and shroud is kept as low as possible to preserve the low inertia of the tracking arm.

Regarding the finish and appearance of the self-made metal parts, both polished brass and aluminium can be protected from tarnish by Letraset aerosol spray No. 101. This provides quite a tough, abrasion-resistant transparent film which is almost undetectable.

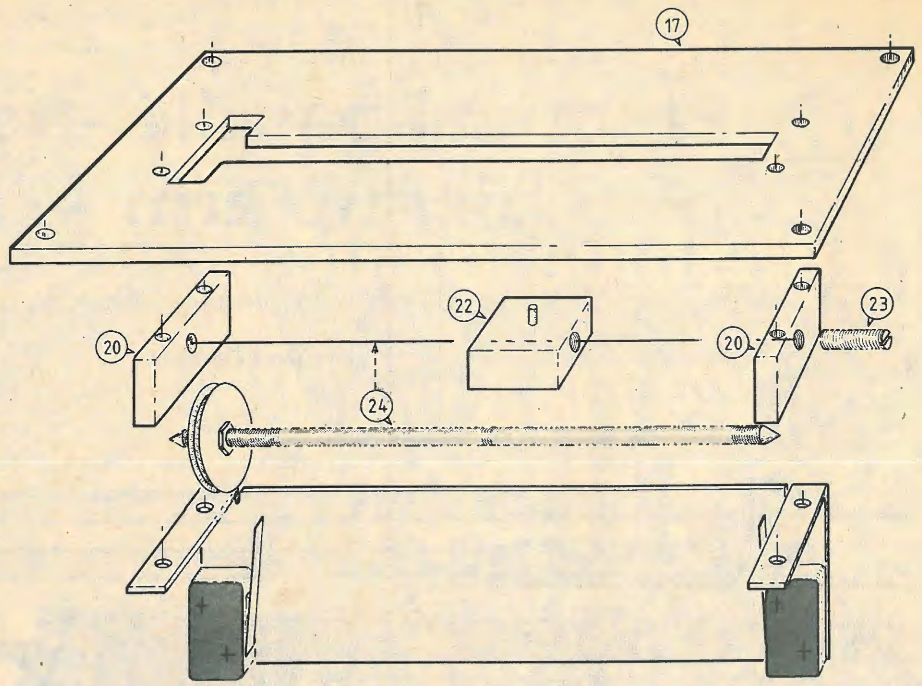
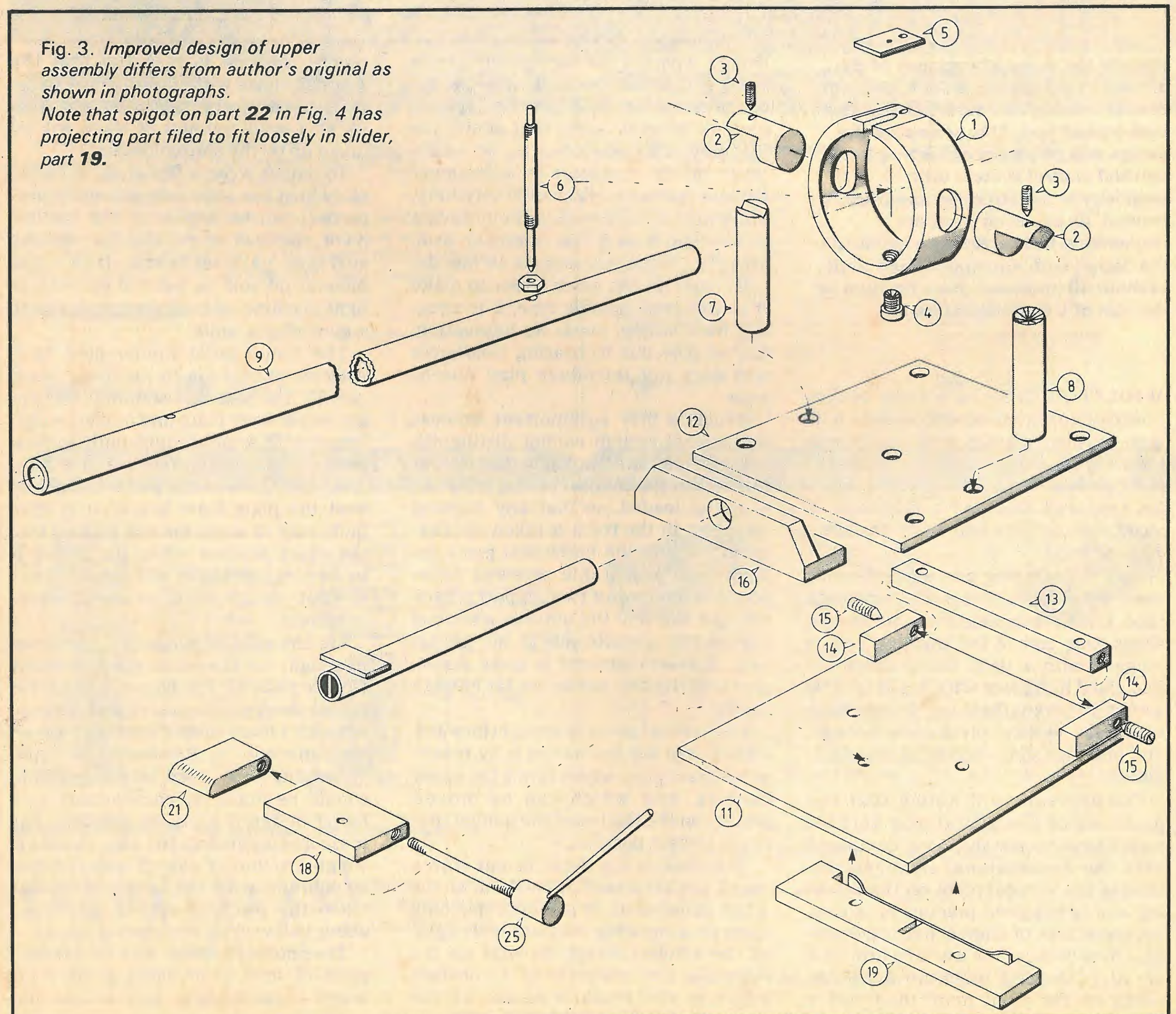
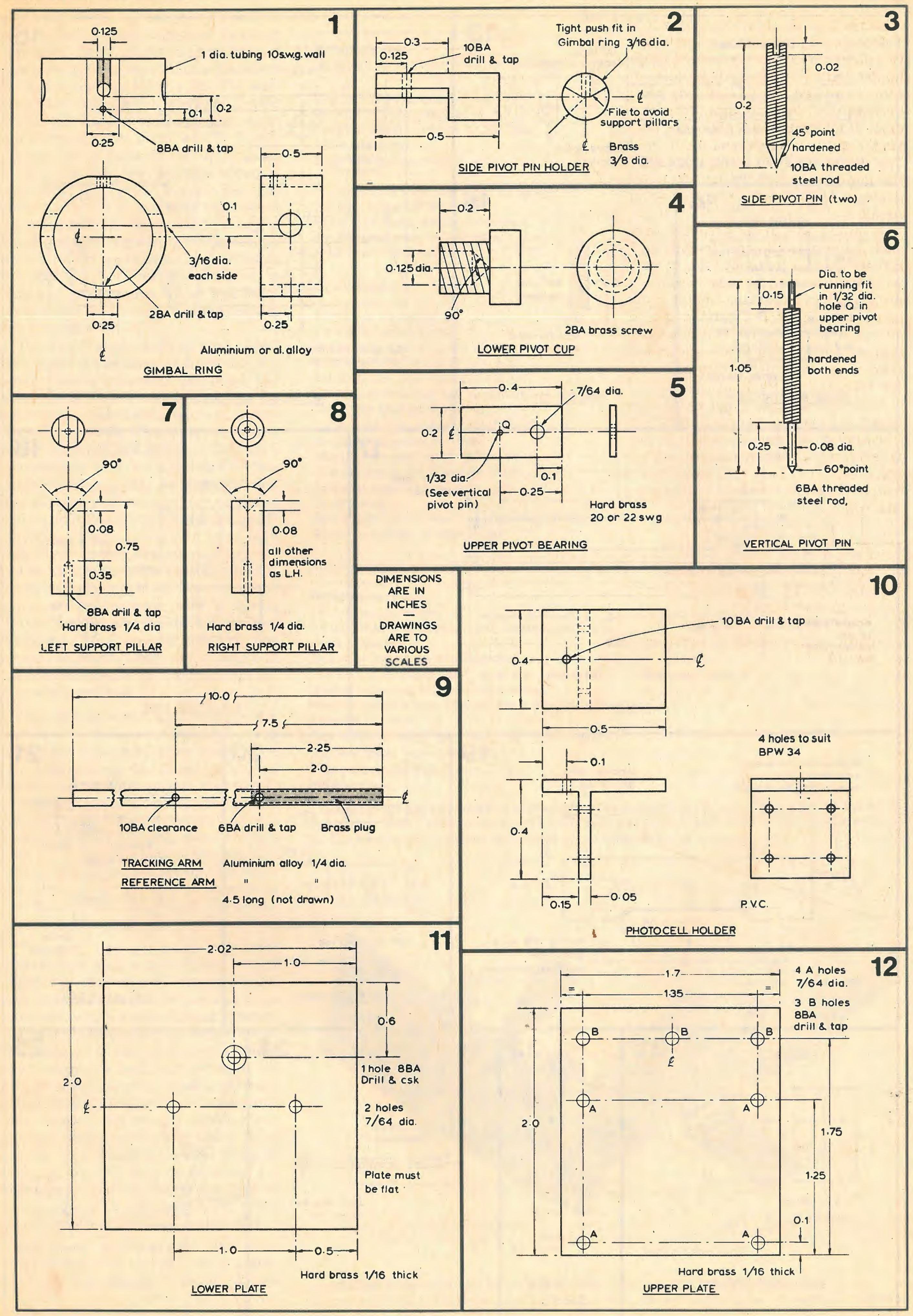
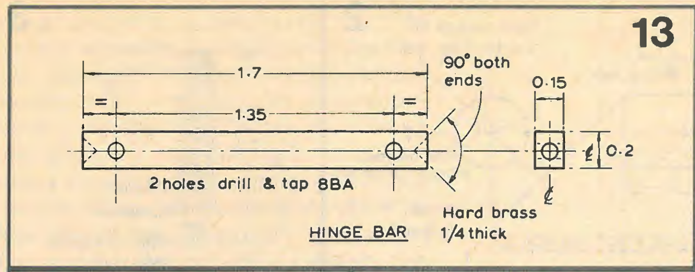


Fig. 4. *Lower assembly comprised lead screw arrangements as shown, together with drive mechanism pictured in December issue.*

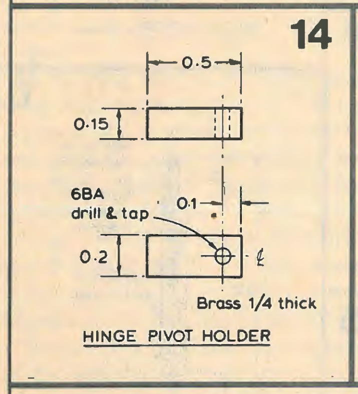
Fig. 3. *Improved design of upper assembly differs from author's original as shown in photographs.*
Note that spigot on part **22** *in Fig. 4 has projecting part filed to fit loosely in slider, part* **19.**



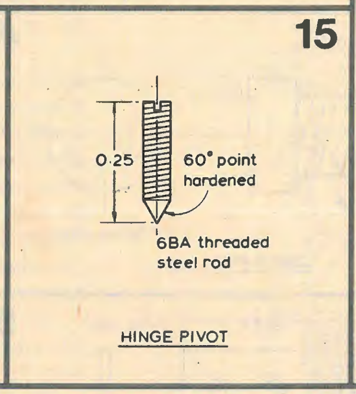




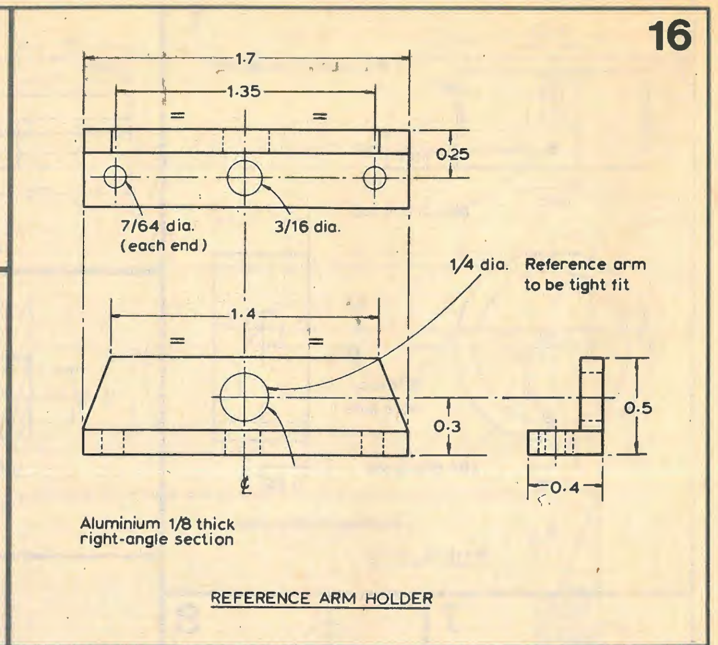
HINGE BAR



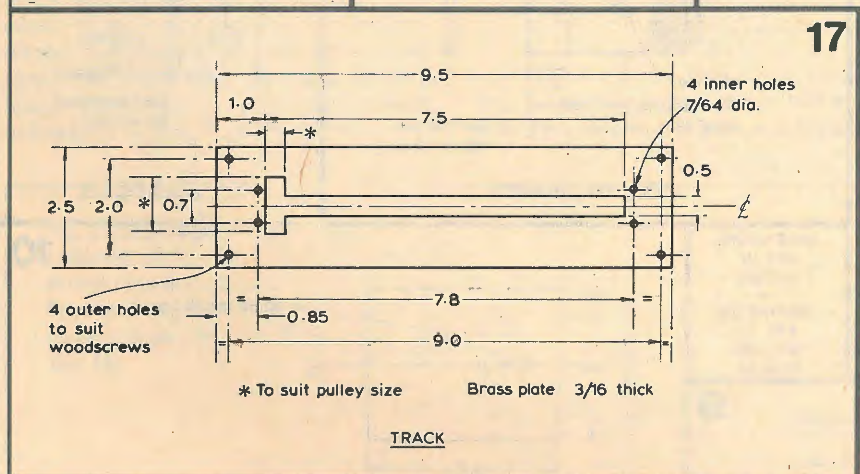
HINGE PIVOT HOLDER



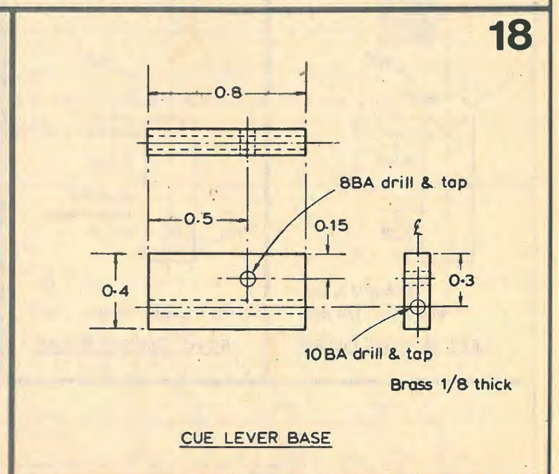
HINGE PIVOT



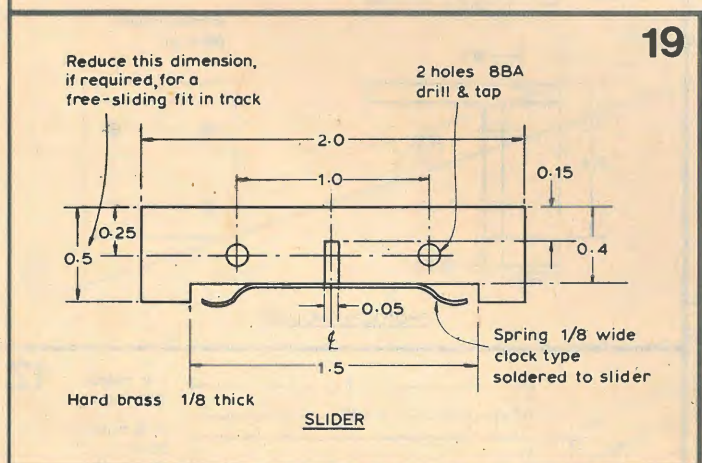
REFERENCE ARM HOLDER



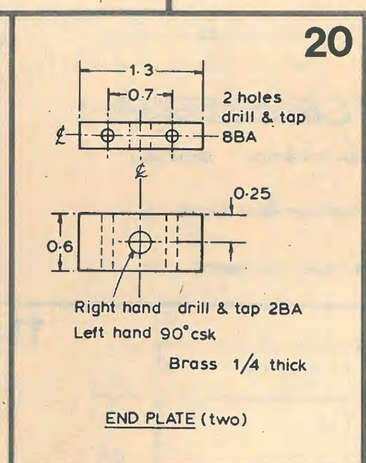
TRACK



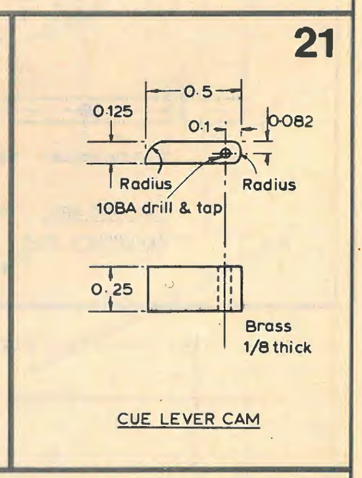
CUE LEVER BASE



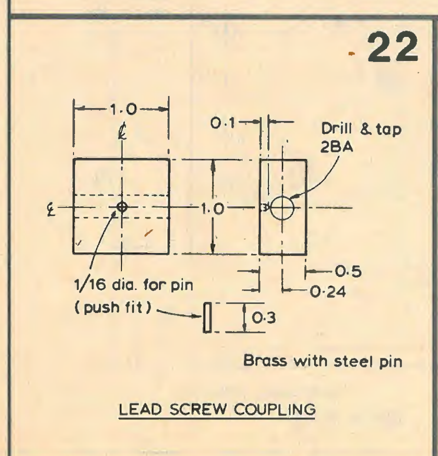
SLIDER



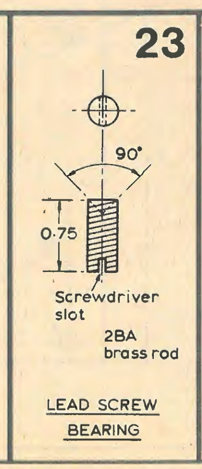
END PLATE (two)



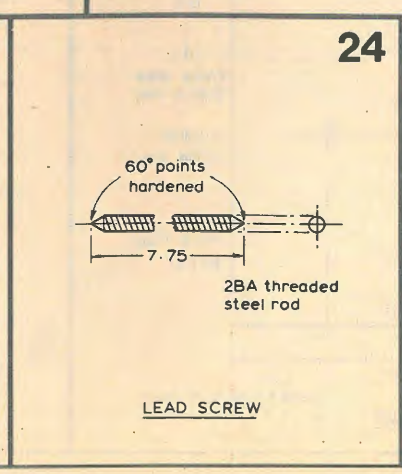
CUE LEVER CAM



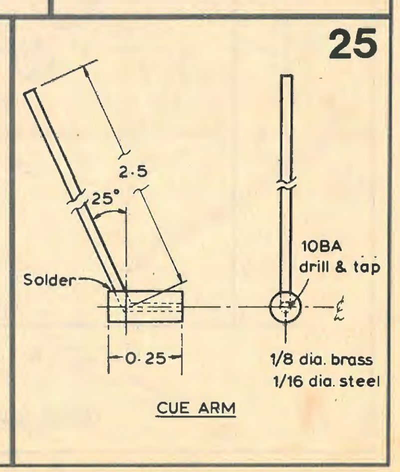
LEAD SCREW COUPLING



LEAD SCREW BEARING



LEAD SCREW



CUE ARM

Wiring to the cartridge, opto-switch and filament bulb is made with 3x45swg Litz wire. There seems to be no readily available alternative to Litz wire which is flexible enough for the job. The cartridge and opto-switch wiring is carried inside the tubular tracking arm, exits near the vertical pivot and is firmly clipped to the back of the upper platform. From here the cartridge wiring is kept apart and carried in p.v.c. sleeving to a 16 pin dual in-line plug and socket on the plinth. The opto-switch wiring is combined with the wiring from the bulb and carried in separate p.v.c. sleeving to the socket. This arrangement gives a neat and symmetrical layout and helps prevent the lead-out wires from fouling the gimbals.

The T1¼ filament bulb is rated at 24V 35mA and is run directly from the 20V supply. When under-run like this it has a very long life but does not emit much white light. This hardly matters, as the response of the BPW34 diode lies mainly in the infra-red and matches the bulb's output quite well. An infrared-emitting diode could propably be used instead. The efficiency of the reference arm tube can be improved by polishing the inside surface — bright aluminium has a high reflectivity in the infra-red register.

The T1¼ bulb is the only commonly available bulb which will insert into the standard ¼in diameter tube. It should not be free to move when in place, and wrapping a small piece of adhesive tape round the plastic body of the bulb will make it a firm push fit. Insert so that the filament is vertical.

The cassette motor used in the prototype drew 60 mA on normal play, rising only a few milliamps when running on full rated voltage, but drawing 500 mA when stalled. The output transistors need to be mounted on heat dissipators to avoid overheating when the motor is stalled; though stalling should never take place in theory, it is not unlikley during testing and setting up. Similarly, the short-circuit protection resistor in the BD135 collector circuit should be generously rated.

The relay used was a sensitive reed-switch type with a coil wound specifically for this circuit, but a standard 12V relay could be used in conjunction with a series ballast resistor. The 47kΩ adjustment potentionmeter should be set so that in normal ambient light conditions and with the light slit off the face of the photodiodes, the relay will close. High ambient light conditions may swamp the diodes despite the shroud, and prevent the relay from closing. However this is never likely to occur if the unit is used sensibly, for example away from bright sunlight. A heavily-tinted or even light-tight cover on the record player is recommended.

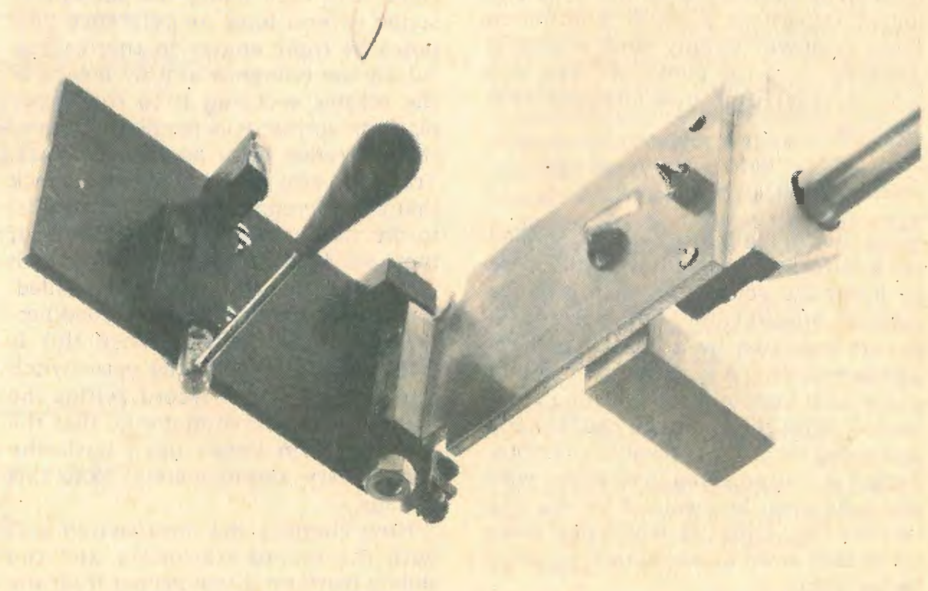
The power supply for the turntable, servo motor and electronics is a 20V stabilized unit capable of giving 1A (my turntable required 350mA peak). As the design of the power supply is by no

PARTS LIST

Raw materials No allowance has been made for wastage during machining.	Identification
½in 2BA brass screws	lead screw bearing **23**
8in 2BA screwed steel rod	lead screw **24**
1in plain round brass rod 3/16in dia.	side pivot holder **2**
2BA brass screw	lower pivot **4**
2½in 6BA screwed rod	hinge pivot **15** and vertical pivot pin **5**
½ x ¼in brass shim (say 20 or 22 gauge)	upper pivot bearing **6**
2in plain brass rod ¼in dia.	support pillars **7 & 8**
9½ x 2½in brass plate 3/16in thick	parallel track **17**
4 x 2in brass plate 1/16in thick	upper & lower plates **11 & 12**
2 x 2 x ¼in brass bar	end plate **20**, hinge pivot holder **14**, hinge bar **13**
2 x 1in brass plate ⅛in thick	slider **19**, cue lever base **18**, cam **21**
2in of ⅛in clock spring	slider **19**
1 x 1 x ½in brass block	lead screw coupling **22**
½ x ½ in aluminium angle 2in length	reference arm holder **16**
10in alloy tube, thin wall, ¼in o.d.	tracking arm **9**
5in alloy tube, thin wall ¼in o.d.	reference arm
2½in plain brass rod, dia. to suit i.d.	plug for tracking arm **9**
¼in 10BA steel grub screws	side pivot pins **3**
1¼in 10BA steel screw (or 1/16in dia. rod)	cue lever shaft
¼in plain brass rod ⅛in dia.	cue lever **25**
Short length steel rod (1/16 dia.)	cue lever **25**
10BA screw to suit photocell holder	
8BA ¼in brass screws	
1in brass bar	counterweight
½in length 10 gauge extruded aluminium tube 1in o.d.	gimbal ring **1**
Aluminium sheet, as appropriate	template, Fig. 6, & microswitch plate, Fig. 4.
Aluminium shim, as appropriate	slit & photocell holder

Other essentials
1mA meter movement
6V d.c. reversible electric motor, cassette deck type
Relay — see text
Two small lever-type microswitches
T1¼ 24V 35mA light bulb*
Chassis-mounting 16 dual in-line socket
Wire-terminating type 16 dual in-line plug for above
4 metres Litz wire*
Four pulley wheels to suit motor, lead screw, gears
Matched worm gears and shafts*
Matched pair BPW34 diodes*
Watch oil*

Raw materials and parts marked with asterisk are available from J. Biles. Send s.a.e. for list to 120 Castle Lane, Solihull, West Midlands B92 8RN. Suitable turntable and motor are available from Symot Ltd, 22a Reading Road, Henley-on-Thames, Oxon RG9 1AG



Suggested simplifications for reference arm hinge include avoiding cuts in top plate by making lower plate larger. Gimbal pivot pillars, shown rectangular on page 67, are more simply made from ¼in rod.

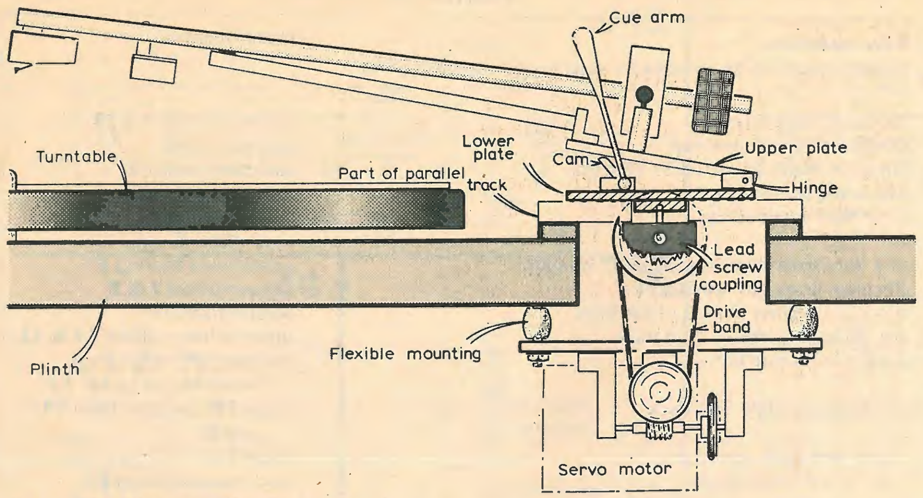


Fig. 5. Assembly details of motor and 100 to one speed reduction (lower portion) are left to individual constructors. Upper assembly is detailed in drawings and Figs. 3 & 4. ▲

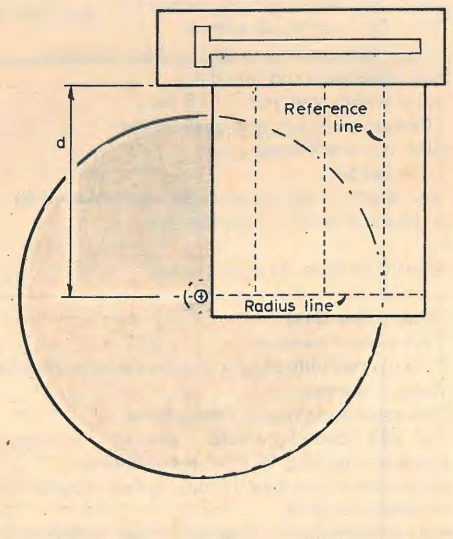


Fig. 6. When properly adjusted a tracking error of 0.2° is corrected in half a second. A set square is needed for scribing reference lines on an aluminium template at right angles to radius line. ▶

means critical it is left to the discretion of the constructor. On the prototype, which had the mains transformer botled to the plinth, it was found that mechanical vibration was finding its way to the tracking arm to give 50Hz hum. Mounting the transformer on rubber grommets cured the problem, but it is perhaps a better solution to have a power supply unit which is separate from the plinth. At least one commercial unit has adopted this approach.

Setting up

With the tracking arm fully assembled with cartridge and counterweight, raise or lower the vertical pivot to produce neutral equilibrium. The horizontal pivots can also be adjusted to help produce equilibrium, and then set in place with Loctite thread-locking compound. With the cartridge resting on a discarded record, the level of the opto-switch is now adjusted to be in line with the light beam, by means of the spacing washer (Fig. 1, part 1), which may have to be filed down or added to in order to achieve this.

A template to check the accuracy of tracking is essential. A sheet of thin aluminium is cut to suit Fig. 6, the corners being checked against an engineer's set-square. Find distance d, which will depend on cartridge position, with the template resting firmly against the front edge of the parallel track. Scribe a radius line at distance d parallel to the front edge of the template, left to right, and then using the set-square scribe several lines for reference purposes at right angles to this radius. Adjust the reference arm by means of the screws securing it to the upper platform so that it is parallel to one of the reference lines on the template. Track the arm fast forward and check that the reference arm remains parallel to the various other reference lines. If there is a discrepancy, the parallel track is not straight, and should be re-filed; fortunately the eye has very good perception of parallelism. When this is satisfactory, and with the opto-switch disconnected, play a record, setting the voltage to the servo motor so that the tracking arm keeps pace with the record, very approximately. Note this voltage.

Now connect the opto-switch and with the record stationary and the sliding platform disconnected from the lead screw, bring the tracking arm parallel to the reference arm. The meter reading should now correspond to that obtained with the opto-switch disconnected. If it is not then either the reference arm must be moved sideways to correct this (and then re-aligned of course) or the opto-switch must be moved in relation to the tracking arm.

As a final check, observe the tracking arm from above as it plays a record properly, and note the changes in meter reading as the servo-system corrects tracking errors. Now is the time to adjust the sensitivity by means of R_f and the maximum voltage to the motor (if necessary), by changing the 13V limiting Zener diode for a higher or lower value as required. The prototype was set to correct an error of 0.2 degrees in about 0.5 seconds, which I found to be adequate. The time taken depends not only on the sensitivity but on how hard one is prepared to drive the servo motor. The amount of noise and vibration generated is naturally small in motors designed for cassette decks, but in the prototype, which used a 6V motor, 5.5V was the optimum voltage, before noise from this motor overtook noise from the turntable motor. □

S. G. Brown, F.R.S.

At the time of his death shortly after the end of the second world war Sidney George Brown F.R.S. had more than 1000 patents for inventions. These included the gyrocompass used by the Admiralty during the first world war, when they wanted to avoid adopting the American Sperry equipment; the tuned-reed headphones, which were so sensitive to weak signals that they were a standard issue for wireless operators; and a loudspeaker. Brown was the son of a family which had already won fame in the USA for proposing methods of preventing a repetition of the fire which destroyed much of Chicago in the eighteenth century.

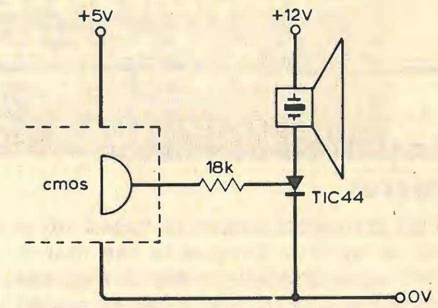
Mr F. P. Thomson, biographer of A. D. Blumlein, is now preparing a biography of Brown. He would like to hear from people who knew the Brown family in the USA or worked for S. G. Brown or his company in Britain and who could give or lend papers, notes, photographs, etc. Mr Thomson's address is 39 Church Road, Watford, Herts WD1 3PY.

C.m.o.s. compatible piezo sounder

Piezo electric sounders are efficient and reliable devices which contain a ceramic transducer and a switching transistor. Although the average current drain is 50mA, the sounder functions as a class C blocking oscillator where the current is pulsed with a peak of 800mA.

It is difficult to switch such a current directly with c.m.o.s. or t.t.l. and a switching transistor would need a wasteful 50mA or so of base current to ensure saturation. Although v.m.o.s. transistors need no drive current they are relatively expensive and have a significant saturation voltage. The simplest solution is a small thyristor which requires a maximum gate current of only 0.2mA. Because the anode current falls to zero between each pulse, the thyristor will turn off unless gate current is present. No gate to cathode resistor is required because a logic low output clamps the gate off.

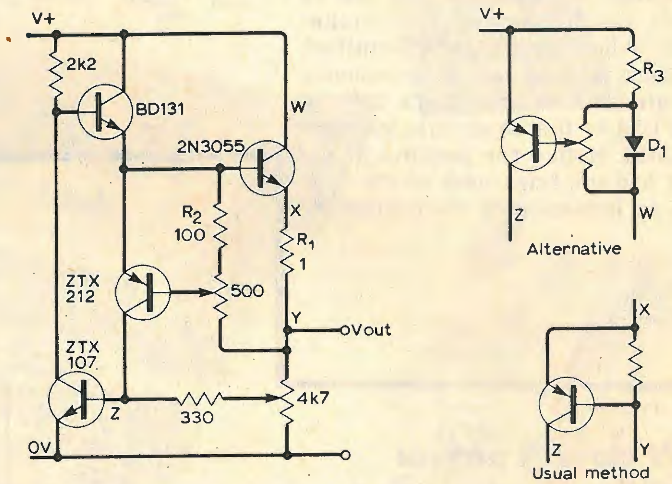
C. Stephens
Woodbridge
Suffolk



Variable current-limiting supply

This simple power supply offers variable current limiting from 10mA to 3A by using the pass transistor to offset the V_{be} of the protection transistor. Resistor R_1 can have any reasonable value and omitting R_2 allows unlimited maximum current. In the alternative circuit, R_3 and D_1 must be chosen for the maximum current required.

D. Rawson-Harris
Stockport
Cheshire



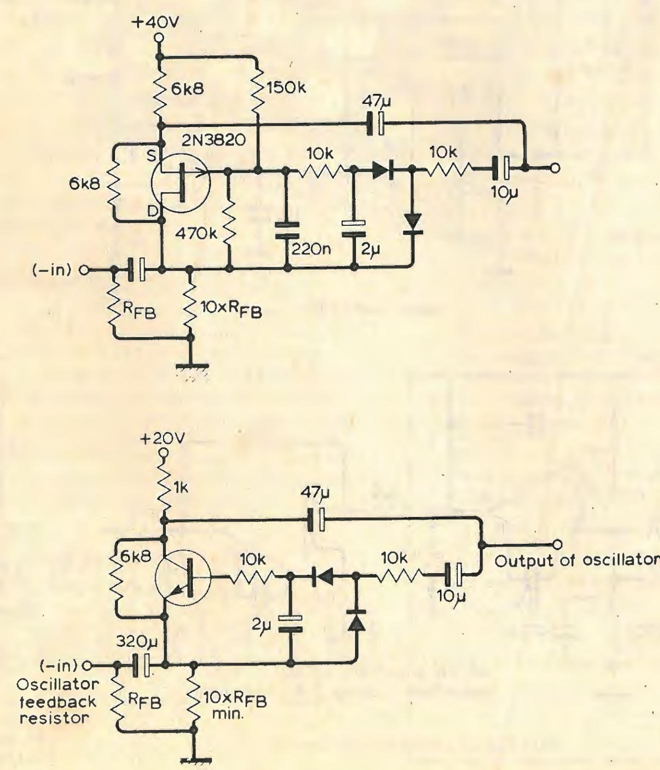
Thermistor replacement for oscillators

The R53 thermistor is often used in oscillator circuits to stabilize the output and reduce distortion. Unfortunately the device is reasonably expensive and intolerant of accidental power surges. This circuit provides a more stable output than the bridge driven rectifier previously published in *Wireless World*.

In the bipolar version the transistor and diodes can be any general purpose silicon types. The output level can be raised by connecting a Zener diode in series with the emitter. As the output of the oscillator is stabilized to 2.5V ± 5% it should be at least 3.5V r.m.s. before limiting.

If low distortion is important, a similar circuit with a f.e.t. can be used as shown. This does, however, require an oscillator output which at least equals V_{gsc}, i.e. 8V r.m.s. for a 2N3820.

R. Dynan
London



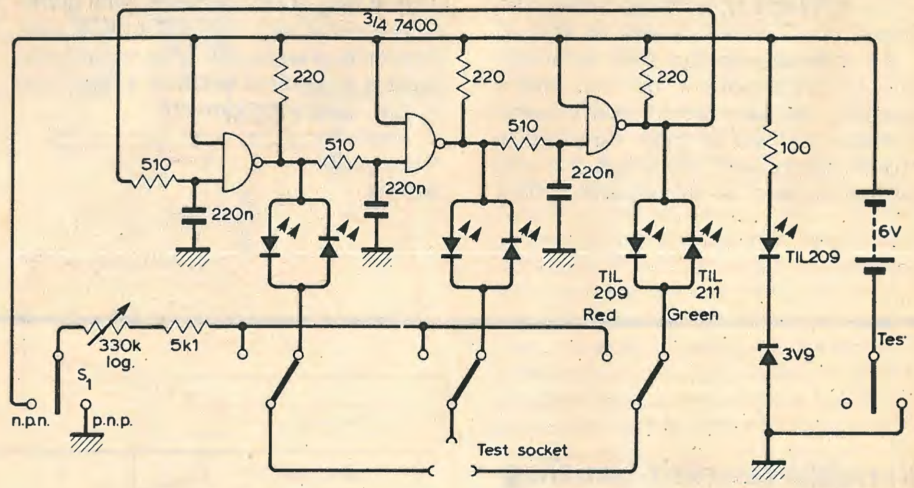
Continued on page 94

CIRCUIT IDEAS

Improved transistor tester

This transistor tester is based on a circuit by N E Thomas in the March 1977 issue of *Wireless World*. Any unknown bipolar transistor can be placed in the test socket and the transistor leads can be in any order. The ring of three oscillator produces a three-phase waveform which switches either two green and one red l.e.d. on for a n-p-n device or two red and one green for a p-n-p type. Other displays indicate a faulty device. By switching S_1 to the appropriate position, the base can be biased via the correct test socket switch. When this has been identified, increasing the base current by reducing the variable resistance turns the collector l.e.d. on first so all three leads are identified. Noting the position of the wiper and the brightness of the l.e.d. gives an indication of the transistors' gain.

M. Odyniec
Podlaska
Poland



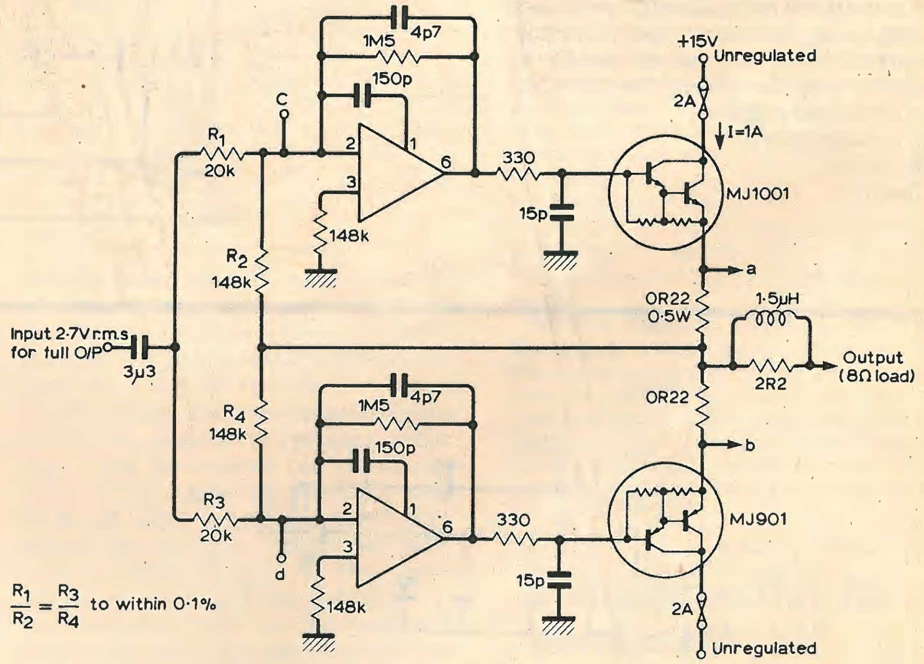
12W class A power amplifier

Almost all of the published audio power amplifier designs have had outputs in excess of 30W. However, there are still many applications where a high quality amplifier with less output is needed.

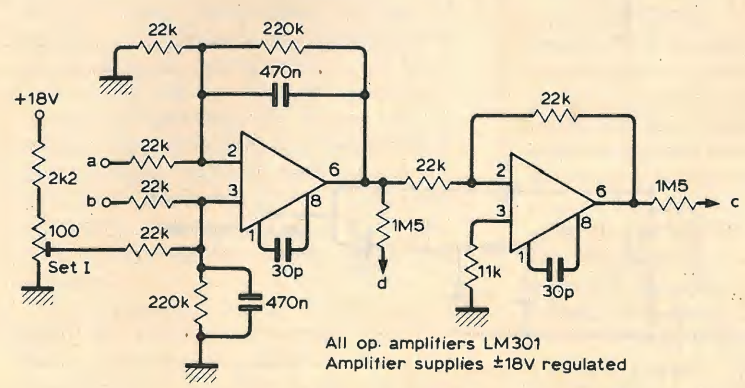
This circuit uses a class A output stage with feedback control of the quiescent current. Two independent amplifiers throughout simplify the circuit and provide a 3 dB improvement in the signal to noise ratio. The necessary trimming of resistors R_1 to R_4 can be achieved by temporarily connecting them in a bridge arrangement. Specification of the prototype is shown below.

Power output into 8Ω	12.5W
Frequency response (−3dB)	5Hz to 225kHz
Output slew rate	10V/μs
Distortion (5Hz to 20kHz, 0 to 10W)	<0.02%
Hum (rel. full power)	−85dB
Noise excluding hum component	−103dB
Stability	Unconditional
Output offset without nulling network	15mV

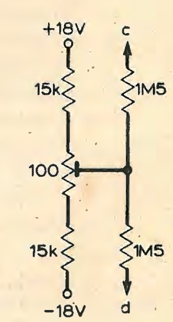
N. Pollock
Victoria
Australia



MAIN AMPLIFIER



QUIESCENT CURRENT CONTROL



OPTIONAL OFFSET NULLING NETWORK

LETTERS TO THE EDITOR

HURRAH FOR TELETEXT

May I, as a television dealer, air my views concerning teletext, which seems to have dominated Letters to the Editor in recent issues?

I feel the first point I must make concerns the letter from Mr Williams in the October 1979 issue. He complains on the one hand that there are not enough pages, and then goes on to add that if there were, he would not have time to read them all. Spelling and punctuation errors, he says, occur frequently but in my opinion they do not occur as often as in some newspapers.

Regarding access time, it takes on average 12 seconds for a page to appear, a little longer on Oracle – not bad for a system that has to ride piggyback on a few borrowed lines.

Teletext is not fading away as some people would have you believe. We dealers must take a lot of the blame for its slow start. My teletext customers are extremely pleased with their sets, which could be due to the fact that we spend over an hour demonstrating the full teletext facilities to them.

I keep wondering why some people wish to change the format of teletext. As far as I am concerned, it offers a very good and comprehensive service the way it is. Teletext sales are on the increase and I feel there is a healthy market developing for the future. So hands off our teletext service, it is the best thing in television for years!

R. J. Timms
Swadlincote
Burton-on-Trent

SIDEBANDS AS PHASORS

The opening remarks of J. M. Osborne's excellent article "Sidebands as Phasors" (September 1979) suggest that Bessel functions are necessary to show that the sidebands of a frequency modulated wave extend to infinity. This is not strictly true for their use is merely a mathematical convenience. The same result can be achieved using mainly traditional trigonometrical methods.

A general expression for a frequency modulated wave (see Terman's "Electronic and Radio Engineering", page 588) is:

$$e = A\sin(\omega_c t + m_f \sin\omega_m t)$$

where ω_c and ω_m are $2\pi\times$ the carrier and $2\pi\times$ the modulation frequency respectively and m_f is the modulation index. This expression can be expanded using the well known "sine–sum" formula to

$$e = A[\sin\omega_c t\cos(m_f\sin\omega_m t) + \cos\omega_c t\sin(m_f\sin\omega_m t)]$$

Thus the problem now turns on finding a simplification for the terms $\cos(m_f\sin\omega_m t)$ and $\sin(m_f\sin\omega_m t)$ and here we must depart into the realms of simple differentiation. Sine x and cosine x can each be expanded in series form (see, for example, Saxelby "A course in Practical Mathematics", page 221) so that:

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} \ldots\ldots$$

$$\text{and } \cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} \ldots\ldots$$

Substituting $m_f\sin\omega_m t$ for x in these two series we arrive at two other series, one with odd powers of $\sin\omega_m t$, and the other with a zero frequency component and even powers of $\sin\omega_m t$. Each has related coefficients in powers of m_f.

The individual terms of each series can be further expanded into fundamental and harmonic components of ω_m. The even indices will produce cosine terms of even harmonics and the odd indices harmonic sine terms, the highest harmonic in a particular term being equal to the order of the index.

For example:

$$\sin^3\omega_m t = \tfrac{1}{4}(3\sin\omega_m t - \sin 3\omega_m t)$$

$$\text{and } \sin^4\omega_m t = \tfrac{1}{8}(3 - 4\cos 2\omega_m t + \cos 4\omega_m t)$$

It is now necessary to collect together terms of similar frequencies and to consolidate their coefficients. We have to substitute these terms back into the original expansion where the cosine terms will be multiplied by $\sin\omega_c t$ and the sine terms by $\cos\omega_c t$. We are now on familiar ground where each term will resemble that of an a.m. wave. The terms will have the form:

$$(\cos\omega_c t)\,.\,\sin p\omega_m t \text{ and } (\sin\omega_c t)\,.\,\cos n\omega_m t$$

where p is an odd integer and n is an even one. The expansion of these two expressions results in:

$$\tfrac{1}{2}[\sin(\omega_c + p\omega_m)t - \sin(\omega_c - p\omega_m t]$$

$$\text{and } \tfrac{1}{2}[\sin(\omega_c + n\omega_m)t + \sin(\omega_c - n\omega_m)t]$$

respectively.

These are, of course, the infinite sidebands of the frequency modulated wave. The carrier term will result from the zero frequency component arising from the expansion of the even powers of $\sin\omega_m t$ and it should be noted that it will have an amplitude depending on a complex function of m_f.

The method is laborious and it does not have the elegance of the more accepted method. However, it may appeal to students who have not progressed far with their mathematics – if they have the time and patience to pursue the complicated calculations. There may also be advantages when the modulating wave is not a simple sine or cosine function as, for instance, in frequency shift telegraphy, although the mind boggles at the intricacy of the ensuing manipulations.

A similar expansion can also be used for showing the infinite extent of the sidebands when phase modulation is employed.

S. F. Brown
Post Office Telecommunications
Rugby Radio Station
Warwickshire

CORRECTIONS

In the second part of J. M. Osborne's article "Sidebands as phasors" in the October issue, several errors occurred on page 68 in Appendices 1 and 2, for which we apologize to readers. In Appendix 1 the expression in the second line (for p.m. of carrier) should read:

$$a\sin(\Omega t + \theta\sin\omega t)$$

The second expression (seventh line) should read:

$$a\sin(2\pi F_0 t + \theta\sin 2\pi f t)$$

In Appendix 2 the first expression (for f.m. of carrier) should read:

$$a\sin(\Omega t + \frac{\Delta F}{f}\sin\omega t)$$

and the second expression (seventh line) should read:

$$a\sin(2\pi F_0 t + \frac{\Delta F}{f}\sin 2\pi f t)$$

Also in Appendix 2 the expression in the middle column of p. 68 for the maximum rate of swing in terms of frequency (11 lines from top of column) should read:

$$2\pi\Delta F = \theta 2\pi f$$

– *Editor.*

WHAT IS AN ELECTRON?

Neither Dr Theocharis nor Professor Jennison appears to understand the aim of modern physics (Letters, October). This is to discover and systematise useful descriptions of the natural universe as we observe it in experiment. Those descriptions are invariably mathematical and some of them are carefully bounded. Professor Jennison has proposed a model and time alone will show whether or not it is useful. Particle-wave duality must be one of the classic paradoxes and it remains unresolved. Dr Theocharis thinks that most physicists actually believe in a real Jekyll and Hyde electron. Professor Jennison actually appears to do so—and that is his prerogative.

Most modern scientists will be happy to leave these two to fight it out. Paradoxes arise through the inadequacy or incompleteness of mathematical descriptions but that does not itself invalidate those descriptions. One must simply tread carefully in making use of them.

D. A. Ross
Poynton
Cheshire

CITIZENS' BAND AND THE LAW

In November a correspondent criticised you for "supporting" the illegal use of c.b. radio, and his criticism was based on the belief that law-breaking is automatically wrong in any circumstances. Is lawbreaking automatically wrong? Let us hear some eminent views.

J. J. Rousseau, 1762: "The inflexibility of the laws, which prevents them from bending to circumstances, may in certain cases make them injurious, and bring about in a time of crisis the ruin of the state."

Edmund Burke MP: "It is not what a lawyer tells me I may do, but what humanity, reason, and justice tell me I ought to do."

J. S. Mill, 1861: "There is no ethical creed which does not temper the rigidity of its laws by giving a certain latitude .... for accommodation to peculiarities of circumstances .... it seems to be universally admitted that there may be unjust laws, and that law, consequently, is not the ultimate criterion of justice."

"There are different degrees of obedience and it is not every degree that is commendable. Only an unmitigated despotism demands that an individual citizen shall obey unconditionally every mandate of persons in authority.

Bertrand Russell: "Individuals who opposed received opinions have been the source of all progress. . . . . Without rebellion mankind would stagnate and injustice would be irremediable."

C.B. is not illegal because it's wrong but only because the constitution has virtually ground to a halt under the strain of modern life. Within government it is mainly the unelected bureaucrats who are against c.b. and neither the Home Secretary nor the Commons has had time to examine the issue closely because of more pressing matters.

So the bureaucrats rule by default. In respect of this and most other matters we are ruled by what J. S. Mill called "the obstructive spirit of trained mediocrity." This is not democracy; it is not even elective dictatorship; it is pure tea-cup tyranny; and in a tyranny it is morally right to break the law because of the absence of democratic procedures for changing the law.

Mr Pearson says that he is opposed to modification of law by blatant disregard for it, but he fails to understand that the only reason the law is being modified in *this* way is because there is, in practice, no *other* way.

C.B. is only one of many issues which are clamouring for the attention of an overburdened parliament. (For an example of another issue see the remarks of Dr Budworth, News, August 1979, p. 41.) The threat to the rule of law does not come from *Wireless World* but from the lack of parliamentary time to deal with these matters. This problem does not exist in federal countries like Australia and Switzerland;it need not exist here.

The more support that respected journals give to the fight against the tyranny of centralism the sooner that tyranny will be ended and the sooner respect for the law will be restored.

Carry on *Wireless World!*

S. Frost

Dunsyre Lanarkshire

COMMENT IS POLITICAL

I have read *Wireless World* for more than 25 years and paid for it out of my own pocket as, unlike many readers, I do not have the subscription paid by my company. During this period it has served me well and I shall be forever grateful for the technical help and guidance it has provided me with. There have also been delightful moments of humour which have helped to demonstrate that technical people can be human.

However, recently I have noticed a tendency to knock the establishment – whatever flavour it might be. I consider the inclusion of political rhetoric out of place in a journal of the calibre of *Wireless World*: your November editorial was particularly distasteful to me. I take *Wireless World* for many reasons but they do not include being subjected to the political bias of the editorial staff, both in editorials and general content.

Please, Mr Editor, can we return to an apolitical journal – crusades I can accept but political bias no.

J. Greenwood

Chelmsford

Essex

DIGITAL FILTERS

It is with great interest that I have been following the *Wireless World* articles on digital filters ever since the original article by Rees[1]. Having programmed the RC low-pass filter on my H-P calculator, I would like to draw attention to a problem that seems to have been overlooked concerning the testing of these algorithms.

As the algorithm is basically derived from the impulse response via the Laplace transform method, the user is tempted to test it by applying a unit step, and feel satisfied when the desired exponential response is obtained. However, the filter cannot operate meaningfully on any frequency above the Nyquist frequency, while any impulsive type of test signal contains a large proportion of its energy in its high frequencies. Thus the only acceptable test signal must be one containing no harmonics beyond a certain frequency.

When a sine wave was used to test the RC filter it was found to be phase advanced by an amount corresponding to half of one time increment. The amplitude error was 0.16% when there were 10 samples per cycle and the period was equal to RC. To correct the time error a sliding mean was applied. Each sample was meaned with the previous sample before being used (see Fig. 1). The sliding mean can be considered as another filter with a rectangular impulse response whose first frequency null falls upon the sampling frequency (see Fig. 2). The equivalent geometrical procedure is to interpolate the samples as shown in Fig 1. Even so the procedure is not entirely satisfactory as odd multiples of the Nyquist frequency are only attenuated, not removed. The interpolated sine wave had negligible phase error but the amplitude error had increased to 3.5%.

The process is equivalent to using an almost ideal filter on the interpolated

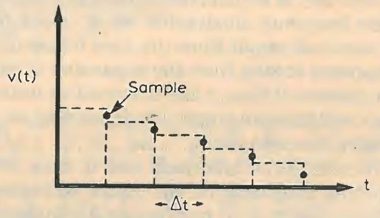


Fig. 1. Replacement of v(t) with ½(v(t)+v(t+Δt)).

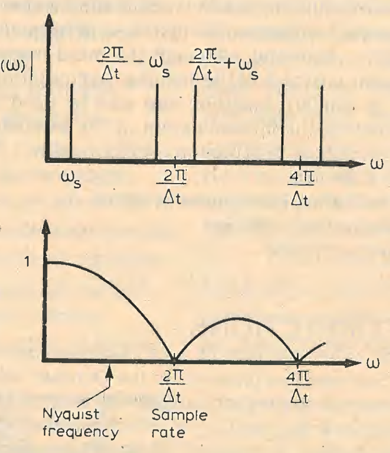


Fig. 2. (a) Spectrum of sampled sine-wave frequency ω_s. (b) Frequency response of sliding-mean pre-processor.

waveform and then sampling the output at the original sample rate. Presumably a more sophisticated pre-processor such as for example a filter with a Gaussian impulse response would reduce errors due to residual harmonics.

In conclusion, and as Ham[2] points out, aliasing of the input signal is to be avoided if at all possible. Thus, at least for instrumental data there is no entirely satisfactory substitute for an analogue anti-aliasing filter to be applied before any digital processing. For synthetic test data, some digital preprocessing is needed to reduce unwanted harmonics. It seems that digital filters are not necessarily as simple as has been implied in your articles.

W. Gray

Farnborough

Hants

References

1. V. J. Rees, "Digital filter design", *W.W.* Oct 1976 and subsequent correspondence.

2. P. A. L. Ham, "Simple digital filters," *W.W.* July 1979.

PROGRAMMABLE NOTES FOR MUSICAL INSTRUMENTS

Your correspondent M. Robins (November letters) does not seem to be aware that the scale of tuning proposed in his letter was in fact discarded some 250 years ago. Until this time 'just' temperament tuning was the standard, but, as M. Robins says, the problem is that a piece of music sounds very different when played in different keys, some keys being unusable. Bach was a great promoter of 'equal' temperament tuning and composed his 48 Preludes and Fugues as proof that all keys could be used with this tuning method. He even called these pieces "The Well-tempered Clavier". Incidentally, even in 'equal' temperament tuning certain keys sound 'brighter' than others. This is a well known fact amongst musicians who would also consider going back to 'just' temperament very much a retrograde step.

Richard Waters

Leighton Buzzard

Beds

POYNTING VECTOR

Apparently many people find the concept of displacement current useful and some find it distasteful. Not being a member of either group I would normally be prepared to continue as a passive spectator of the fascinating correspondence which has been stimulated by the recent articles on the subject; after all, no-one is suggesting that $\partial D/\partial t$ should be struck out from Maxwell's equations, and presumably no-one is insisting that everyone must believe that there is any physical reality in a current which is said to flow in empty space where there is nothing to carry it (and nothing to be displaced). I would even leave it to others to point out that in Fig. 4 of "The history of displacement current" in your March issue the current i will vary continuously between B and B′, as is the way

with transmission lines, so if you want a continuous "current" you do need a displacement current, not localised at B, but distributed along the length of the transmission line.

However, the excellent iconoclasts Catt, Davidson and Walton have spurred me to action by their uncharacteristically unquestioning use of a concept/mathematical construct which is far less harmless than displacement current, namely the Poynting vector or "energy current" **E**×**H**. A single example will show what I mean. Suppose I take a battery and connect it to a lamp by a pair of good thick metal wires. Since the electric field is negligible inside the wires the Poynting vector is too. In fact the Poynting vector is mainly localised in the space surrounding and particularly between the wires. By examining the Poynting vector one can validly draw the conclusion that energy flows from the battery to the lamp. One could even, in principle, integrate the Poynting vector over a surface containing the battery or the lamp, but not both, and calculate correctly the rate at which energy flows from the battery to the lamp, but one would be allowing oneself to be blinded by one's own mathematics to deduce from the fact that the Poynting vector is partially zero in the wires and is at a maximum between the wires that the energy flows mainly between the wires and not to any appreciable extent through them.

In case anyone does believe that even in this case the Poynting vector represents a physical energy flow I propose the following experiment. First, interpose a metal screen between the battery and the lamp, insulated from the wires themselves, but fitting as closely as possible, so as not to leave more than the tiniest space for the Poynting vector to squeeze through. Note the effect (if any) on the amount of energy which gets to the lamp. Now take away the screen and make a break (just a little one, mind) in one of the wires. Again, note the effect on the amount of energy (if any) which gets through. A similar experiment could be carried out on telegraph lines, at some inconvenience to the public. If the Poynting vector really represents a flow of energy, the screen should have more effect than the break. After all, what do we mean when we say (if we do) that the energy flows between the wires rather than through them; other than that if we wish to obstruct the flow of energy we would do better, to a first approximation at least, to insert a barrier where the energy flows than where it does not flow.

Perhaps it is time someone did a hatchet job on the Poynting vector along similar lines to that of Catt, Davidson and Walton on displacement current, with the hoped-for result being that it is cut back to its proper size, not that it is necessarily cut out completely. It may be less entertaining (surely not if the same team could be persuaded to take on the job) but the usefulness in actual practice would arguably be greater.

C. M. K. Watts

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Essex

The authors reply:

The last sentence of Mr Watts's first paragraph shows that he does not understand the mechanism for a TEM signal travelling undistorted between two perfect uniform conductors.

We should however applaud, not condemn, those who come out in the open and discuss electromagnetic theory even though their grasp of the fundamentals is weak. CAM Consultants have found that those professors and text book writers who are hiding from the present dialogue, although their professional duty would direct them otherwise, are more ignorant than Mr Watts and the other brave men who are rushing in to the vacuum. CAM Consultants challenge professors of physics and electronics to come out of the undergrowth and start *earning* their salaries by discussing the fundamentals of electromagnetic theory.

Returning to para. 2, if Mr Watts bares his chest to the sun, does he believe that the electromagnetic energy (light) burning his skin is travelling from the sun to him down conducting wires, or through a dielectric?

Paragraph 3 is very instructive. (Why must he leave the "tiniest space"? Why leave a space at all if the conductor is what it is all about?) Our book Electromagnetic Theory Vol. 2 discusses such situations thoroughly, on pages 245 and 319 and elsewhere. Referring again to his second sentence, conventional transmission line theory lets us calculate the mechanism by which energy current rapidly builds up to a high flow rate through a small gap as a result of repeated reflections. The argument somewhat resembles that in the appendix to our article in the December 1978 issue. If in his second sentence, the screen hugs the conductors for a long length (say one mile), creating a long section with very low characteristic impedance, transmission line reflection theory correctly tells us that energy flow from battery to lamp is delayed. More conventionally, this delay would be thought of as an *RC* time constant, the C being the narrow gap between conductor and screen for the very long distance. Referring to his sentence 3; once the tiny break in the conductor (which Heaviside called an obstructor) is made, energy current flows through the break and out into the vast space beyond. This space presents a rapidly increasing (characteristic) impedance, causing all the outgoing energy current to be reflected back through the break into the narrow channel through which energy was previously gliding calmly (at the speed of light) from the battery to the lamp. After the initial disturbance of the steady state caused by the breaking of the conductor (obstructor), the lines of energy current gradually, through the mechanism of reflections, settle down to a new pattern where energy (of the same amplitude as before the conductor was broken) flows out of the battery to the gap in the wire, there to be fully reflected back into the battery, in a "continual dance of energy" which Carter dismissed as absurd but CAM Consultants do not. (The Electromagnetic Field in its Engineering Aspects, by G. W. Carter, Longmans 1954, page 321.) If however the break made in the conductor is extremely narrow (and long), it will take time for its existence to become apparent. Very traditionally, this very narrow, long gap in the conductor would be regarded as a capacitor. *We* should regard it as a transmission line of very low characteristic impedance.

Dealing with his third para. in a lighter vein, one is urged to suggest that it is the "phlogiston" in a balloon material which keeps it doing its job. The absurd theory that it is the air pressure in the space inside which maintains a balloon's femininity can easily be disproved by making a tiny hole in the balloon; too small to let the air out but large enough to collapse any imagined air pressure inside. Alternatively, we can show that the goods travelling in a railway system travel *inside* the rails, or an obstruction across between the rails, *nearly* touching the rails; close enough to leave too little space for the train wheels to get through. This will prove that goods are really piped along *inside* the railway lines and it is absurd to think that the lines merely guide the flow of merchandise.

When all is said and done, however, the acid test is the question of whether the *velocity* of propagation of the energy (/electric) current is a function of the characteristics μ, ε of the dielectric or of the conductor. When a seagull (or merely the reflection of a seagull) glides along above (/below) the surface of the water, does its speed depend on the nature of the air or of the water?

I. Catt, M. F. Davidson, D. S. Walton

"TRIVIAL" AMPLIFIER DESIGNS

I find it quite incredible that *Wireless World* should see fit to publish yet another article describing amplification equipment for domestic sound reproduction, in which purely academic distortion levels are pursued virtually for their own sake. The author states that he designed the amplifier with a view to its being "competitive with current commercial designs." Can this really be an altruistic aim? In my experience the second and third harmonic distortion audibility threshold (even where skilled sound engineers and producers are concerned) is in the region of 0.1%. Given that this is so, then an amplifier with second and third harmonic distortion not in excess of 0.1% over its entire bandwidth should sound as good as one with 0.0002% second harmonic distortion, all other factors being equal — entrance slew rate limitations, overload effects, audibility threshold of high harmonics, et al.

A multitude of exotic schools of thought currently abound to extol the 'sound' of polypropylene capacitors, special loudspeaker cables, discrete circuitry, valves, f.e.t.s, 'real time' amplification, 180V/μs slew rates, passive equalisation, minimal overall feedback, etc. I challenge *Wireless World* to seek out the truth of this mysticism, rather than to present conventional designs ad-nauseam. I wish to state that I in no way whatsoever wish to depreciate *per se* the designs presented by Douglas Self and B. J. Codd, but rather to suggest that whilst their engineering approaches are interesting, they are really grossly trivial in a world where the allowable second harmonic distortion on a studio tape machine is of the order of 3%, where 70% of record pressings are defective and electromechanical transducers from the cutting head to the loudspeaker are as yet imperfect.

To exemplify: I have recently built Douglas Self's Mk 1 advanced preamplifier design using TDA 1034N op-amps. Using horn-loaded loudspeakers and Crimson Electrik amplifiers in a tri-amplified configuration, I perceive no difference. I am still waiting for my friends to say "Your equipment sounds different." The chances are high that your recently acquired records were mixed in the studio on desks stuffed with 'nasty' op-amps and transformers. Need I say more?

Ben J. Duncan

Tattershall

Lincoln

THERMIONIC DEVICES

I know of nothing more likely to start an argument between historians than that of throwing into the ring a seemingly innocuous statement such as '. . . no doubt that Fleming's diode ushered in the thermionic valve era . . .' (November 1979, p.94).

Dare I suggest that Edison's patent of 1884 (nothing to do with wireless of course) covered a most practical application of thermionics to the control of a generator? For all I know this may also have been the first thermionic closed-loop servo-mechanism to be described. But Edison was very busy inventing hundreds of other things, and can perhaps be excused for not applying his "so-called" effect to wireless, the phonograph, moving pictures etc. as well.

What is most puzzling is that Fleming was apparently so slow off the mark – a whole 20 years before the penny dropped! Of course he had been fairly busy around 1900 combining the more recent ideas of Tesla, Thomson and Marconi into the Poldhu transmitter, a very substantial engineering task; and this may have diverted his mind from developments in Germany, such as Wehnelt's lime-coated thermionic filament also published in 1904 which was incorporated into the Braun-Wehnelt cathode ray tube of 1905. (The same Braun, of course, who later shared a Nobel prize with Marconi.)

In the event it must have been a little humiliating for Fleming that there was not more interest in his thermionic diode (though it may have stimulated the invention of the crystal detector). The reasons were that the carbourundum detector was simpler and more rugged and the Marconi magnetic detector needed no battery. Thermionics really took off in a more obvious fashion about a decade later, with the advent of better vacua and other technical improvements. In fact, it became important enough for litigation over rights; and though neither side seemed to emerge with much of value, the ruling did confirm Fleming's legal title to his (rather gassy) diode valve.

Desmond Thackeray
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MICROPROCESSOR PERIPHERAL ICs

A problem exists in the design of circuits using the latest microprocessor peripheral i.cs. I would like to suggest a solution which, although using one more pin of the package, would require little complication of the i.c.

The problem is evident when several such peripherals interface to the same data bus, and this bus includes one or more sets of bi-directional bus buffers. In order to ensure that these buffers are always driving in the correct direction, the logic designer finds himself duplicating circuitry that must already exist inside the i.c. Some peripheral chips put data on the bus for up to one of three different reasons. To determine the direction of the relevant bus buffer, all these states must be decoded, and ORed together, along with similar lines from other peripheral chips on that section of the bus.

My suggestion is that a 'drivers active' function be brought out to a pin of each bus-interfacing device. Relevant bus buffers could be turned around by a simple OR of these few signals. Even greater simplicity could be achieved if the 'drivers active' lines were open-collector types, a wired-OR then being possible.

I feel sure that this line would also be useful in the debugging phase of microprocessor support circuitry where problems of bus conflicts and floating buses may have to be resolved.

E. J. Board
St Albans
Herts

PRE-AMPLIFIER WITH NO T.I.D.

Potential builders of the Miloslavskij passive de-emphasis preamplifier (August issue) might like to note that its RIAA network is *grossly* in error. Correct design formulae for passive de-emphasis can be found in the literature[1,2]

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References

1. Livy, W. H., Disc replay equalizers. Letters to the editor, *Wireless World*, vol. 63, January 1957, p.29.
2. Lipshitz, S.P., On RIAA equalization networks, *J. Audio Eng. Soc.*, vol 27, June 1979, pp458-481.

ELEMENT OR DIAMOND?

While experimenting in television during the "mechanical" period, I realised that the accepted theory of the "picture element", based on the chessboard idea, is a fallacy. I found that a continuously moving spot cannot resolve a picture detail as small as itself; it smudges along the traced line, generating a maximum frequency only two-thirds that calculated by the element-based line-standard formula. This was proved by the failure of the "low definition" broadcast to reach the frequency of 13kHz, the theoretical maximum for a picture with 2,100 elements (30 lines with aspect ratio 3:7) at 12½ pictures a second. Only about 9kHz was achieved, yet the same erroneous formula was employed for the 405-line transmission, and is still the basis of the 625-line standard. "Line" still means "line of elements", with line-pitch "elemental".

My letter in *Wireless World* for July 1961 explained how practical engineers, with a calculated "high frequency" definition to achieve, focus spot-size to half-elemental (4/9) by reducing spot diameter to two-thirds of line-pitch. This is easily proved on any monochrome screen by reducing picture height until the traced lines touch; the closed up lines leave about one-third of the screen dark.

I eventually found a spot shape which forms no visible structure, however large the spot: the "playing card" diamond. Cutting experimental discs (thin black card was adequate) I turned the original square "elemental" aperture on end, then extended it transverse to the scan direction, reducing it along the scan. Each field traced double-spaced lines (which just touched), and alternate lines "interlinked" their lines by half-overlap both ways. Diamond scan exposure tapers uniformly about line-centre, so two interlinking lines conceal structure. The line-free complementary scanning allows diamond size to be chosen for desired definition only, with resolution enhanced by the reduced scanning depth of the diamond.

The ideal "diamond" focus may be impossible electronically, and would be wasted on a 625-line picture. A close approximation is possible by extending the existing half-element spot vertically to points, while compressing it horizontally. The resulting pointed oval, resembling the contracted pupil of a cat's eye, would raise resolution to the standard's limit.

Astigmatic focus has been tried but the "elemental line" taboo seems to have prevented any attempt at elongating the spot sufficiently to achieve complementary overlap. This inexpensive focus correction at camera and receiver would improve definition and remove all trace of visible structure from our screens.

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Worthing
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JOHN SCOTT-TAGGART

Your brief, but nostalgic, obituary on John Scott-Taggart (p.55 October 1979) recorded his prowess as an engineer. In his earlier days he was also a formidable showman. From the mid-twenties to the early thirties, thousands of experimenters were persuaded that the 'ST' series of circuits had supernormal powers.

The celebrated 'ST100' offered plenty of scope for compulsive twiddlers, with two tuning capacitors, plug-in coils with variable coupling, filament rheostats and a cats whisker. Although it was an essentially simple reflex arrangement, Scott-Taggart showed real originality in circuit-diagram presentation. Scorning ordinary logic in layout, he produced bafflingly devious links.

One of the figures I have sent you is copied from an 'ST100' diagram, which involved 15 crossed wires. The other one is the same circuit, but as it would more commonly have been drawn 50 years ago – with only three crossovers [Diagrams supplied.—Ed.] The contrast speaks for itself.

C. Leslie Thomson
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RADIO AMATEUR INVALID AND BLIND CLUB

May I bring to your attention the change in the title, secretary and address of the Radio Amateur Invalid and Blind Club.

Now celebrating its silver jubilee, the Club is formed of invalid and blind members interested in the hobby of amateur radio; their local representatives who undertake to help by visits, repairs and advice; and supporter members whose financial contributions enable help to be given. The sole condition of membership in any of the above categories is an annual subscription of £1 minimum for *Radial* the Club newsletter which is issued every six weeks.

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More on the scientific computer

Further details of the monitors

By J. H. Adams, M.Sc.

After publication of the scientific computer series (April to September 1979) there have been many requests for more information on the firmware. This article describes in more detail the machine code and BURP monitors in terms of hexadecimal machine code. Readers will need a hex print-out of the three p.r.o.m.s and the mnemonic to hex conversion tables published in the July 1979 issue of *Wireless World*.

Several readers have expressed incredulity at the thought of working directly in machine code rather than using assembly language mnemonics. However, the hex codes for 50 to 60 of the most regularly used operations can soon be learnt and, thanks to the logical distribution of codes to operations, many more follow from these. The once-in-a-megabyte ones such as IN D (C), ED 50 in hex, can be obtained from the conversion table. This does not rule out working in assembly language and using an assembler, or translating yourself, but in my experience the latter soon becomes tiresome and it is easier to write in hexadecimal.

When writing software it is useful to have a supply of the forms shown in Fig. 1. The instruction 18, a relative jump, should be pronounced one eight and not eighteen. Similarly, the second byte is one seven and definitely not seventeen. If you want to jump forward with a relative jump, simply make the jump byte the number of bytes (up to 7F) over which execution must move, in this case 17 — 1 row and 7 bytes, to reach the target byte FF. For a jump back to the same target from the second 18, calculate the jump forward code to the next byte immediately under the target, 02 in this case, and then jump up row by row, decrementing the higher order hex character, i.e. from 02, F2, E2. When using a jump back the byte must be in the range 80 to FD (FE and FF serve no useful purpose).

Machine code monitor

Both monitors follow the same basic sequence as illustrated in Fig. 2. With the machine code monitor the base address of the Z80 stack is set, the address for the top corner of the screen is loaded into the DE register pair which is then used throughout the monitor as the destination pointer or vector for v.d.u. operations, and the message READY is printed by the subroutine at 03CE. This is one of several routines in the computer which draws data from the locations directly following the call of the routine. The program counter, which will have been pushed onto the stack, is exchanged with the contents of the HL register pair and then used as a pointer to that data before being exchanged back onto the stack, at the end of the routine, to cause a return to, in this case, 0010. The start procedure then clears the rest of the top line, resets the teleprinter output flip-flop and, using the subroutine at 0355, reads in and encodes a command from the keyboard. As explained in table 1, only the first and last letters are important to the subroutine. Whilst this limits the number of possible combinations which will produce different codes, a byte by byte comparison with a look-up table comprising all of the commands would use far too much p.r.o.m. space. After this has been achieved (001A), a comparison is made and if the code is not FC (the entry code for RUN) executions jump over 0D bytes for a further comparison and so on until a match is found, whereupon a block of instructions is executed before operation reverts to 0000 again.

Fig. 1. Typical software form.

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
					18	17									
														FF	
										18	E2				

Work . . . . No . . . . . .

Table 1. Low level monitor subroutines.

Address	
0254	Sets tape interface tone to 2400Hz and then calls 255 long time delays — about 4 seconds.
0260	Transmits the byte in register A to the tape interface, preceded by a start bit and followed by two stop bits.
027F	Calls a new line and then prints the contents of HL on the teleprinter.
028E	Formats the hex byte in register A for printing as two characters on the teleprinter.
02EC	Prints a space on the teleprinter.
02F0	Calls a new line on the teleprinter.
0301	Prints the contents of the A register on the teleprinter.
0317	List subroutine. Entered at 0317, the starting address must be loaded in from the keyboard. Entry at 031D assumes the address to be at 1FF0 to 1. Entry at 0320 assumes that the address is already in HL.
0336	A programmable time delay. The computer loops through six E3s, a long exchange instruction which, if used in pairs, does nothing but use up time. The number of loops is set by the byte immediately following the CALL in the original program. Each loop lasts 64μs.
0345	Clears the top line and sets DE at 8000.
034E	Used to format results, as in FIND and COR, this rounds DE up to the next multiple of 8.
0355	The algorithm for encoding input commands. Returns with last letter of the command minus the first letter in register A.
0372	The formatter used in LOAD and LIST in machine code language.
0393	Clears the v.d.u., leaving DE unaffected.
039F	Displays HL and a space. Used in LIST, LOAD, FIND, COR and in BURP lists.
03AA	Displays the contents of A as a two character hex byte.
03C4	Calls a new line on the v.d.u. and clears the remainder of the current one.
03CE	Displays the string of characters following the call in the program block up to byte 1D.
03DE	Loads HL from the keyboard.
03E7	Loads A with a hex byte from the keyboard.
03F6	Reads in a single keyboard character and, if a letter adds 6, then truncates to four bit binary (used as part of 03E7).

An exception to this is for the code FC, the routine for which 001E jumps immediately to 0042. This avoids one of the subroutines which have to be located at particular points in the memory map. Several subroutines can be called by single byte instructions which are known in mnemonic form as RSTs. These were originally intended for use with the 8080 and the Z80's "8080 mode" interrupt response which, after receiving the interrupt, calls for the interrupting device to place one or more instruction bytes onto the data bus for execution. Although this mode is not used, the single byte calls are a useful space-saver where a subroutine may be short and often needed. The subroutine which is expected in this case at 0020 is called by byte E7 and produces a space on the v.d.u. At address 0028 is a jump to a subroutine which would require more than eight bytes. It is intended for use during the testing of machine code programs and when its RST byte EF is inserted into the program by using an ALT, it will suspend the execution of the program and display the contents of the HL, DE and AF registers, the point at which the EF was found, and the last entry onto the stack. Note that whilst there is not a specific subroutine at 0000

Table 2. Machine code routine starting addresses.

002F	FILL	0042	RUN	004D	MOV
0099	LOAD	00F7	PROM	0120	ALT
0113E	ALPH	014D	PRINT	016F	COR
01CD	FIND	0203	TAPE	0226	READ
01A6	LIST				

the one byte call CF for this address is used as an end command to a program. Although it does not do the same as C3 0000, because the stack is immediately re-defined at 0000, it has the same effect and saves two bytes.

The two interrupts also use fixed service routines. At 0038 is the maskable interrupt routine which reads in and stores number cruncher data using HL as a pointer. At 0066 the non-maskable interrupt's routine services the keyboard, first checking if the computer is at a HALT byte (76) and reading in the keyboard if it is or reseting the computer if it is not (006B is an example of a long relative jump). This particular software does not make use of the control characters available in ASCII except for the RETURN byte 0D, which it translates to 1F. Instead, it blanks off the top three bits of any codes above 3F (mainly the letters) at 007C and moves lower and upper case codes into the area 00 to 1F. This compression of the ASCII code into six bits produces bytes which are compatible with the v.d.u. character generator and this makes writing to the v.d.u., which occurs at many places in the monitors, a simple operation.

Beyond the service routines, the routines for the various operations in table 2 fit end to end up to 0253, with the exception of some unprogrammed space at 0130-9. This space may be used by overprogramming the jump byte 011F-10 and the ten bytes as required. Note that the LIST (01A4) routine is just a call to a subroutine at 0317 because an identical block of instructions are required as part of the ALT routine. As this is the last command code to be checked, the call is conditional on a match so that if the code is undefined, execution passes to 01A9 and a software reset.

Table 3. BURP subroutines.

0400	Used in graph plotting. Converts a number stored in 1E00-F to the nearest integral value. Negative values are put to zero.
042E	Executes MM57109 instruction present in register A. The sequence checks that the 57109 is ready, outputs the instruction with the hold off, waits for the ready to go off and then puts the hold on again.
0446	Repeats 042E for the string of 57109 instructions following the call in the main program. The list is terminated by FF.
0452	Jumps over the next word in the program line. Used in FOR statements to miss STEP and UNTIL.
045A	04E6 with BC protected.
0460	Outputs the contents of the 57109 X register to locations 1FF4 - 1FFF and then reformats it into the location specified by the contents of register A at the call, i.e. 1E10 for 01 in A, 1E20 for 02 etc.
04BA	Converts denary digits in the text to binary in register C. HL must be pointing to the first digit which must be in register A.
04D4	Graph plotting routine which scales the variables to be plotted to the screen matrix of 63 × 126. It divides the variable specified by the contents of A, by the declared maximum for that axis, and then multiplies by 126 before outputting to 1E00.
04E6	Jumps any spaces in the text and then analyses the following for (a) operators (04FB) which are converted by algorithm to 57109 code and executed (b) numbers (050F) which are rearranged and then input to the 57109 (c) instructions (054E) which are encoded by algorithm and the result used as part of the address for the location in a look-up table (positioned at the end of the r.o.m.) where the 57109 instruction code can be found, drawn and executed (d) variables (057B) which are foundas in 0460 and entered as a series of 57109 instructions. When encoding words the standard algorithm two times first plus last is used but to compress the range of codes produced, those under 20 have 20 added and those above 50 are reduced by 10. This compressed byte is then added to 07B4 which is used as a pointer to the instruction required. Some instructions need two bytes for their execution, the first being 20, e.g. 24 is SIN but 20 then 24 is SIN^{-1}. These are encoded in the table and detected at 0566 by bit 7 of the instruction being set.
058A	Handles the 57109 $\overline{BR}$ (branch) output which pulses low whenever one of the 57109 test instructions proves to be true. The subroutine starts the execution of the instruction in register A and then reads in the 6-bit data word from the 57109. The four digit out lines are blanked off so that only the READY and BR lines, both initially high, get through (0591). By continually re-reading and jumping back on even parity, the Z80 is effectively waiting for one of these two lines to become active. If it is the BR line the Z80 outputs a NOP to the 57109 because, when tests prove true, the 57109 immediately looks for a new instruction and waits for its completion. If READY became active to indicate a failed test, the last procedure is jumped. Finally, the read in and masked byte which caused the exit from the parity checking loop, stored in register B as part of that loop, is read into A and masked for bit 6 so that the state of this line and hence the zero flag in the F register is set on a successful test.
05A9	With the HL register pointing to a variable in the text, and with that variable in register A, this subroutine computes the variable's address, formats it into 6 bit ASCII in the area 1E00-F and converts results in the range 0.000 1-99 999 999 to floating point. The byte in the text is checked and, if a digit, is used as the new mantissa digit count to be stored at 1FE0 (063A). Whether or not the contents of 1FE0 are then drawn out, the block from 0641 to 0681 rounds off the figures after the decimal point to the extent indicated by this digit. Blanked figures are replaced by ASCII spaces. The mantissa is then sent to the v.d.u. and the text interrogated again, this time for a comma, which has the effect of suppressing the printing of any spaces and close packs the digits in the number (0693-7). Finally, at 06A3 an E for the exponent is looked for and if found the exponent is displayed. The alternative is three spaces or nothing, depending upon the comma, for floating point numbers.
06BB	Prepares the store area specified by the contents of A using 0714 and then reads in a number from the keyboard, converting standard and non-standard scientific and floating point arrangements to the machines standard format.
0714	Prepares a number store by dumping 9 00s, 60Fs and a 3F. This means that 06BB dump the input data into the store without having to worry about leading or trailing zeroes or the non-existance of an exponent (0Fs being NOPs as well). The 3F terminates number entry to the 57109 as well as being a NOP therefore two consecutive variable inputs to the 57109 do not have to be separated by an ENTER as with reverse polish calculators.
0729	Algorithm for entering words from keyboard (two times first letter plus last).
0736	Inputs denary keyboard digits to binary in C.
074A	Converts A to three digit denary and displays on v.d.u.
076D	Converts A to three digit denary and displays on teleprinter.
07A2	Data for MOD command.
07AC	Forms the address for the start of a variable store area in HL from the variable code in A.
07B7	Displays a number formatted by 05A9 in 1E00-F displaying E for 0B,. for 0A, a space for 0F, - for 0C and ASCII digits for 00 to 09.
07D6	The look-up table for the 57109 instructions.

Table 4. Format for storing and printing three variables.

```
005 LET A=23.45
006 LET B=-0.00733
007 LET C=3.456E33
008 PRINT A
009 END
```

0C45

1E00	A0	32	33	2E	34	35	30	30	20	20	A0	A0	A0	A0	A0	6F
1E10	02	0A	03	04	05	00	00	00	00	0F	0B	0F	00	01	0F	3F
1E20	07	0A	03	03	00	00	00	00	00	0C	0B	0C	00	03	0F	3F
1E30	03	0A	04	05	06	00	00	00	00	0F	0B	0F	03	03	0F	3F

Table 5. BURP routine starting addresses.

083F	DEL	08C7	MOD	08F7	ADD
0929	LOAD	092F	LIST	0939	DUMP
0977	RUN				
099A	INPUT	09B2	PRINT	09D8	END
09DF	GOTO	09EB	LET	0A04	IF
0A43	WRITE	0A83	ERASE	0A8F	TOP
0A9E	GOSUB	0AAA	RETURN	0AB2	FOR
0AE2	NEXT	0B13	HALT		

From 0254 to 03FF are the subroutines listed in table 1. When necessary, the subroutines PUSH registers to be used solely within the subroutine and then POP them back before the return so that no interference is caused to data within the main program. Most subroutines are self-contained but some, e.g. 02EC, jump on to others for their completion. As subroutines are sometimes called within subroutines, within subroutines etc., the stack storage area, which extends into the r/w.m. from 1FDF, should be left free to at least 1FC0 for the computer's use. Like C7, other space savers will be found in the subroutines, e.g. AF to clear the register A instead of 3E 00, A7 to set the flags according to the contents of A. To save byte space some apparently unnecessary bytes appear, e.g. E3 at the start of the routine at 03C4 is included so that it and 03CE can share the same ending. Care is needed when writing subroutines because with a lot of PUSHing, POPping and EXchanging taking place it is important to ensure that the bytes called back off the stack by the return command at the end of a subroutine are definitely the correct ones. I have found this to be the Z80's most adept way of erasing painstakingly developed programs. This type of error is common when a conditional return is used as in 034E which prints spaces until the lower three bits of DE are zero. Ideally this should have pushed AF initially as it uses A and F, but to also arrange for them to be restored on return would extend the routine to at least nine bytes. The EF described earlier is a very powerful tool for sorting out these problems.

BURP monitor

For the BURP monitor the first p.r.o.m. is solely for subroutines whilst the second contains the operating system which makes use of them. Details of the subroutines are given in table 3. In BURP, program material is loaded from 0C00 on, the area 1E00 to 1E0F is used for the formatting of results to be printed and 1E10-F stores variable A and so on up to 1FB0-F which holds the FOR loop step. Table 4 shows the formatting used for the storage and printing of three different variables. Note that all results are stored scientifically to maintain eight digit accuracy. Although the MM57109 can operate in either mode, it is quicker to stay in the scientific mode and let the Z80 convert the results within the range 0.0001-99999999 to floating point for display.

At 0800 the stack pointer is set and DE is assigned as the screen pointer again. BURP is then displayed and the rest of the top line cleared. The mantissa digit count is set at 04 (0817) and the screen position reset to 8008 ready for the input of a command. 081E to 0823 is harmless nonsense and 0824 to 0837 resets the number cruncher by sending the operation 3F (NO OP) with the hold to the 57109 off, pausing for 8ms and then reapplying the hold. During this sequence the interrupt mode is set but as it is the masked one that is driven by the number cruncher, the somewhat capricious behaviour of the i.c. before it has been reset has no effect upon the rest of the system. The i.c. is then given a master clear (2F) and switched to the scientific mode (22) by a multiple executive subroutine at 0446 (0832).

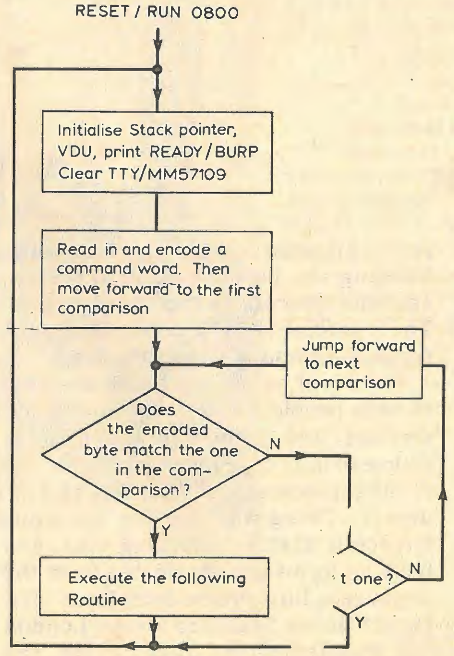


Fig. 2. Basic operating sequence for both monitors.

At 0838 another command encoder is called to read in a command from the keyboard. The algorithm used here is two times first plus last, so once again only two letters are required. However, this algorithm is capable of producing a far greater list of codes and therefore reduces the chance of two words deriving an identical one. As with the low level monitor, routines entered by recognition of this code ensue, see table 5. The start of the last of these, for the RUN command, reads in and encodes the line number input in the command and stores it in register C. The v.d.u. pointer is then set to 8040, the start of the second line, and C is decremented, pushed, popped, incremented and then pushed again. Four of these operations might seem to do nothing to C and on this occasion they do not. The total effect is to store the current line number on the stack. When the execution of a line is completed however, the next line number can be computed and saved by returning to 097F. After GOTOs, when A will hold the next line number, a pop to remove the old number followed by a jump to 0981 will load this as the next line to be executed. As all lines will terminate by jumping back to one of these locations (except for END which returns to 0800), to avoid absolute jumps (i.e. jumps to specific addresses), relative jumps to these two critical points are string out through the third p.r.o.m.

A line of BURP is stored as the hex byte ED, the line number in hex, the actual data in modified ASCII and then the byte 1F to signify its end. The end of the memory block in use is signalled by the byte C0. With the commands ADD, DEL, DUMP, LIST and RUN involving line numbers, the interpreter scans the program block up to C0 and looks for ED followed by the line number in question. During a RUN the next word in the line is encoded using the two times first plus last algorithm (0993) and again, the routines for all of the commands are strung end to end and each is preceded by an immediate compare and a jump-on-not-zero (20 hex). The last command, HALT, compares at 0B0F and if a match is not made the computer jumps over the single byte 76 of the HALT routine and goes on to the next line by executing several relative jumps back to 097F. This explains why there is no routine for REM as it and any unrecognised first word on a line is just

Table 6. New features of the improved firmware.

General
V.d.u. cursor on all modes.
DEL delete last character on all modes.
RETURN available in graphics mode.
Interface for ASR or KSR teleprinter (as printer and/or punch).

BURP
Extended IF statements. Any statement may be conditioned by IF.
Mathematical capability available in IF, FOR PRINT, WRITE, GRAPH and AXIS statements.
Printed strings in INPUT as well as PRINT statements.
Multiple statements — virtually unlimited numbers of statements may be written against a single line number. This speeds execution and expands the effective statement capacity well beyond the 254 lines.

Extra maths functions;	ABS	makes current result positive
	INT	blanks digits following decimal point
	FRAC	blanks digits preceding decimal point
	RND	places pseudo-random number into the MM57109

No need for LET at the start of LET-type lines.
' in a line, causes the computer to ignore the data following, up to the end of that line (alternative to REM).

Hardware changes required
The wiring of several spare keys.
The teleprinter interface shifted from D_7, to D_0, and 55V reduced to 5V.

P.r.o.m. required
Complete with the graph plotting firmware, this will still fit into three 2708 e.p.r.o.ms.

ignored (the very requirement for REM). Throughout the monitor the register pair HL address the program block contained from 0C00 onwards, whilst B and C are available for general use within the execution routines.

Subroutine p.r.o.m.

As far as possible, subroutines have been written which can be called in many different places within the interpreter. This particularly applies to 04E6 which can be thought of as a basic text handler which recognises and deals with words, variables, numbers and operators.

In the next part a new monitor will be described, the features of which are given in table 6. I would like to thank all of the readers who have contacted me with suggestions for extra facilities and I hope that the new system will meet their requirements. Lists of the new firmware will be available from *Wireless World* (editorial department) upon receipt of a large s.a.e. and these will be a useful accompaniment to the details in part two.

The author is offering a set of three p.r.o.ms programmed with the new monitor hardware for £30. Alternatively, existing p.r.o.ms can be reprogrammed for £6.50 (both plus 35p post and packing).

Micro show is bigger

Personal computers are prominent among the systems to be displayed and discussed at the Microsystems '80 conference and exhibition, January 30 to February 1. Sponsored by *Wireless World* and associated electronics and computer journals, this annual event has grown in size to such an extent that it has had to be moved from its hotel venue to the Wembley Conference Centre (opening hours, 0930 to 1800 hours each day).

The 1980 conference has a four-part programme ranging from an introduction to microprocessors to an overview of the latest developments in microelectronics. Topics include: technology update, micro processor software, controlling microprocessor projects, microprocessor applications, bridging the hardware/software gap, and microprocessors in process control. The conference will concentrate on personal computers on its third day.

There will be buyers' forum sessions to help people in selecting goods and services, and a one-day appreciation course to introduce managers to the use of microprocessors in business and industry. Delegates' fee for the conference is £145.50, including v.a.t. and booking forms are obtainable from the organizers, Iliffe Promotions, Room 821, Dorset House, Stamford Street, London SE1 9LU (telephone 01-261 8113). The exhibition, with some 110 stands, is open to all at no charge, whether or not the visitor is a conference delegate.

Literature Received

Reference sheets on the world's **electronics industry** produced by Mullard, showing exports, consumption, production of a variety of products. Sheets can be obtained from Mullard, Ltd, Mullard House, Torrington Place, London WC1E 7HD. WW401

Leaflet on the ZIP KDP **computer terminal**, comprising 30ch/s dot-matrix printer, keyboard and v.d.u., can be had from Data Dynamics, Data House, Springfield Road, Hayes, Middx. WW402

Fourteenth edition of **Intel News** contains descriptions of an 8086 single-board computer, 1Mbit bubble memory and other items of interest in the computing field. Intel Corp (UK) Ltd, 4 Between Towns Road, Cowley, Oxford OX4 3NB. WW403

Solid-state relay applications manual on specification, preotection circuits, loading and failure modes, with typical circuits, is available from Hamlin Electronics Europe Ltd, Diss, Norfolk IP22 3AY. WW404

Full ordering information on the component parts of the Elma **collet knob** range is available in broadsheet or wall-chart form from Radiatron Components Ltd, 76 Crown Road, Twickenham, Middx. WW405

Signal-conditioning amplifiers in the SE 990 series are described in a leaflet now available from Spur Road, Feltham, Middx, TW14 0TD. WW406

Data for meteorologists, oceanographers, and ecologists can be collected by sensors on ships, without attention from the crew, collated by a **data collection platform** and transmitted to a satellite for retrieval. The McMichael platform is briefly described in a new leaflet from McMichael Ltd, Wexham Road, Slough, Berks SL2 5EL. WW407

Leaflet from Astralux gives full details of 8000 series of opto-coupled, **solid-state relays** in 10, 20, 30 and 40A versions. Sales department, Astralux Dynamics Ltd, Brightlingsea, Colchester, Essex CO7 0SW. WW408

Selection of test equipment for **logic-testing** is presented by Electroplan in a four-page leaflet, obtainable from Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts. SG8 5HH. WW409

Various types of **panel meter**, counters, printers, etc., are described in a 48-page catalogue, produced by Techmation, Ltd, 58 Edgware Way, Edgware, Middx. HA8 8JP. WW410

Brochures on the American Crown (Amcron) range of **audio equipment** can be had from the sole UK distributors, HHB PA Hire and Sales, Unit F, New Crescent Works, Nicoll Road, London NW10 9AX. WW411

A collection of tools for **bending and cutting** component leads and for handling i.c. packages is detailed in a Wybar catalogue from Eraser International Ltd, Unit M, Portway Industrial Estate, Andover SP10 3LU. WW412

Two-metre s.s.b. and f.m. transceiver—4

Alignment procedure and operating notes

by G. R. B. Thornley, G2DAF

For satisfactory alignment the following test instruments will be required: a c.w. signal generator; an absorption wavemeter; an AVO Model 8 or equivalent; a diode probe valve-voltmeter; a digital frequency meter; and an audio oscillator.

It is advantageous to test and align as many units as possible before final assembly in the chassis, so the following instructions will be based on this method. Initially, each unit should be connected to a stabilized power supply, set to 12.7V, with a milliameter in series to monitor the current drain and to ensure that there is no short circuit or fault condition on the circuit.

S.s.b. generator unit

Connect the power supply, still set to 12.7V, to the +12V TX terminal post on the s.s.b. generator board and wire an external 1-pole, 2-way switch in place of S_{1a}, with the pole connected to the power supply. Check that there is 9.1V feeding Tr_4. Set the slider of R_{11} to mid position and connect the diode probe of the valve-voltmeter to the test point TP. Adjust the core of L_5 for maximum carrier output – this will be in the range 0.3 to 0.5V r.m.s. Operate the temporary switch S_{1a} to select crystals XL_1 and XL_2 in turn, and ensure that they are both oscillating at approximately equal amplitude.

Remove the valve-voltmeter probe and connect the digital frequency meter via a 5pF series capacitor to the test point TP. Switch to the l.s.b. crystal and adjust C_{30} until the crystal is on exactly 10,701.5kHz. Next, switch to the h.s.b. crystal and adjust C_{32} until the crystal is on exactly 10,698.5kHz. (The author found that additional 20pF capacitors, C_{29} and C_{31}, were necessary for the crystals used in the prototype, and these were soldered across C_{30} and C_{32} on the etched side of the p.c.b.) The i.f. gain is determined by the gate 2 potential of Tr_1 and Tr_2. Initially, set the R_2 slider to mid position. Unbalance R_{11} by turning the slider to one end of the track, and adjust the cores of L_4, L_3 and L_2 for maximum r.f. output, monitoring by connecting the diode probe of the valve-voltmeter to the input connection of the s.s.b. filter (junction of C_{44} and R_{30}). Disable the carrier oscillator by removing the 12V connection to the temporary switch and ensure that the valve-voltmeter indicates a zero reading. If this is not the case, the i.f. stages Tr_2 and Tr_1 are unstable, and R_2 requires adjusting to reduce the gate 2 potential of the transistors until stability is ensured.

Reconnect the 12V supply to the temporary switch and balance the diode modulator by adjusting R_{11} and C_{18} in turn to the point at which the valve-voltmeter indicates zero reading. Note that C_{18} is not connected by the p.c.b. and must be connected by a wire link to one side of R_{11}. If adjusting C_{18} does not improve the modulator balance, transfer the link to the other side of R_{11}.

With a short length of screened cable running along the top of the p.c.b., connect the "A out" terminal post to the "A in" terminal post. Transfer the valve-voltmeter probe to the "I.F. out" terminal post (output side of C_{91}). Connect a microphone to the "Mic" terminal post and adjust R_{25} for maximum gain. If all is well, a whistle into the microphone will produce an s.s.b. signal and will deflect the pointer of the valve-voltmeter to approximately 0.25V r.m.s.

Connect an 8-ohm loudspeaker to the circuit, transfer the 12.7V supply to the +12V amplifier terminal post and adjust R_{57} for exactly 6.35V at the junction of R_{60} and R_{61}. Open circuit the wire link between the test point TP and the ground plane, and connect the AVO, on the 1,000mA range, in lieu. Adjust R_{75} for a quiescent Tr_{13}, Tr_{14} collector current of 20mA. Set the audio signal generator to 1.5kHz and zero output, and connect it to the "A in" terminal post (connection to C_{69}). Advance the audio generator output to 100mV r.m.s. while watching the AVO reading, which should increase to 250-300mA. A clean undistorted note, at full volume, should be heard from the loudspeaker. Reduce the audio drive to about 100mA collector current and swing the audio generator output frequency from 300 to 3,000Hz. The sound amplitude should remain approximately constant and without distortion at any frequency. Remove the AVO and reconnect the link. (Note that R_{75} is soldered across D_{13} on the etched side of the p.c.b.)

Temporarily bridge the "A out" terminal post of the demodulator (junction of R_{44} and C_{64}) to the "A in" terminal post of the audio amplifier using screened cable. Connect the 12.7V power supply to the +12V RX terminal post, check that the source rail is at 3.3V and set the a.g.c. rail to 5.5V by adjusting R_{65}. Set the wiper arm of the balancing potentiometer R_{45} to mid position, connect the signal generator, set to exactly 10,700kHz to the "IF. in" terminal post (input to C_{92}) and advance the r.f. output until a 1.5kHz tone can be heard from the loudspeaker. Adjust the cores of L_9, L_8 and L_7 for maximum output while progressively reducing the signal generator output to avoid overloading the demodulator and the audio stages.

Make a screened-cable link from C_{62} to the drain of Tr_9, on the underside of the p.c.b. and temporarily connect R_{62} and R_{63} to a 1mA-movement S-meter. With no signal generator input, set the S-meter to zero by adjusting R_{63}. This will alter the a.g.c.-line potential because R_{63} and R_{65} interact, so it will be necessary to reset R_{65}. Repeat the two adjustments until the S-meter reads zero and the a.g.c. reads 5.5V. Set the signal generator output to 10mV and adjust the core of L_{12} for maximum S-meter reading. Reduce the signal generator output to 100μV. If all is well the meter should give about an S9 reading. When the transceiver is completed, R_{66}, which controls the S-meter sensitivity, can be set to obtain an S9 reading for a 50μV two-metre-band signal.

Reduce the signal generator output to zero, and the S-meter should return to zero. If it does not do this, it means that the carrier oscillator output is leaking into the i.f. amplifier. Connect C_{65} to one side of the balanced-modulator potentiometer, R_{45}, and adjust R_{45} and C_{65} in turn to balance the modulator and obtain a zero indication on the S-meter. If adjusting C_{65} does not improve the balance, remove the link and connect C_{65} to the other side of R_{45}. While making these adjustments ensure that the correct h.s.b. crystal (10,698.5kHz) is switched into operation. If balance cannot be fully obtained and C_{65} is at full capacity, wire a 25pF ceramic capacitor across C_{65} on the underside of the p.c.b. and readjust C_{65}.

F.m. generator unit

Connect a 100μA f.s.d. S-meter to the SM terminal post of the f.m. generator board. Turn the i.f. gain control, R_{81}, to

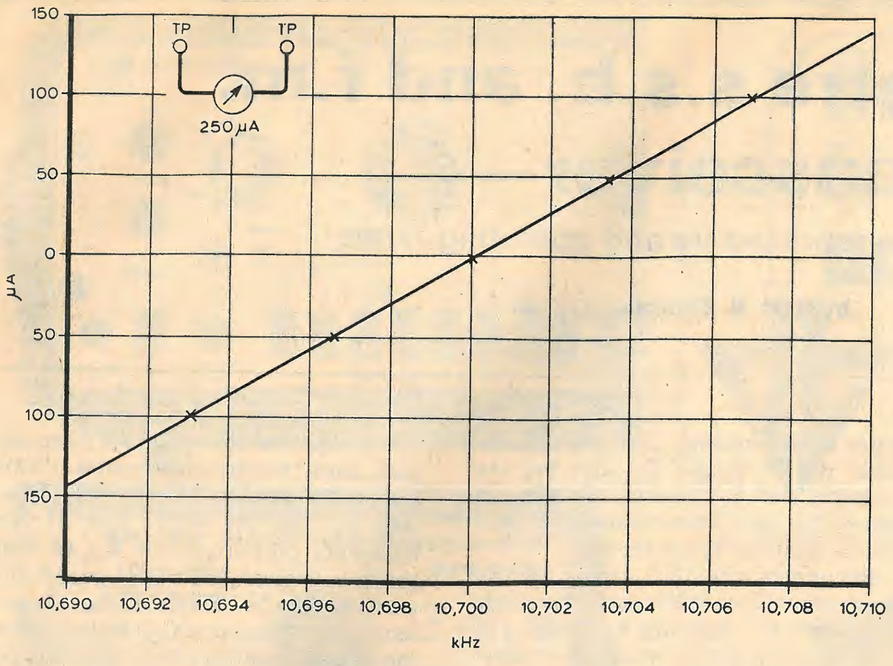


Fig. 18. S-curve for the CA3089E f.m. crystal discriminator

maximum, and inject exactly 10,700kHz, from the signal generator, into the "F.M. in" terminal post, at a level that starts to deflect the S-meter. (Note that the meter will read approximately 50μA with no signal input.) Adjust the cores of L_{14} and L_{15} to obtain maximum S-meter reading. At the same time as the tuned circuits are brought onto resonance, reduce the signal generator output to avoid overloading the i.f. stages.

Set the signal generator input to obtain an S-meter deflection of three-quarter full scale and connect the digital frequency meter in parallel with the signal generator so that the frequency can be monitored. Connect the AVO, on the 250μA range, to the two test points TP adjacent to IC_1. If the meter does not show a reading, reverse the connecting leads. Check that the meter is indicating 10,700,000Hz and carefully adjust C_{111} until the AVO reading falls to 0μA. Carefully alter the generator frequency until the AVO reads 50μA and make a note of the frequency. Repeat for 100μA and 150μA and note these frequencies too. Go back to the 0μA reading and reverse the AVO connecting leads. Set the frequency until the AVO reads 50μA, note the frequency and again repeat for 100μA and 150μA. Plot the readings taken on graph paper to obtain the crystal discriminator S-curve. This should look like the graph shown in Fig. 18, and it should be noted that a signal deviation of plus or minus 10kHz produces a detector output of plus or minus 150μA. The curve should be symmetrical about the 10,700kHz centre, and have straight lines indicating low distortion. Note that the crystal XL_3 must be cut for series resonance operation.

Connect the valve-voltmeter probe to "FM out" terminal post, and the +12V supply to the "+12V TX" terminal post. Set the slider of R_{101} to give maximum gate 2 voltage, and adjust the core of L_{19} for maximum r.f. output. Remove the valve-voltmeter and connect the d.f.m. to "FM out" terminal post. Adjust the core of L_{20} until the carrier crystal XL_4 is exactly on 10,700,000Hz. Note that crystal XL_4 must be cut for parallel resonance operation.

Wire the microphone to "Microphone in", and high impedance headphones to "Mod out". Set the slider of R_{117} for maximum audio gain. Speak into the microphone, and if all is well this should produce low-level crisp, clean audio in the headphones.

Phase-lock v.c.o. unit

The alignment instructions for the phase-lock v.c.o. unit assume that the three p.c.b.s and the MC7805 regulator have been assembled in the screening box, and the l.e.d. indicator D_{29} connected to C_{203} and C_{204}. All interconnections should be made, and supply and switching terminal posts wired to the appropriate box via 1,000pF feed-through capacitors. Measure the output voltage of the MC7805 regulator and ensure that this is 5.0V.

With a soldered link, short circuit TP_1 on the v.c.o. p.c.b. to the groundplane in order to disable the oscillator Tr_{30}. Apply the signal generator output to TP_2, and connect the valve-voltmeter probe to "RF out" terminal post. Set the signal generator to 134.3MHz and adjust the core of L_{24} for maximum r.f. output. Transfer the valve-voltmeter probe to "V.C.O. out" terminal post and adjust core of L_{23} for maximum r.f. output.

Wire an external single-pole two-way switch S_2 to C_{169} and C_{170} and +12V terminal posts. With a two turn link, couple the absorption wavemeter to L_{25} and set wavemeter to 62.5MHz. Set external switch S_2 to the position that will connect XL_5 into circuit, and adjust core of L_{25} for maximum r.f. output. Set S_2 to connect XL_6 into circuit, and with the wavemeter set to 63.0MHz ensure that the circuit is oscillating at approximately the same amplitude. Switch back and forth a number of times to be sure that each crystal "fires" first time – it may be necessary to slightly re-adjust the core of L_{25}. With XL_5 oscillating and wavemeter set to 125MHz, couple the two-turn link to L_{26}, and adjust core of L_{26} for maximum output. Set the wavemeter to 126MHz, switch to XL_6 and ensure that the r.f. output is approximately equal to 125MHz. If necessary, slightly readjust the core of L_{26}.

Connect the d.f.m. to test point TP_3, and with trimmers C_{171} and C_{172} trim each crystal as near as possible to the required frequencies 125,000kHz and 126,000kHz. Note that crystals for amateur use are normally supplied to a frequency tolerance of ±0.005% and it may not be possible to pull XL_5 and XL_6 completely on to the required frequency. Finally operate S_2 a number of times, and ensure that both crystals operate without hesitation and without frequency jumping. Remove the d.f.m. and connect the signal generator, set to 9,300kHz to test point TP_4 and the valve-voltmeter probe to "I.F. out". Adjust cores of L_{28} and L_{29} for maximum r.f. output.

Set the AVO to the 10V d.c. range, connect to "D.C. out" and observe reading which should be 4.9V. Remove the short-circuit link from TP_1 and the AVO should now read 0.85V. With the external switch S_2, select the 125MHz crystal and connect the signal generator, on 9.3MHz and 500mV r.f. output, to "V.F.O. in". Screw the core of L_{21} completely into the winding. The AVO will now read 4.9V. Slowly unscrew the core of L_{21} until the AVO indication drops from 4.9V to 2.9V. At this point the indicating l.e.d. will light. The loop is now locked.

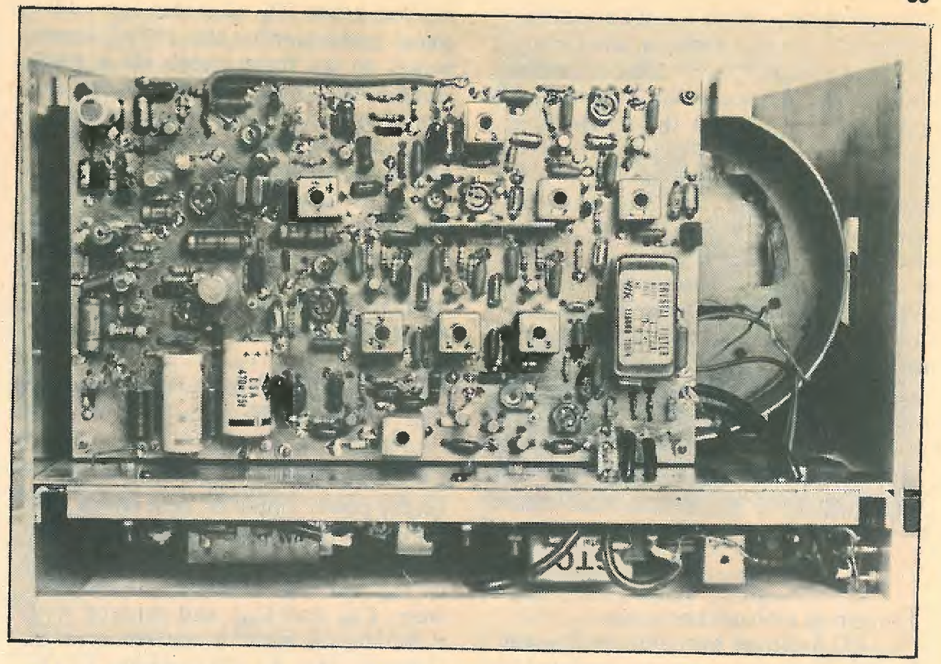
Operate the external switch S_2 to select the 126MHz crystal. The AVO should now read 4.5V and the l.e.d. should remain lit. Select the 125MHz crystal and tune the signal generator to 8.3MHz. The AVO should now read 1.6V with the l.e.d. illuminated. Switch to the 126MHz crystal and the AVO should read 2.9V with the l.e.d. illuminated.

It will be noted that with the 126MHz crystal selected and the v.f.o. (signal generator) input of 9.3MHz, the loop control voltage is 4.5V falling to 2.9V with a v.f.o. input of 8.3MHz. Swing the signal generator across the 1MHz tuning range and the control voltage will follow in step, within the above limits. Select the 125MHz crystal and repeat. The control voltage will follow in step within the limits of 2.9V to 1.6V.

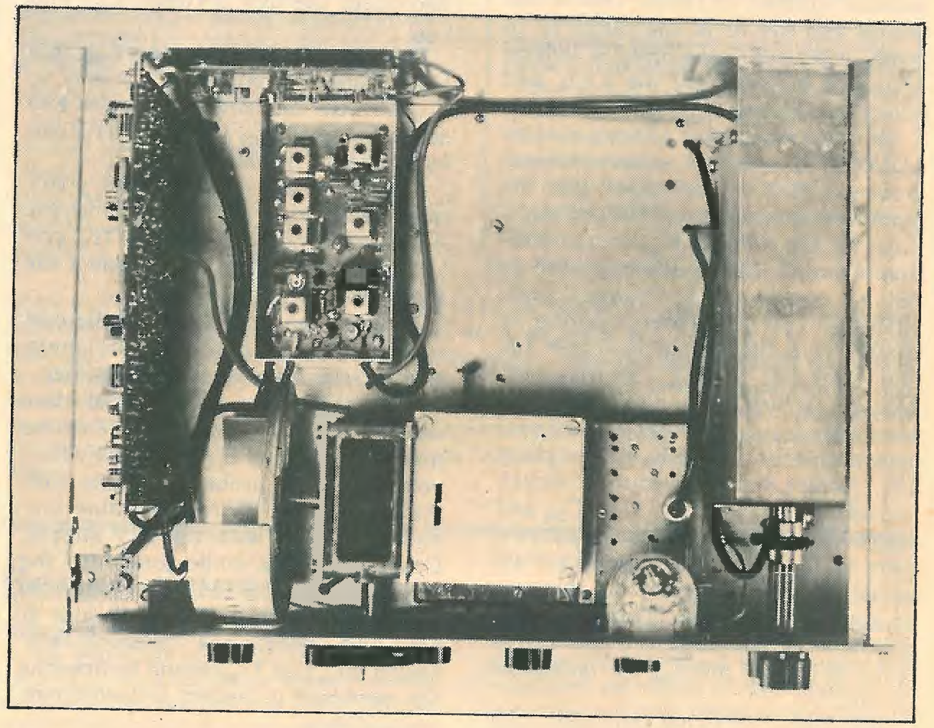
As a final check of reliable phase-lock loop operation, short circuit the "I.F. in" terminal post to chassis earth. This should cause the AVO reading to change to 4.9V and the l.e.d. to cease illumination – loop unlocked. Immediately the short circuit is removed, the AVO should revert to its original reading and the l.e.d. should illuminate – loop locked. Switch the 12.7V power supply on and off a number of times, and check that the loop always locks reliably from switch on, at any 8.3 to 9.3MHz input frequency.

For reliable operation the v.f.o. input should be not less than 500mV r.m.s. The i.f. input at "I.F. in" will only appear when the loop is locked, and this, measured with the valve-voltmeter diode probe, will be in the range 0.6 to 1.2V r.m.s., depending on the v.c.o. operating frequency (133.3 to 135.3MHz).

Note that it is important that the v.f.o. input drives Tr_{39} and the i.f. input drives Tr_{40} as shown. If these input connections are reversed the MC4044P phase detector will be disabled and the loop will not lock.



Transceiver with top chassis rail removed to show detail of the s.s.b. generator p.c.b.



Top view of the transceiver showing, left to right, the s.s.b. generator p.c.b., the transmit-converter p.c.b. with screening box, the reduction drive gear box and v.f.o. assembly, and the power amplifier screening box

V.c.o. amplifier unit

Connect the signal generator set to 134.3MHz to "V.C.O. in", and the valve-voltmeter probe to "Out RX".

Adjust cores of L_{30} and L_{31} to obtain maximum r.f. output. Transfer valve-voltmeter probe to "Out TX" and check that both readings are approximately the same. The measured output should be in the range 500 to 700mV r.m.s.

V.f.o. unit

These alignment instructions assume that a 100:1 ratio gear drive is being used (i.e. 50:1 for 180 degrees rotation of C_{222}) and that 40 turns of the tuning knob will change the v.f.o. by 1,000kHz, equal to 25kHz per turn.

Fully mesh the vanes of C_{222} and mark a reference point on the drum dial. Turn the tuning knob two complete turns clockwise. Mark a calibration point on the drum dial and number 0. This is 0kHz and is the start of the tuning drum scale. Now turn the tuning knob 40 complete turns, mark the calibration point on the drum dial and number 1,000. This is 1,000kHz and is the end of the v.f.o. tuning range.

Unscrew the cores of L_{33} and L_{34} so that they are outside the windings. Check that there is 8.5V feeding Tr_{45}, Tr_{46} and Tr_{47}. Connect the "V.F.O. out" terminal to the d.f.m. and with the dial at 0kHz adjust the dust core of L_{32} for an output frequency of 8,300kHz. Turn the drum dial to 1,000kHz and adjust C_{220} for 9,300kHz. These two adjustments interact with each other, and must be repeated until the d.f.m. readout is correct at each end of the tuning range. Once this has been achieved the drum dial can be calibrated each 100kHz with main divisions, and every 25kHz for intermediate divisions. Finally the tuning knob circumference is divided into 25 equal sections and numbered 0 to 24 so as to provide a calibration mark every 1kHz.

Disconnect the d.f.m. and replace with the valve-voltmeter probe and measure the r.f. output at 8,300kHz and 9,300kHz. The two readings should be approximately equal and in the range 0.9 to 1V r.m.s. (unloaded value). Set the v.f.o. output to 9,300kHz and screw in the cores of the low-pass filter L_{33} and L_{34} equally until the valve-voltmeter reading just begins to reduce. At this point unscrew each core by one turn. Alignment has been undertaken without any biasing potential on D_{31}. When in normal operation with R_{190} connected to the "Calibrate" control, the mean potential on D_{31} will be about 2V and this will reduce the capacitance by approximately 10pF. The v.f.o. can be brought back to correct calibration by re-adjusting C_{220}.

Receiver converter unit

Because a second signal generator is required for the heterodyning input (133.3 to 135.3MHz) to the receiver converter unit and the transmitter converter unit, it is at this stage an advantage to complete the construction by installing and wiring all units and panel controls in the main chassis – with the exception of the power amplifier.

Connect the valve-voltmeter probe to the "HET in" terminal and check that the input level is 500 to 700mV r.m.s. Set slider of R_{211} to mid position, and tuning dial to 144.9MHz. Couple 100mV output from signal generator via a two turn link, to L_{39} and adjust the transceiver tuning knob until a 1.5kHz tone can be heard from the loudspeaker. Adjust cores of L_{40} and L_{41} for maximum S-meter reading. Transfer the link to L_{38} and adjust C_{249} and C_{244} for maximum S-meter reading. Couple the signal generator to the aerial input socket and adjust C_{242} and C_{237} for maximum meter reading. As each circuit is brought into resonance reduce the signal generator output to avoid overloading the following stages.

Re-set R_{211} as necessary to give equal voltages at source connection of Tr_{51} and Tr_{52}.

Transmit converter unit

Fit a TO-5 clip-on heat sink to Tr_{56} and bend the vanes as necessary to clear the screening can of L_{52}. Check that the emitter potential is 0.15V indicating a collector current of 15mA. This is not critical and can be in the range 10 to 20mA. If outside these limits it will be necessary to withdraw the p.c.b. and adjust the value of R_{224}.

Set the transceiver tuning dial to 145MHz. Connect the valve-voltmeter probe to "HET in", and check that the input level is in the range 500 to 700mV r.m.s. Set the slider of R_{216} to mid position. Connect 75ohm dummy load to "RF out" via two feet of coaxial cable, with the valve-voltmeter probe in parallel with the 75ohm load. Set the dust cores of L_{49} and L_{52} so that each core is just level with the top of the screening can. Connect the signal generator, set to 145MHz, to test point TP_6. Operate the "press-to-talk" switch and adjust trimmers C_{276}, C_{277}, C_{281} and C_{282} for maximum output. Unscrew cores of L_{48}, L_{47} and L_{46} for maximum adjust C_{276}, C_{277}, C_{288} and C_{282} for any improvement in output. Transfer signal generator to test point TP_5 and adjust cores of L_{48}, L_{47} and L_{46} for maximum output.

Disconnect the signal generator from the test point TP_5. Connect the audio signal generator to the "Mic" input socket on the front panel, via a 40dB attenuator (1 megohm series arm, 1k-ohm shunt arm). Set the audio generator to 1.5kHz, operate "press-to-talk" switch and advance the audio output to drive the converter until the valve-voltmeter just begins to show a reading. Adjust cores of L_{45} and L_{44} for maximum output. As the circuits are brought into resonance reduce the audio drive to ensure that the following stages are not overloaded.

Finally adjust R_{216} for equal Tr_{53} and Tr_{54} source voltage.

Power amplifier

On the power amplifier, first check that the damping resistors R_{230} and R_{233} have been wired across the r.f.cs. to the bases of Tr_{58} and Tr_{59}. Unsolder the link between C_{288} and C_{289} and replace with a milliameter wired to extension leads. Connect the +12.7V supply to the +12V terminal. Adjust value of R_{227} to obtain Tr_{57} collector current of 10mA. Reconnect the link between C_{288} and C_{289}.

Unsolder the link between C_{303} and C_{314}. Connect stabilised 20V supply to C_{303} with the milliameter in series and adjust value of R_{229} to obtain Tr_{58} collector current of 40mA.

Connect a 20V supply to the +20V terminal with the milliameter in series. Adjust value of R_{232} to obtain Tr_{59} collector current of 90mA. Reconnect the link between C_{303} and C_{314}.

Assemble the amplifier in the die-cast screening box, install in the main chassis, and complete all connections.

Connect a 75ohm dummy load via a two foot length of coaxial cable to the junction of L_{66} and C_{312}, with the valve-voltmeter diode probe in parallel with the 75ohm load. Wire a suitable ammeter in series with the 20V supply. Couple a 1.5kHz audio tone into the "MIC" socket via a 40dB attenuator. Set the output of the audio generator to zero and operate the "press-to-talk" switch. Tr_{58} and Tr_{59} should be drawing the combined quiescent collector current of 130mA.

S.s.b. generator unit a.g.c. performance

Signal Input µV	dB relative 1µV	A.g.c. Line (volts)	Audio Output relative that at 10µV signal mA	dB
0		5.5		
10	20dB	4.4	20	0dB
100	40dB	3.9	27	+3dB
1,000	60dB	3.5	30	+3.5dB
10,000	80dB	3.2	33	+4dB
100,000	100dB	2.9	35	+5dB

Test procedure

1. Signal generator on 10,700kHz connected "IF in" terminal post.
2. A.g.c. volts. AVO 8 on 10Vd.c. range.
3. Audio output, AVO 8 on 100mA a.c. range in series with loudspeaker.
4. Source rail, 3.3 volts. (2.7V BZY88 zener).
5. R_{16} set at mid position (110 ohms).

It will be noted that the change in audio output is within 2dB for a change in i.f. input of 60dB and within 5dB for a change in i.f. input of 80dB. This represents very acceptable receiver i.f performance.

Set all trimmer capacitors and Tr_{59} tuning and loading capacitors to half value. Advance the audio generator output to drive the transmitter until a reading just begins to show on the valve-voltmeter. Adjust C_{283} and C_{284} for maximum output and immediately tune up C_{310} and C_{312}. Adjust C_{300}, C_{301}, C_{290} and C_{291} in that order. As the circuits are brought into resonance the ammeter reading will rise. Initially do not allow it to rise beyond 500mA by progressively reducing the audio drive as required. Now increase the drive from the audio generator to the maximum intended. which should be about 1.5 amps from the 20V supply and quickly re-adjust all capacitors for maximum r.f. output because they are all sensitive to the power level at which the associated transistor is running.

Disconnect the audio generator and plug the microphone into its socket. Whistle into the microphone to obtain a full output reading on the valve-voltmeter, and at the same time reduce the microphone amplifier gain with R_{25} (on the s.s.b. generator p.c.b.) until the power output just begins to drop.

At full output (single tone) expect a reading on the valve-voltmeter of 30 to 35V r.m.s. across a 75-ohm dummy load.

Set the "MODE" switch to the "FM" position, and adjust R_{101} (on the f.m. generator p.c.b.) until the power output just begins to drop.

Note that the continuous power output capability is limited by the available heat sinking. During the first weeks of operation it is a wise precaution to use a 20V power supply with an indicator ammeter. This enables the collector current of the power transistors Tr_{58} and Tr_{59} to be continuously monitored. If at any time the (zero signal) standing current starts to rise, it means that the transistors are being overdriven and denotes the onset of thermal runaway, (i.e., the dissipation is exceeding the capability of the heat sinking). Switch off immediately to allow the transistors to cool. Adjust the i.f. gain controls R_2 (s.s.b.) and R_{101} (f.m.) as appropriate to give some reduction to Tr_{58} and Tr_{59} power levels.

Dust core locking

It is most important that all the dust cores are an interference fit in the former and will hold their setting, and the material used must hold the core firmly but must not become solid, in case re-adjustment should be necessary at some future date. Before commencing alignment it is recommended that the screwed threads of each core and former are smeared with zinc ointment (obtainable from any chemist). The author has used this method for many years without any problems.

Operating notes

It is worth noting that the transmit output from the f.m. generator unit is a

c.w. carrier and the frequency modulation on the final 144 to 146MHz signal is derived from the v.f.o. Deviation is controlled by the microphone amplifier gain control potentiometer R_{117} (on the f.m. generator p.c.b.), and, in the absence of a deviation meter, this can be set to accepted amateur band requirements by "on-the-air" reports. The "CALIBRATE" control – nominally set at the mid position – will provide the required reference bias of 2 volts for the varicap diode in the v.f.o. unit.

For a final check on s.s.b. carrier attenuation, connect the "Aerial" output socket to a 75ohm dummy load with the diode probe of the valve-voltmeter in parallel across the load. Set the valve-voltmeter to the 1.5 volt range and remove the microphone from its socket. Operate the "press-to-talk" switch, and if there is a reading on the valve-voltmeter this denotes carrier leakage. Carefully re-balance the transmit modulator on the s.s.b. generator p.c.b. by adjusting R_{11} and C_{18} in step, until there is zero reading on the valve-voltmeter.

For the c.w. operator, transmission is conveniently effected by keying an outboard transistorised 1kHz audio oscillator fed into the microphone input socket.

Both the receiver converter unit, and the transmitter power amplifier will work equally well into a 50ohm aerial system.

Modifications

As a result of more than two years "on-the-air" experience, two modifications have been incorporated to improve the s.s.b. operating convenience. These are as follows:

1. Wire a 10µF 10V capacitor across the end pins of R_2 on the printed circuit side of the s.s.b. generator p.c.b. This delays the gate 2 potential of Tr_1 and Tr_2 and prevents the transmission of a small "splash" of carrier caused by the switching transient when relay RL_1 changes over from "receive" to "transmit".

2. Relay RL_2 has a spare set of contacts which can be used to speed up the receiver a.g.c. recovery time, for those operators who like fast "break-in" operation. Connect the pole (pin 12) to chassis earth and the by-pass contact (pin 13) to chassis earth via a 47µF 25V capacitor. With a length of PVC-covered connecting wire routed along the fold of the chassis rear apron, connect pin 13 to gate 2 of the a.g.c. amplifier Tr_{17} (junction of R_{71} and R_{72} on the etched side of the p.c.b.) This modification shorts down Tr_{17}'s gate-2 potential to zero when transmitting, and prevents the switching transient feeding from the 10.7MHz i.f. amplifier into the a.g.c. system at high level.

Conclusion

This transceiver has been designed to provide a high level of performance on both transmit and receive, together with a high standard of reliability and convenience of operation.

For the f.m.-only operator, construction can be greatly simplified by omitting the s.s.b. generator unit. Repeater operation on any channel in the 145 to 146MHz section of the band can be provided by installing two crystals 300kHz apart, in the phase-lock unit. (That is, 63.0MHz and 62.7MHz giving heterodyne frequencies of 126.0MHz and 125.4MHz.) The switching lines can be taken to a spare set of contacts on the change-over relay RL_2, so that 126.0MHz is selected on "receive" and 125.4MHz on "transmit" for normal repeater operation. If reverse repeater operation is also required, it is only necessary to add a panel-operated, 2-pole 2-way switch and wire this so that the crystal switching lines can be reversed.

Because there is ample information in textbooks and other literature on stabilized power supplies, detailed constructional details have not been given. The two units used by the author incorporate simple series stabilization using BDY20 transistors with the usual BC108 and BZY88 reference diode, and have proved to be entirely satisfactory.

All prospective constructors are strongly advised to use – with the exception of the surplus S.T.C. 445-LQU 901B FM filter specified – only first class new guaranteed components and transistors.

Richard Thornley spent almost a lifetime in the electronics industry and during the last 20 years, before retiring in December 1977, worked for the Pye/Philips Group commissionining and planning v.h.f. wired television systems. He has been a licensed radio amateur for 41 years and is mainly interested in research, development and construction – particularly in the field of s.s.b. Richard is well known in the amateur movement for his many technical articles which the Radio Society of Great Britain published from 1959 to 1973. Among his many designs is a patented simple method of operating tetrode valves as linear power amplifiers for s.s.b. transmission, without the use of conventional bias and screen power supplies.

Notes on Part 3. Component suffixes for L_1 to L_{14} in Fig. 11 are incorrect and should read respectively: 53, 54, 55, 60, 57, 56, 59, 62, 61, 58, 63, 64, 65 and 66. C_{228} in line four of p78 should read C_{288}. Fourth line of last column on p79 should read ". . . die-cast box are mounted vertically at either end of the chassis platform, and the squelch unit is mounted vertically on the rear panel." Caption to Fig. 16 on p80 refers to Tr_{58} and Tr_{59} and not Tr_{227} and Tr_{228} as shown. Component suffixes for C_{50} to C_{54} in Fig. 17 are incorrect and should read respectively: 200, 206, 203, 204 and 193. **A table of d.c. voltage checks** for this transceiver will be made available on request.

Books Received

Manual of Avionics, by Brian Kendal, is said by the publishers to enable the layman to acquire a working knowledge of radio navaids, but to have as its primary aim the detailed analysis of electronics in civil aviation for the professional reader. The author, however, maintains that he has steered a middle course between the elementary and the mathematical analysis.

The book is certainly of interest to the layman, and is written at this level: it will probably not be of great help to the professional for the reasons given in the author's introduction — it is simply not possible to perform both tasks in one book. At the layman's level, it is extremely detailed, comprehensive and authoritative, if one bears in mind that the 'avionics' of the title is restricted to communications and navigational aids, including radar.

A short historical chapter, which manages to cover everything from Clerk Maxwell to cavity magnetrons in 26 pages, is followed by seven chapters on air traffic management, radio telephony and direction-finding, short-range navaids and radio landing systems, radar, and the hyperbolic systems and Doppler navigation.

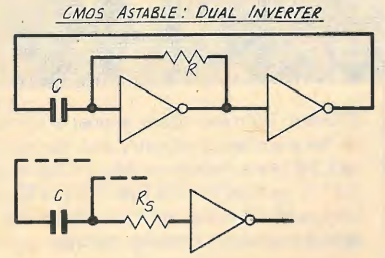
For anyone interested in gaining a fairly superficial (in professional terms) idea of the control and navigation of civil aircraft, the book can be highly recommended for its comprehensiveness and authority — the author is Senior Air Traffic Engineer of the Civil Aviation Authority. It is published by Granada Publishing, PO Box 9, Frogmore, St. Albans, Herts. at £10.

A Window in the Sky, by A. T. Lawton, is concerned with the possibilities opened up for astronomers by the use of equipment outside our atmosphere. In contrast to many works on astronomy, the book is not only immensely detailed and factual, it is also a 'good read.' Mr Lawton puts the case for extra-terrestrial instruments, discusses the techniques for putting them there and examines several possible 'sites' in space. When all the equipment is in place, there is then the problem of what to investigate and, after a detour into the physics of integrated circuits and optical and radio telescopes, the rest of the book is a survey of some of the astronomical phenomena already known and others only guessed at. The book is published in hardback by David and Charles, Brunel House, Newton Abbot, Devon, at £6.50.

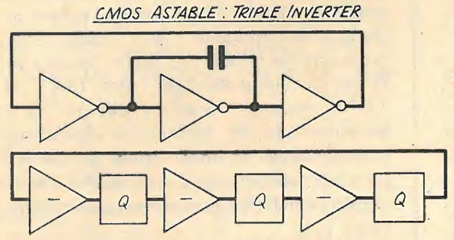
Astables: Logic gate circuits

by **Peter Williams,** Ph.D. Paisley College of Technology

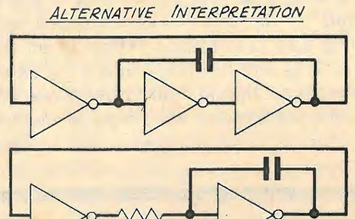
CMOS ASTABLE: DUAL INVERTER



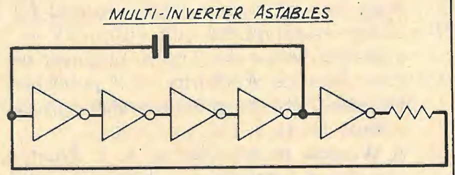
CMOS ASTABLE: TRIPLE INVERTER



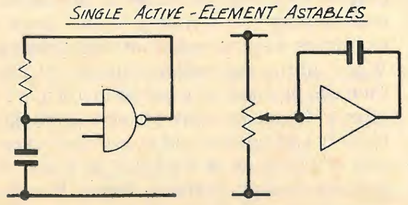
ALTERNATIVE INTERPRETATION



MULTI-INVERTER ASTABLES



SINGLE ACTIVE-ELEMENT ASTABLES



A widely quoted astable circuit using inverters from the c.m.o.s. logic family is shown, using one capacitor and one resistor. A modification using a second resistor R_s is also well-known but R_s plays no part in the frequency control; rather it isolates the protective diodes at the inverter input from the voltage step applied via the capacitor, thereby protecting the input and preventing the diodes from conducting heavily and disturbing the frequency. Because only two passive components are needed the circuit seems not to conform to any of types I to V (December issue). It does, however, contain a differentiator as in type IV and though the amplifier gain is much less the behaviour should be similar in this respect. The other amplifier has an inverting gain of relatively small magnitude and this corresponds to the see-saw amplifier of type IV. Hence this apparently new circuit is in fact type IV whether the inverters be c.m.o.s., t.t.l. or e.c.l.

Another common form of astable circuit quoted in the literature uses three inverters and a single capacitor with no passive resistors. It is sometimes described in terms of a three-phase oscillator. Such circuits are used as sinusoidal oscillators with 60° phase-shift per stage and with feedback or attenuation to limit the gain of each stage such that oscillation is not excessive. The present circuit is then argued to be a development of this with one external capacitor to define a longer time constant and hence lower the frequency. It is not then clear how the other inverters contribute to the response and the circuit certainly seems quite different from types I to V. It is unwise to press arguments based on sinusoidal response too hard when applied to switching behaviour and vice versa. The absence of a passive resistor does not mean that the circuits have no resistance. The output slope resistance of a c.m.o.s. invertor is quite high and the maximum current may be limited to <1mA. Hence to compare the circuit with one based on op.amps it has to be visualized with a resistor at each output.

There is a simple change tht suggests a different interpretation of the circuit and allows it to be classified as a known type. The circuit is simply redrawn with the capacitor appearing to shunt two of the cascaded inverters rather than one. This involves no actual change since the capacitor *is* still connected across the single inverter — it is merely a changed appearance. The two cascaded inverters are equivalent to a single high-gain, non-inverting stage and, adding a resistor at the output of the first stage to represent its output resistance, the circuit is now seen to be functionally identical with type V. An inverting amplifier of finite gain drives a non-inverting amplifier with capacitive feedback via a resistive path. It is important to try re-arranging unfamiliar or difficult circuits to see if various sub-sections become recognizable. Many circuit diagrams have a layout that suits the whims of a designer or the convenience of a draughtsman; they have to be made to serve the understanding of the user.

Other apparently more complex astable circuits can sometimes be simplified readily. In the circuit shown the cascaded inverters become equivalent to either a high gain inverting or non-inverting amplifier depending on whether an odd or even number of inverters is employed. Once this is noted, then this circuit is obviously a type V astable again. As in the previous circuit the external resistor offers a considerable advantage — the resulting time constant can be very large and hence the frequency can be very low while using only a small value of capacitance. If the resistor is omitted the frequency also becomes strongly dependent on supply voltage via the variation in output resistance of the individual devices composing the inverter. The multiple delays in the cascaded inverters limit the upper frequency of oscillation but the high gain makes lower frequencies less dependent on parameter variations. Such circuits are not recommended for stable frequency clock generators, a task normally performed by crystal-controlled oscillators.

Astables can also be devised that use only a single active circuit and correspond to types I and II. In some logic families Schmitt circuits are already available often with more than one input. These add the AND function to the switching action. The circuit with the unused inputs inhibited beaves like an operational amplifier with series positive feedback and the signal applied to the inverting input, i.e. when the output is returned to the input via an RC section it becomes a type I astable. When the output is positive the capacitor charges until it reaches the upper threshold voltage, switching the output to zero and discharging the capacitor back toward the lower threshold. The op.amp. and potential divider in type II comprise a non-inverting amplifier of finite gain. If the combination is replaced by a non-inverting logic buffer an astable action should again result. The missing factor is that the circuit must have a quiescent state in the capacitor's absence that brings it into the linear region. A grounded resistor is not valid for a logic gate, and is here replaced by a potentiometer. When set in the linear region oscillations commence — an additional series resistor can be used to set the frequency.

Astables: Logic gate circuits

THEORY

- Both gates must enter their linear region for the loop gain to reach unity and initiate regenerative feedback. If these regions correspond to a small range of input voltages centred on $V_S/2$ the analysis is simple. For low-gain inverters both the waveforms and frequencies are less precise. It is assumed that input conduction is avoided (or minimized) as shown.

Under these conditions the outputs are anti-phase square waves with the transitions occurring as the differentiator input passes through $V_s/2$. On the positive going step this input is driven up to $V_s/2+V_s=3V_s/2$. At that instant the other end of the resistor is taken down to zero. Hence $V_1=-3V_S/2$ while $V_2=-V_S/2$

$$t_2-t_1=\tau\log_e 3\approx 1.1\tau$$

The second part of the cycle has the differentiator input driven to $V_S/2-V_S=-V_S/2$ while the other end of the resistor rises to V_S. Hence $V_1=3V_S/2$, $V_2=V_S/2$ giving an identical time interval.

$$\text{Hence } T=2\tau\log_e 3=2.2\tau$$

If the circuit is interpreted as a phase-shift circuit using analysis as for a sinusoidal response, invalid results are obtained.

- The modified form of the circuit has an inverter with a voltage-gain $\gg 1$. Hence its output is saturated for most of the timing cycle, and though type V in structure, a modified analysis is required. Again the thresholds are assumed to be close to $V_S/2$ and the CR junction is driven to $3V_S/2$ and $-V_S/2$ on the transitions.

This leads to comparable values of period and frequency, viz $T\approx 2.2\tau$

Second-order effects are important at high frequencies where gate delays modify the response. In each case an additional large value resistor should be added in series with any gate/inverter input subject to voltage steps going outside the supply lines.

- The first-order response is identical with that of the previous circuit. The Schmitt trigger is assumed to have upper and lower threshold voltages V_U and V_L. The time for the rising ramp is

$$t_2-t_1=\tau\log_e\left[\frac{V_2}{V_1}\right]=\tau\log_e\left[\frac{V_S-V_L}{V_S-V_U}\right]$$

and for the falling ramp $\tau\log_e\left[\frac{-V_U}{-V_L}\right]$

$$\text{The period is } T=\tau\log_e\left(\frac{V_S-V_L}{V_S-V_U}\right)+\log_e\left(\frac{V_U}{V_L}\right)$$

$$\therefore T=\tau\log_e\left[\frac{(V_S-V_L)V_U}{(V_S-V_U)V_L}\right]=\tau\log_e\left[\frac{\frac{V_S}{V_L}-1}{\frac{V_S}{V_U}-1}\right]$$

But for symmetrically placed thresholds

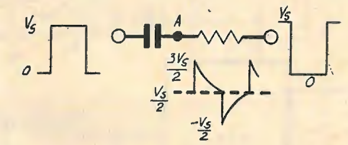
$$\frac{V_U+V_L}{2}=\frac{V_S}{2}$$

$$\therefore T=\tau\log_e\left[\frac{\frac{V_U+V_L}{V_L}-1}{\frac{V_U+V_L}{V_U}-1}\right]=\tau\log_e\left(\frac{V_U}{V_L}\right)^2=2\tau\log_e\left(\frac{V_U}{V_L}\right)$$

EXAMPLES

1. The c.m.o.s. astable has $R=100\text{k}\Omega$ and is required to oscillate at 10kHz. Assuming that R_S is large enough to avoid conduction choose a suitable value of capacitance stating any assumptions.

The threshold of c.m.o.s. inverters is normally within the range 45 to 55% V_S. It is convenient to take the threshold as $V_S/2$.



$$\therefore V_1=\frac{3V_S}{2}-0$$

$$V_2=\frac{V_S}{2}-0$$

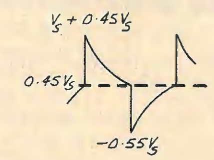
$$\therefore \text{Half-period } t_2-t_1=\tau\log_e\left(\frac{3V_S/2}{V_S/2}\right)$$

$$\frac{-V_S}{2}=\tau\log_e 3=1.1\tau$$

$$\therefore \text{Period}=2.2\tau=100\,.\,10^{-6}$$

$$C=\frac{100\times10^{-6}}{2.2\times10^5}=470\text{pF}$$

To check the effect of the variable threshold, assume each inverter switches at $0.45V_S$.



$\therefore V_1=V_S+0.45V_S$

$V_2=0.45V_S$

$\therefore$ First time interval

$$=\tau\log_e\left(\frac{1.45}{0.45}\right)=1.170\tau$$

The second part of the cycle has

$V_1'=-1.55V_S$

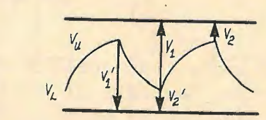
$V_2'=-0.55V_S$

$\therefore$ Second time interval $=\tau\log_e\left(\frac{1.55}{0.55}\right)=1.036\tau$ $\therefore T=2.206\tau$

This compares with a value of 2.197 for the symmetrical case if $\log_e 3$ is evaluated more accurately i.e. on changing the threshold by 5% of supply (or 10% of its initial value) the mark-space ratio changes from 1:1 to 1:1.12 a change of 13%, though the frequency changes by only 0.4%.

2. An astable is constructed with a c.m.o.s. Schmitt circuit having upper and lower thresholds of 3V and 6.5V at a supply voltage of 10V. Estimate the frequency of oscillation with an RC section having $\tau=500\mu$s.

$$T=\tau\left[\log_e\left(\frac{V_1}{V_2}\right)+\log_e\left(\frac{V_1'}{V_2'}\right)\right]$$



$$=\tau\left[\log_e\left(\frac{V_S-V_L}{V_S-V_U}\right)+\log_e\left(\frac{-V_U}{-V_L}\right)\right]$$

$$=\tau\left[\log_e\frac{(V_S-V_L)\;V_U}{(V_S-V_U)\;V_L}\right]$$

$\therefore T_1=1.47\tau$, $f=1.36$kHz.

For symmetrically placed thresholds but with the same hysteresis of 3.5V,

$V_U'=5+1.75=6.75$

$V_L'=5-1.75=3.25$

$$T'=2\tau\log_e\left(\frac{V_U}{V_L}\right)=1.46\tau$$

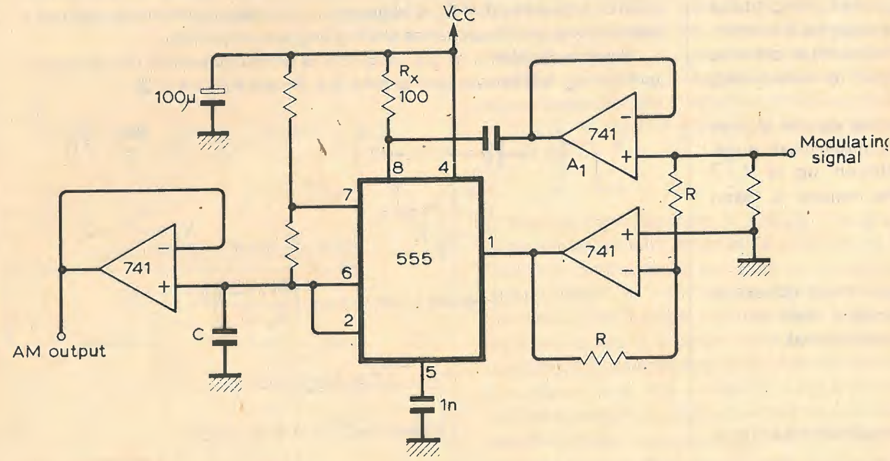
This result can be obtained from the general case above by substitution as in the analysis opposite.

Circuit Ideas continued

Amplitude modulator

With a 555 connected in the astable mode the timing capacitor charges and discharges between $V_H=2V_{cc}/3$ and $V_L=V_{cc}/3$. By simultaneously increasing or decreasing V_H to V_L symmetrically about $V_{cc}/2$, amplitude modulation can be achieved. Resistor R_x is a compromise between excessive drop under d.c. conditions and loading of op-amp A_1.

A. D. Teckchandani
Faridabad
India

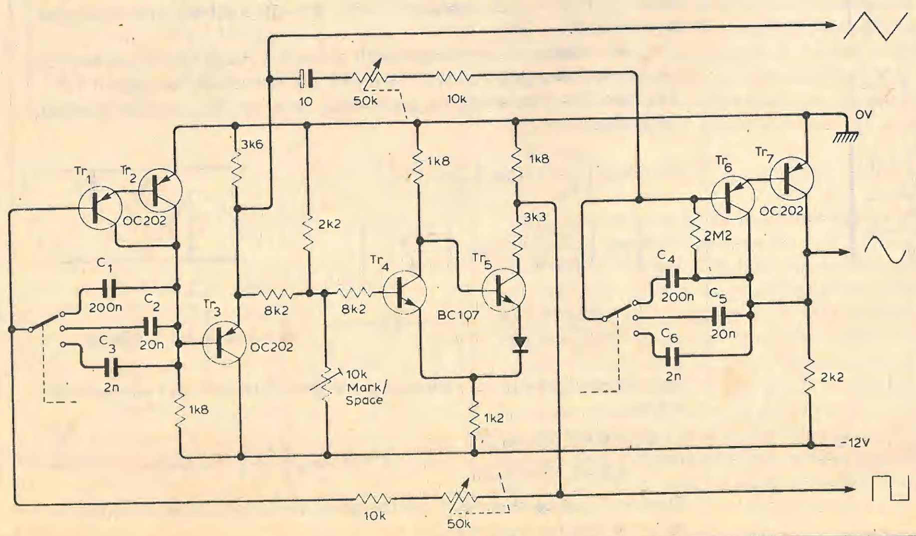


Simple waveform generator

For audio frequencies this waveform generator offers several advantages over the usual Wien bridge circuit. No amplitude stabilization is required, there are no spasmodic interruptions to the output when switching range, and a range of 10-1 is easily achieved with a standard twin-gang potentiometer.

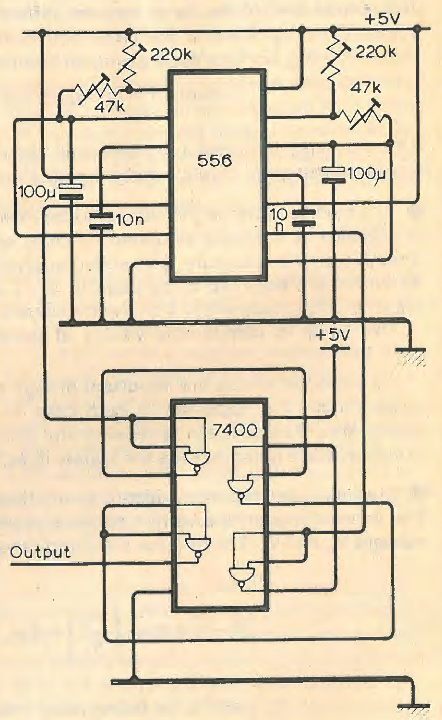
The integrator Tr_1 Tr_2, the emitter follower and the Schmitt trigger Tr_4 Tr_5 produce a triangular waveform at the collector of Tr_2. This output is of constant amplitude throughout the frequency range due to fixed triggering points. The triangular waveform also feeds a second integrator Tr_6 Tr_7 which produces a good sine wave of constant amplitude. The audio range is easily covered by three pairs of capacitors and the three outputs can be taken selectively to a single emitter follower.

F. V. Goodfellow
Southampton



Long duration timer

The two oscillators constructed from a 556 have periods T_1+t_1 and T_2+t_2, where the outputs of the oscillators are high during T_1 and T_2 and low during t_1 and t_2. Also, t_1 is much smaller than T_1 and t_2 is much smaller than T_2, but T_1 and T_2 are almost, but not quite, equal. When the supply is connected the oscillators start simultaneously and there is a long duration before the low periods of the oscillators overlap. When this occurs a short low pulse is produced by the 7400. The maximum interval between the pulses can be estimated as follows. Let $t_1=t_2=t$ and let $T_2=T_1+t$.



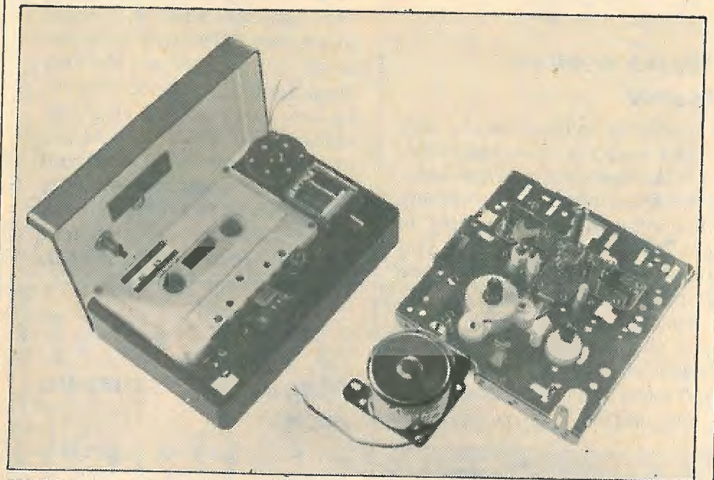
It then takes T_1/t periods of the slow oscillator to overlap at the low duration. Therefore, the time delay T is T_1T_2/t and can be very long. For example, if t is 50µs and T_1T_2 is 18 min, T is 778 years. In the practical circuit with a 556 or two 555s, such long periods are not possible because the well known current spike, caused when the output of a 555 goes high, triggers the other oscillator into a low state before its high period has been completed. However, the new 355 timer should produce better results.

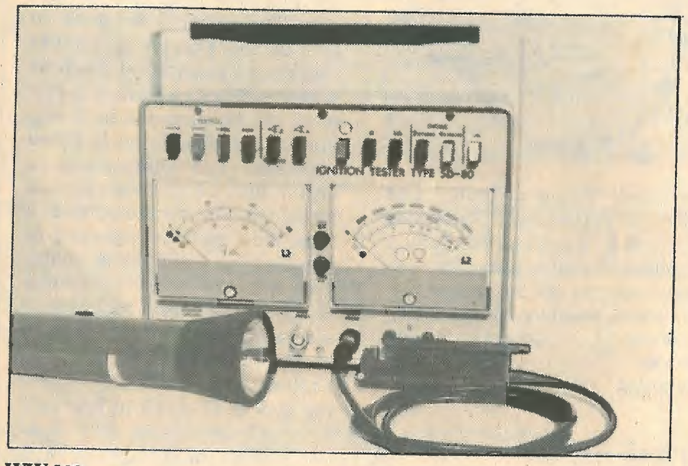
O. B. Hellman
Turku
Finland

NEW PRODUCTS

Solenoid-operated cassette units

Typical applications of two new solenoid-operated cassette mechanisms, the Symot models LW 104 and YME 1006, include remote data acquisition, automatic annunciation, and processing activities in security systems. The LW 104 has been designed for use with continuous loop cassettes and is manufactured in corrosion-resistant plastic with a close-fitting translucent dust cover. The control solenoid, which operates on either 6V or 12V d.c., pulls on the pinch wheel and head assembly. The standard motor is an electronically-regulated type with an external circuit. YME 1006 is an all-metal skeleton mechanism for use with either continuous loop or conventional compact cassettes. Three forms are available. — play only, record/replay with rewind facility and record/replay with cue and review facility. A (specially compounded) rubber capstan pinch roller permits permanent tape engagement without damage or roller indentation. Mono tape heads are fitted as standard and motors are mechanically regulated at 6V or 9V d.c. Symot Ltd, 22a Reading Rd, Henley-on-Thames, Oxfordshire RG9 1AG.
WW 301

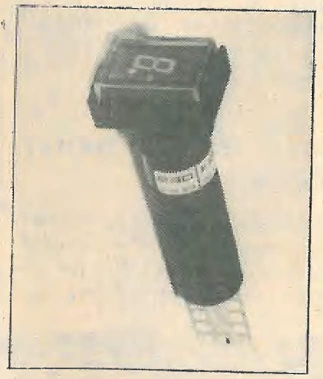

WW 301



WW 302

Diagnostic engine tester

Diagnosis of engine timing and faults in the electrical system of petrol engines is the function of the SD-80 ignition tester manufactured by Albol Electronic and Mechanical Products. The unit is supplied from a 12V battery and the makers claim that, by its use, savings of about 10% can be made on petrol costs, although we assume that this presupposes that the engine is already operating below par. Functions covered by the tester include engine revs, ignition angle (with respect to t.d.c.), contact breaker make angle (dwell), battery voltage, h.t. voltage, plus two resistance checking ranges. The unit also powers a stroboscopic lamp for advance/retard measurement and dimensions are $250\times310\times170$mm at a weight of 4.8kg (2.2lb). Price is £198 plus v.a.t. and a six-month guarantee is provided. Albol Electronic and Mechanical Products Ltd, 3 Crown St, London SE5.
WW 302


WW 303

7-segment l.e.d. display

Each of the seven segments of the Highland Electronics 31-019 l.e.d. display can be illuminated separately and the unit can be panel-mounted in a single 16mm diameter round hole. Terminations are provided on a miniature p.c.b., which is an integral part of the unit's construction and extends in a vertical plane from the moulded body of the display. The terminal print on the board aligns with a standard 7-way d.i.l. socket with 2.54mm terminal spacing. Alternatively, the unit may be hard-wired. Ten connections are provided, one for each segment, one for the decimal point and two commoned negative supply terminals. The display will operate on voltages between 1.7 and 2.7V (d.c.), with each segment and the decimal point drawing 15mA continuous, 80mA pulse, for 1ms at max. voltage. The display provides, apart from numerals, upper case letters ACEFHJLPUY and lower case letters bcdeghlnoruy. Highland Electronics, 8 Old Steine, Brighton, East Sussex BN1 1EJ.
WW 303

WW 304

Pocket frequency meter

Mobile communications applications are the areas of use which Electroplan quotes for the Labgear CM7044 portable frequency meter. This instrument covers the range 10MHz to 500MHz and it is powered by rechargeable batteries. A small antenna (with b.n.c. fitting) is provided enabling measurement of transmissions to be made without disturbing the transmitter or making internal connections. Readings are presented on a 7-digit l.e.d. display in two ranges — 10 to 50MHz and 50 to 500MHz. Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts SG8 5HH.
WW 304

Radial component pre-former

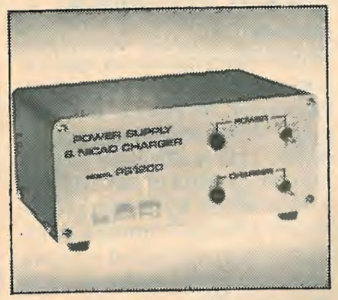
An automatically fed machine, capable of forming and cropping up to 5000 components (radial capacitors and transistors) an hour is now available from Elite Engineering Ltd. The design of the machine allows the cropping and forming of components to the same form even where their bodies are different, without changing the tooling, although interchangeable tooling permits most different transistors to be cropped and formed for insertion in p.c. boards. Radial lead capacitors can be hopper fed if necessary or hand fed on to a belt if an especially difficult form is required. Demonstrations of the machine can be arranged or sample components sent to the makers for forming on standard


WW 305

tools. Peter J. W. Noble, Elite Engineering Ltd, Unit 3, Saltern Lane, Fareham, Hants PO16 0TD.
WW 305

Power supply and ni-cad charger

Producing an output of 13.8V d.c. at 750mA for amateur radio transceiver operation and a second output at 45mA, constant current, for recharging nickel-cadmium batteries, the Lar Modules PS1200, permits trans-



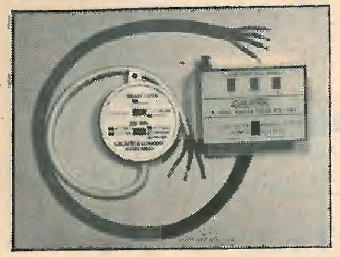
mission from the base station while recharging is taking place. The transceiver output supply is regulated and all switching is automatic. Protection circuits are included and output 2 (charger) is at negative ground. LAP Modules Ltd, 27 Cookridge St, Leeds, LS2 3AG.
WW 306

R.f.i. sealing paste

Described as "extremely fine in texture, consisting of a high concentration of pure silver particles in silicone resin" by the makers, Emerson and Cumming (UK) Ltd, Eccoshield SX is a conductive, non-hardening sealant and gasketing material for use as an r.f. shield. Volume resistivity of the paste is less than 0.005-Ωcm and it can be used at temperatures from −70°F to +400°F (−56°C to +204°C) with no adverse effects. The paste's consistency can be changed by thinning with toluene and the manufacturer quotes its use on cover plates of conduit junction boxes, to replace knitted metal gaskets and on bolt threads where it can help to assure continuous electrical contact and to prevent corrosion. The claim is also made that structures sealed with Eccoshield have a measured insertion loss in excess of 100dB for both electric and magnetic fields in the frequency range 10kHz to 10GHz. Emerson and Cumming (UK) Ltd, Colville Rd, Acton, London, W3.
WW 307

Mains socket tester

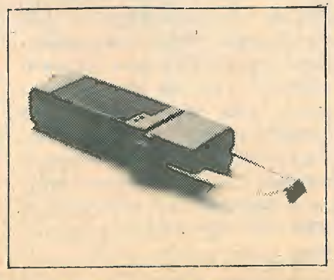
Constructed in the form of a 13A mains plug top, a socket tester with a visual display which indicates a variety of fault conditions in a domestic mains supply is available from Galatrek. The makers say that when the tester is plugged into a socket (any form, including 5A or 15A round pin, these are connected by a length of cable) the neon display indicates "correct," "live fault," "no earth," "live/neutral



reversed," "neutral fault," and "live/earth reversed." The tester costs £4.50 including v.a.t. and a 3-phase remote tester is also available at £8.95 inc. v.a.t. Galatrek, Scotland St, Lanrwst, Gwynedd, LL26 0AL, North Wales.
WW 308

Tape head demagnetizer

Demagnetization of tape heads without the need to withdraw the demagnetizing yoke away from the head at a constant speed is the claim made by TDK for its battery-operated electronic head demagnetizer, type No. HD11. The defluxing operation can be carried out in 1s, and the yoke is adjustable to settings of 15° and 30° from the horizontal. The design of the unit also makes it possible to carry out defluxing of heads on many older models of tape recorder, some of which are difficult in terms of head access. TDK Tape Distributor (UK) Ltd., 11th Floor, Pembroke House, Wellesley Rd, Croydon, Surrey.
WW 309



Auto transformers

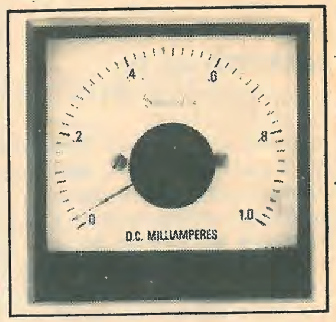
A range of transformers intended for the adaptation of modernized equipment which has been imported from the US is now available from F. H. Radford Ltd. This comprises a series of single phase auto transformers for either 240 or 220V supply, this input being transformed to 115V, by means of a single connection change. Four basic models are available as 500, 1000, 2000 and 3000VA units, each of which is equipped with two American 15A 3-pin outlets and a 3-core output lead. F. H. Radford Ltd, 38 Charlotte St, London W1P 1HP.
WW 310

Magazine storage rack

A collapsible frame moulded from polythene and held together by four metal tubes constitutes the Multi-file magazine storage rack. The frame is designed to hold up to 24 issues of a fairly weighty A4 publication (such as *Wireless World*) although a few more can be squeezed in if required. Each magazine is fitted with two clips which pinch at either end of the spine, and located at the centre spread — these must be fitted carefully to avoid tearing — and the journal is then hung by these polythene clips from the rails at each side of the frame. The price, ex works, is £8.50 each, including v.a.t. or £3.50 each per unit per 1000 and the rack is available in four colours — brown, light grey, blue and yellow. Alternative colours and "house" branding can be arranged on orders over 5000 at extra cost. Multi-file Ltd, Sands Industrial Estate, Hillbottom Rd, High Wycombe, Bucks.
WW 311

Long scale panel meter

Applications requiring higher than usual accuracy are quoted by Bach-Simpson (UK) for its new range of panel meters featuring a 250° pointer deflection angle. These meters, specified as 2123L for d.c. and 2143L for a.c. (rectified) are self-shielded, permanent magnet moving-coil instruments with non-magnetic



pivots and spring-backed jewels; zero adjustment is via the front pivot. The facia dimensions of these meters are identical to the Simpson "Century" range of 3½ in panel meters. Bach-Simpson (UK) Ltd, Trenant Estate, Wadebridge, Cornwall, PL27 6HD.
WW312

Noise blanking chip

Designed for the removal of noise spikes from broadcast f.m. composite signals before decoding, the Toko KB4436 is claimed by the UK distributor, Ambit International, to be capable of providing an improvement of approximately 25 to 30dB on the unblanked signal to noise ratio. This i.c. is specifically intended for the removal of short duration impulse noise such as that generated by a car's ignition circuits or d.c. motors. In order to maintain the 19kHz pilot tone during blanking periods, a signal derived from the decoder v.c.o. is added to the input signal for a period determined by the setting of externally-controlled time constants. This method ensures that the blanking process does not impair the quality of the output signal. Further information for alternative applications is available from the distributor and the one-off price of the i.c. is £2.53 excluding v.a.t. Ambit International, 200 North Service Rd, Brentwood, Essex CM14 4SG.
WW313

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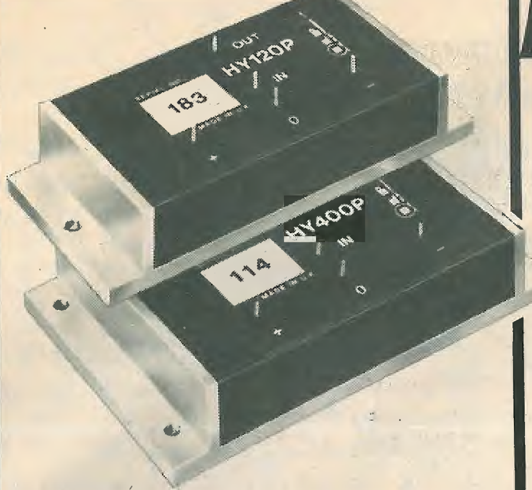

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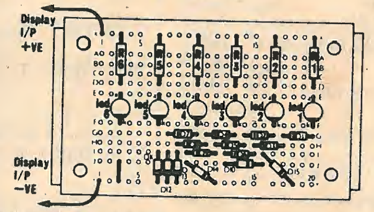

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e.g. LED Bar Graph (a previous project)
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R1 to R6 Resistors
LED 1 to LED 6 Light emitting diodes

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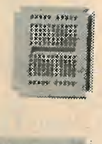

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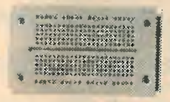
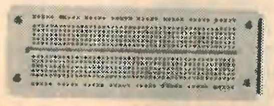
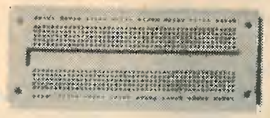


EXP 300 £5.75 The most widely bought bread-board in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 × 14 pin DIPS.



EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600



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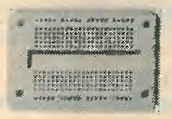

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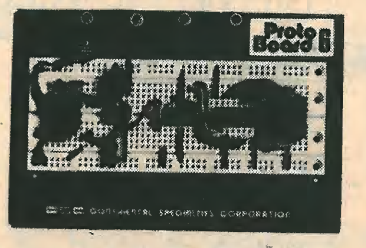
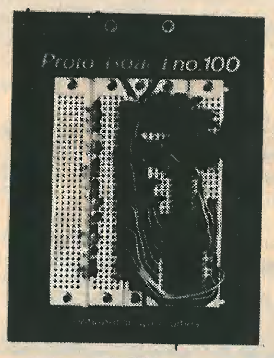


PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

PROTO-BOARD 6 KIT £9.20



PB 100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy.

PROTO-BOARD 100 KIT £11.80

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TO RECEIVE YOUR FREE COPY OF PROJECTS 4, 5 and 6.

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EXP 350	270	3	£ 4.48	
EXP 300	550	6	£ 7.76	
EXP 600			£ 8.39	
EXP 650	270	use with 0.6 pitch Dip's Strip Bus-Bar	£ 5.00	
EXP 4B	Four 40 Point Bus-Bars		£ 3.50	
PROTO-BOARDS				
PB6	630	6	£11.73	
PB100	760	10	£14.72	

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Tel: Saffron Walden (0799) 21682. Telex: 817477

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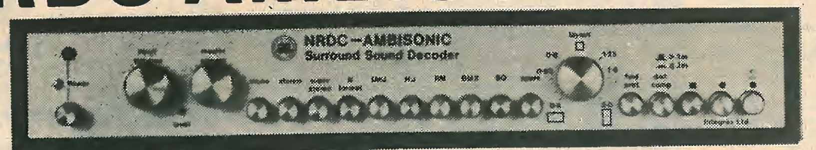
NRDC-AMBISONIC UHJ



SURROUND SOUND DECODER

The **first ever** kit specialy produced by Integrex for this British NRDC backed surround sound system which is the result of 7 years' research by the Ambisonic team. W.W. July, Aug., '77.
The unit is designed to decode not only UHJ but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC HJ 10 input selections
The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.

Complete kit, including licence fee **£49.50** + VAT
or ready built and tested **£67.50** + VAT

NEW S5050A STEREO AMP

50 watts rms-channel. 0.015% THD. S/N 90 dB, Mags/n 80 dB.
Output device rating 360w per channel

Tone cancel switch. 2 tape monitor switches.
Metal case—comprehensive heatsinks
Complete kit only **£63.90 + VAT.**

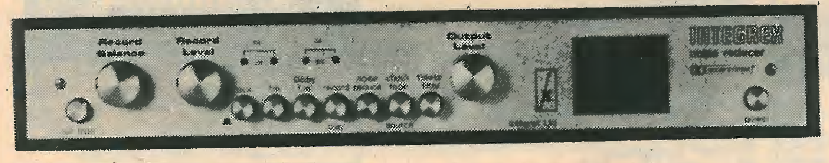
INTRUDER 1 Mk. 2 RADAR ALARM

With Home Office Type approval

The original "Wireless World" published Intruder 1 has been re-designed by Integrex to incorporate several new features, along with improved performance. The kit is even easier to build. The internal audible alarm turns off after approximately 40 seconds and the unit re-arms. 240V ac mains or 12V battery operated. Disguised as a hard-backed book. Detection range up to 45 feet.
Complete kit £49.50 plus VAT.

Wireless World Dolby noise reducer

Trademark of Dolby Laboratories Inc.



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.

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.

Complete Kit **PRICE: £43.90** + VAT

Also available ready built and tested .... **Price £59.40** + VAT
Calibration tapes are available for open-reel use and for cassette (specify which) .... **Price £2.40** VAT
Single channel plug-in Dolby(TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts and all components .... **Price £9.00** + VAT

Please add VAT @ 15%

We guarantee full after-sales technical and servicing facilities on all our kits, have you checked that these services are available from other suppliers?

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All kits are carriage free

Please send SAE for complete lists and specifications

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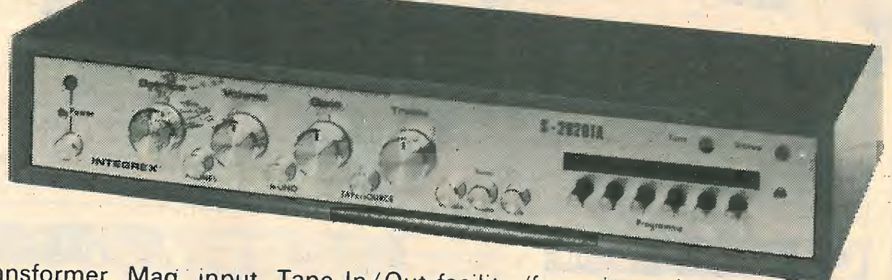
Portwood Industrial Estate, Church Gresley, Burton-on-Trent, Staffs DE11 9PT
Burton-on-Trent (0283) 215432 Telex 377106

INTEGREX

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.



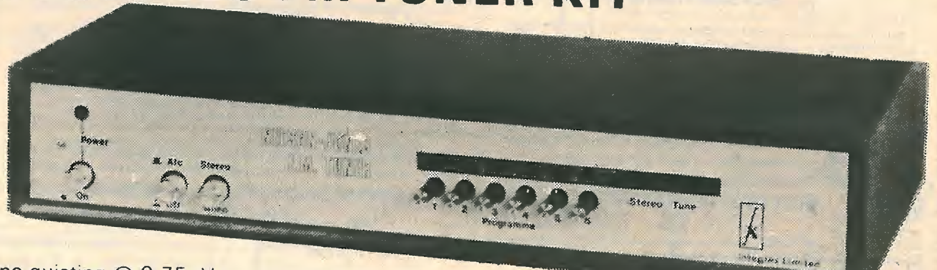
Brief Spec. Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring 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 @ 1.2μV. THD 0.3%. Pre-decoder 'birdy' filter. **PRICE: £59.95** + VAT

NELSON-JONES MK.2 STEREO FM TUNER KIT

Improved performance with linear phase IF and second generation IC decoder. Price: **£69.95** + VAT.

NELSON-JONES MK. I STEREO FM TUNER KIT

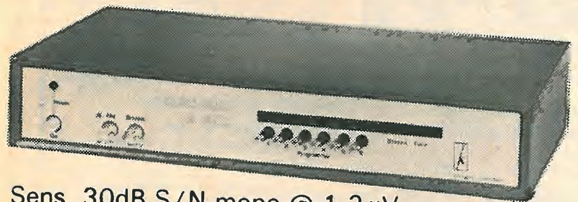
A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.



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 £36.40 + VAT
With ICPL Decoder £40.67 + VAT
With Portus-Haywood Decoder £44.20 + VAT



STEREO MODULE TUNER KIT

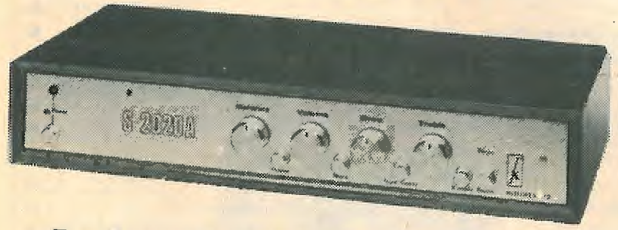
A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter Push-button tuning

Sens. 30dB S/N mono @ 1.2μV
THD typically 0.3%
Tuning range 88—104MHz
LED sig. strength and stereo indicator

PRICE: Stereo £33.95 + 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 Power 'on/off' FET transient protection.



Typ 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: £35.95 + VAT

BASIC NELSON-JONES TUNER KIT £15.70 + VAT
BASIC MODULE TUNER KIT (stereo) £18.50 + VAT
PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT .... **£8.80** + VAT
PHASE-LOCKED IC DECODER KIT ... **£4.47**+VAT
PUSH-BUTTON UNIT .... **£6.00** + VAT

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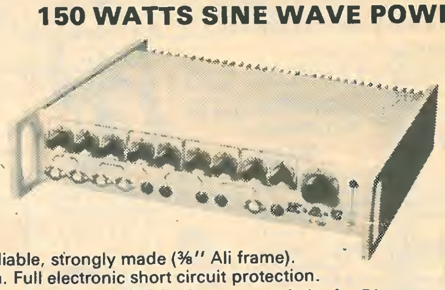
K·A·C A150 MIXER AMPLIFIER
150 WATTS SINE WAVE POWER

£149.50
inc. VAT



Mono, all purpose, reliable, strongly made (⅜" Ali frame).
Double anodised facia. Full electronic short circuit protection.
Six independent inputs: Dual Phono, RIAA, change-over fader for Discos.
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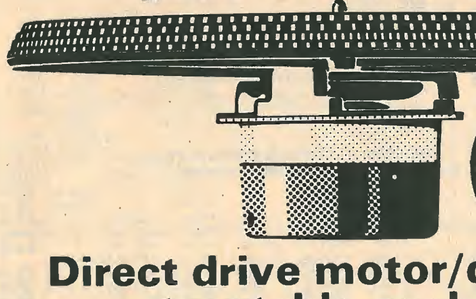

As discussed on page 67 of this issue

Direct drive motor/die cast turntable pack -
£26.00+£3.90 V.A.T.
including post & packing
(V.A.T. shown at present rate of 15%)

Further details of these top quality components in return for s.a.e. - or personal callers welcome.
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Manufactured in France
British Patents applied for

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4. All diamond grains are rigidly calibrated to ensure a perfectly uniform grain size of either 200, 300 or 400.
5. The chrome gives a very weak co-efficient of friction and the rigidity of the nylon handle is calculated to permit proper utilisation and yet pliant enough to avoid undue pressures on highly delicate relays.

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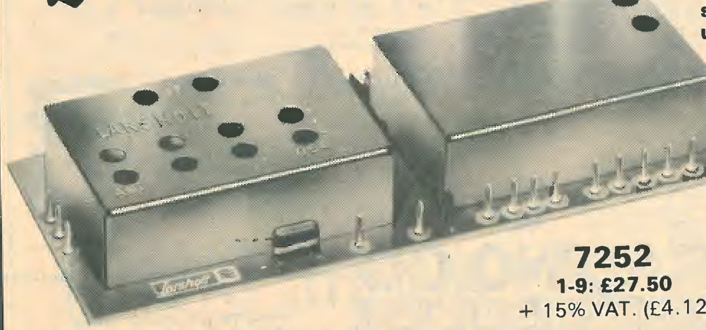
Larsholt
EURO VHF FM TUNERSET 7252

The long experience of Larsholt Electronics is reflected in this superbly engineered VHF Band II varicap FM tunermodule. (As used in the Signalmaster Mk 8.)

The four stage frontend employs dual gate MOSFET transistors for both RF and Mixer stages, providing the 7252 with a 1uV sensitivity for 30dB S/B (m). The IF uses a dual ceramic IF filter, and provides all usual HiFi functions, of tuning meter drives, muting, AFC and AGC. THD is only 0.1%.



7252
1-9: £27.50
+ 15% VAT. (£4.12)

Write or phone for free brochure which gives full technical details and application notes for this and other Larsholt products.

LARSHOLT ELECTRONICS
DK 4622 HAVDRUP - DENMARK

ex-stock from: **AMBIT INTERNATIONAL**
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Brentwood, ESSEX CM14 4SG
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INTO THE 80's WITH CATRONICS TELETEX DECODERS!

READY-BUILT DECODER SALE

Specially reduced prices for ready-built Teletext Decoders . . . from only £160. Send SAE for details and current list

KITS including ULTRASONIC REMOTE CONTROL

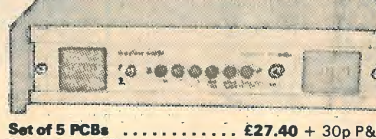
Kits and PCBs are now available for the Ultrasonic Remote Control unit as described in recent issues of W.W. Kit includes plated-through hole "Board 5", RX and TX PCBs, all components and installation instructions.

Price only £67.92 + VAT + Post = £78.80 total
Character Rounding "Board 4" Kit £26.62 total
New Facilities "Board 3" Kit for £39.00 total

Catronics main kits contain all the printed circuit boards and components necessary to build the complete decoder.

A reprint of the series of articles is available at £1.95 + large 21p SAE (included free in complete kit).

Prices are for the Version with TEXAS X887 INCLUDING VAT.



Set of 5 PCBs . . . . **£27.40** + 30p P&P
Components Kits incl. PCBs £147.40 + £1.50 P&P
Cabinet . . . . **£21.47** + £1.00 P&P

Also **PLATED THROUGH** hole PCB at additional cost of £28.62
FULL FAULT-FINDING AND REPAIR SERVICE AVAILABLE.
COMPONENTS ALSO AVAILABLE SEPARATELY — SAE for price list.
READY BUILT AND TESTED DECODERS ALSO AVAILABLE

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Centre Tapped and Screened

Ref.	VA (Watts)	£	P&P
07★	20	**4.84**	.91
149	60	**7.37**	1.10
150	100	**8.38**	1.31
151	200	**12.28**	1.31
152	250	**14.61**	1.73
153	350	**18.07**	2.12
154	500	**22.52**	2.47
155	750	**32.08**	OA
156	1000	**40.92**	OA
157	1500	**56.52**	OA
158	2000	**67.99**	OA
159	3000	**95.33**	OA

★115 or 240 sec only. State volts required. Pri. 0.220-240V.

12 or 24-VOLT
Separate 12V windings Pri 220-240V

Ref	Amps 12v	Amps 24v	£	P&P
111	0.5	0.25	**2.42**	.52
213	1.0	0.5	**2.90**	.90
71	2	1	**3.86**	.90
18	4	2	**4.46**	1.10
85	5	2.5	**6.16**	1.10
70	6	3	**6.99**	1.10
108	8	4	**8.16**	1.31
72	10	5	**8.93**	1.31
116	12	6	**9.89**	1.52
17	16	8	**11.79**	1.52
115	20	10	**15.38**	2.39
187	30	15	**19.72**	2.39
226	60	30	**40.41**	OA

50 VOLT RANGE
Pri 220-240V. Sec. 0-20-25-33-40-50V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40 or 20V-0-20V and 25V-0-25V Screened

Ref.	Amps	£	P&P
102	0.5	**3.75**	.90
103	1.0	**4.57**	1.10
104	2.0	**7.88**	1.31
105	3.0	**9.42**	1.52
106	4.0	**12.55**	1.73
107	6.0	**16.57**	1.89
118	8.0	**22.29**	2.39
119	10.0	**27.48**	OA
109	12.0	**31.79**	OA

30 VOLT RANGE
Pri 220-240V Sec. 0-12-15-20-24-30V
Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V and 15V-0-15V.

Ref.	Amps	£	P&P
112	0.5	**2.90**	.90
79	1.0	**3.93**	1.10
3	2.0	**6.35**	1.10
20	3.0	**6.82**	1.31
21	4.0	**8.79**	1.31
51	5.0	**10.86**	1.52
117	6.0	**12.29**	1.67
88	8.0	**16.45**	1.89
89	10.0	**18.98**	1.89
90	12.0	**21.09**	2.24
91	15.0	**24.16**	2.39
92	20.0	**32.40**	OA

60 VOLT RANGE
Pri 220-240V
Sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48. 60V, or 24V-0-24V and 30V-0-30V

Ref.	Amps	£	P&P
124	0.5	**4.27**	1.10
126	1.0	**6.50**	1.10
127	2.0	**8.36**	1.31
125	3.0	**12.10**	1.39
123	4.0	**13.77**	2.12
40	5.0	**17.42**	1.89
120	6.0	**19.87**	2.12
121	8.0	**27.92**	OA
122	10.0	**32.51**	OA
189	12.0	**37.47**	OA

SCREENED MINIATURES
Primary 240V

Ref.	mA	Volts	£	P&P
238	200	3-0-3	**2.83**	.63
212	1A, 1A	0-6, 0-6	**3.14**	.90
13	100	9-0-9	**2.35**	.44
235	330, 330	0-9, 0-9	**2.19**	.44
207	500, 500	0-8-9, 0-8-9	**3.05**	.85
208	1A, 1A	0-8-9, 0-8-9	**3.88**	.90
236	200, 200	0-15, 0-15	**2.19**	.44
239	50MA	12-0-12	**2.88**	.37
214	300, 300	0-20, 2-20	**3.08**	.90
221	700 (DC)	20-12-0-12-20	**3.75**	.90
206	1A, 1A	0-15-20, 0-15-20	**5.09**	1.10
203	500, 500	0-15-27, 0-15-27	**4.39**	1.10
204	1A, 1A	0-15-27, 0-15-27	**6.64**	1.10

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MAINS ISOLATING
Pri 200/220 or 400/440
Sec 100/120 or 200/240

VA	Ref.	£	P&P
60	243	**7.37**	1.58
350	247	**18.07**	2.12
1000	250	**45.94**	OA

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Ref.	VA (Watts)	TAPS	£	P&P
113	15	0-115-210-240V	**2.73**	.81
64	75	0-115-210-240V	**4.41**	1.10
4	150	0-115-200-220-240V	**5.89**	1.10
67	500	" "	**12.09**	1.91
84	1000	" "	**20.64**	2.39
93	1500	" "	**25.61**	OA
95	2000	" "	**38.30**	OA
73	3000	" "	**65.13**	OA
80s	4000	0-10-115-200-220-240	**84.55**	OA
57s	5000	" "	**98.45**	OA

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400v	6A	**£1.40**
500v	12A	**£2.35**

P&P 17p. VAT 15%

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20VA	**£6.55**	1.03	56W
75VA	**£8.50**	1.31	64W
150VA	**£11.00**	1.31	4W
200VA	**£12.02**	1.67	65W
250VA	**£12.55**	1.67	69W
500VA	**£20.13**	1.89	67W
1000VA	**£30.67**	2.65	84W
1500VA	**£42.82**	OA	93W
2000VA	**£54.97**	OA	95W

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AC/DC-1000Ω/V
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173	2A	**3.95**	.90
174	3A	**4.13**	.99
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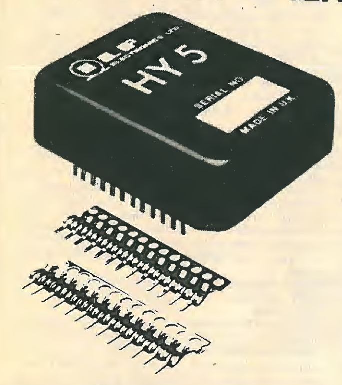
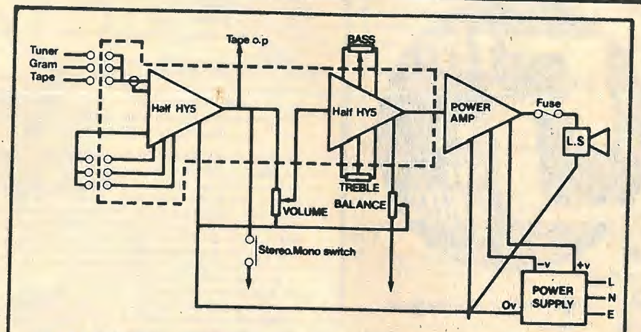


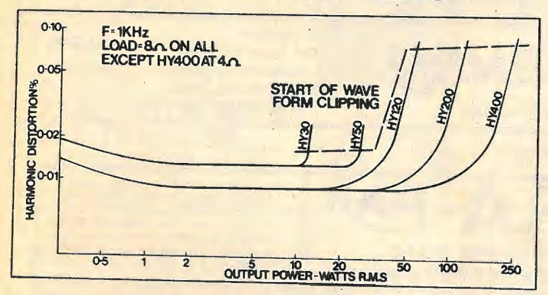


VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume — 10K Ω log.
Bass/Treble — 100K Ω linear. Balance — 5K Ω linear.

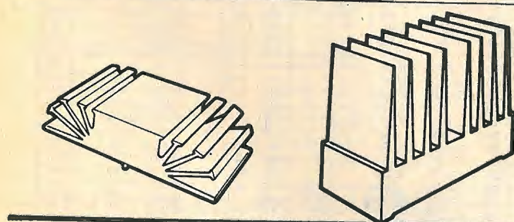
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz—0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS

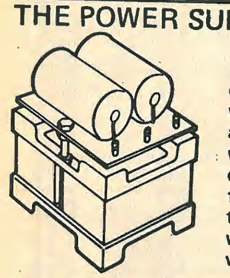


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45.-0- +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	£27.68 + £4.15



Load impedance — all models 4 - 16 Ω
Input sensitivity — all models 500 mV
Input impedance — all models 100K Ω
Frequency response — all models 10Hz - 45Hz - 3dB

THE POWER SUPPLY UNITS



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7402	0.12	7497	2.38	74192	0.99	74LS123	0.82	4009	0.45	4089	1.55
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7404	0.13	74104	0.40	74194	0.90	74LS125	0.44	4011	0.15	4094	1.80
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7411	0.18	74118	0.82	74273	2.15	74LS153	0.50	4018	0.87	4412	0.30
7412	0.21	74119	1.30	74279	1.25	74LS154	1.20	4019	0.42	4428	0.80
7413	0.25	74120	0.82	74283	1.70	74LS155	0.86	4020	0.92	4445	1.50
7414	0.54	74121	0.25	74284	6.85	74LS156	0.86	4021	0.82	4449	0.30
7416	0.27	74122	0.40	74293	1.35	74LS157	0.47	4022	0.82	4501	0.17
7417	0.27	74123	0.53	74298	1.92	74LS158	0.53	4023	0.15	4502	0.88
7420	0.13	74125	0.44	74390	1.92	74LS160	1.22	4024	0.66	4507	0.50
7421	0.28	74126	0.45	74393	2.12	74LS161	0.69	4025	0.15	4508	2.25
7422	0.17	74128	0.62	74LS00	0.19	74LS162	1.22	4026	1.28	4510	1.05
7423	0.25	74132	0.68	74LS01	0.19	74LS163	0.69	4027	0.50	4511	0.98
7425	0.20	74135	0.68	74LS02	0.19	74LS164	1.20	4028	0.67	4512	0.92
7426	0.25	74136	0.75	74LS03	0.19	74LS168	2.00	4029	0.86	4514	2.85
7427	0.25	74137	0.94	74LS04	0.20	74LS169	2.00	4030	0.48	4515	2.80
7428	0.34	74141	0.58	74LS05	0.20	74LS170	1.76	4031	2.34	4516	1.02
7430	0.13	74142	2.00	74LS08	0.19	74LS173	1.05	4033	1.25	4518	0.99
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7433	0.32	74144	2.00	74LS10	0.19	74LS175	1.05	4035	1.00	4520	1.05
7437	0.24	74145	0.64	74LS11	0.19	74LS189	2.85	4036	2.40	4521	2.00
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7441	0.52	74150	0.99	74LS14	1.10	74LS192	1.80	4039	2.80	4528	0.92
7442	0.55	74151	0.60	74LS15	0.19	74LS193	1.80	4040	0.88	4529	1.10
7443	0.90	74153	0.60	74LS20	0.19	74LS195	1.12	4041	0.77	4536	3.56
7444	0.90	74154	1.05	74LS21	0.19	74LS196	1.20	4042	0.72	4553	4.20
7445	0.70	74155	0.63	74LS22	0.19	74LS197	1.20	4043	0.82	4555	0.85
7446	0.70	74156	0.63	74LS26	0.24	74LS221	1.12	4044	0.82	4556	0.85
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7448	0.60	74159	1.70	74LS30	0.19	74LS248	0.97	4046	1.32	4566	1.40
7450	0.13	74160	0.80	74LS32	0.25	74LS249	0.97	4047	0.96	4583	0.78
7451	0.13	74161	0.80	74LS37	0.27	74LS251	1.00	4048	0.60	4585	1.03
7453	0.13	74162	0.80	74LS38	0.27	74LS253	1.05	4049	0.42		
7454	0.13	74163	0.80	74LS40	0.19	74LS257	1.05	4050	0.42		
7460	0.13	74164	0.89	74LS42	0.53	74LS258	1.05	4051	0.84		
7470	0.28	74165	0.89	74LS47	0.97	74LS266	0.39	4052	0.84		
7472	0.22	75166	0.99	74LS48	0.97	74LS273	2.50	4053	0.84		
7473	0.26	74167	2.70	74LS49	0.97	74LS279	0.50	4054	1.10		
7474	0.26	74170	1.68	74LS51	0.19	74LS283	1.00	4055	1.00		
7475	0.30	74172	4.00	74LS54	0.19	74LS289	2.85	4060	0.98		
7476	0.26	74173	1.18	74LS55	0.20	74LS293	0.90	4066	0.48		
7480	0.45	74174	0.89	74LS73	0.30	74LS298	1.60	4067	3.50		
7481	0.90	74175	0.68	74LS74	0.34	74LS352	0.92	4068	0.24		
7482	0.80	74176	0.88	74LS75	0.45	74LS353	1.05	4069	0.17		
7483	0.72	74177	0.88	74LS76	0.32	74LS365	0.50	4070	0.17		
7484	0.90	74178	1.20	74LS78	0.32	74LS366	0.50	4071	0.17		
7485	0.88	74179	1.10	74LS83	0.78	74LS367	0.50	4072	0.17		
7486	0.26	74180	0.90	74LS85	0.90	74LS368	0.50	4073	0.17		
7489	2.00	74181	1.92	74LS86	0.35	74LS386	0.37	4075	0.17		
7490	0.35	74182	0.75	74LS93	0.95	74LS670	2.00	4076	1.05		
7491	0.65	74184	1.20	74LS95	1.10	4000	0.14	4077	0.46		
7492	0.44	74185A	1.20	74LS107	0.36	4001	0.15	4078	0.22		
7493	0.40	74186	7.20	74LS109	0.36	4002	0.16	4081	0.17		
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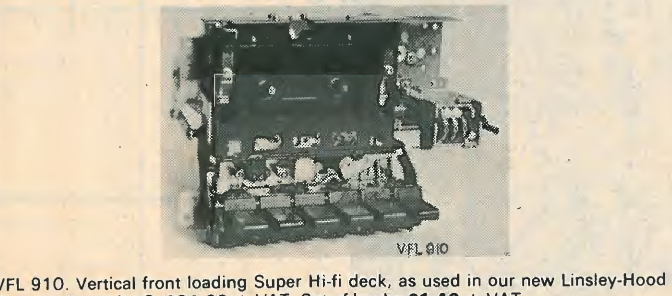
J. L. Linsley-Hood High Quality Cassette Recorders

LINSLEY-HOOD CASSETTE RECORDER 1

We are the Designer Approved suppliers of kits for this excellent design. The Author's reputation tells all you need to know about the circuitry and Hart expertise and experience guarantees the engineering design of the kit. Advanced features include: High quality separate VU meters with excellent ballistics. Controls, switches and sockets mounted on PCB to eliminate difficult wiring. Proper moulded escutcheon for cassette aperture improves appearance and removes the need for the cassette transport to be set back behind a narrow finger trapping slot. Easy to use, robust Lenco mechanism. Switched bias and equalisation for different tape formulations. All wiring is terminated with plugs and sockets for easy assembly and test. Sophisticated modular PCB system gives a spacious, easily built and tested layout. All these features added to the high quality metalwork make this a most satisfying kit to build. Also included at no extra cost is our new HS15 Sendust Alloy record/play head, available separately at **£7.60** plus VAT, but included FREE as part of the complete kit at **£81.50** plus VAT.

REPRINTS of the 3 articles describing this design **45p** No VAT.
REPRINT of Postscript article **30p** No VAT.



VFL 910. Vertical front loading Super Hi-fi deck, as used in our new Linsley-Hood Cassette Recorder 2. **£31.99** + VAT. Set of knobs **£1.46** + VAT.

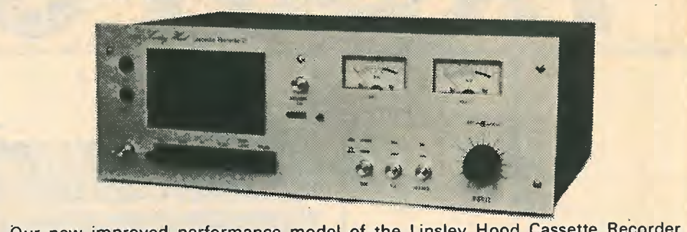
LENCO CASSETTE MECHANISMS

We hold stocks of a range of Lenco tape transports for all uses, we can also supply spare parts. For example:
CRV Motors complete **£4.00** plus VAT.
CRV Drive Belts **90p** plus VAT.

CASSETTE HEADS

A large range of cassette heads for domestic, industrial and audio visual purposes is available from us. The very best stereo head that we can find is our HS15 Sendust Alloy Super Head. This has an even better high frequency response than our HS14 which it replaces. Unlike cheaper and ferrite types this excellent high frequency performance is combined with a high output, thus maintaining the best possible signal to noise ratio. **Price £7.60** plus VAT.
4-TRACK Record/play head. Scans all 4 tracks on cassette tape. Suitable for auto-reverse mechanisms, film sync, quadrophonics and many other purposes. Standard impedance **£7.40** plus VAT.
Full details of these and other heads are in our lists.

LINSLEY HOOD CASSETTE RECORDER 2



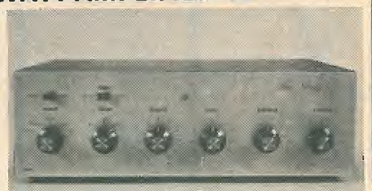
Our new improved performance model of the Linsley Hood Cassette Recorder incorporates our VFL 910 vertical front mechanism and circuit modifications to increase dynamic range. Board layouts have been altered and improved but retain the outstandingly successful mother and daughter arrangement used on our Linsley Hood Cassette Recorder 1.

This latest version has the following extra features. Ultra low wow-and-flutter of .09% — easily meets DIN Hi-fi spec. Deck controls latch in rewind modes and do not have to be held. Full Auto stop on all modes. Tape counter with memory rewind. Oil damped cassette door. Latching record button for level setting. Dual concentric input level controls. Phone output. Microphone input facility if required. Record interlock prevents re-recording on valued cassettes. Frequency generating feedback servo drive motor with built-in speed control for thermal stability. All these desirable and useful features added to the excellent design of the Linsley-Hood circuits and the quality of the components used makes this new kit comparable with built-up units of much higher cost than the modest **£94.90** + VAT we ask for the complete kit.

SUPER BARGAIN OFFER
LENCO FFR CASSETTE DECK

For those who missed our recent bargain CT4s we now are delighted to be able to offer Brand New Lenco FFR Decks complete with motor speed and auto-stop control board fitted and tested. These will operate with any supply between 9 and 16 volts. This deck can be used for both record and playback applications and is fitted with an erase head. A mono record/play head is fitted and we can supply an extra stereo head, if ordered with the deck at the very special price of £2 plus VAT. We also supply, with each deck and completely FREE, one of our specially moulded escutcheons. This deck would normally cost about £25 but we are able to offer them, while they last, at only £9.99 plus VAT.

BAILEY 30 WATT AMPLIFIER



We have now completed our redesign of this popular amplifier to make it as easy to build as our latest kits. The power amplifiers are complete modules plugging into a power supply master board, all possible wiring has been eliminated but faith has been maintained with the existing metal work to enable owners to update if they wish. Send for full details in our list.

ALL UK ORDERS ARE POST FREE
Please send 9x4 SAE for lists giving fuller details and price breakdowns.

COME AND SEE US ON STANDS C9 & C10 AT BREADBOARD '79

HART ELECTRONICS

Penylan Mill, Oswestry, Salop

Personal callers are always welcome
but please note we are closed all day Saturday

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Faircrest Engineering Ltd., manufacture a comprehensive range of equipment for processing all types of picture tubes, colour and mono. Standard or custom built units for established or new businesses. We export world-wide and have an excellent spares service backed by a strong technical team.

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PPM2: PEAK PROGRAMME METERS

- ★ Approved by broadcasting authorities in the U.K. and overseas for critical programme monitoring.
- ★ Reviewed *Studio Sound* September, 1976. Meets IEC268-10A, draft BS5428-9.
- ★ Accurate law at and between all PPM marks with minimal preset adjustment. Marginal adjustment is retained to allow compensation for the tolerance in scale markings between meter manufacturers and different meters from the same maker.
- ★ Decay matching of all boards allows use with twin movements without pairing.
- ★ Flat frequency response at all PPM marks and also below minimum calibration point.
- ★ Gold plated connector and floating input protected against mains or static voltages on the signal lines. Supply input protected against reverse polarity.
- ★ Close tolerance components with excellent temperature and ageing characteristics used throughout.
- ★ Soak tested boards. *Ernest Turner* meter movements 640, 642, 643, and TWIN flush mounting adaptors and illumination kits from stock. Scalings available 1/7, IEC268-10A Type IIb—12/TEST/+12 Type IIb used by EBU and conforming to CCITT recommendation N15(1972) but not recommended by us except for EBU and measuring instruments.

Stereo Disc Amplifier 2 ★ 10 Outlet Distribution Amplifier 2 ★ Stabilizer ★ Peak Deviation Meter ★ Chart Recorders.

SURREY ELECTRONICS

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RST Tel: 01-677 2424 Telex: 946708 RST

SEMICONDUCTORS

Type	Price
AA119	0.12
AAY30	0.31
AAY32	0.48
AAZ13	0.21
AAZ15	0.39
AAZ17	0.31
AC107	0.69
AC125	0.23
AC126	0.23
AC127	0.23
AC128	0.23
AC141	0.29
AC141K	0.40
AC142	0.23
AC142K	0.35
AC176	0.23
AC187	0.23
AC188	0.23
ACY17	0.98
ACY18	0.92
ACY19	0.86
ACY20	0.80
ACY21	0.86
ACY39	1.72
AD149	0.80
AD161	0.52
AD162	0.52
AF106	0.52
AF114	0.86
AF115	0.86
AF116	0.86
AF117	0.86
AF139	0.46
AF186	1.38
AF239	0.52
AFZ11	3.16
AFZ12	3.16
ASY26	0.46
ASY27	0.46

Type	Price
ASZ15	1.44
ASZ16	1.44
ASZ17	1.44
ASZ20	1.72
ASZ21	2.30
AU113	1.96
AUY10	2.30
AU110	1.96
BA145	0.15
BA148	0.15
BA154	0.10
BA155	0.12
BA156	0.10
BAW62	0.06
BAX13	0.07
BAX16	0.10
BC107	0.14
BC108	0.14
BC109	0.15
BC113	0.14
BC114	0.15
BC115	0.16
BC116	0.17
BC117	0.20
BC118	0.12
BC125	0.18
BC126	0.23
BC135	0.16
BC136	0.17
BC137	0.17
BC147	0.10
BC148	0.09
BC149	0.10
BC157	0.10
BC158	0.09
BC159	0.12
BC167	0.14
BC170	0.13
BC171	0.12

Type	Price
BC172	0.12
BC173	0.14
BC177	0.17
BC178	0.16
BC179	0.18
BC182	0.13
BC183	0.12
BC184	0.13
BC212	0.15
BC213	0.14
BC214	0.17
BC237	0.10
BC238	0.14
BC301	0.38
BC303	0.38
BC307	0.12
BC308	0.12
BC327	0.23
BC328	0.21
BC337	0.21
BC338	0.20
BCY30	1.15
BCY31	1.15
BCY32	1.15
BCY33	1.04
BCY34	1.04
BCY39	3.45
BCY40	1.15
BCY42	0.29
BCY43	0.29
BCY58	0.18
BCY70	0.17
BCY71	0.20
BCY72	0.15
BCZ11	1.72
BD115	0.52
BD121	1.50
BD123	1.50
BD124	1.50

Type	Price
BD131	0.40
BD132	0.44
BD135	0.39
BD136	0.39
BD137	0.40
BD138	0.46
BD139	0.49
BD140	0.51
BD144	2.30
BD181	1.26
BD182	1.36
BD237	0.46
BD238	0.63
BDX10	1.05
BDX32	2.30
BDY20	1.44
BDY60	1.72
BF115	0.29
BF152	0.21
BF153	0.23
BF154	0.20
BF159	0.26
BF160	0.18
BF167	0.23
BF173	0.23
BF177	0.28
BF178	0.28
BF179	0.29
BF180	0.35
BF181	0.35
BF182	0.35
BF183	0.29
BF184	0.29
BF185	0.29
BF194	0.10
BF195	0.10
BF196	0.12
BF197	0.14
BF200	0.31
BF224	0.23
BF244	0.32

Type	Price
BF257	0.28
BF258	0.30
BF259	0.37
BF336	0.35
BF337	0.35
BF338	0.36
BFS21	4.55
BFS28	2.56
BFS61	0.23
BFS98	0.23
BFW10	0.74
BFW11	0.74
BFX84	0.25
BFX85	0.26
BFX87	0.24
BFX88	0.24
BFY50	0.30
BFY51	0.30
BFY52	0.30
BFY64	0.30
BFY90	1.44
BSX19	0.24
BSX20	0.23
BSX21	0.23
BT106	1.44
BTY79/400R	3.67
BU205	2.02
BU206	2.59
BU208	2.30
BY100	0.52
BY126	0.16
BY127	0.17
BZX61 Series	0.21
BZY88 Series	0.15
CRS1/40	0.69
CRS3/06	0.52
CRS3/40	0.86

Type	Price
CRS3 60	1.04
GEX66	1.73
GEX541	4.60
GJ3M	0.86
GM0378A	2.02
KS100A	0.52
MJE340	0.92
MJE370	1.35
MJE371	0.71
MJE520	0.60
MJE521	0.63
MJE2955	1.44
MJE3055	0.86
MPF102	0.35
MPF103	0.35
MPF104	0.35
MPF105	0.35
MPSA06	0.28
MPSA56	0.30
MPSU01	0.41
MPSU06	0.53
MPSU56	0.56
NE555	0.52
NKT401	2.30
NKT403	1.99
NKT404	1.99
OA5	1.09
OA7	0.63
OA10	0.74
OA47	0.16
OA70	0.35
OA79	0.35
OA81	0.35
OA85	0.35
OA90	0.09
OA91	0.09
OA95	0.09
OA200	0.10
OA202	0.10
OA211	1.15
OAZ200	1.15

Type	Price
OAZ201	1.15
OAZ206	1.15
OAZ207	1.15
OC16	2.30
OC20	2.88
OC22	2.88
OC23	3.16
OC24	3.45
OC25	1.04
OC26	1.04
OC28	2.30
OC29	2.30
OC35	1.73
OC36	1.73
OC41	0.92
OC42	0.86
OC43	2.59
OC44	0.69
OC45	0.63
OC71	0.63
OC72	0.63
OC73	1.15
OC74	0.74
OC75	0.74
OC76	0.63
OC77	1.38
OC81	0.74
OC81Z	1.38
OC82	0.74
OC83	0.74
OC84	0.74
OC122	1.73
OC123	2.02
OC139	2.59
OC140	3.16
OC141	3.74
OC170	1.15
OC171	1.15
OC200	1.73
OC201	2.02
OC202	2.02

Type	Price
OC203	2.02
OC204	2.88
OC205	2.88
OC206	2.88
OC207	2.02
OCP71	1.44
ORP12	1.15
R2008B	2.02
R2009	2.59
R2010B	2.02
T1C44	0.35
T1C226D	1.38
TIL209	0.23
T1P29A	0.47
T1P30A	0.48
T1P31A	0.51
T1P32A	0.55
T1P33A	0.79
T1P34A	0.84
T1P41A	0.72
T1P42A	0.81
T1P2955	0.77
T1P3055	0.64
T1S43	0.52
ZS140	0.29
ZS170	0.24
ZS178	0.62
ZS271	0.26
ZS278	0.65
ZTX107	0.13
ZTX108	0.12
ZTX109	0.14
ZTX300	0.14
ZTX301	0.15
ZTX302	0.17
ZTX303	0.20
ZTX304	0.22
ZTX311	0.14
ZTX314	0.23
ZTX500	0.15
ZTX501	0.16

Type	Price
ZTX502	0.18
ZTX503	0.20
ZTX504	0.23
ZTX531	0.23
ZTX550	0.18
1N914	0.06
1N916	0.08
1N4001	0.07
1N4002	0.07
1N4003	0.08
1N4004	0.08
1N4005	0.09
1N4006	0.09
1N4007	0.10
1N4009	0.07
1N4148	0.07
1N5400	0.15
1N5401	0.15
1S44	0.05
1S920	0.08
1S921	0.08
2G301	1.15
2G302	1.15
2G306	1.27
2N404	1.15
2N696	0.29
2N697	0.29
2N698	0.35
2N705	1.38
2N706	0.17
2N708	0.23
2N930	0.23
2N1131	0.30
2N1132	0.30
2N1302	0.40
2N1303	0.40
2N1304	0.52
2N1305	0.52
2N1306	0.58
2N1307	0.58
2N1308	0.63

Type	Price
2N1309	0.63
2N1613	0.29
2N1671	1.73
2N1893	0.29
2N2147	2.02
2N2148	1.89
2N2218	0.29
2N2219	0.28
2N2220	0.21
2N2221	0.21
2N2222	0.21
2N2223	3.16
2N2368	0.20
2N2369A	0.24
2N2484	0.23
2N2646	0.63
2N2904	0.29
2N2905	0.29
2N2906	0.24
2N2907	0.24
2N2924	0.24
2N2925	0.25
2N2926	0.16
2N3053	0.29
2N3054	0.58
2N3055	0.81
2N3440	0.69
2N3441	0.92
2N3442	1.26
2N3614	1.73
2N3702	0.13
2N3703	0.15
2N3704	0.15
2N3705	0.15
2N3706	0.15
2N3707	0.15
2N3708	0.12
2N3709	0.15
2N3710	0.12
2N3711	0.12

Type	Price
2N3771	2.02
2N3772	2.30
2N3773	3.45
2N3819	0.41
2N3820	0.52
2N3823	0.63
2N3866	0.83
2N3904	0.15
2N3905	0.15
2N3906	0.15
2N4058	0.16
2N4059	0.12
2N4060	0.14
2N4061	0.14
2N4062	0.15
2N4124	0.17
2N4126	0.17
2N4286	0.23
2N4288	0.25
2N4289	0.28
2N5457	0.40
2N5458	0.40
2N5459	0.40
2S017	7.48
2S019	7.48
2S026	13.80
2S103	1.73
2S302	0.86
2S303	0.86
2S322	0.92
2S324	1.44
2S701	1.73
2S745A	0.40
2S746A	0.40

VALVES

Type	Price
A1834	10.35
A2087	13.58
A2134	10.06
A2293	8.62
A2426	13.50
A2521	11.62
A2900	10.98
A3343	25.56
AZ31	1.26
AZ41	1.32
BK448	88.43
BK484	119.54
BS90	31.33
BS810	35.24
BT5	43.47
BT17	79.29
BT19	27.08
BT29	242.93
BT69	287.50
BT75	102.46
BT95	95.16
CBL31	2.30
CL33	2.30
CY31	1.15
C1K	11.50
C3A	11.50
C3JA	23.23
DA41	21.50
DA42	12.30
DA100	52.90
DAF91	0.46
DAF96	1.15
DET22	24.15
DET24	52.90
DF91	0.46
DF96	1.15
DK91	1.21
DK92	1.44
DK96	1.26
DL92	1.26
DL94	1.38
DL96	1.26
DLS10	9.48
DLS15	12.37
DLS16	12.37
DLS19	12.37
DM70	1.44
DM71	1.44
DM160	3.96
DY86/7	0.73
DY802	0.96
E55L	25.17
E80CC	9.27
E80CF	11.96
E80F	9.75
E80L	9.51
E81CC	6.62
E81L	10.28
E82CC	7.03
E83CC	7.16
E86C	12.48
E88C	6.71
E88CC	3.86
E90CC	9.34
E90F	9.71
E91H	5.34
E92CC	8.86
E99F	9.39

Type	Price
E130L	19.39
E180CC	8.86
E180F	7.83
E182CC	9.34
E186F	11.62
E188CC	7.36
E280F	25.88
E283CC	9.02
E288CC	17.72
EA52	19.43
EA76	2.02
EABC80	1.38
EAC91	0.92
EAF42	1.44
EAF801	2.02
EB41	2.30
EB91	1.01
EBC33	2.02
EBC41	1.44
EBC81	1.26
EBC90	0.97
EBF80	0.58
EBF83	1.44
EBF89	0.97
EBL31	2.88
EC90	1.28
EC91	7.87
EC92	1.44
EC157	276.92
ECC33	4.02
ECC35	4.02
ECC40	1.44
ECC81	1.01
ECC82	0.82
ECC83	1.01
ECC84	1.36
ECC85	1.38
ECC86	2.30
ECC88	2.07
ECC89	1.88
ECC91	8.72
ECC189	1.90
ECC807	2.02
ECC808	2.59
ECF80	1.24
ECF82	1.38
ECF86	1.73
ECH35	2.30
ECH42	1.32
ECH81	1.38
ECH83	1.44
ECH84	1.47
ECL80	1.15
ECL81	1.73
ECL82	1.15
ECL83	1.73
ECL84	1.61
ECL85	1.28
ECL86	1.38
EF37A	4.02
EF39	3.16
EF40	1.32
EF41	1.38
EF42	2.30
EF50	1.73
EF54	5.75
EF55	2.88
EF80	0.92
EF83	2.02
EF85	0.92

Type	Price
EF86	1.74
EF89	1.84
EF91	2.07
EF92	6.03
EF93	1.15
EF94	1.24
EF95	5.25
EF98	1.44
EF183	0.92
EF184	0.96
EF804S	7.47
EF805S	8.05
EH90	1.61
EK90	1.26
EL32	1.73
EL33	4.02
EL34TH	2.53
EL34M	2.57
EL36	1.84
EL41	1.44
EL42	2.02
EL81	1.26
EL83	1.44
EL84	1.15
EL86	2.48
EL90	1.10
EL91	7.44
EL95	1.51
EL156	18.68
EL360	6.32
EL500/504	2.16
EL509	3.63
EL821	11.06
EL822	11.38
EM34	5.75
EM80	1.26
EM81	1.15
EM84	1.15
EM85	1.44
EM87	1.73
EN32	14.80
EN91	2.94
EN92	5.61
EY51	2.02
EY81	1.89
EY83	2.02
EY84	9.75
EY86	0.96
EY88	2.02
EY500A	2.23
EY802	94
EZ35	97
EZ40	1.44
EZ41	1.44
EZ80	0.96
EZ81	0.96
EZ90	1.38
FW4-500	2.88
FW4-800	2.88
G1.371K	23.23
G551K	12.65
G180.2M	18.42
G240.2D	12.85
G400.1K	19.28
GN4	8.62
GN4A	8.62
GS16	10.35
GT1C	10.61
GU50	14.31
GU51	13.62

Type	Price
GXU1	16.10
GXU2	28.43
GXU3	30.49
GXU4	32.77
GXU50	12.80
GY501	2.95
GZ32	1.44
GZ33	4.60
GZ34	2.18
GZ37	4.60
KT61	4.02
KT66	11.50
KT88	13.80
KTW61	2.02
KTW62	2.02
KTW63	2.02
M8079	11.50
M8080	7.88
M8081	8.05
M8082	6.41
M8083	7.20
M8091	10.85
M8096	4.31
M8097	4.09
M8098	4.37
M8099	5.98
M8100	8.23
M8136	8.46
M8137	8.72
M8140	5.17
M8141	5.52
M8142	6.15
M8144	4.31
M8149	5.86
M8161	7.87
M8162	7.59
M8163	5.17
M8190	5.29
M8195	4.25
M8196	7.47
M8204	6.57
M8212	11.76
M8223	3.16
M8224	3.85
M8225	2.99
M8248	11.55
MU14	1.73
MX119	53.82
MX123	63.25
MX145	50.40
MX151	15.18
MX152	115.00
MX161	129.72
MX163	19.55
MX164	21.14
MX166	126.50
MX168	40.25
N78	10.35
OA2	1.78
OA3	5.93
OA4	4.02
OB2	1.44
OB3	2.20
OC2	3.04
OC3	2.20
OD3	2.20
OZ4	1.84
PC86	1.61
PC88	1.61
PC95	1.49

Type	Price
PC97	1.38
PC900	1.38
PCC84	1.15
PCC85	1.38
PCC88	1.38
PCC89	1.56
PCC189	1.61
PCC805	1.51
PCC806	2.07
PCE82	2.07
PCF80	1.15
PCF82	1.15
PCF86	1.84
PCF87	1.84
PCF200	2.82
PCF201	2.45
PCF801	1.84
PCF802	1.82
PCF805	1.84
PCF806	[illegible]
PCF808	[illegible]
PCH200	[illegible]
PCL82	1.15
PCL83	[illegible]
PCL84	1.15
PCL85	[illegible]
PCL86	1.24
PCL805/85	1.24
PD500	4.14
PE06-40N	31.40
PFL200	2.07
PL36	1.38
PL81	1.38
PL81A	1.38
PL82	1.38
PL83	2.55
PL84	1.24
PL504/5	1.61
PL508	2.07
PL509	3.45
PL519	3.73
PL801	1.27
PL802	3.40
PY33	1.27
PY81	0.97
PY82	0.92
PY83	0.81
PY88	1.01
PY500A	2.07
PY800	0.97
PY801	0.97
QQV02-6	13.16
QQV03-6	5.44
QQV03-20A	20.13
QQV06-40A	40.25
QQV07-50	50.14
QQZ03-20A	59.80
QQZ06-40A	55.10
QU37	14.38
QV03-12	4.31
QV04-7	2.88
QV08-100	118.45
QY3-65	53.74
QY3-125	56.78
QY4-250	65.93
QY4-400	75.67
QY5-500	59.39

Type	Price
QY5-3000A	82.56
QZ06-20	27.72
R10	5.75
R17	1.89
R18	4.89
R19	1.38
R20	1.66
RG3-250	22.98
RG3-250A	34.69
RG3-1250	29.56
RG4-1250	73.13
RG4-3000	75.44
RR3-250	48.68
RR3-1250	86.25
S11E12	30.48
S130	[illegible]
S130P	2.88
STV280-40	11.50
STV280-80	24.15
SU41	[illegible]
SU42	[illegible]
TD03-10	24.73
TD03-10E	26.16
TD03-10F	27.60
TT15	34.50
TT21	14.16
TT22	14.16
TT100	59.51
TY2-125	65.33
TW4-400	71.61
TY4-500	95.40
TY5-500	147.20
TY6-800	165.70
TY6-5000A	263.05
TY6-5000B	238.90
TY6-5000W	236.44
TY7-6000A	286.93
TY7-6000W	232.47
TZ40	17.25
U18-20	2.88
U19	10.33
U25	1.33
U26	1.66
U37	10.35
UABC80	1.44
UAF42	1.44
UB41	1.44
UBC41	1.73
UBF89	1.38
UCC84	1.26
UCC85	1.38
UCF80	1.32
UCH42	1.38
UCH81	2.67
UCL82	1.20
UCL83	1.66
UF41	1.15
UF42	1.44
UF80	1.66
UF85	1.66
UF89	1.66
UL41	2.88
UL84	1.38
UM80	1.15

Type	Price
UY41	1.44
UY85	1.20
VLS631	15.24
XG1-2500	32.37
XG2-6400	92.98
XG5-500	19.32
XGQ2-6400	106.15
XR1-1600A	[illegible]
XR1-3200	[illegible]
XR1-3200A	[illegible]
XR1-6400	[illegible]
XR1-6400A	149.30
YD1120	226.60
YD1240	241.50
Z759	[illegible]
ZM1000	[illegible]
ZM1001	[illegible]
ZM1005	[illegible]
ZM1020	[illegible]
ZM1021	[illegible]
ZM1022	[illegible]
ZM1023	[illegible]
ZM1040	22.28
ZM1041	19.16
ZM1042	20.44
ZM1051	100.05
1B3GT	2.58
1B24	11.50
1B35A	28.75
1B63	57.50
1R5	1.21
1S5	0.46
1T4	0.46
2AS15	11.50
2C39A	21.85
2C43	20.70
2D21	2.94
2E26	7.82
2J42	89.70
2J55	201.25
2J70A	270.25
2J70B	287.50
2K25	40.25
3-400Z	51.75
3-500Z	63.25
3A5	1.55
3B24	9.20
3B28	5.18
3B29	11.50
3B240M	17.25
3B241M	17.25
3C23	13.89
3C45	22.77
3CX100A5	23.00
3E29	29.67
3S4	1.26
3V4	1.38
465A	29.15
4-125A	41.99
4-250A	41.99
4-400A	52.05
4B32	29.16
4C35	46.00
4CX250B	28.53
4CX350A	48.88
4X150A	24.41
4X150D	28.75

Type	Price
5B254M	23.12
5B255M	23.12
5C22	46.00
5J180E	851.00
5R7GY	2.30
5U4G	4.35
5U4GB	2.60
5V4G	1.75
5Y3GT	[illegible]
5Z3	1.73
5Z4G	1.75
6/30L2	1.79
6AB4	[illegible]
6AB7	[illegible]
6AC7	[illegible]
6AF4A	1.84
6AG7	[illegible]
6AH6	[illegible]
6AK5	3.98
6AK6	[illegible]
6AL5	1.01
6AM4	[illegible]
6AM5	[illegible]
6AM6	[illegible]
6AN5	6.12
6AN8A	3.80
6AQ5	1.10
6AR5	1.84
6AS6	6.42
6AS7G	7.76
6AT6	0.98
6AU5GT	4.81
6AU6	1.24
6AV5GT	4.36
6AV6	0.98
6AX5GT	3.57
6B7	1.73
6B8	2.02
6BA6	1.15
6BA7	5.89
6BA8A	4.31
6BC4	4.27
6BE6	1.24
6BH6	1.75
6BJ6	1.24
6BK4	4.84
6BL6	97.75
6BL7GT	4.44
6BM6	97.75
6BN6	1.89
6BQ7A	4.14
6BR7	4.60
6BR8	2.02
6BS7	4.60
6BW6	4.60
6BW7	1.75
6BX7GT	5.70
6BZ6	2.62
6C4	1.01
6CB6A	2.86
6CD6GA	5.64
6CG7	2.55
6CH6	7.48
6CL6	4.12
6CW4	8.33
6D2	1.01
6DK6	2.59
6DQ6B	4.49
6EA8	3.31

Type	Price
6EB8	2.44
6EW6	1.73
6F6	2.02
6F23	1.84
6F28	1.33
6F33	22.08
6H1	14.38
6H2N	1.21
6H6	[illegible]
6J4	[illegible]
6J5	[illegible]
6J6	[illegible]
6J7	[illegible]
6K6GT	[illegible]
6K7	[illegible]
6K8	[illegible]
6KD6	[illegible]
6L6G	[illegible]
6L6GA	[illegible]
6L6GT	[illegible]
6L7	[illegible]
6N2P	[illegible]
6N3P	[illegible]
6N7	1.73
6P25	4.14
6Q7	2.53
6R7	2.07
6SA7	1.67
6SC7	1.73
6SF7	1.84
6SH7	1.73
6SJ7	1.84
6SK7	1.50
6SK7GT	3.08
6SN7GT	1.84
6SQ7	1.50
6SR7	1.73
6SS7	2.07
6U5G	2.30
6U8	0.92
6U8A	3.24
6V6GT	1.84
6X4	1.38
6X5GT	0.97
7B7	1.96
7C5	2.02
7C6	1.44
7H7	2.30
7R7	1.73
7S7	2.59
7Y4	1.84
7Z4	2.13
11E3	60.82
12AT6	1.38
12AT7	1.01
12AU6	2.83
12AU7	0.83
12AV6	2.30
12AV7	3.98
12AX7	1.01
12AY7	5.24
12B4A	3.50
12BA6	2.42
12BE6	2.55
12BH7	1.29
12BY7	3.01
12E1	8.17
12E11TT	19.26

Type	Price
12E14	34.50
13E1	62.20
19H4	28.75
19H5	40.25
24B9	43.87
30C15	1.84
30C17	1.84
30C18	1.84
30F5	[illegible]
30FL1/2	[illegible]
30FL12	[illegible]
30FL14	[illegible]
30L1	[illegible]
30L15	[illegible]
30L17	[illegible]
30P4	[illegible]
30P19	[illegible]
30PL1	[illegible]
30PL13	[illegible]
30PL15	[illegible]
35W4	[illegible]
50C5	[illegible]
75B1	[illegible]
75C1	[illegible]
85A1	[illegible]
85A2	2.19
90AG	9.15
90AV	9.15
90C1	2.24
90CG	15.73
90CV	15.30
92AG	9.15
92AV	9.15
95A1	5.98
150B2	2.76
150B3	5.06
150C2	1.73
150C4	2.19
211	6.90
723AB	40.25
803	11.50
805	23.00
807	2.30
811A	9.78
812A	9.60
813	36.80
833A	86.25
866A	6.61
872A	15.81
922	5.01
931A	14.08
1624	2.59
1625	1.96
2050	8.00
4212E	169.90
4212H	207.00
5544	62.10
5545	67.85
5551A	88.44
5552A	119.54
5553A	259.10
5642	6.05
5654	4.05
5651	2.07
5670	5.29
5675	14.03
5687	7.08
5696	4.53
5718	7.36

Type	Price
5725	6.28
5726	4.05
5727	5.52
5749	5.73
5751	5.36
5763	4.14
5814A	4.81
5840	5.06
5842	[illegible]
5876A	[illegible]
5879	[illegible]
5886	[illegible]
5963	[illegible]
5965	[illegible]
6005	[illegible]
6021	[illegible]
6057	[illegible]
6058	[illegible]
6059	[illegible]
6061	[illegible]
6062	[illegible]
6063	[illegible]
6064	[illegible]
6067	[illegible]
6072	[illegible]
6080	7.88
6097A×B×C	46.00
6146A	5.89
6146B	6.42
6159	9.18
6189	9.25
6201	5.93
6442	17.25
6883B	6.81
6973	4.05
7025	2.62
7551	6.83
7586	13.09
7587	22.54
7609	36.57
7868	4.53
7895	14.84
8005	34.50
8068	6.33
6122	48.30
8136	2.81
8417	6.14
18042	6.92
18045	10.66

Tested Ex-Equipment

Type	Price
4CX250B	5.75

BASES

Type	Price
B7G unskirted	0.17
B7G skirted	0.35
B9A unskirted	0.17
B9A skirted	0.35
Int Octal	0.29
Loctal	0.63
Nuvistor base	0.86
8 pin DIL	0.17
14 pin DIL	0.17
16 pin DIL	0.20
Valve screening cans all sizes	0.35

CRTs

Type	Price
2AP1	9.78
2BP1	10.35
3BP1	9.20
3DP1	5.75
3EG1	8.05
3FP7	6.90
3GP1	6.90
3JP1	9.20
3JP2	9.20
3JP7	11.50
3KP1	17.25
3RP1	40.25
3WP1	23.00
5ADP1	40.25
5BP1	11.50
5CP1	11.50
5CP1A	46.00
5FP15A	17.25
5UP7	16.10
DG7-5	28.75
DG7-32	41.40
DH3-91	35.65
DH7-11	78.20
VCR97	13.80
VCR138	11.50
VCR138A	14.38
VCR139A	9.20
VCR517A	11.50
VCR517B	11.50
VCR517C	11.50

Tube Bases Prices on application

INTEGRATED CIRCUITS

Type	Price
7400	0.18
7401	0.18
7402	0.18
7403	0.18
7404	0.20
7405	0.18
7406	0.46
7407	0.46
7408	0.23
7409	0.23
7410	0.18
7412	0.30
7413	0.37
7416	0.37
7417	0.37
7420	0.20
7422	0.23
7423	0.37
7425	0.35
7427	0.35
7428	0.49
7430	0.20
7432	0.35
7433	0.41
7437	0.37
7438	0.37
7440	0.21
7441	0.97
7442	0.83
7447AN	1.04
7450	0.21
7451	0.21
7453	0.21
7454	0.21
7460	0.21
7470	0.40
7472	0.38
7473	0.41
7474	0.46
7475	0.62
7476	0.46
7480	0.63
7482	0.86
7483	1.04
7484	1.15
7486	0.40
7490	0.60
7491	0.92
7492	0.69
7493	0.69
7494	0.92
7495	0.83
7496	0.92
7497	3.45
74100	1.73
74107	0.52
74109	0.81
74110	0.58
74111	0.81
74116	2.02
74118	1.15
74119	1.73
74120	0.95
74121	0.46
74122	0.69
74123	1.15
74125	0.63
74126	0.63
74128	0.69
74132	0.81
74136	0.63
74141	0.92
74142	2.65
74143	2.88
74144	2.88
74145	1.04
74147	2.30
74148	2.02
74150	1.84
74151	0.97
74154	2.02
74155	0.97
74156	0.97
74157	0.86
74159	2.42
74170	2.65
74172	5.06
74173	1.61
74174	1.73
74175	1.04
74176	1.26
74178	1.44
74179	1.44
74180	1.32
74190	1.73
74191	1.73
74192	1.55
74193	1.55
74194	1.44
74195	1.15
74196	1.38
74197	1.26
74198	2.59
74199	2.59
76013N	2.02
TAA570	2.65
TAA630S	4.02
TAA700	4.50
TBA480Q	2.12
TBA520Q	2.65
TBA530	2.28
TBA540Q	2.65
TBA550Q	3.70
TBA560CQ	3.70
TBA673	2.52
TBA700	1.75
TBA720Q	2.65
TBA750Q	2.38
TBA800	1.38
TBA920	3.34
TBA920Q	3.34
TBA990Q	3.34
TCA270Q	3.34
TCA760A	1.59

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WW — 084 FOR FURTHER DETAILS

WW — 086 FOR FURTHER DETAILS

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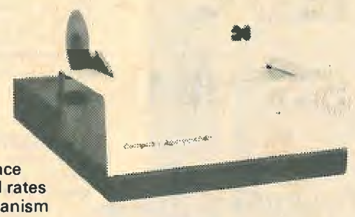
TERMINALS

EXTEL MATRIX PRINTERS



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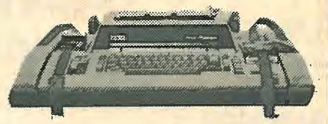

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Maximum Gain		43dB
Gain Control Range		38dB
Gain Reduction in Unbalanced Mode (Input to Terminal +)		10dB
Maximum Input Level (Unbalanced Mode, Input to Terminal +)		+15dBV
Input Impedance (Each Input Terminal to Ground)		5Kohm
Optimum Source Impedance		200 ohm
Maximum Output		+20dBV
Frequency Response	+ 0.5dB Ref. 10Hz to	50KHz
Slew Rate	Better than	10V microsec
Hormonic Distortion	Better than	0.03% Ref 1KHz
	Typically	0.027%
Common Mode Rejection Ratio	Better than	80dB
Equivalent Input Noise (Unweighted)	Better than	−125dBV (Din Audio band weighted)
Recommended Output Looding		10Kohm
Dimensions		40mm x 40mm x 20mm
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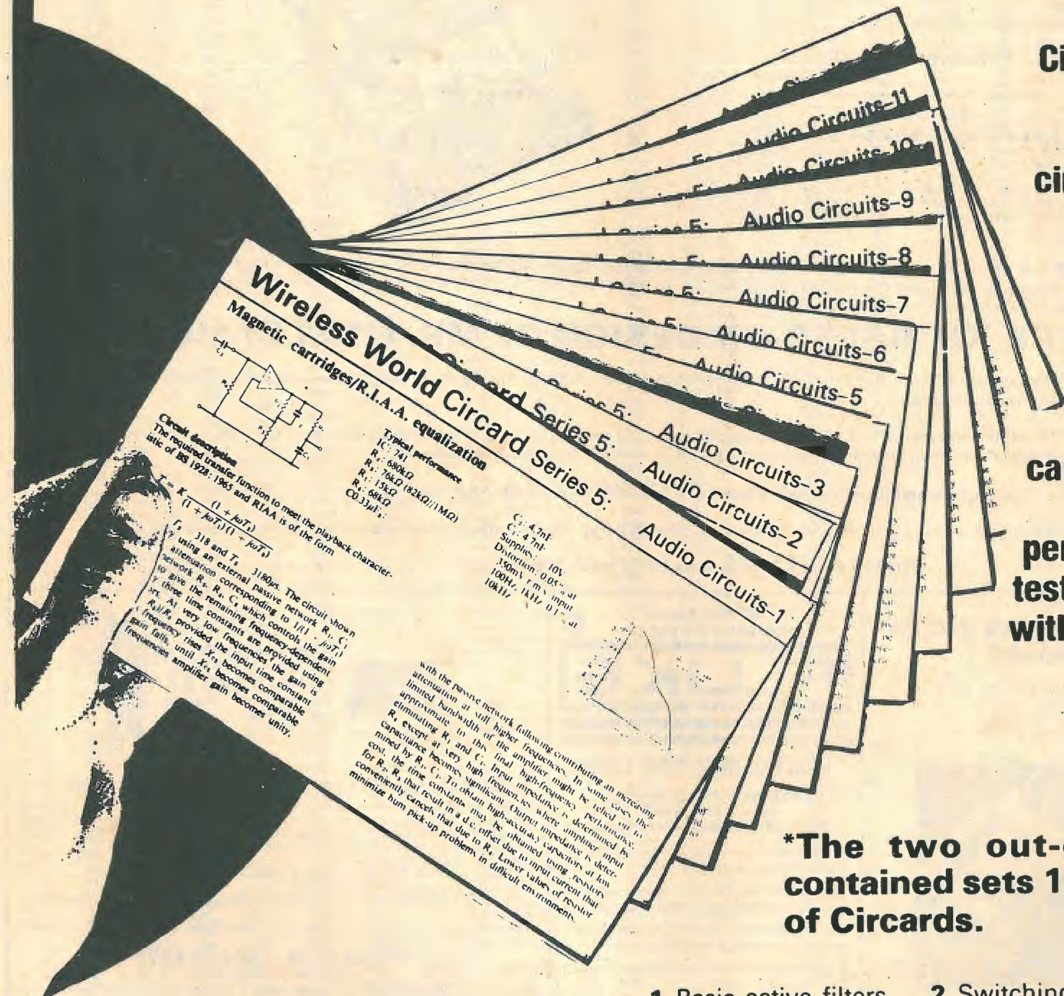

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WW1

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7423	34p
7425	30p
7426	40p
7427	34p
7428	38p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
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7443	112p
7444	112p
7445	100p
7446A	93p
7447A	50p
7448	60p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	35p
7472	30p
7473	34p
7474	30p
7475	30p
7476	35p
7480	50p
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7482	84p
7483A	90p
7484	100p
7485	110p
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7490A	30p
7491	60p
7492A	48p
7493A	30p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74104	65p
74105	65p
74107	34p
74109	55p
74110	55p
74111	70p
74116	200p
74118	130p
74119	210p
74120	110p
74121	28p
74122	48p
74123	48p
74125	55p
74126	60p
74128	75p
74132	75p
74135	50p
74136	75p
74137	50p
74141	60p
74142	200p
74145	90p
74147	190p
74148	150p
74150	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
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74LS85	100p
74LS86	40p
74LS90	40p
74LS92	70p
74LS93	60p
74LS96	110p
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74LS109	80p
74LS112	100p
74LS113	90p
74LS114	45p
74LS122	80p
74LS123	70p
74LS124	190p
74LS125	60p
74LS126	60p
74LS132	95p
74LS133	30p
74LS136	55p
74LS138	75p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	100p
74LS153	60p
74LS154	200p
74LS155	90p
74LS156	90p
74LS157	60p
74LS158	90p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	100p
74LS164	120p
74LS165	180p
74LS166	180p
74LS173	110p
74LS174	110p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
74LS197	120p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	195p
74LS245	250p
74LS247	140p
74LS248	140p
74LS249	140p
74LS251	140p
74LS253	140p
74LS257	120p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	175p
74LS279	90p
74LS298	249p
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4020	100p
4021	110p
4022	100p
4023	22p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4036	295p
4037	115p
4038	120p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	40p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4086	72p
4089	138p
4093	80p
4094	250p
4095	95p
4096	95p
4097	340p
4098	107p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	99p
40106	90p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4411	1100p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	150p
4512	80p
4514	265p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	100p
4538	120p
4543	180p
4553	450p
4556	72p
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AY5-1317A	775p
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CA3048	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	400p
DAC1408-8	200p
FX209	750p
ICL7106	850p
ICL8038	340p
LF356P	95p
LF358P	75p
LM10C	425p
LM301A	30p
LM311	120p
LM318	200p
LM319	225p
LM324	50p
LM339	75p
LM348	95p
LM377	175p
LM380	75p
LM381AN	160p
LM709	38p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	250p
LM3900	70p
LM3909	70p
LM3911	130p
LM3914	250p
LM4136	120p
MC1310P	150p
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MC1495L	350p
MC1496	100p
MC3340P	120p
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TDA1022	600p
TDA1024	120p
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TDA2020	320p
TL071	50p
TL072	95p
TL074	150p
TL081	45p
TL082	95p
TL084	130p
TL170	50p
UAA170	200p
UAA180	200p
UDN6118	320p
UDN6184	320p
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XR2206	350p
XR2207	400p
XR2211	600p
XR2216	675p
XR2240	400p
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95H90	800p
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VEROBOARDS

	0.1	0.15 (copper clad)
2.5×3.75"	48p	43p
2.5×5"	57p	51p
3.75×3.75"	57p	—
3.75×5"	64p	64p
3.75×17"	222p	194p
4.75×17.9"	290p	—
Pkt of 100 pins		50p
Spot face cutter		86p
Pin insertion tool		118p
Vero Wiring Pen + 2 wire spools + combs		370p
Combs		7p

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		—ve	
5V	7805	60p	7905	70p
12V	7812	60p	7912	70p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
LM317T	200p	78HGKC	725p
LM323K	550p	78HO5KC	625p
LM723	37p	78MGT2C	135p
		78P05	900p

OPTO-ELECTRONICS

2N5777	45p	ORP60	90p
OCP71	130p	ORP61	90p
ORP12	90p	TIL78	70p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	NSB5881	570p
DL704	140p	TIL311	600p
DL707 Red	140p	TIL312/3	110p
707 Gr	140p	TIL321/2	130p
DL747 Red	225p	TIL330	140p
747 Gr	225p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	120p	9638	200p
FND507	120p	9370	200p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

BREADBOARDS

EXP350 3.6" x 2.1" (Up to 3 x 14 pin ICs)	£3.15
EXP650 3.6" x 2.4" (Up to 1 x 40 pin IC)	£3.60
EXP300 6" x).1" (Uto 6 x 14 pin ICs)	£5.75
EXP600 6" x 2.4" (Up to 1 x 40 pin DCs)	£6.30

IC TEST CLIPS

14 pin	£2.60	24 pin	£2.90
16 pin	£2.75	40 pin	£2.90

PROTOBOARD (R) SOLDERLESS BREADBOARDS
Socket Strips/Bus Strips/Binding Posts mounted on sturdy base plate.

PB6	6 x 14 DIL ICs	£9.20
PB100	10 x 14 DIL ICs	£11.80
PB102	12 x 14 DIL ICs	£22.95
PB103	24 x 14 DIL ICs	£34.45
PB104	32 x 14 DIL ICs	£45.95

(The above boards are suitable for all DIL ICs.)

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116	50p
AD149	70p
AD161/2	45p
AU107	200p
BC107/8	11p
BC109	11p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	18p
BC337	16p
BC338	16p
BC461	36p
BC477/8	30p
BC516/7	50p
BC547B	16p
BC548C	9p
BC549C	18p
BC557B	16p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	80p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BDX53B	150p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	36p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFX29	30p
BFX30	34p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU205	200p
BU208	240p
BU406	145p
E300	50p
E308	50p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	50p
MJE2955	100p
MJE3055	70p
MPF102	40p
MPF103/4	40p
MPF105/6	40p
MPS6531	60p
MPS6534	60p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	90p
MPSU45	90p
MPSU65	78p
OC28	130p
OC35	130p
R2008B	200p
R2010B	200p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	180p
TIP147	160p
TIP2955	78p
TIP3055	70p
TIS43	34p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	20p
2N2369A	18p
2N2484	30p
2N2646	45p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3565	30p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	12p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4058/9	12p
2N4060	12p
2N4061/2	18p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5179	90p
2N5191	90p
2N5194	90p
2N5245	40p
2N5296	55p
2N5401	50p
2N5457/8	40p
2N5459	40p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	65p
40410	85p
40411	300p
40594	97p
40595	105p
40673	75p
40841	90p
40871/2	90p

DIODES

BY127	12p
BYX36-300	20p
OA47	15p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
1S920	9p

HEAT SINKS
For TO220 Voltage Regs. and Transistors 22p
For TO5 12p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	35p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	90p
6A 400V	110p
10A 400V	200p
25A 400V	400p

ZENERS
2.7V-33V 400mW 9p
1W 15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	40p
1A 400V	65p
3A 400V	85p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	118p
C106D	40p
MCR101	38p
2N3525	120p
2N4444	140p
2N5060	34p
2N5064	40p

LOUDSPEAKERS

Size		
2½"	64R	70p
2½"	8R	70p
2"	8R	80p
1½"	8R	80p

MEMORIES

2102-2L	120p
2107B	500p
2111-2	225p
2112-2	300p
2114	525p
2114-2L	600p
4027	375p
4044	900p
4116	900p
5101	510p
6810	350p
74S201	325p
82S16	325p

ROM/PROMs

71301	700p
74S188	225p
74S287	350p
74S387	350p
74S470	650p
74S471	650p
74S571	650p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	1000p

CPUs

1600	£12
2650A	£20
6502	£10
6800	900p
6802	1250p
6809	£25
8080A	550p
8085A	£14
1NS8060	£11
Z80	£11
Z80A	£12.50

EPROMS

1702A	500p
2516	£29
2708	800p
2716	£29

SUPPORT DEVICES

3245	400p
6532	1100p
6820	500p
6821	500p
6850	500p
8205	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
8259	1400p
Z80P10	650p
Z80CTC	650p
MC14411	1100p
MC14412	1100p

UART

AY-3-1015P	500p
AY-5-1013P	400p
IM6402	500p
TMS6011NC	400p

CHARACTER GENERATORS

3257ADC	990p
MCM6576	£10
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	650p
SN74S262AN	1350p

KEYBOARD ENCODER
AY-5-2376 £9

TRANSFORMERS (prim 220/240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
12-0-12	100mA	95p
0-120	12500mA	280p
0-25V (5VA)		250p
9-0-9	1A	270p
12V 2A		350p
0-12-15		[illegible]
20-24-30 1A		340p
15-0-15 1A		[illegible]

(Please add 50p p&p charge to all marked * above over our normal p&p charge)

RESISTORS High Stab 5% E12 Carbon Film
¼W 10R-1M 7p/5pcs one value
½W 10R-10M 5p/3pcs one value

Miniature Presets Hor/Vert 100R-1M 12p
Carbon Track Pots 5K-1M Log or Lin Single 30p
Single with Switch 60p
Dual 72p
SLIDER POTS 60mm Track LIN 5K, 10K, 50K, 100K 60p
LOG 10K 60p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	10p	18 pin	22p	24 pin	30p
14 pin	11p	20 pin	25p	28 pin	38p
16 pin	12p	22 pin	28p	40 pin	48p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	70p	24 pin	90p
14 pin	40p	20 pin	75p	28 pin	110p
16 pin	55p	22 pin	80p	40 pin	140p

SUBMINIATURE SWITCHES

Toggle SPST	60p
SPDT	65p
DPDT	70p
DPDT (centre off)	85p
Push to make	15p
break	25p
Push latching SPCO	
SLIDE DPDT	18p
ROCKER SPST	28p
WAFER 1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

ANTEX SOLDERING IRONS

C-15W	400p
CX-17W	415p
CCN-15W	415p
X25	415p
SPARE BITS C/CX/CCN	46p
X25	50p
SPARE ELEMENTS C/CX/X25	180p
CCN	200p
ADCOLA IRONS K1000	550p
K2000	550p

CRYSTALS

100KHz	300p
1MHz	370p
1.008MHz	370p
3.2768MHz	300p
3.579545MHz	200p
4MHz	350p
8.867237MHz	400p
10.7MHz	350p
18MHz	300p
26.690MHz	210p
27.145MHz	210p

VEROBOARDS
DIP Breadboard 4.15 × 6.15 300p
(Suitable for 20 × 14 pin or 16 × 16 pin DIL ICs)
DIP Breadboard as above with tracks for 31 way connector 375p
V-Q Boards for ICs 115p

CONNECTOR PLUGS
31 way Plug 110p
31 way Socket 110p
S-100 Busboard £12

EDGEBOARD CONNECTORS 0.156" PITCH

2 × 10 way	85p	2 × 22 way	135p
2 × 15 way	100p	2 × 25 way	160p
2 × 18 way	120p		

COUNTERS

74C925	475p
74C928	600p
ICM7216B	£20
ICM7217A	850p
ZN1040E	700p

TTL & ECL

MC4024	325p
MC4044	325p
10116	70p
10231	350p

★ SPECIAL OFFER ★

555	£18/100	2708	£6.75
741	£16/100	2716(+5V)	£21
2114L-3	£4.50	7805/12/15	£5/10
2114L-3	£32/8	7905/12/15	£6/10

please add P&P and VAT. All offers valid until 31/1/80 and subject to stocks.

16 KEY KEYPAD (Reed Switches)	£4.00
UHF Modulators	£3.75
Reed Switches (12VA)	£0.25
LOGIC PROBE	£18.00
MULTIMETERS	
SUPERTESTER 680R	£33.00
MICROTEST 80R	£17.00
TMK500	£22.00
Pocket multimeter	£4.75

COMPUTER KITS

MEMORY MAPPED VDU INTERFACE KIT	£45.00
SERIAL I/P VDU INTERFACE KIT	£56.00
ELF II MICROCOMPUTER KIT	£79.95
ELF II WIRED AND TESTED	£99.95
GIANT MONITOR BOARD KIT FOR ELF II	£35.00
4K STATIC RAM BOARD FOR ELF II	£69.44
ASCII KEYBOARD KIT	£50.58

(Please add 75p p&p to all above items).

We carry a large stock of 74 and 74LS TTLs, CMOS, Linears, Memories, etc. and can normally offer ex-stock deliveries. We welcome inquiries for volume quantities both from local and overseas buyers.

VAT RATE: Please add VAT at 15% on total order value.
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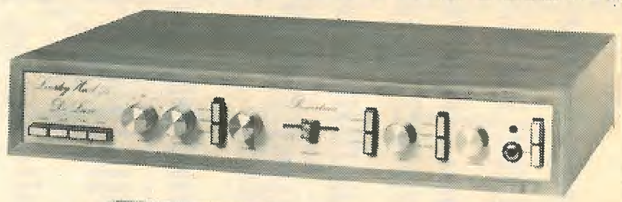
ELECTRONIC KITS OF DISTINCTION FROM POWERTRAN

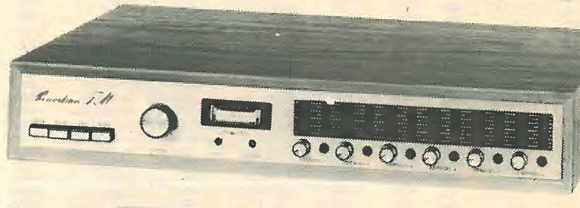
DE LUXE EASY TO BUILD LINSLEY-HOOD 75W STEREO AMPLIFIER £99.30 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.



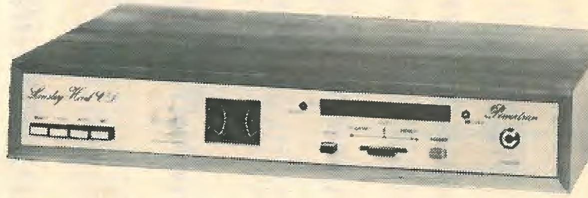
WIRELESS WORLD FM TUNER £70.20 + VAT

A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder, incorporating active filters for "birdy" suppression.



LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.



TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

As featured in Electronics Today International

Cabinet size 24.6"x15.7"x4.8" (rear) 3.4" (front)

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

COMPLETE KIT ONLY £168.50 + VAT!

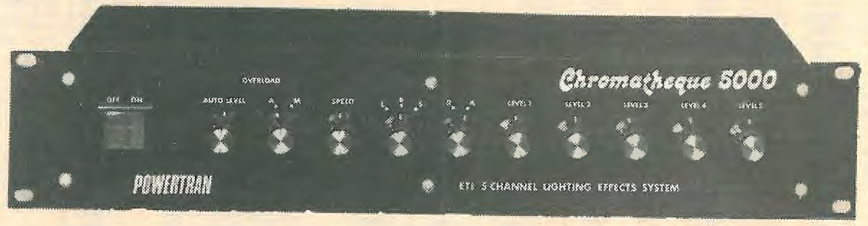
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more than a multi-meter and a pair of ears!

CHROMATHEQUE 5000 5-CHANNEL LIGHTING EFFECTS SYSTEM

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control setting or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. — Complete right down to the last nut and bolt!

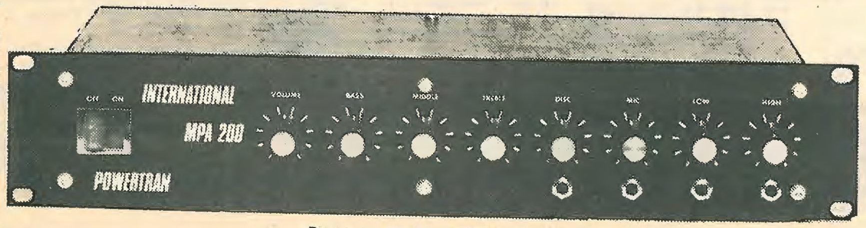
COMPLETE KIT ONLY £49.50 + VAT



Panel size 19.0"x3.5". Depth 7.3"

MPA200 100W MIXER/AMPLIFIER

Featured as a constructional article in Electronics Today International the MPA 200 is an exceptionally low-priced but professionally finished general purpose, rugged, high-power amplifier which has an adaptable range of inputs such as disc, microphone, guitar, etc. There are 3 wide range tone controls and a master volume control. Mechanically the design is simplicity in the extreme with minimal wiring making construction very straightforward. Kit includes fully finished metalwork, fibreglass PCB's, controls, wire, etc. — Complete right down to the last nut and bolt!



Panel size 19.0"x3.5". Depth 7.3"

COMPLETE KIT ONLY £49.90 + VAT

All kits also available as separate packs (e.g. P.C.B. component sets, hardware sets, etc.). Prices in FREE CATALOGUE.

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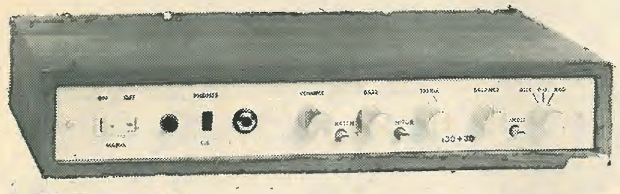
T20+20 AND T30+30 20W, 30W AMPLIFIERS



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 rms per channel of true Hi-Fi at exceptionally low cost. The **easy to build** 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 headphones 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 model is 30W rms per channel.

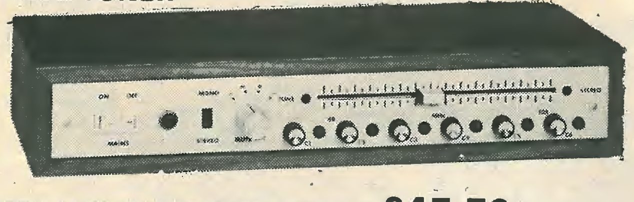
SPECIAL PRICES FOR COMPLETE KITS

T20+20 KIT PRICE £33.10 + VAT

T30+30 KIT PRICE £38.40 + VAT

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

WWII TUNER

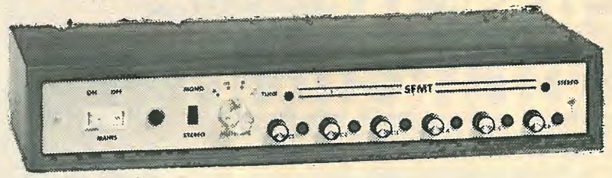


SPECIAL PRICE FOR COMPLETE KIT £47.70 + VAT

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

Following the success of our **Wireless World FM Tuner Kit** this cost reduced model was designed to complement the **T20+20** and **T30+30** amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either.

POWERTRAN SFMT TUNER



PRICE FOR COMPLETE KIT £35.90 + VAT

AVAILABLE AS COMPLETE KIT ONLY

This is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the **T20+20** and **T30+30** amplifiers.

WE'VE MOVED! NEW FACTORY UP! PRICES DOWN!

INCREASED CAPACITY AT OUR BIG NEW FACTORY MEANS MANY PRICES DOWN! ALL OTHER FROZEN!

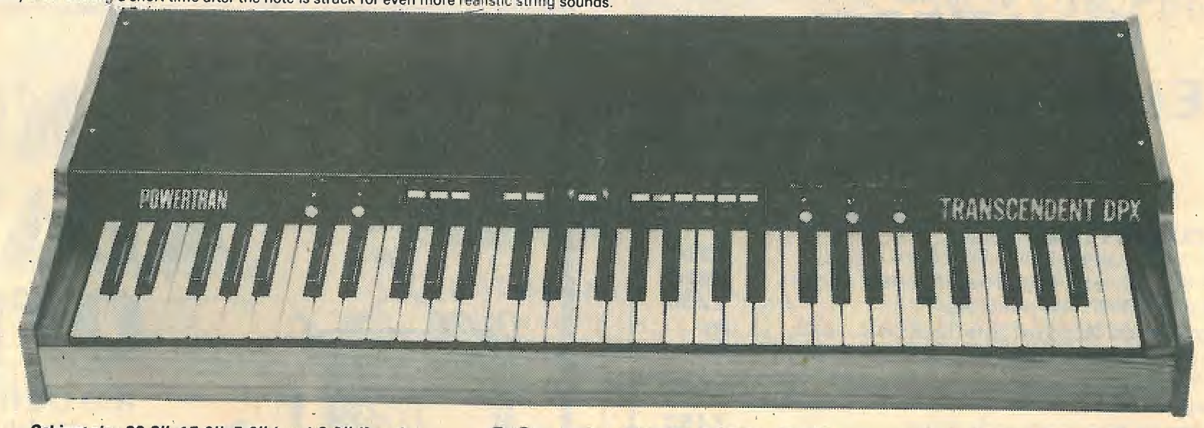
Another superb design by synthesizer expert Tim Orr!

TRANSCENDENT DPX

As featured in Electronics Today International August, September October, 1979 issues

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

The Transcendent PDX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive? The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds.



Cabinet size 36.3"x15.0"x5.0" (rear) 3.3" (front)
Also available as separate packs — prices in free catalgoue

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.
As the system is based on digital circuitry data can be easily taken to and from a computer (for storing and playing back accompaniment with or without pitch or key change, computer composing etc., etc.) and an interface socket (25 way D type) is provided for this purpose.
Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.
The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug — you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1200!

EXPORT A SPECIALITY!

Our Export Department can readily despatch orders of any size to any country in the world. Some of the countries to which we sent kits last year are shown in this advertisement. To assist in estimating postal costs our catalogue gives the weights of all packs and kits. This will be sent free on request, by airmail, together with our "Export Postal Guide" which gives current postage prices. There is no minimum order charge. Prices same as for U.K. customers but no Value Added Tax charged. Postage charged at actual cost plus 50p documentaton and handling. Please send payment with order by Bank Draft, Postal Order, International Money Order or cheque drawn on an account in the U.K. Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London.

**Value Added Tax not included in prices
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PRICE STABILITY. Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until February 28th, 1980, if this month's advertisement is mentioned with your order.
Errors and VAT rate changes excluded.

U.K. ORDERS. Subject to 15%* surcharge for VAT. No charge is made for carriage. * Or current rate if charged.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter. Open 9 a.m.-4.30 p.m. Monday-Thursday.

QUALITY: All components are brand new first grade full specification guaranteed devices. All resistors (except where stated as metal oxide) are low noise carbon film types. All printed circuit boards are fibreglass, drilled roller tinned.

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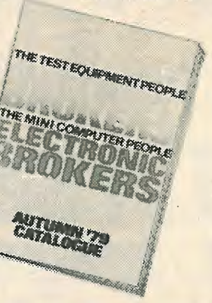
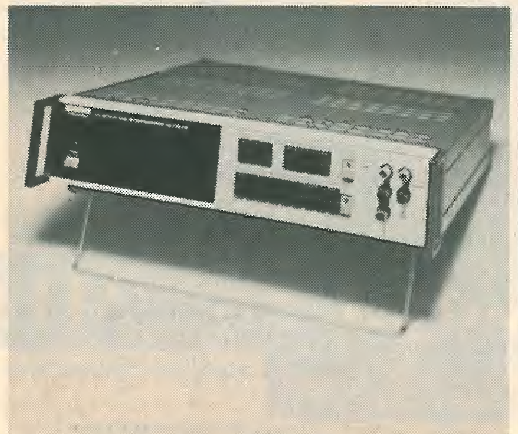


MARCONI INSTS.
TF 2162 M.F. Attenuator
0-11 1dB. Steps of 0.1 dB.
DC-1MHz 600Ω
Large Stocks
£135.00



SOLARTRON
7055 Microprocessor Controlled D.M.M.
Without processor option **£975.00**
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35MHz Delayed Sweep Dual Channel
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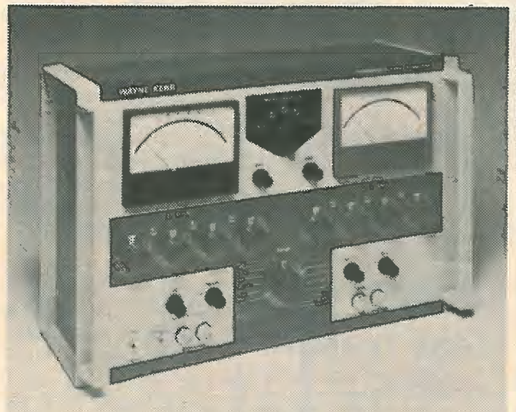
HEWLETT PACKARD
Spectrum Analyser System
141T Display
8552A IF Section
8554L RF Section
500KHz-1250MHz
TOTAL PRICE £5,250



WAYNE KERR
B642 Autobalance Univ. Bridge.
Typically 0.1% accuracy L.C.R. & G measurements
£695.00

MARCONI INSTRUMENTS
TF 2300B FM/AM Modulation Meter
Carrier Freq. 4 to 1200MHz. Deviation range up to 500KHz.
Measures AM depth up to 95% at carrier freqs. up to 400MHz.
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Add 15% VAT to ALL PRICES

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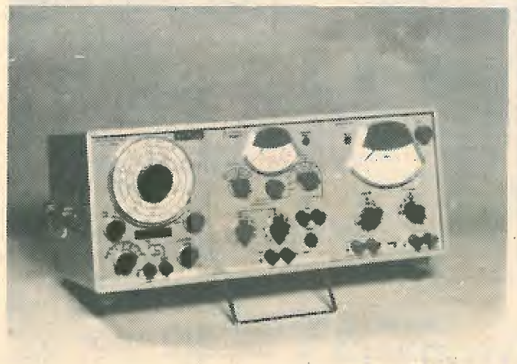
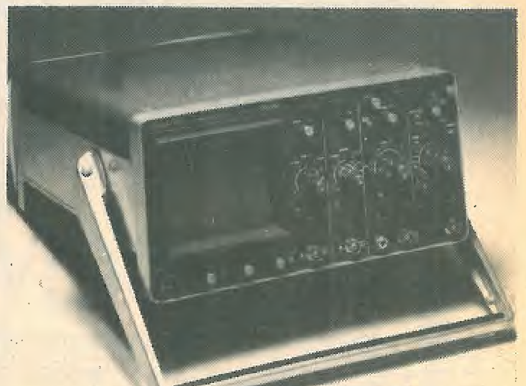
WW — 107 FOR FURTHER DETAILS



MARCONI INSTRUMENTS
TF2333 M.F. Transmission Test Set.
Freq. Range 30Hz-550kHz
£600



PHILIPS
PM 3240 Scope.
50MHz Dual trace and Sweep Delay
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Immitance Bridge 1607A ... £750
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D.M.M. (Microprocessor Controlled) 7065 ... £1,150
— with processor option .. £1,450

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COSSOR
35MHz Dual Trace CDU 150 £450
75MHz Dual Trace 4100 ... £695
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500KHz High Sensitivity 130C £345
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24MHz Dual Trace 545B + CA £299
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25MHz Split Screen Storage Scope 434 ... £1600
Large stocks of Plug ins for 500 series mainframes at new low prices. Details on request.
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10MHz Single Trace P7CRT S54AR (Mint) ... £175
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X1 Probe Kit EB90 ... £9
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8640A AM-FM Signal Generator. 500kHz-512MHz £1800

MARCONI INSTRUMENTS
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TF2000AF Oscillator. 20Hz-20kHz ... £325
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TF2950/5 Mobile Radio Test Set. 65-108MHz. 138-180MHz. 420-470MHz. AM/FM Generator. 1kHz audio oscillator. RF power meter. AF mV/meter. AM/FM modulation meter ... £1250
RACAL
9081 Synthesized Signal Generator. Frequency Range 5-520MHz. AM/FM. Phase & Pulse modulation £1900
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PM5167 Function Generator. 1MHz-10MHz Sine, square ± pulse, ramp, triangle, single shot with variable phase ... £675
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DC Voltage Calibrator 126B . £27
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LF Wave Analyser 1771 .... £37
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True R.M.S. voltmeter 3400A £50
16 Channel Logic Analyser 1600A ... £205

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Divider TF2422 ... £7
Sine SQ. Pulse & Bar Generato TF2905 ... £45
AM/FM Mod. Meter TF2300A £55
RF Millivoltmeter TF2603 ... £52
Diff. Voltmeter TF2606 .... £20
D.F.M. TF2331 ... £47
Wave Analyser TF2330A ... £72
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AC Millivoltmeter PM2454B . £29
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Wow & Flutter PM6307 .... £27

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- Programmable Cold Junction Compensation
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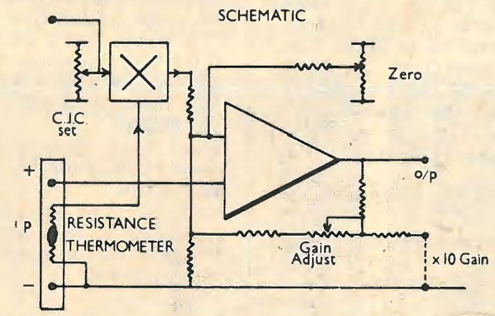

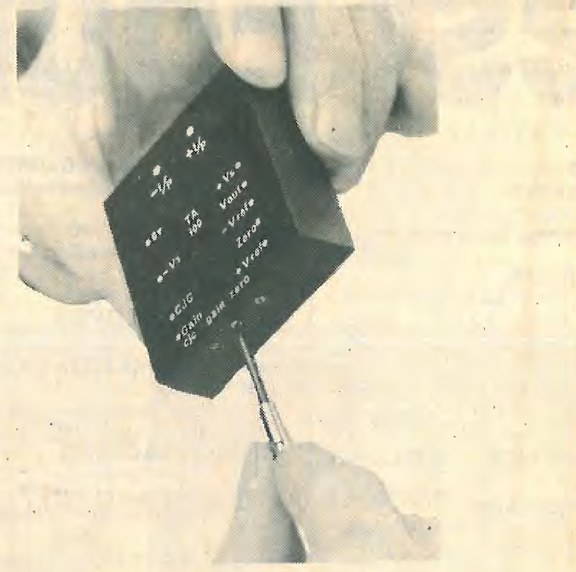

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Simply dial in the Thermocouple sensitivity (in μV/°C), set gain and zero, and the Unit automatically corrects for the Thermocouple you are using.
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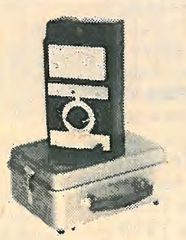
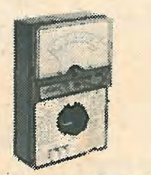
SPECIAL OFFER OF BRAND NEW USSR MADE MULTIMETERS



TYPE	U4313	U4315
Sensitivity D.C.	20,000 o.p.v.	20,000 o.p.v.
Sensitivity A.C.	2,000 o.p.v.	2,000 o.p.v.
D.C. Current	60μA-1.5A	50μA-2.5A
A.C. Current	0.6mA-1.5A	0.5mA-2.5A
D.C. Volts	75m V-600V	75mV-1000V
A.C. Volts	15V-600V	1V-1000V
Resistance	1K-1M	300Ω-500kΩ
Capacity	0.5μF	0.5μF
Accuracy	1.5% D.C. 2.5% A.C.	2.5% D.C. 4% A.C.
Price complete with pressed steel carrying case and test leads	**£10.50**	**£10.50**
Packing and postage	**£1.50**	**£1.50**

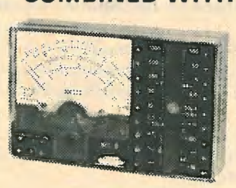
TYPE U4324



D.C. Current	0.06-0.6-60-600mA-3A
A.C. Current	0.3-3-30-300mA-3A
D.C. Voltage	0.6-1.2-3-12-30-60-120-600-1200V
A.C. Voltage	3-6-15-60-150-300-600-900V
Resistance	500Ω-5-50-500kΩ
Accuracy	D.C. 2.5% A.C. 4% (of F.S.D.)

PRICE complete with test leads and fibreboard storage case **£9.50** Packing and postage £1.20

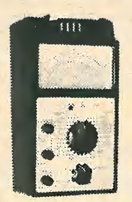
TYPE U4323
COMBINED WITH SPOT FREQUENCY OSCILLATOR



Sensitivity	20,000Ω/V
Voltage ranges	2.5-1000V A.C./D.C.
Current ranges	0.05-500mA D.C. only
Resistance	5Ω-1MΩ
Accuracy	5% F.S.D.
Oscillator output	1kHz 50/50 squarewave 465KHz sinewave modulated by 1KHz squarewave

PRICE, in carrying case, complete with leads and manual **£8.00**
Packing and postage £1.00

TYPE U4341
COMBINED MULTIMETER AND TRANSISTOR TESTER



Sensitivity	16,700Ω/V D.C., 3,300Ω/V A.C.
Current	0.06-0.6-6-60-600mA D.C., 0.3-3.0-30-300mA A.C.
Voltage	0.3-1.5-6-30-60-150-300-900V D.C. 1.5-7.5-30-150-300-750V A.C.
Resistance	2-20-200kΩ-2MΩ
Transistors	Collector cut-off current 60μA max D.C. current gain 10.350 in two ranges

PRICE, complete with steel carrying case, test lead, battery and instruction manual **£9.50**
Packing and Postage £1.50

THIS OFFER IS VALID ONLY FOR ORDERS ACCOMPANIED BY REMITTANCE WHICH SHOULD INCLUDE DELIVERY CHARGES AS INDICATED AND 15% V.A.T. ON THE TOTAL

OUR 1978 CATALOGUE/PRICE LIST OF VALVES, SEMICONDUCTORS, PASSIVE COMPONENTS AND TEST EQUIPMENT IS AVAILABLE. PLEASE SEND P.O. for £0.30 FOR YOUR COPY

WW — 048 FOR FURTHER DETAILS

Appointments

Advertisements accepted up to 12 noon Monday, January 21st for February issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £10.00 per single col. centimetre (min. 3cm).
LINE advertisements (run on): £1.50 per line, minimum three lines.
BOX NUMBERS: 70p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)
PHONE: Neil McDonnell on 01-261 8508
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

ELECTRONICS TEST ENGINEERS

We need your skills to stay true to type

Staying true to type is our business.
We're Linotype-Paul, world leaders in the design, development and marketing of an advanced range of photo-typesetting equipment. Our highly sophisticated computer-controlled machines are revolutionising the graphics industry and setting increasingly higher standards of type production. Keeping our systems on the leading edge of technology is our aim – and to back us in our efforts, we need more skilled electronics test engineers.
If you have 2-3 years experience of testing complex digital equipment, ideally reinforced by ONC or equivalent, you could build a great career with us. A knowledge of analogue circuitry would be an added advantage.
The work is deeply interesting and stimulating – and never routine. Staff facilities include superb working conditions, sick pay scheme, a subsidised canteen and relocation expenses where appropriate.
And salary structures are highly competitive.
Posts are open to both men and women. For full details, write or telephone to the Personnel Department, Linotype-Paul Limited, Runnings Road, Cheltenham. Tel: Cheltenham 45001.

Linotype-Paul (9827)

THORN CONSUMER ELECTRONICS LTD.

Advance Study Engineer

Thorn Consumer Electronics Limited, leading manufacturers of television and audio equipment in the U.K. wish to appoint an experienced Engineer for their Advance Study Group situated in the Research and Engineering Centre at Enfield.

The successful applicant will join a team investigating new ideas and systems including digital techniques and microprocessors as well as modern analogue methods.

He/she should preferably be under 35 years of age with a degree or H.N.C. or relevant experience, recent graduates will be considered.

Please apply in writing to:

The Personnel Manager (ASE/WW),
Thorn Consumer Electronics Limited,
Great Cambridge Road, Enfield, Middlesex EN1 1UL
or telephone 363 5353 extension 2201 for an application form.

THORN (9948)

UWIST

University of Wales

DEPARTMENT OF PHYSICS ELECTRONICS AND ELECTRICAL ENGINEERING

M.Sc./DIPLOMA COURSE IN ELECTRONICS

Applications are invited for places in the full-time one-year M.Sc./Diploma course in Electronics, commencing October 1, 1980.

Further details and application forms (returnable as soon as possible) may be obtained from the Academic Registrar, UWIST, Cardiff CF1 3NU.

(9914)

AMPEX

AMPEX MOSCOW 1980

OFFICIAL SUPPLIERS

AMPEX CORPORATION, a world leader in analogue and digital data recording technology, has been designated the official supplier of video recording and magnetic tape products to the 1980 Moscow Olympics.

Early in 1980 the Group's Training Department in Reading will need an additional

INSTRUCTOR

IN BROADCAST TELEVISION COLOUR CAMERAS AND VIDEO TAPE RECORDERS

This is an opportunity to join a company in the forefront of technological innovation in a position involving contact with engineers from all over the world and some overseas travel.

The essential qualification are:

★ experience as, or personality to become, an expert instructor training engineers of many nationalities.

★ sound knowledge of advanced electronics, particularly in the broadcast television field.

★ sound knowledge of foreign language would be useful.

An attractive salary and benefits package is offered.

Please telephone Clive Legg on Reading 85200, Ampex Great Britain Limited, Acre Road, Reading, Berks.

(9906)

QUEEN ELIZABETH COLLEGE
Kensington
(University of London)

ELECTRICAL LABORATORY/ WORKSHOP TECHNICIAN GRADE 5

Technician needed with particular interests in electrical safety aspects of equipment and instruments in science laboratoris. Work will involve inspection of existing and new equipment, advice on installation, drawing up (in conjunction with College Safety Officer) safety checking schedules. Knowledge of electronics useful, but post will be located in Electronics Unit, which will provide assistance. Maintenance and repair also involved.

Salary in range £3,700 - £4,320 p.a. (under review) plus London weighting of £780 p.a.

Applications with brief particulars of education and experience to the College Secretary, Queen Elizabeth College, Campden Hill Road, London W8 7AH.

(9944)

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Unusual opportunity for introducing Kathrein FM, TV and communication transmitting antennas to UK customers and to increase sales of Spinner and Kabelmetal products in same market.

The job entails calling on existing customers throughout the UK, developing new customers, the preparation of quotations and tenders and assisting customers with their technical problems.

The successful candidate will be over 25 and preferably have good sales ability, suitable experience and qualifications. A good salary and an above average car will be offered. Four weeks' holiday per annum and a non-contributary pension scheme complete the package.

Please apply in writing, marked confidential, to:

The Managing Director

Hayden Laboratories Limited

Hayden House
Churchfield Road
Chalfont St Peter, Bucks

HAYDEN

(9918)

Foreign and Commonwealth Office

Telecommunications Officers

. . . in London and at Hanslope Park, Milton Keynes, for work in the installation, modification, maintenance and operation of HF, VHF, UHF and microwave receivers, associated test equipment, recorders, telephone and teleprinter equipment, electronic ancillary apparatus (some using analogue and digital techniques), voice frequency telegraph and other specialised equipment.

Candidates must have served an apprenticeship or have had equivalent training. They should normally have 3 years' relevant experience, and hold ONC in Engineering (with pass in Electrical Engineering 'A') **or** Applied Physics **or** TEC/SCOTEC certificate or equivalent qualification in a relevant subject. **Ex-Service personnel** who have had suitable training and at least 3 years' appropriate service (as Staff Sergeant or equivalent) will also be considered.

Salary: £4,575-£6,100; London £780 more. Starting salary may be above the minimum for those with additional relevant experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 17 January, 1980), write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). **Please quote T/5274.**

(9943)

IMPERIAL COLLEGE
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ELECTRONIC TECHNICIAN GRADE 5

A Technician is required to join a small enthusiastic team of Engineers engaged on a variety of interesting and challenging projects involving the application of modern electronic techniques within the department for both teaching and research.

The successful candidate will be expected to work in close liaison with academic and technial staff, and must be able to produce the necessary equipment from initial designs.

A basic knowledge of analogue and digital techniques is required and some experience of computer interfacing and microprocessors would be an advantage.

Minimum qualifications are ONC or equivalent together with relevant experience.

Salary in the scale £4,480-£5,100 inc., under review 1.10.79 with further minimum increase of £226-£264 from 1.4.80.

Post is superannuable; there is a generous sick pay scheme. The working week is 37-and-a-half hours; 5 weeks' annual holiday plus several days in addition to public holidays at Christmas and Easter. There is a modern staff club and excellent facilities with sports centre and swimming pool.

Please apply to Mr. J. S. Oakley, Departmental Superintendent, Chemical Engineering Department, Imperial College, South Kensington, S.W.7. Tel. 01-589 5111, ext. 1912. (9936)

KING'S COLLEGE, LONDON

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For interesting work in busy Physics Research Department including construction, repair and maintenance of equipment. Experience in integrated circuits and digital electronics desirable. Good conditions. 5-weeks' annual holiday. Superannuation scheme. Interest-free loans for annual rail season tickets. Salary on scale £4,480 p.a. to £5,100 p.a. inclusive (under review).

Apply in writing with full details to: The Head Clerk (Ref. 221743WW), King's College, London, Strand WC2R 2LS.

(9935)

Success is simply a matter of Luck — ask any failure — Earl Wilson.

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Ext. 502, 24 hours

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(9927)

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(8994)

Career Opportunities in Audio Electronics

Dolby Laboratories®

The UK operation of this international name in audio electronics manufactures a comprehensive range of professional noise reduction systems which is employed world-wide in the broadcasting, recording and film industries. Dramatic increase in world demand has stimulated the company's development, creating the following exciting career opportunities.

Application Consultants c. £9,000

Reporting to the International Marketing Director, the prime responsibility will be the provision of a full technical consultancy to professional users. Major activities will include advice on installations and equipment compatibility in cinemas and studios; training installation and service technicians; distributor and end-user liaison; field servicing and trouble-shooting operational problems; and sound consultancy during film dubbing. Candidates are likely to have a broad-based audio background ideally including practical experience in electronics, as well as professional recording and mixing. Essential personal qualities include the ability to work with considerable autonomy and flexibility to high professional standards. World-wide travel is involved for which a working knowledge of a European language would be an advantage. *Ref: AA57/7146/WW.*

Production Engineers (Electromechanical & Electronic) c. £7,000

Reporting to the Production Director, the principal responsibilities of these posts will include the introduction of new products to line production; production improvements/trouble-shooting; modification control; and liaison with the California-based R & D team. The electromechanical engineer will have prime responsibility for all mechanical aspects of production, with major emphasis on assembly processes; jig, fixture and tool design; and packaging. The electronics engineer will have responsibility for defining test procedures and for the design, development, specification, and/or procurement of test equipment. An analogue background is desirable.

Candidates, probably in their mid-20s to 30s, will be of graduate or equivalent status, and should be able to demonstrate an ability to produce reliable, cost-effective solutions. Considerable autonomy is offered; experience gained in a small-company environment would be an advantage. *Ref: TE61/7147/WW.*

Inspection Supervisor c. £7,000

Reporting to the QA Manager, the Supervisor will assume full responsibility for inspection of 'in-house' assembly operations. Key tasks will be the motivation, control, training and development of the inspection team, and the preparation and analysis of inspection reports and quality investigations to improve both quality standards and cost-effective production. This post is likely to appeal to young electronics engineers (from age 23 years) who seek a stepping stone into line management. The attractive salaries will be supplemented by competitive benefits which include relocation assistance. Location: London SW9.

Ref: W61/7149/WW.

Initial interviews are conducted by PA Consultants. No details are divulged to clients without prior permission. Please send brief career details or write for an application form, quoting the appropriate reference number on both your letter and envelope, and advise us if you have recently made any other applications to PA Personnel Services.

PA Personnel Services

Hyde Park House, 60a Knightsbridge, London SW1X 7LE. Tel: 01-235 6060 Telex: 27874

PA

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(9928)

AMPEX

AMPEX MOSCOW 1980

BROADCAST VTR ENGINEERS

FOR MIDDLE EAST AND AFRICA BASED IN ATHENS

We seek HNC calibre Electronics Engineers or those with equivalent experience, to whom product training will be given. They will be required to travel and work independently and to join our highly professional team serving this area from its Regional Office in Athens.

Salaries reflect the demanding nature of the job. Assistance with relocation, rent, education expenses will be given. Pension, medical expenses and insurance.

Write fully to Don Cameron, AMPEX, P.O. Box 45, Halandri, Athens, Greece, or for application form from Clive Legg, Ampex Great Britain Ltd., Acre Road, Reading, Berks. on Reading 85200.

The Group parent company, Ampex Corporation, has been designated the official supplier of video recording and magnetic tape products to the 1980 Moscow Olympics.

(9915)

London Borough or Bromley
RAVENSBOURNE COLLEGE OF ART AND DESIGN

SENIOR ENGINEER

TELEVISION AND BROADCASTING

A senior television broadcast engineer is required to manage a small engineering section of the television department. Duties will include installation and maintenance of the broadcast standard colour television installations which are used by the department.

The successful applicant should be qualified to H.N.D. level with recent experience in the unsupervised maintenance of colour television broadcast studio and video systems, including cameras and quadruplex video tape equipment.

Salary on grade T5 within the range £5610 to £5937 including London Weighting.

Further details and application forms from the: **Registrar, Ravensbourne College of Art and Design, Walden Road, Chislehurst BR7 5SN.**

(9899)

THE POLYTECHNIC OF CENTRAL LONDON
Engineering Division

ELECTRICAL WORKSHOP/ LABORATORY TECHNICIAN GRADE 3

Salary: £3456-£3861 inclusive of London Allowance (Under Review)

Technician required for an expanding group working in communication and computer fields. Experience in electronics and workshop practice necessary. Workload includes laboratory and research projects.

The following qualifications are required: ONC with 3-5 years' experience (inclusive of training) or the equivalent and/or appropriate industrial experience.

Application form and further details from the Establishment Officer, PCL, 309 Regent Street, London W1R 8AL. (Tel: 01-580 2020 ext. 212).

(9894)

Electronic Engineers – What you want, where you want!

TJB Electrotechnical Personnel Services is a specialised appointments service for electrical and electronic engineers. We have clients throughout the UK who urgently need technical staff at all levels from Junior Technician to Senior Management. Vacancies exist in all branches of electronics and allied disciplines - right through from design to marketing - at salary levels from around £4000 to £8000 p.a.

If you wish to make the most of your qualifications and experience and move another rung or two up the ladder we will be pleased to help you.

All applications are treated in strict confidence and there is no danger of your present employer (or other companies you specify) being made aware of your application.

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Tunbridge Wells,
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Tel: 0892 39388

TJB

Please send me a TJB Appointments Registration form:

Name ....

Address ....

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(9238)

TELECOMMUNICATIONS ENGINEER

Salary £7,000

Good all round engineer required for an International Company with worldwide telecommunication network.

Good knowledge of telecommunications peripherals and multiplexing. Facsimile experience an advantage. Some international travelling will be necessary.

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(9909)

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(9959)

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If your trade or training involves radio operating, you qualify to be considered for a Radio Officer post with the Composite Signals Organisation.

A number of vacancies will be available in 1980/81 for suitably qualified candidates to be appointed as Trainee Radio Officers. Candidates must have had at least 2 years' radio operating experience or hold a PMG, MPT or MRGC certificate, or expect to obtain this shortly.

On successful completion of 40 weeks' specialist training, appointees move to the Radio Office Grade.

Salary Scales:

Trainee Radio Officer	Radio Officer
Age 19 **£3271**	Age 19 **£3961**
Age 20 **£3382**	Age 20 **£4107**
Age 21 **£3485**	Age 21 **£4243**
Age 22 **£3611**	Age 22 **£4359**
Age 23 **£3685**	Age 23 **£4571**
Age 24 **£3767**	Age 24 **£4854**
Age 25+ **£3856**	Age 25+ **£5166**

then by 5 annual increments to £6981 inclusive of shift working and Saturday, Sunday elements.

For further details telephone **Cheltenham 21491 Ext. 2269,** or write to the address below.

GCHQ

Recruitment Office

Government Communications Headquarters

Oakley, Priors Road, Cheltenham GL52 5AJ (9493)

MARTIN-BAKER (ENGINEERING) CO. LTD.
has a vacancy for an

ELECTRONIC TECHNICIAN

AT CHALGROVE AIRFIELD, OXFORD

The successful applicant will be required to assist small team, on commissioning and operation of telemetry and instrumentation systems for ejection seat trials.

QUALIFICATIONS — Ability to make prototype units from rough drawings and test to specifications using standard test equipment. Knowledge and experience of U.H.F. Trans/Recs., tape recorders and logic systems. (Gained as a radio amateur perhaps).

Salary range £5500-£5700 per annum. Weekly paid. 40-hour week. 22 days' holiday per year, non-contributory pension scheme after five years.

Enquiries to: **Mr. G. B. Thompson, Martin-Baker (Eng) Co. Ltd., Chalgrove Airfield, Oxford OX9 7RJ. Telephone: 0865-890251.** (9807)

Editorial writer for Wireless World

Wireless World *needs a new person on its editorial staff. Technical experience in electronics and/or communications and an ability to write are essential. The work is varied and includes writing technical news reports and other material, attending meetings, exhibitions, press conferences and other events, some abroad, and editing contributed technical articles. A good deal of freedom will be given to a person who shows ability and responsibility. Preferred age range 25 to 35.*

Write to: The Editor
WIRELESS WORLD
Dorset House, Stamford Sreet
London SE1 9LU (9947)

TELEVISION PROJECTS ENGINEERS

We have vacancies in our expanding Projects Section for Junior and Intermediate engineers. Responsibilities cover all stages of custom-built vision/audio switching system manufacture from customer liaison through design, production and test to final acceptance.

The positions offer the chance for energetic engineers with initiative to join a small, expanding company manufacturing and supplying electronic equipment to many professional TV broadcasters in the UK and Europe. A certain amount of travel here and abroad could be involved.

In particular this opportunity would suit engineers possessing some experience in electronic testing wishing to expand their horizons and gain experience in television broadcast systems.

In addition to a good salary the company offers profit-sharing and non-contributory pension schemes, free BUPA membership, a friendly environment in rural settings and excellent career prospects.

For more details contact David Steel at:

pro-bel LIMITED

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BERKSHIRE, RG12 5DN, ENGLAND
telephone BRACKNELL (0344) 56969/56960 (9958)

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VIDEO ENGINEERS

Experienced Video Engineers are required for important work, mainly in the field of high security systems. Some work on short contracts is available in the Middle East, North Africa etc, if required, but not mandatory. A company car, pension scheme and generous salary can be expected but loyalty and a determination to do the job well are necessary. We are looking for Engineers who expect to earn £4,000 - £7,000.

Please apply to:

ANDROMICA (T.V.) LTD.
34 Rockingham Road
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Tel. Uxbrige 57971 (9956)

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Train for the future as a Broadcast Transmission Engineer

Through our network of over 500 transmission stations the IBA is responsible for the transmission of all Independent Television and Local Radio services. With a steadily increasing number of stations, the preparations for the fourth television channel and more local radio stations now underway we are taking on increased responsibilities.

We take great pride in the fact that our system is one of the best in the world and great importance is placed on maintaining the efficiency of the service. To do this we have teams of highly trained and experienced engineers all over the country.

Internal promotions and continued expansion have created a number of opportunities for H.N.C. or H.T.C. or equivalent level engineers (male or female) to train for a challenging future. Our carefully devised training programme, which will commence this summer, can lead to a recognised Diploma and combines theoretical study and practical training. This comprehensive training is a step beyond traditional learning and gives a grounding in broadcast engineering that is second to none. Naturally, course fees, accommodation and meals will be paid during the course. A full driving licence is required, but if you do not already have one, we will assist you by arranging and paying for instruction.

On the satisfactory completion of the training programme, your salary will be £5,880 per annum and then rise annually to £7,280 per annum, with further progression to £8,202 per annum. (During the training period you will receive a salary of up to £4,700 per annum, depending upon experience.)

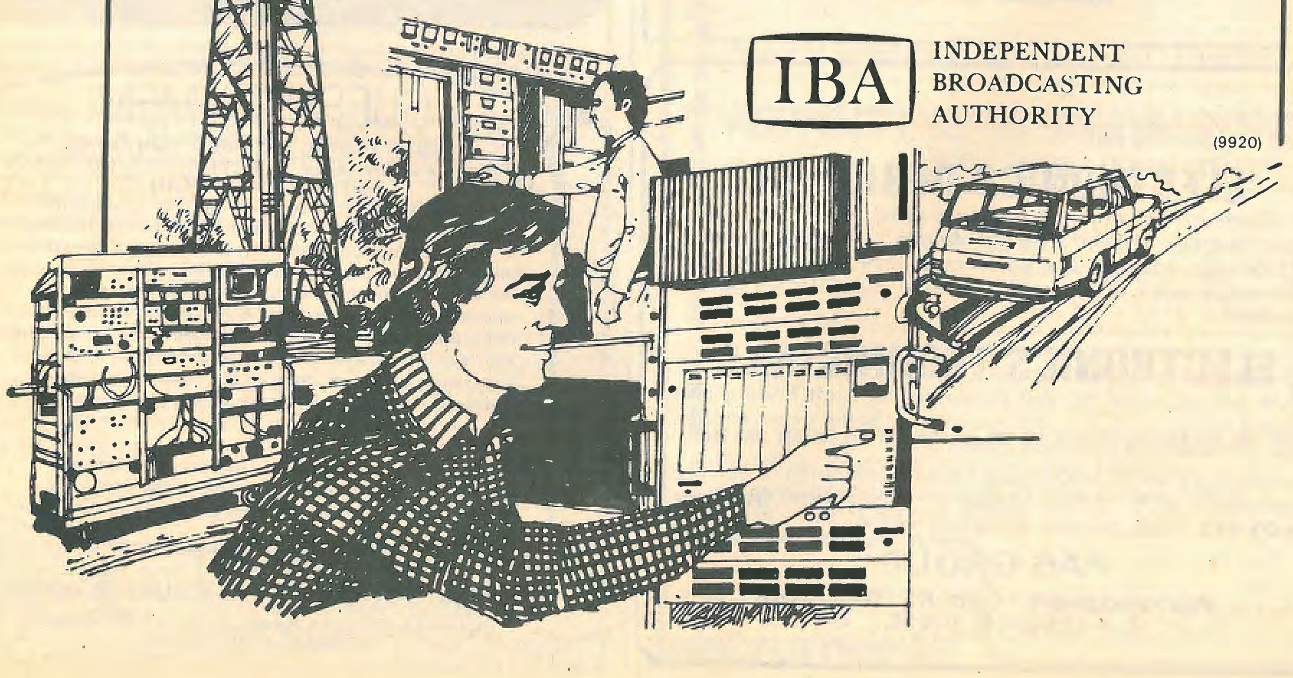
At higher levels it will be up to you to demonstrate your ability as promotions are based on internal competition – all of our Regional engineering managers started their careers at transmitting stations.

Employment benefits include Free Life Assurance and Personal Accident Schemes, a Contributory Pension Scheme, generous relocation expenses and subsidised mortgage facilities.

Please write or telephone Mike Wright for a fully illustrated information package and application form, at IBA, Crawley Court, Winchester, Hampshire SO21 2QA. Telephone: Winchester 822574.

IBA INDEPENDENT BROADCASTING AUTHORITY

(9920)



DESIGN ENGINEER

Thorn Consumer Electronics Limited, leading manufacturers of television and audio equipment in the U.K., wish to appoint an experienced Design Engineer for their Research and Engineering centre at Enfield.

The successful applicant will join a team investigating new ideas and systems for the television industry and should have a degree or equivalent, with at least two years in television design, with some digital design experience, and be preferably under 35 years of age.

The ability to work on his/her own initiative, liaising with internal development departments and outside suppliers is essential.

Please apply in writing, stating age, experience and qualifications to:

The Personnel Manager, (DE/WW),
THORN CONSUMER ELECTRONICS LTD.
Great Cambridge Road, Enfield, Middlesex, EN1 1UL. (9949)

ITA EXPANSION

We need more high-calibre engineers conversant with current recording equipment. Applicants must be able to assume responsibility in return for attractive salary and secure future.

Apply: Chief Engineer
ITA, 1-7 Harewood Avenue
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01-724 2497 (9921)

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JUNIOR DEVELOPMENT ENGINEERS
ELECTRONICS

John Player and Sons, a leading manufacturer of tobacco products, offer the opportunity to young electronics engineers to gain valuable practical experience in industrial electronics.

Vacancies exist for work in the Machinery Evaluation Section where new generation cigarette making and packing machines are undergoing pre-production trials. These machines are equipped with increasing numbers of modern electronic control circuits using the latest technological advances including microprocessors.

The successful applicants will undergo a period of familiarisation, look after specific machines during the evaluation period, be involved in the development of special features as well as devising evaluation aids and ultimately in the training of others in the maintenance of these machines on the production floor.

We are looking for men or women who are qualified to HNC or equivalent, and who have 2 years' experience in one or more of the following areas:

a) electronic control and logic circuits
b) process control systems
c) microprocessors

A knowledge of the tobacco industry is not essential.

We offer a starting salary of £5,500 per annum together with other benefits associated with a large progressive company including relocation assistance where applicable.

Application forms can be obtained by phoning Nottingham (STD 0602) 787711 Extension 345 or writing to:

Lorna Blayney
JOHN PLAYER AND SONS
Nottingham NG7 5PY

(9902)

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Independent concern represented in 80 countries

SENIOR TEST AND CALIBRATION ENGINEERS

With a background in RF and microwaves, experienced in analogue, digital techniques, logic and microprocessor controlled ATE.

also vacancies exist for

TEST & CALIBRATION ENGINEERS

with knowledge of one or more of the above techniques.

We offer an exceptional salary ★ Performance related bonus scheme ★ Training abroad ★ Prospects of promotion ★ A wide variety of work ★ A happy atmosphere ★ Non-contributory pension scheme ★ Subsidised restaurant.

Please write or phone to.
Mr. Z. Eres (Technical Manager) extension 43.

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Surrey KT9 1LP
01-397 8771

(9757)

Manufacturers of professional film and video equipment now need the following staff:

ELECTRONICS DESIGNER

An engineer with some experience is required to join a small design team working on a variety of projects. Fields of interest include logic, analogue and power control circuits. The level of work would suit a Graduate or someone with relevant design experience.

ELECTRONICS TECHNICIANS

There are vacancies for test personnel for fault finding and general testing of PCB's and equipment. Some experience of logic and analogue circuits is essential.

The above vacancies are suitable for men or women. If you are interested in either of them please telephone **Nigel Gardiner on 01-543 3131,** or come along and see us.

PAG GROUP
565 KINGSTON ROAD, RAYNES PARK
LONDON, SW20

(9955)

GUERNSEYMEN
come home, we need you here!

We have vacancies for, ELECTRONICS ENGINEERS and a DRAUGHTSMAN

We are forming a Product Development group within our company here in Guernsey which will be involved in the introduction, appraisal, and design of new products aimed at our European Markets.

We are in the business of manufacturing data communications equipment including sophisticated microprocessor - based monitoring and test equipment.

We have immediate vacancies for Engineers with experience in one or more of the following areas: Systems, Analogue, Software, and digital design.

We also have a vacancy for a Draughtsman with electronics experience.

Applicants, who must have Guernsey residential qualifications are invited to write to the Personnel Manager giving details of experience and qualifications.

Dynatech DATA COMMUNICATIONS LTD
Place du Commerce, Bouet, St.Peter Port, Guernsey
Telephone 0481 26475

SOUTHERN ELECTRICITY
Littlewick Green, Maidenhead

SECOND ENGINEER (TELECOMMUNICATIONS)

CHIEF ENGINEER'S DEPARTMENT HEAD OFFICE

SALARY WITHIN THE RANGE £6,830-£8,955 PER ANNUM

Applications are invited for the above post in the Technical Services Section of the Chief Engineer's Department.

The successful applicant will be part of a team engaged in the design, commissioning, and subsequent maintenance of telecommunications systems throughout the Southern Electricity Board, and must be able to spend periods away from Head Office when carrying out these duties.

Schemes in progress include telecontrol, data communications, medium capacity microwave links, multi-channel line circuits and radio and line telephony systems. Applicants should have had experience in some of this work and preferably be in possession of suitable technical qualifications.

The successful candidate will be required to drive a motor vehicle which may be either a private car or a Board-owned car.

Appropriate relocation assistance will be provided.

Applications on forms obtainable from the Secretary, Southern Electricity, Southern Electricity House, Littlewick Green, Maidenhead, Berks., SL6 3QB, and returned to him quoting 76/79 by not later than January 11, 1980.

(9916)

FIELD ELECTRONICS ENGINEERS

Gardline Surveys are a leading Hydrographic and Geophysical Survey Company providing shipping, offshore positioning and site investigation services to oil companies and other clients.

Due to continuing expansion we have vacanices for the following personnel:

SEISMIC ENGINEERS—with a strong electronics background, a familiarity with digital acquisition systems and preferably with marine or shallow marine operations.

UNDERWATER SYSTEMS ENGINEERS—with a sound background in electronics and an aptitude for practical work and fault finding. Gardline operates a variety of equipment including Huntec Deep Tow Boomers, E. G. and G. Sidescan Sonars, Magnetometers, Sparkers, etc. Experience with one or more of these systems is desirable but not essential.

POSITIONING ENGINEERS—with experience in the field of survey vessel navigation or oil rig positioning. Gardline operates a variety of positioning systems including Satellite Navigation, 2MHZ Systems, Syledis and Trisponder. A computer and track plotter are usually used in conjunction with the above equipment. Familiarity with digital techniques and the ability to fault-find desk top calculators would be an advantage.

Whilst formal qualifications are an advantage, experience and the ability to work effectively in a field environment is considered to be of prime importance. We expect our engineers to be adaptable and willing to learn to use systems that they are not familiar with at present.

Employment will be based at Great Yarmouth or if required Aberdeen. Operations are primarily North Sea based but there are good prospects of overseas employment through our branch offices in Houston and Sharjah (U.A.E.).

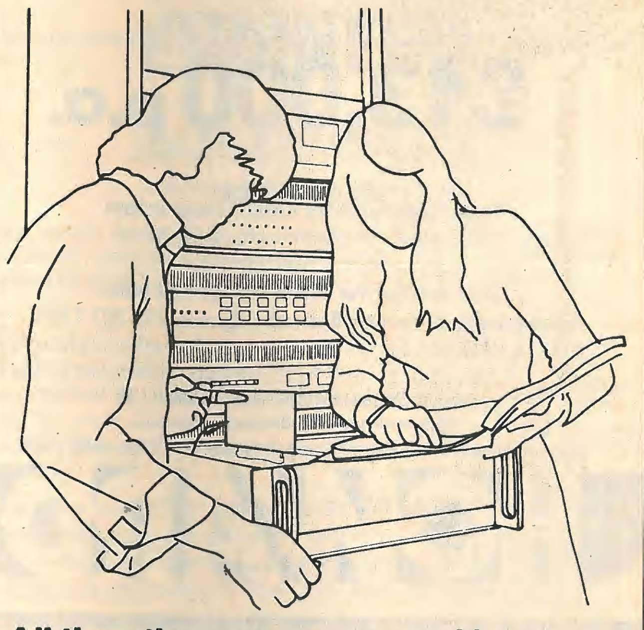
Salary is fully negotiable and with sea pay is likely to be around £8,000.

There is a company pension scheme and 4 weeks' annual leave plus roster leave accrued whilst at sea.

Applicants should write or telephone **The Technical Manager, Gardline Surveys, Oilmar House, Admiralty Road, Great Yarmouth, Norfolk. Tel. Great Yarmouth (0493) 50723.**

(9926)

Professional Careers in Electronics



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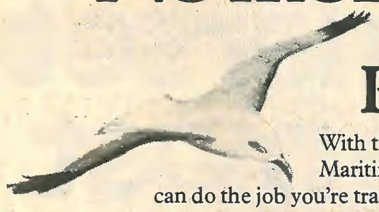

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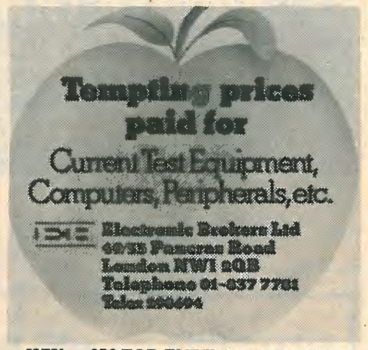

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INDEX TO ADVERTISERS
Appointments Vacant Advertisements appear on pages 133-151

	PAGE
Acoustical Mfg. Co. Ltd.	14
AEL Crystals	32
Aero Elec (AEL) Ltd	33
Ambit International	112
Antex	66
Apex	85
Aspen Electronics Ltd.	27
Astra Elec. Comps	110
Avo Ltd	11
Barrie Electronics Ltd.	107
BIB Hi-Fi	Cover iv
Bi-Pak Semiconductors Ltd.	101
Bull, J.	123
Butterworth & Co. Ltd.	26
Cambridge Learning	4, 5
Carston Electronics Ltd.	24, 25
Carter Associates	26
Catronics	107
Chiltern Electronics	128
Chiltmead Ltd.	119
Cintec	7
CIL	132
Circard No. 5	123
Colomor (Electronics) Ltd.	116
Communications '80	110
Compec (Europe) '80	30
Computer Appreciation	122
Continental Specialities	99
Crimson Elektrik	10
Cropico Ltd.	18
Datong	15
Display Electronics	116
Dominus	104
Drake Transformers	86
Eagle Internatinal	17
Edicron	34
Eddystone Radio Ltd.	10
Electronic Brokers Ltd	129, 130, 131, 152
Electro-Tech Comps Ltd	124
Electrometric Services	26
Electrovalue	15
Elvins/Dalston	15
Eraser	122
Faircrest Eng.	114
Farnell Instruments Ltd.	28
Feedback Instruments	86
Fylde Electronic Labs Ltd.	22

	PAGE
GEC Semiconductors	76
GEC M-O Valve	27
Hameg Ltd.	2
Harris Electronics (London) Ltd.	22, 32
Hart Electronics	114, 116
Henry's Radio	110, 116, 120
H.L. Audio	23
I.L.P. Electronics Ltd.	98, 108, 109
Industrial Tape Applications	117, 128
Integrex Ltd.	102, 103
Intel Electronic Comps. Ltd.	85
Intersil	13
ITF/IEA	9
K.A.C. Electronic Investment	106
Keithley Insts.	97
Kelsey Acoustics Ltd.	122
Kirkham Amplifier	35
Langrex	115
Larsholt Electronics	106
Lascar Electronics	12
Legal Ad	120
Leevers-Rich Equip. Ltd.	18
Levell Electronics Ltd.	3
Lindos Electronics	28
Lowe Electronics Ltd.	34
Maclin-Zand Electronics Ltd.	21
Maplin Electronic Supplies	Cover iii, 16
Marshall, A. & Sons (London) Ltd.	118
Medelec	112
Microcircuits Ltd.	21
Milward, G.F.	120
Multicore Solders Ltd.	Cover iv
Newbear Computer Store	22, 100
Newtronics	23
Olson Electronics	33
OMB Electronics	33
PBRA Ltd.	107
Powertran Electronics	121, 126, 127
Precision Instruments.	19
Pyrdex Components	34

	PAGE
Quantum Electronics	4
Racal Recorders	6
Radio Components Specialists	111
Radio Shack	104
Ralfe, P.	118
R.C.S. Electronics	100
R.S.T. Valves	115
Sabtronics International	65
Sandwell Plant Ltd.	107
Sasgan	132
Science of Cambridge	75
Scopex Instruments Ltd.	113
Service Trading	105
Shure Electronics	36
Softy Ltd.	98
Sonic Sound Audio	8, 116
Sota Communications Systems Ltd.	100
Southern Electronics	15
Special Products Ltd.	106
Star Devices	29
Strumech Eng. Ltd.	27
Strutt Elec. & Mech'l Engrs. Ltd.	98
Sugden, J. E. & Co. Ltd.	104
Surrey Electronics Ltd.	114
Swanley Electronics Ltd.	122
Symot Ltd.	106
Tally Computer	8, 9
Tandy Corporation	20
Technomatic Ltd.	125
Tektronix (U.K.) Ltd.	Cover ii
Teleradio Electronics	106
Texas Instruments	12
Toolrange Ltd.	28
Valradio Ltd.	18
Vero Electronics Ltd.	120
Vero Speed	128
Vero Systems	122
West Hyde Developments Ltd.	104
Wilmslow Audio	31
Wolfsen Electronics	32
Z. & I. Aero Services Ltd.	32, 132

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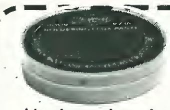

'Ersin' A fast non-corrosive, rosin flux for general and electrical soldering. Use in conjunction with 'Ersin' Multicore solders. **Size RF10 60p** inc. VAT

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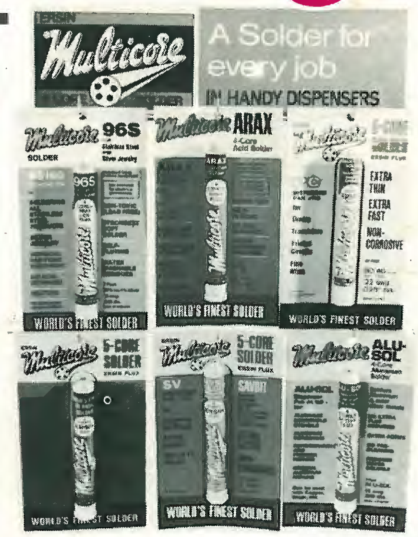
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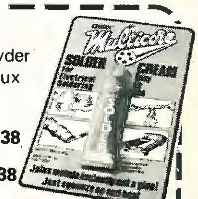
A reel of 3mm 'Arax' Multicore solder for general non-electrical use. **Size 16A £2.99** inc. VAT

Solder Cream



Tacky mixture of solder powder and correct percentage of flux for difficult to reach areas.

Electrical/Electronic ('Ersin' Flux) **Size BCR10 £1.38**

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USA Pat. No. 4067563 (splicer)
Brit. Pat. No. 1507583
Brit Pat. No. 1258280 (method of splicing)

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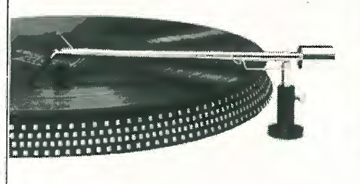

For single-play turntables. Removes harmful dust to protect records and stylii. Finished in chrome, bright anodised aluminium and shiny black.

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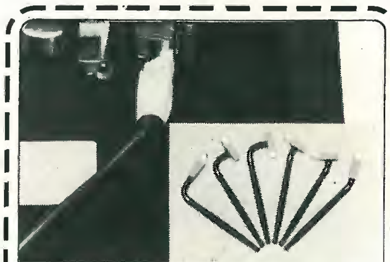

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