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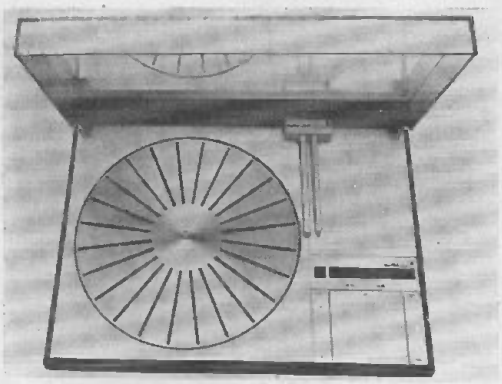
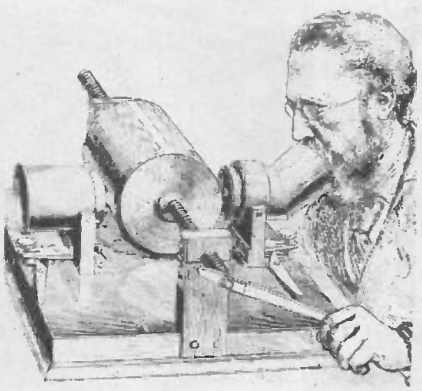


page 12

page 40



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ALTHOUGH a magazine is a highly perishable commodity, with a life expectancy of only a month, once it has been published we hope that that is not the end of the matter.

We get our copies just before they appear on the bookstands and we study them eagerly....certainly we have seen the individual pages several times before it is printed but there is nothing like seeing the finished issue. After our initial examination we get round to wondering what reaction you, the reader, will have.

After a few days we begin to know when your letters start coming in. Cynics often believe that we sort these into two; the nice ones are set aside for Input Gate, the nasty ones being consigned to the wastepaper basket. In fact we take note of every comment; that is not to say that we automatically assume that one reaction is typical and that an individual letter will reshape our policy but, in conjunction with others, it may well do. We welcome criticism, especially if it is constructive, and about the only way for us to know what you like (or don't like) is if you tell us. If we receive no comment about a feature there could be two reasons: it might be so boring that no one has bothered to read it or it may be so informative and so complete that no queries arise from it.

Our readership survey which was published in last September's issue has provided us with plenty of useful information (thanks to all of you who filled it in) but we still need to know what you feel about individual features.

Letters from the readers are the essential feedback that we need to keep ourselves on the right course so, do us a favour, keep 'em coming.

H.W.M. ●

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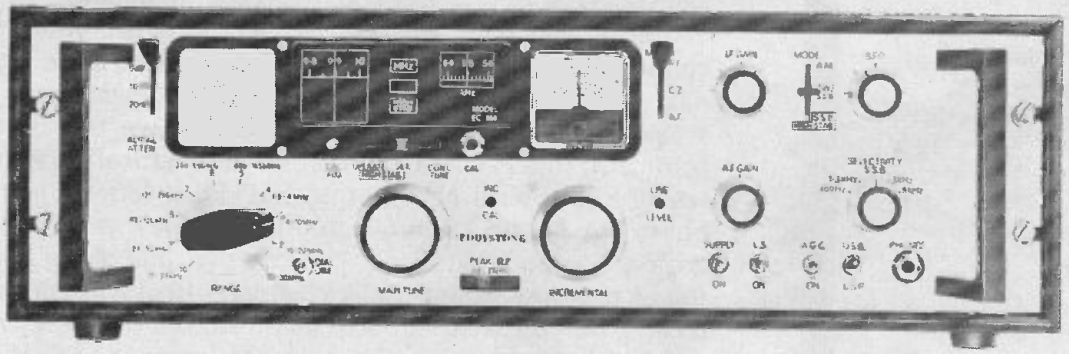

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news digest

NIPPING THE NIPS !

Pressure is growing in many European countries to curb the import of Japanese electronic goods.

The Dutch have temporarily stopped issuing new import licences to Japan for goods including radios, TV sets, tape recorders and calculators. West German manufacturers have also expressed concern over the imports from the far east which have risen by leaps and bounds in the past two years.

In Britain similar pressure is growing, for although the domestic electronics industry is riding on the crest of a wave with sales of virtually all electronic goods at record levels, the Japanese have gained a very large share of the market. They have a virtual monopoly of the small screen TV market, both colour and black and white and sales of radios cassette tape recorders and pocket calculators are also substantial. The recent revaluation of the Yen may do something to stem the flow, but only temporarily.

The Japanese themselves enjoy a highly protected domestic market and place massive tariffs on imports but this doesn't stop them fretting when other countries operate a bit of protectionism.

Most European countries are disturbed by the flow even while their economies are doing well; when a trade recession occurs (and judging by recent history it can't be long) this protest will rise to a scream.

Jap equipment is usually good and very cheap but we must not assume that it will be available 'ad infinitum'.

I.C. DESIGNED FOR ELECTRONIC IGNITION IN CARS

Emihus Microcomponents have been investigating the use of MOS integrated circuits in automobile equipment, and as a first result they have designed an electronic ignition system.

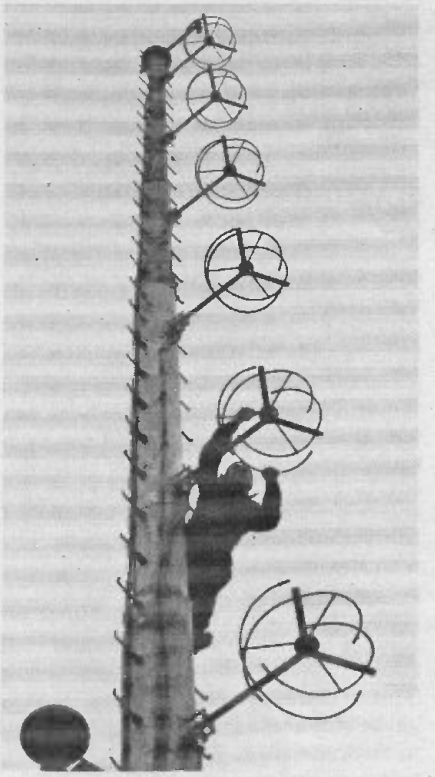
One of the chief aims of this device is to reduce the pollution output from the engine by effecting closer control of the engine timing. It is also expected that the electronic ignition system will help reduce engine wear and will eliminate the need for current maintenance such as points adjustments and lubrication of balance weights.

The major feature is that it enables the timing function to be adjusted to a quarter of a degree of accuracy at engine speed increments as small as 100 revs per minute, with the added advantage that the negative advance can be introduced at any point in the positivley advancing timing function.

Another likely effect produced by this electronic ignition system is an improvement in fuel consumption.

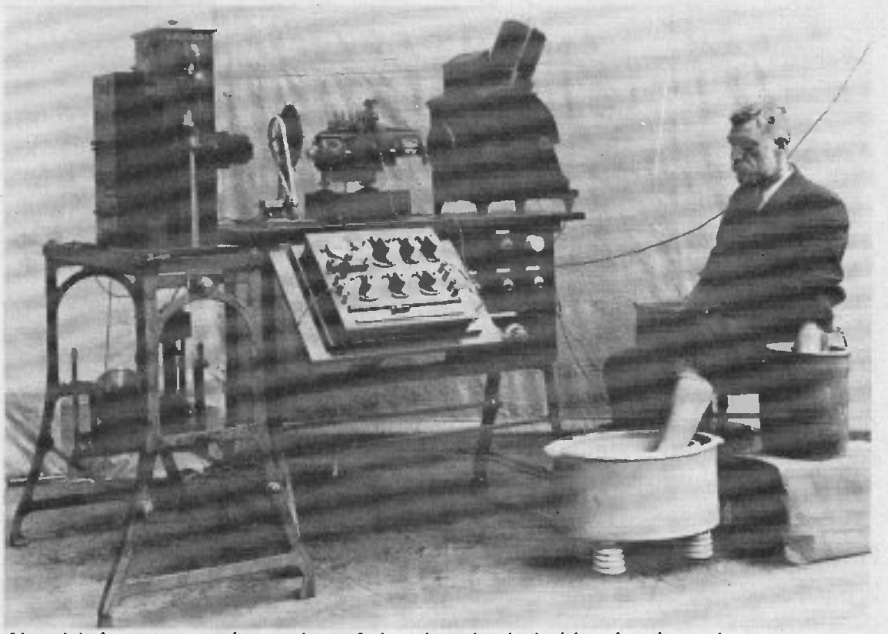
GETTING READY FOR COMMERCIAL RADIO

Commercial radio is on its way; anyone doubting this should tune around the medium wave band where tests transmissions are already being conducted. Contracts for the supply of the transmitters and the aerials have been placed with EMI, the value of the order is put at £160,000.



The new stations will broadcast on both VHF and the medium waves. The former will use circular polarisation, as yet untried in the UK though widely used in the USA where it is claimed to give much better reception on simple transistor radios and in cars. A number of the BBC local stations have been using slant polarisation to overcome this same problem.

ELECTRONICS YESTERDAY



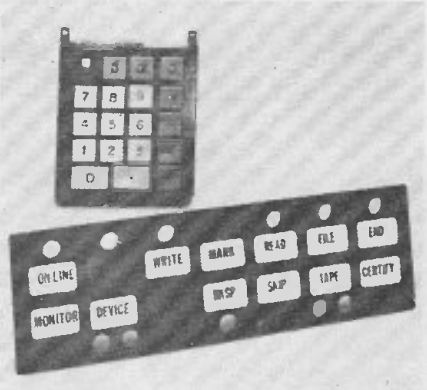
No, this is not an early version of the electric chair (despite the unhappy expression on the chap's face !) but one of the worlds first electrocardiographs. An instrument very similar to this is featured in an exhibition to celebrate the 850th anniversary of London's St. Bartholomews Hospital (Bart's). This horrifying device was installed in the hospital at the turn of the century by the Cambridge Instrument Company who are still in the field and whose modern equipment is used in the hospital today.

news digest

ELASTOMERIC KEYBOARDS

A new concept in keyboard switches comes from Guest International with their range of 'Flex Key' flexible membrane switches. These are claimed to have a life of 100 million cycles.

The membrane switch structure is a simple, three-level composition. In operation, a conductive silicon elastomer is deformed through an aperture in a Mylar insulating sheet and bridges two sets of gold-plated contact pads. This design, together with the inherent semiconducting properties of the carbon-silicon elastomer, reduces the possibility of contact bounce to a minimum and even removes the necessity for anti-bounce circuitry. All 'Flex Key' keyboards are claimed to be impervious to dust, moisture, or even direct contact with liquid. They are suitable for use in the most rugged of conditions and mechanical wear and contact degradation are almost non-existent. The elastomer-to-gold interface eliminates the inherent problems of mechanical switches and switch



Examples of the elastomeric 'Flex Key' keyboard switches from Guest International

actuation is achieved by flexing the elastomer just 0.005in.

The obvious use is in electronic calculators, but keyboards can be used in almost any application requiring sequential switching.

PEKING EXHIBITION

A small chink appeared in the bamboo curtain (forgive the pun) earlier this month when the British Industrial Technology Exhibition was staged in Peking. 347 British exhibitors took part and the electronic and electrical industries were well represented. British exports to red China run at about £30 million per year at present but it is hoped that this exhibition will boost these sales.

Despite the thaw in diplomatic relations very little is know about the Chinese electronics industry but ETI are planning to bring you a special feature next month giving details of the state-of-the-art in China.

METAL LOCATOR KIT

Treasure hunting is one of the fastest growing hobbies in Britain with sales of metal locators running at 20,000 a year. To cater for those who wish to build their own, Minikits Electronics have just announced a complete metal locator kit for £8.90 plus 30p postage. This comes with a preconstructed search head which the makers say requires special engineering skills in manufacture and is not suitable for the home constructor.

The Treasure Tracer Mk III, as the model is known, operates using the BFO principle but it incorporates a unique tuning principle which is claimed to overcome the disadvantages of this system. The BFO principle makes use of two r.f. oscillators operating very close together in frequency (nominally 130kHz) and one of these uses a coil which is panned over the ground. When a metal object is brought into the vicinity of the coil the r.f. frequency changes very slightly altering the difference in frequency between the two r.f. oscillators. This difference appears as an a.f. note which is fed to a loudspeaker.

Until now the problem with this design has been in obtaining a thoroughly stable circuit and this has been hindered by the use of a variable capacitor which contributes to instability. The Treasure Tracer Mk III however has varicap tuning, overcoming this problem. The kit comes absolutely complete, even down to solder and battery and uses a fibre-glass p.c. board with the component siting printed on the reverse.

A ready built version is also available for £12.50. MINIKITS ELECTRONICS 35 Langley Drive, Wanstead, London E11.

The Treasure Tracer Mk III metal locator from Minikits Electronics

NEW R AND D CONTROLLER FOR SINCLAIR

Sinclair Radionics has appointed Mike Pye, 29 as Research and Development Controller. He takes responsibility for all new design projects including the development of a 2in screen, portable television set, a range of digital wrist-watches and an expansion of the Sinclair calculator range. Original work is also taking place on computers and integrated circuit design.

The company are placing increasing emphasis on research at their St. Ives, Hunts headquarters – in the next 12 months the research team will be expanded by more than 30%.

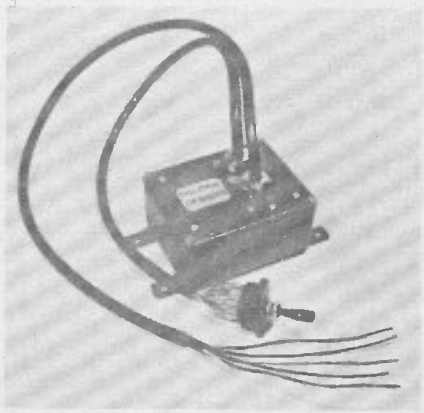
NEW TRANSISTORISED IGNITION SYSTEM FROM DOLPHIN DESIGNS

Transistorised ignition systems offer considerable advantages when fitted to almost any car; starting is much easier, the performance improves noticeably and petrol consumption is reduced. The advantages are so marked that several car makers are planning to fit this system within a few years.

The problems of electronic reliability which plagued earlier designs have now been solved and most of the units now available are electrically sound but, in

operation near the engine, troubles still occur due to 'skimping' on the housing and connections.

A recently announced Transistorised Ignition System from DOLPHIN DESIGNS overcomes these problems; reliability and ruggedness, both electrically and mechanically, are claimed to be quite exceptional. The circuit (an improvement of the design by R.M. Marston) produces the performance expected from a high quality unit but in addition the mechanical design incorporates several attractive features.



An indicator light, viewed through an epoxy seal, shows instantly when the unit is operating correctly.

The circuit will work on all 12V cars, either positive or negative chassis. Although supplied for the system requested, changing from one to the other is a simple operation enabling the unit to be transferred from one car to another.

A dash-mounted changeover switch, supplied as standard, will instantly revert the car to conventional ignition, whilst driving, either for comparison or in the unlikely event of failure (after all, even THAT car has a starting handle !)

The Transistorised Ignition is priced at £12.95 plus 30p postage and is available from DOLPHIN DESIGNS, 59, Leighton Avenue, Leigh-on-Sea, Essex.

NEW TV STATIONS

The expansion of the UHF TV network continues and the IBA have just begun transmissions from another four relay stations. As with many of the relay stations, the signals are vertically polarised, unlike the main stations which use horizontal polarisation; this reduces possible interference between stations on the same channel.

The new stations are: *Nottingham*, Channel 24 carrying ATV programmes, *Bacup*, Lancs, Channel 43 carrying Granada programmes, *Lethanhill*, Ayrshire, Channel 60 with STV and *Rhymney*, South Wales, also on Channel 60 carrying HTV. In all these stations will improve the reception, or bring colour programmes for the first time to about 50,000 people.

OPTO-ELECTRONICS FOR PETROL PUMPS

Improvements to self-service petrol pumps (notably increased delivery rates) and in many instances the poor performance of the means of transmitting quantity and price to the cash desk, has prompted the oil companies and petrol delivery equipment manufacturers to look for more accurate and reliable ways of transmitting this information. The current method of relaying this data is by rotating electro-mechanical devices opening and closing electrical contacts. Although accepted by the various authorities, these devices are prone to wear and are unreliable, causing inaccuracies and necessitating frequent servicing. Therefore, the oil companies and pump manufacturers are faced with the problem of either improving the existing electro-mechanical devices or looking for a radically different technique. Ferranti Ltd claim to have the solution in their new type-24R low-cost opto-electronic transmitter.

Recently, when Ferranti were conducting a European sales survey into low-cost optical shaft encoders, a well-known Swedish manufacturer of self-service petrol equipment was found looking into alternative ways of transmitting data from the pumps to the cash desk. On hearing of the new low-cost transmitter and after technical discussions, the manufacturer placed a pilot order for 250 units. Although marginally more expensive than existing electro-mechanical methods, the type-24R is more accurate — by some ten times — and is less prone to wear because of the non-frictional sensing element. Moreover, the intrinsic safety requirements demanded by the Petroleum Inspectorate are met because of the transmitters's non-frictional sensing and solid-state light source.

According to a NEDO report published in October 1970, only around 24% of the UK's retail petrol outlets have self-service pumps; yet these account for over half of the total petrol sales. Therefore, there is a sizeable market for new self-service installations and an even greater demand for replacing electro-mechanical transmitters with a more accurate and reliable device like the type-24R. Currently some self-service equipment manufacturers are slowly replacing their pump's mechanical counters with electronic displays. Here Ferranti consider their optical transmitter the ideal solution: for it can be mounted onto the shaft of the flowmeter and is accurate enough to measure flow directly without the need for reduction gearboxes and other interface equipment.

COLOUR TV CAMERA

Although it looks more like an 8mm movie camera, the photograph is actually of a complete colour TV camera made by Akai. At £1450 it may not seem all that cheap but this is only half the cost of comparable equipment now available.

The camera provides a signal output directly compatible with PAL standard video recorders and monitors irrespective of tape size and with an appropriate r.f. converter shows a colour image on a domestic colour TV set.

The model, known as the CCS 150 is fitted with a 6:1 ratio f2 zoom lens with a monochrome viewfinder. A highly directional microphone is built into the camera.

The Akai CCS 150 is marketed in the UK by Rank Audio Visual, P.O. Box 70, Brentford, Middlesex.

CQ, LADIES

Electronics is often regarded as an all-male preserve and it must be admitted that we know of very few ladies in the field.

The British Amateur Electronics Club have not a single female amongst their 250 members and Cyril Bogod, Chairman and Editor of their magazine wants to do something about it. He says, 'I hope you will agree that in these days of Women's Lib that this will not do; we would love to hear from any ladies interested in electronics and if they wish we shall even address them as Ms!'. So, how about it girls, if you are interested write for details of the club to C. Bogod, 'Dickens', 26 Forrest Road, Penarth, Glamorgan. Come to think of it, at ETI we are also keen on hearing from any lady readers. ●

Meanwhile, let's tell you about Rotel.

In the past couple of years, the name Rotel has come to mean the best value-for-money hi-fi equipment available.

And we intend to keep it that way.

So we've made the range bigger and better than ever.

There are two new amplifiers – the RA 810 (40W per channel at 8 ohms) and the RA 1210 (60W per channel at 8 ohms). Two new receivers – the RX 600A (30W per channel at 8 ohms) and the RX 800 (40W per channel at 8 ohms). And, for the first time, a 4 channel FM/AM receiver, the RX-154A, that will perform any 4 channel activity.

What's more, all the other models in the range have been brought right up to date.

So now Rotel offer you an outstanding range of amplifiers, tuners, receivers and headphones to suit every hi-fi need.

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BEOGRAM 4000 TURNTABLE

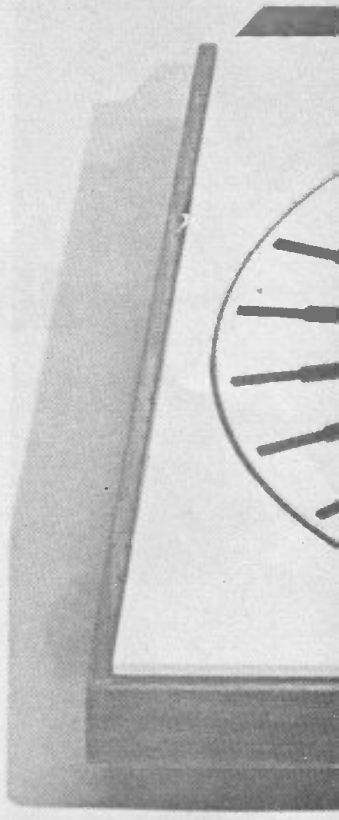
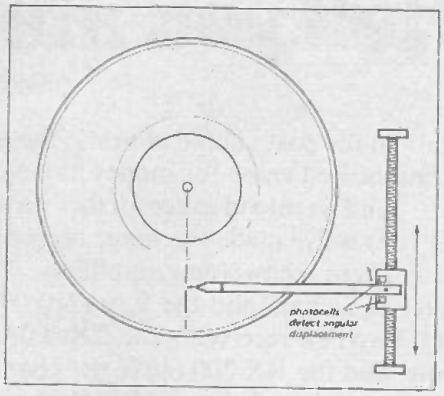
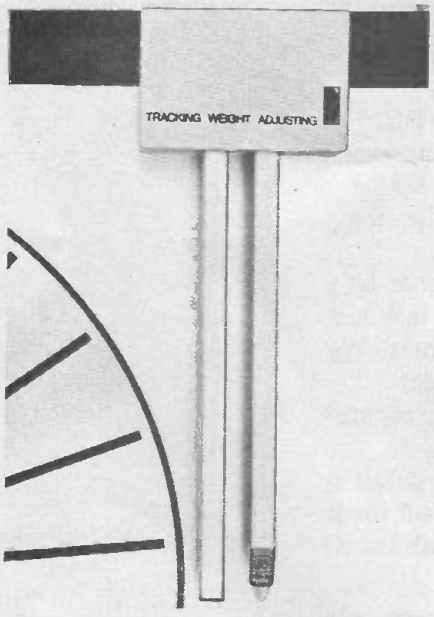


Fig. 1. Simplified drawing of Beogram 4000 shows how tone arm is free to pivot in horizontal plane. Photocells detect angular displacement and servo mechanism then drives complete arm assembly longitudinally to maintain the arm tangentially to record groove. (For simplicity the sensing arm and assembly guide rails have been deleted).





Electronically controlled turntable from Bang and Olufsen combines ingenious engineering with elegant appearance.

DEVELOPMENT of most audio equipment is done on a 'vertical' basis — each step being predicated on the rightness or otherwise of what went before. This is a very common engineering approach and leads to competent if sometimes dull results.

It is rare for any organisation to take a 'horizontal' approach, starting as it were with a fresh sheet of paper and not too many preconceived ideas of how things should be.

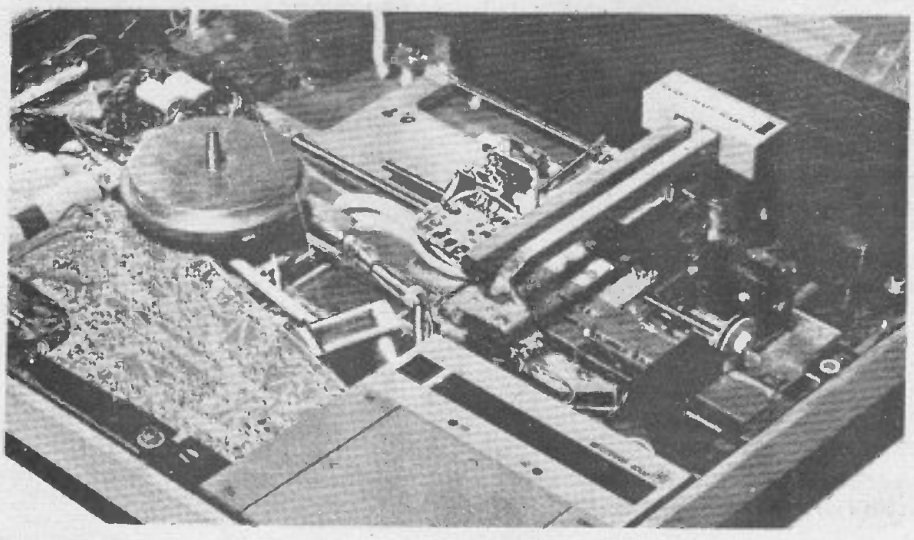
But this is what Danish hi-fi manufacturers Bang and Olufsen have done, and their new Beogram 4000 turntable is the result.

The unit virtually bristles with new solutions to old problems — from the use of a powered and tangentially moving arm — to an automatic system that senses record size and selects the correct playing speed.

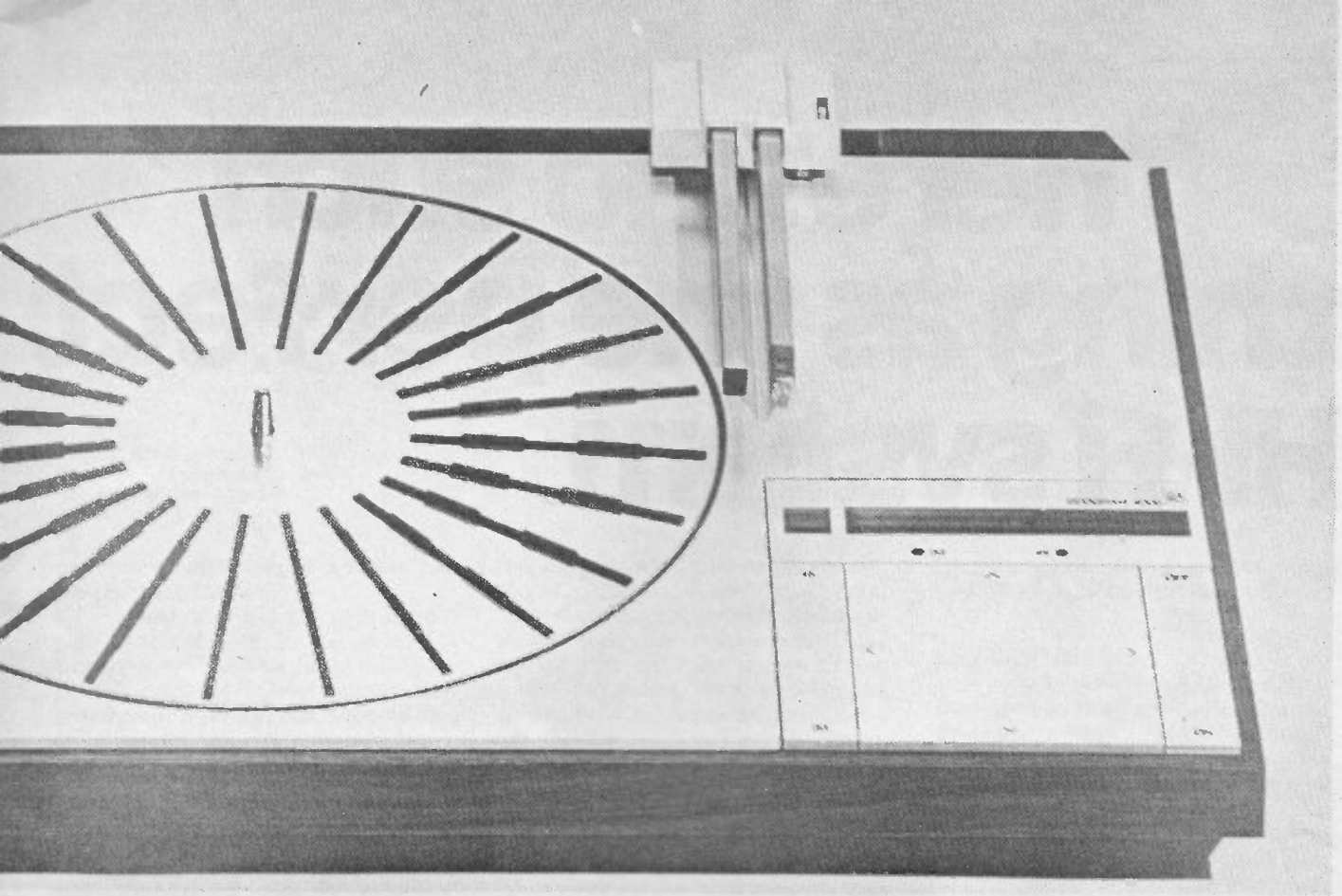
The most obvious difference between this and other turntables is the tangential arm which ensures that the pick-up cartridge moves in a straight line across the full playing width of the record. The purpose of this is to ensure that the cartridge tracks the record groove at the same angle as that of the original recording stylus.

This does not happen with conventional turntables — and in theory at least — distortion is introduced due to the stylus tracking the groove at a continually changing angle.

Manufacturers of conventional tone arms attempt to reduce this so-called tracking error by bending the arm at an angle. Although this reduces tracking errors, it does so at the



This interior shot of the Beogram 4000 turntable shows the two guide rails and drive shaft of the sliding arm assembly.



expense of introducing a force which causes the stylus to be pressed against the inner face of the record groove.

This force – commonly known as 'skating' is counteracted in good quality turntables by some form of mechanical or magnetic compensation, although in practice it is virtually impossible to provide precisely the right amount of 'anti-skating' bias across the full width of the record.

Bang and Olufsen's solution to the problem is ingenious and elegant. The tone arm, plus a second 'sensing' arm is cantilevered out from a rectangular slide which in turn is positively located – but free to move longitudinally – along a pair of 'rails'. The complete slide assembly is driven through worm gearing by a small servomotor.

Apart from the 'sensing arm' the function of which will be described later, the tone arm also carries a sensing system the purpose of which is to provide the servomotor with positional information.

The tone arm is pivoted in both vertical and horizontal planes, and the horizontal movement is monitored by a small lamp and shutter assembly in conjunction with a pair of photocells. These photocells sense any deviation of the arm away from a true tangential position, and by producing outputs proportional to the deviation, cause the servo motor driving the arm assembly to take up the 'correct' position. The system is remarkably sensitive – to the extent that tracking angle error is contained to within 0.04°.

The servo mechanism can cope with both eccentric and warped records. A very eccentric record may on occasion cause the servomotor to go into reverse – but the mechanism will ensure that tracking error is kept to a minimum. Warped records will simply cause the pick-up arm to rise and fall as with a conventional arm.

Figure 1 shows a simplified version of the system. A block schematic diagram of the servo-control system is shown in Fig. 2.

Circuitry associated with the servo mechanism is used to sense when the stylus reaches the 'run-out' grooves at the end of the record. Figure 3 shows how this part of the circuit operates. As the stylus approaches the last grooves of the record, a mechanical contact (SW) is closed by the moving slide. This contact connects the servomotor to the base-emitter circuit of transistor Q11. As soon as the stylus actually runs onto the run-out grooves, the increased lateral velocity the tone arm causes a sudden increase in voltage to the servomotor. This suddenly increased voltage is sensed and amplified by Q11 which in turn causes Q10 to conduct. Transistor Q10 switching to conduction causes Q9 to conduct – and point A (which was previously at +6V) falls to virtually zero potential. This latter action is used to operate the 'tone-arm raise' mechanism and subsequently, to initiate a fast return and and switch-off sequence.

A further logic system, operating via Q12, enables the user to override the automatic mechanism.

The purpose of the main sensing arm briefly described at the beginning of this article, is to detect the presence or absence of a record on the turntable platter, and then to ensure that the stylus is lowered onto the edge of the record – no matter what size record is used. It also automatically switches the main drive from 33-1/3 rpm to 45 rpm whenever a seven inch record is sensed.

As with practically every part of this turntable, the mechanism and circuitry used for the sensing functions are ingenious in the extreme.

The turntable platter has a reflective metal surface onto which are mounted a number of radial black plastic 'spokes'.

A small lamp and photocell housed in the tip of the sensing arm detect the

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A rigid smoke-tinted styrene dust cover and a polished wooden plinth are available as extras.

For a preview just return the coupon, or ask to see and hear the deck at your local dealer.

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BSR McDONALD

BEOGRAM 4000 TURNTABLE

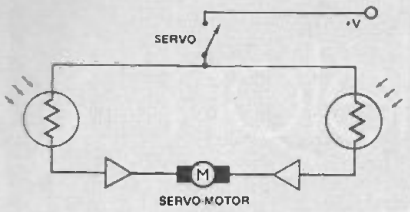
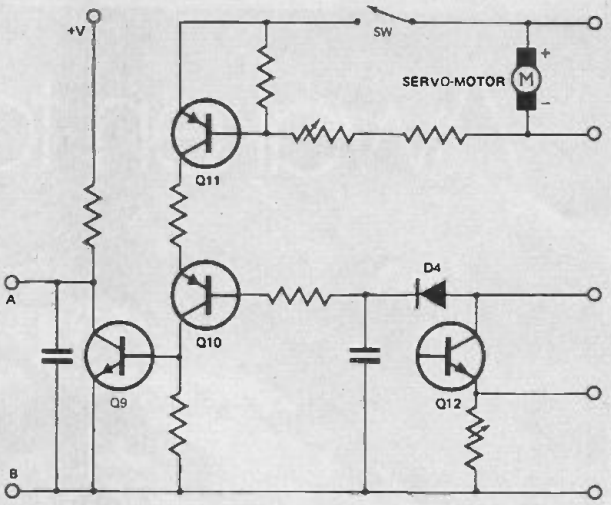


Fig. 2. Block schematic drawing of servo system used to sense angular errors in tone arm.

Fig. 3. This logic circuit detects the voltage increase as the tone arm drive motor compensates for the increased lateral velocity of the stylus running onto the run-out grooves at the end of a record. This sudden increase in voltage is used to actuate the arm return and 'switch off' mechanism.



presence or otherwise of a record on the revolving platter.

If a record is on the platter the light reflected back to the photocell from the lamp will be fairly steady – hence a constant dc level indicates the presence of a record. But if the matter is uncovered, the reflected light from the polished metal turntable will be regularly interrupted by the radial black strips, and a chopped dc voltage will be produced by the photocell.

When the turntable is switched on and the record playing sequence initiated, the sensing arm and the tone arm move steadily along their track until the sensing arm detects the edge of a record. At this point the tracking servomotor is de-energized and the tone arm automatically lowered.

The sensing arm's photocell is sensitive to the strobe effect when the turntable is in motion. Hence if the sensing arm reaches the point where the edge of a 12" record should be, and still de ects the signal from the moving ribs, it deduces that there is no 12" record on the platter. Similarly if it passes the 10" point and still detects rib movement it knows that there is no 10" record there either. It then continues inward seeking the possible presence of a 7" record. If it finds one, the turntable speed, which always starts off at 33-1/3 rpm, is automatically switched to 45 rpm. The pick-up is then lowered and the record played in the normal way.

If there is no record on the platter at all, then the sensor detects the moving ribs until the centre of the record is reached. At that point the arm is returned automatically to the rest position.

Although manual overrriding controls are provided to enable the user to lower the tone arm onto any required part of a record, these manual controls are interlocked with the rib sensing circuitry – thus ensuring that the arm can only be lowered if a disc is on the turntable platter.

Additional logic circuitry is used to monitor continuity of the lamp filament in the sensing system. If this lamp becomes open circuit, the control logic prevents the arm being lowered.

ELECTRONIC SPEED CONTROL

In common with an increasing number of high performance turntables, the main drive motor is powered by a stabilised oscillator and power amplifier. Thus turntable speed is virtually independent of mains supply voltage and frequency. Fine speed adjustment is provided – independently for both 33-1/3 rpm and 45 rpm – by varying oscillator frequency. No provision has been made for operation at 78 rpm.

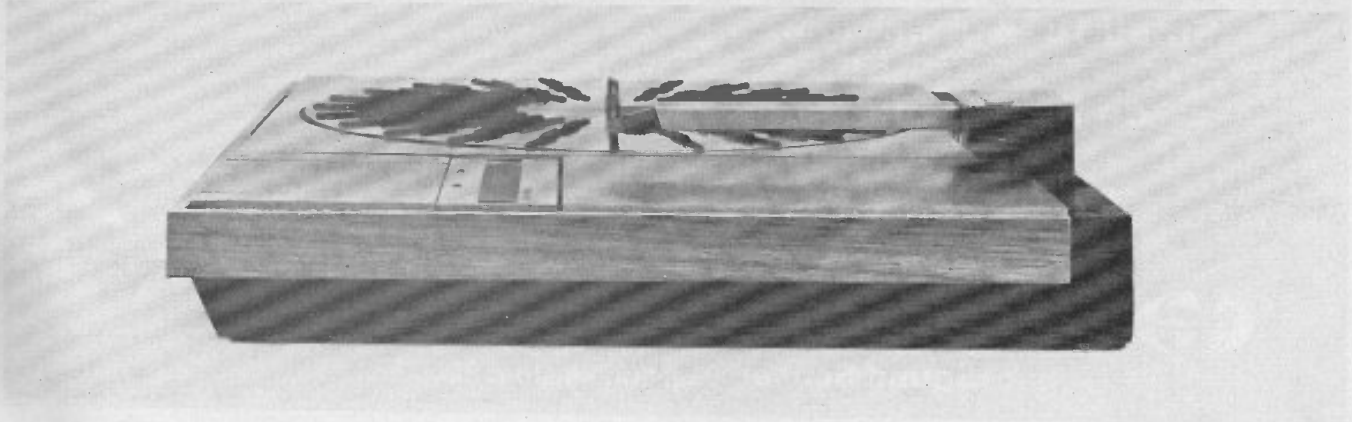
NEW CARTRIDGE

A totally new cartridge has been developed by Bang and Olufsen for the Beogram 4000 unit. Although basically conventional in design, the stylus fitted to the new SP 15 cartridge is an integral part of the unit. The whole cartridge is manufactured as a sealed unit and is not repairable. In the event of damage Bang and Olufsen supply a new replacement cartridge for half the cost of the original. Recommended tracking weight is a mere 0.8 gram.

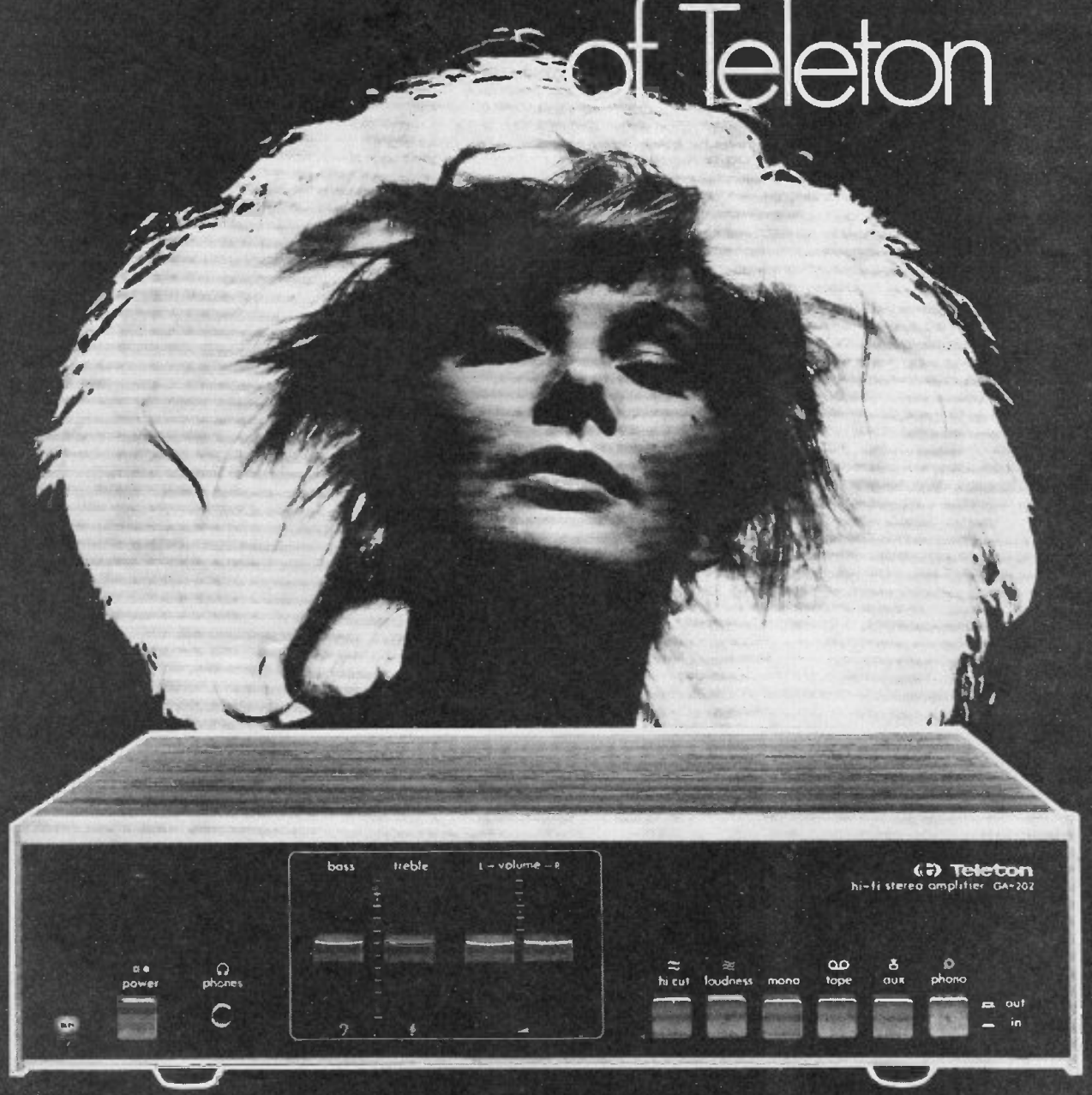
Although the Beogram 4000 was first shown in this country at last October's Audio Fair, few of these units have found their way onto the market.

At the time of going to press the price for the teak plinth version is £160.50, the rosewood version is £1 dearer. These prices will change shortly, the floating pound signals an increase but VAT will bring about a small reduction – with luck these should cancel each other out.

Electronics Today International hope to run a complete review of this unusual unit in the near future, it is not an inexpensive turntable but the features may well herald a new approach by all the manufacturers. ●



Awaken to the sound of Teleton



Join the procession in Aida. Smell 1812 gunsmoke. Shiver on Bare Mountain. *Awaken to the sound of Teleton.*

There's a new world of high fidelity in a Teleton sound system, with the GA 202 amplifier at its heart to bring you new standards of purity, new heights of quality in the faithful reproduction of the world's greatest music.

The Teleton GA 202 combines all the latest advances in hi-fi technology—calibrated slider controls for bass, treble and channel volume, hi-cut filter, loudness contour, headphone socket, tape and auxiliary inputs, to give you 16 watts per channel (RMS) at under one per cent distortion, 30-30,000 Hz—the soaring choruses and the whispers of a cathedral inside an elegant walnut and brushed aluminium cabinet.

Listen to the Teleton GA 202—your ears have been asleep. Price £50 recommended retail.

Teleton
Sound Sense

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Tel : Chelmsford 62442.

WHAT'S A WATT?

I must offer some criticism of the article entitled "How Many Watts?" (Electronics Today —April 1972 issue).

It is directed at the section headed "What's a Watt?" The explanation given in the first two paragraphs of the section is quite misleading. The definition of the rms value of a sinewave is correct but only applies to voltage or current, and not to power.

For test purposes an audio amplifier would be connected to a pure resistance as a load, so that voltage and current would be in phase. If they are sinusoidal and of frequency f Hz, then the power in the load also fluctuates sinusoidally at 2f Hz. The product of V and I (both rms values) gives the average or mean value of the power which is half of the peak power.

The rms value of the power waveform can be calculated but it has no significance. To any electrical engineer, or to an engineering student, the word "power" is always taken to mean the average value. With non-sinusoidal waveforms, "peak power" and "average power" retain their significance and are useful terms, although the factor of one half mentioned above no longer applies.

I realise that the term "rms power" is widely used nowadays to describe the output of an audio amplifier when, in fact, "average power" is intended.

I cannot understand why this error in terminology has arisen. It is bad enough when used in manufacturers' advertisements and I feel that it has no place at all in an article which purports to be technical.

Yours sincerely,
T. Brownlee, C. Eng.
Head of School of Engineering,
Caulfield Institute of Technology.

The above letter arrived on our desk some time ago — and for a short time it created quite a stir.

Our correspondent is quite correct. His point is true by definition. The rms value of a power wave-form *has* no significance.

As our correspondent points out, the only term that has any real validity is 'average' power. For those who are interested the relevant mathematics are set out in the accompanying panel.

Technically we are in the wrong — but we are in very good company — for almost without exception, technical journals, testing consultants and audio equipment manufacturers the world over — also use this term.

So why do we do it?

We do it for the sake of clarity — as we feel sure do most other journals.

Manufacturers do it for another reason, perhaps mistakenly, but nevertheless with good intentions.

The reason is that there are many different ways of expressing the power output of an amplifier, and most of these ways have some validity.

For example, the argument used to justify instantaneous or 'music' power ratings is that orchestral music has a very wide dynamic range. The average power may be quite low yet when there is an orchestral crescendo the instantaneous power requirement may be very high.

Therefore, say the 'instantaneous' power protagonists, let us quote the output in terms of what the unit can produce for a short time, a measurement in fact of the 'instantaneous' power output.

This can be quite a large number. Just how large depends on how the measurement is taken. For 'instantaneous' is not a very precise term.

Is the measurement taken for a few seconds, one second, or perhaps just a few milliseconds?

And at what level of distortion? A realistic 1% to 2% — or is it taken at the current US figure of 5%. Or with the power transformer on fire?

At the other extreme 'pop' music tends to be more uniform, and therefore the available average power is a more relevant quantity.

NO RECOGNISED STANDARD

There is no internationally

recognized standard for amplifier power ratings, and until a decade or two ago average power was the figure implied when power output was quoted. If a specification read 'Output Power – 20 Watts' you knew exactly what it meant.

At least you did if you were in Europe or were looking at a European amplifier.

The Americans on the other hand used a system that enabled a 10 Watt European stereo amplifier to be marketed in the US at 40 to 60 Watts.

(Rolls Royce ran up against a similar problem with horse-power ratings of their cars. But rather than accept a phony measurement they described their power output as 'adequate'. Not that it did them much good.)

The US rating is converted into the European rating as follows:-

(1) divide by two to obtain the output per channel.

(2) divide by one and a half to obtain an approximate conversion from short duration signals in one channel to continuous signals in both channels.

(3) divide by two to convert from peak to average power.

In other words divide the quoted figure by between four and six and this will approximate the average power per channel.

BUT WHY RMS?

The argument is that the buying public must have some basis for comparison and that whilst an rms figure is technically incorrect, it has the implication of the method of measurement. This implication is not carried by average or continuous power.

The term rms Watts is in fact a pseudonym for average power, or in another context, continuous power, and, technically correct or not, it has become a generally accepted expression. As we found out when we rang the design engineers at two of Britain's leading manufacturers, Their reaction was a surprised "what's wrong with Watts rms?".

Our correspondent is, as we have said, perfectly correct and we *also* deprecate terms that have precise meanings being used in such loose fashion.

But does it really matter all that much? After all, there are no internationally accepted methods of either measuring or quoting amplifier power output. At least we all know what is implied by Watts RMS, even if the term is technically doubtful. Those who consider that it does matter must read this to mean average watts.

As Chaucer sayde – "Forgetting not uniforme and goodly laws of propre tonge, the ways of manne and his colloque shul shew doutles how it is to be sayde".

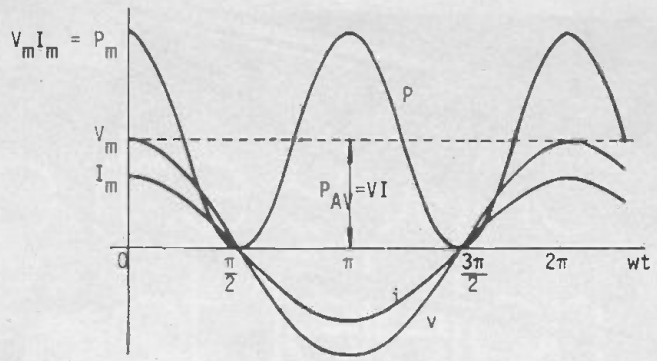


Fig. 1 – Relationship between voltage, current and power curves in a resistor.

(a) for resistive loads and sinusoidal inputs. V and I as functions of time are:–

$V_1 = V_m \cos 2\pi ft$

$I_1 = I_m \cos 2\pi ft$

where V_m is the max. instantaneous voltage and I_m is the max. instantaneous current.

The resistive load R, the applied voltage V, and the resulting current I.

Then V and I as functions of time are respectively:–

$V_1 = V_m \cos 2\pi ft$

$I_1 = I_m \cos 2\pi ft$

Where V_m is the maximum instantaneous voltage and I_m is the maximum instantaneous current.

The instantaneous power is given by V x I = P.
Thus power is given by:–

$P = V_m I_m \cos^2 2\pi ft.$

This quantity is plotted in Fig 1. As can be seen, the power varies between 0 and $V_m I_m$ in a sinusoidal manner and the average power is $V_m I_m/2$. Using Ohm's law this is equivalent to $V_m^2 R/2$ or $I_m^2 R/2$ Thus we define the effective voltage and current so that the average power is given by P = VI, and the relations between the rms and peak value are

$V = V_m/\sqrt{2}$ and $I = I_m/\sqrt{2}$.

(b) A similar argument (although more complex) for non-sinusoidal signals produce the equivalent voltages and currents as

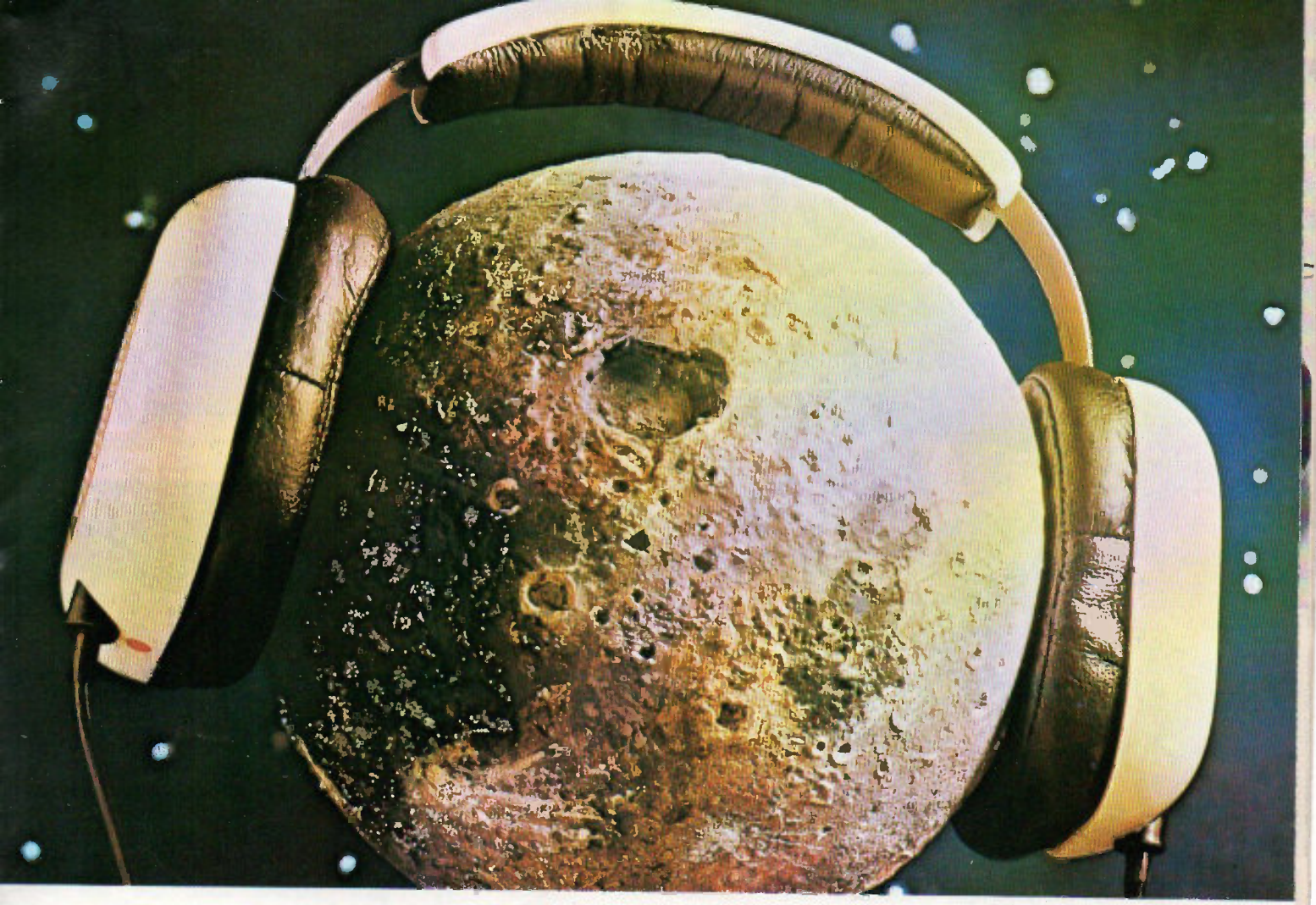
$V \sqrt{\text{ave}(V_1^2)}$ and $I = \sqrt{\text{ave}(I_1^2)}$

hence the term 'root mean square' which is a way of expressing the operation of squaring the voltage (or current), taking the average or mean, and then taking the square root of the result.

Whilst this may seem complicated, the meters which we (and most other laboratories) use for measuring voltage or current perform this operation automatically.

Thus as we see from the above, the rms voltage is defined through the average power and nowhere is rms power defined.

Congratulations are due to Alex Mellon, Advertising Manager of ETI, and his navigator, Trevor Robertson, for coming second in the Press Section of the Mobil Economy Run. Alex is a veteran rally enthusiast with plenty of trophies on the shelf and he is at present testing for ETI a special project designed for the motorist. Plans must remain secret at the moment but we have a real winner under our belts and, all being well, we shall be making an announcement in the near future.



Wharfedale Hi Fi Isodynamic Headphones.

(Isodynamic, *adj*. Of or pertaining to equal (magnetic) force).

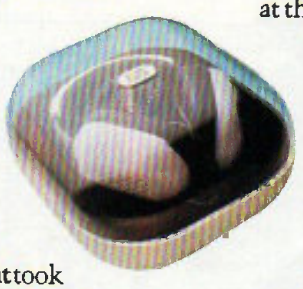
Mission Accomplished: electrostatic quality for less than half the price.

That was our mission.

The same superb quality of performance as electrostatic headphones. But for less than half the price.

And by going to the moon we've accomplished it.

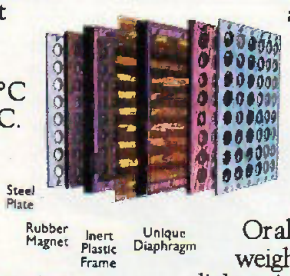
Because one of the things that took man to the moon was a unique polyimide film. And we've turned it into a unique diaphragm. Giving you pure stereo sound at the revolutionary price of £19.95*.



Plus. Lightweight comfort. And good looks. Complete with this elegant foam-lined container with transparent lid. It'd look good beside your deck. And let you store the phones neatly and dust free

Unique Diaphragm

In the NASA space capsules polyimide film has to withstand great temperature fluctuations. As low as –269°C or high as 400°C. And it also has to withstand tremendous vibrations. So it has to be flexible. But without destroying the printed circuitry. Which is bonded into the polyimide film.



Rubber Magnets

Another Wharfedale Hi-Fi exclusive. Which give you an equal magnetic force from lightweight magnets. And so avoid the heavy iron magnets used in more conventional headphones.

Weightless Capsule

Or almost. For the whole lot weighs a mere 13ozs of sheer lightweight strength. So you can wear the phones for as long as you like. And if you'd like the full inside story then fill in the coupon.

*Manufacturer's recommended retail price at time of printing.

UK and Foreign Patents exist. Further Patents applied for.
UK Registered Design No. 956537. Other Design Registrations Pending.
Made in England.

Wharfedale Hi Fi. Pure and simple.

HET/5

Send me details of Isodynamic Headphones and your nearest recommended dealer.

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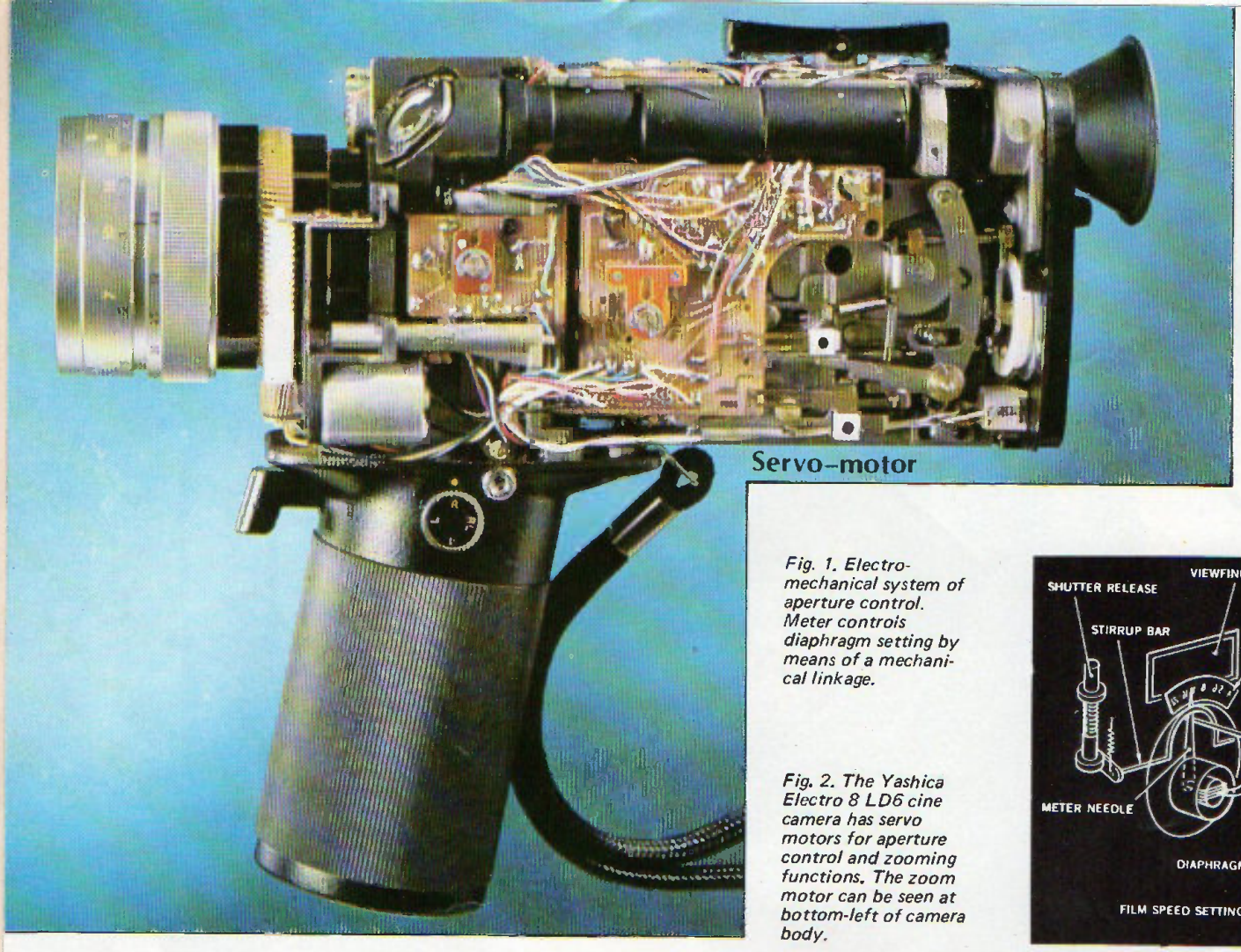


Fig. 1. Electro-mechanical system of aperture control. Meter controls diaphragm setting by means of a mechanical linkage.

Fig. 2. The Yashica Electro 8 LD6 cine camera has servo motors for aperture control and zooming functions. The zoom motor can be seen at bottom-left of camera body.

AUTOMATIC CAMERAS

Latest cameras incorporate electronic systems to provide previously unmatched operational features — Brian Chapman reports.

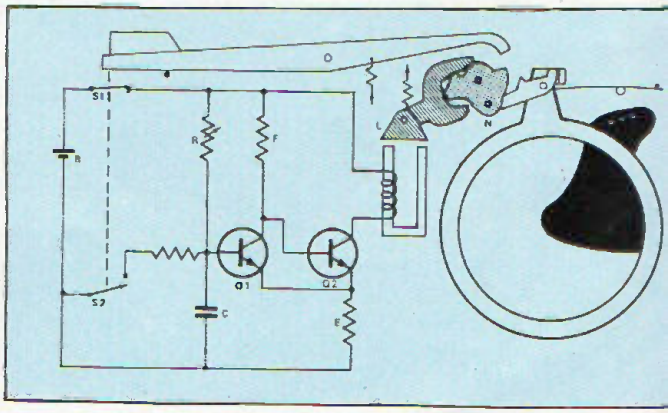


Fig. 3. Typical electronic control system for Compur type shutter uses electromagnet and transistor timing circuit to programme the shutter.

AROUND 10 years ago the first cameras incorporating electronic systems were introduced to the market by companies such as Minolta and Yashica. Unfortunately the use of such terms as "Electronic Brain" and "Computerized Shutter" did not go down well with the public. The buyer felt that all these electronic additions were of dubious value and liable to be expensive to repair. In fact Minolta was forced to withdraw its first electronic model because of sales resistance. When they did re-enter the market, it was with a changed advertising image which played down the electronic features and concentrated on the functional advantages of the new cameras.

Nowadays there is a proliferation of cameras in the $50 to $150 bracket which feature electronic control of shutter, diaphragm or both.

Fully automatic exposure control has been incorporated on cheaper cameras allowing 'point and shoot' photography, but until recently, although cameras in the medium to high price brackets have been fitted with electronic shutters and TTL (through the lens) metering, they have retained semi-automatic operation. This again has been because of buyer resistance amongst advanced amateurs and professionals who, quite rightly, insist on having over-riding control.

Now the last vestiges of such buyer resistance seem to be crumbling and, in the top price bracket, fully automatic cameras with overriding manual control are coming onto the market. Typical amongst these are the Pentax ES and the Yashica Electro AX.

PRACTICAL SYSTEMS

The age of automation in cameras really began when light meters were first built into camera bodies. From this first step it was only logical to develop a method of controlling aperture directly by means of the internal metering system. This method of automation was in fact the subject of patent applications as early as 1902 but a practical system was not developed until the advent of the photo-voltaic cell in 1930, and another 30 years were to elapse before the technique became commercially feasible.

One of the earliest electro-mechanical systems is illustrated in Fig. 1. Here the film-speed setting dial adjusts the position of a stop ratchet and the photocell produces a meter needle deflection which is indicated on a scale visible in the viewfinder. When the shutter release is pressed a stirrup bar closes down until a scanner, driven by the closing diaphragm, hits the meter needle thus stopping the diaphragm from closing further. This action automatically determines the correct aperture to be used for the exposure.

Automatic control of the diaphragm is performed in conjunction with selected film speed and shutter speeds. The shutter speed setting is usually coupled to a potentiometer in series with the photocell circuit, or, to a mechanical means of varying the light entering the photocell, alternatively, the sensitivity of the meter may be varied by a magnetic shunt,

The electromechanical systems as described above, although quite reliable under normal circumstances, are mechanically complex and delicate. One of the most common causes of trouble in such cameras has been failure of the metering system. Unless the camera has manual override such failure makes the camera unusable. Additionally repairs of such systems are invariably quite expensive.

With photo-conductive cells more versatile systems may be used. The cell may be placed in a bridge circuit and, when the bridge is unbalanced, a servo-motor is used to open or close the lens aperture until bridge balance is achieved. Such systems as this are seldom used in still cameras, but are very popular in electronically controlled cine-cameras. The Yashica Electro 8 LD6 is typical of such better quality cine-cameras and includes servo-motors for aperture control and zoom functions (see Fig. 2).

ELECTRONIC SHUTTERS

Aperture control was the easiest to implement in the past but now most new cameras are using electronically controlled shutters to provide automatic exposure. The beauty of using an electronic shutter is that the whole of the aperture setting mechanism is eliminated as well as the light meter of earlier control systems.

A typical electronic shutter control is as shown in Fig. 3. and an actual shutter mechanism from a Yashica Electro 35 is shown in Fig. 4. This Compur type shutter is exactly the same as that used in a manual camera except that the escarpment controlling the exposure time is replaced by an electromagnet. The shutter is held open for a period determined by the associated electronic circuit in the following manner.

When the shutter release is pressed S1 closes and transistor Q2 conducts energizing the solenoid. The armature is attracted to the solenoid, the shutter blades open (one only shown for convenience) and are held open as the pawl, linked to the armature, blocks the movement of the rotating member N. This situation persists as long as the solenoid is energized. Initially

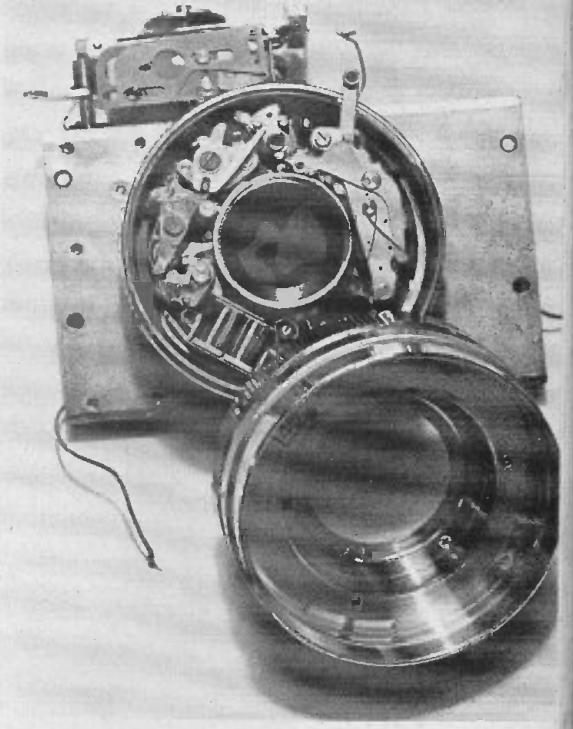


Fig. 4. Shutter assembly of the Yashica Electro 35. The electro-magnet can be clearly seen bottom left.

transistor Q1 is not conducting and capacitor C charges via R. The resistor R is usually a photo cell whose resistance is high with low light levels (hence longer charging time for C) and low for high light levels. When C has charged sufficiently, Q1 conducts shorting out the base/emitter of Q2 which turns off, de-energizing the solenoid and closing the shutter.

A further advantage of shutter control over aperture control is that shutter times may be extended to 30 seconds or more electronically, providing excellent low-light level performance, whereas reliable mechanical shutters with exposure times longer than about 2 seconds cannot be made. Hence low light level performance with aperture control is limited by the maximum aperture available.

The first widely accepted camera to use electronic shutter control was introduced by Polaroid in 1963. The shutter was designed for them by Yashica and is elegantly simple mechanically. Basically the same electronic control circuit as for Compur type shutters is used, a typical configuration being as shown in Fig. 6a and 6b. The mechanical construction of the shutter is shown in Fig. 7a and 7b.

Operation of the circuit is as follows. When the shutter release is pressed TR2 conducts and the solenoid is energized. Both the opening and

AUTOMATIC CAMERAS

Fig. 5. Topping the line of the new "300 series" of Polaroid Colour Pack Cameras, the Model 350 Land Camera features a transistorised electronic shutter and an electronic development timer.
The electronic timer is built into the back of the camera. After loading a film pack into the camera, the user simply dials the recommended development time (60 seconds for colour, 15 seconds for black-and-white) into the timer, which then becomes fully automatic. As the user pulls an exposed film pack from the camera, the timer lights up and begins a silent "countdown". When the picture is fully developed, the timer light goes out and a distinct "beep" signals that the picture is ready.

closing blades are mechanically released but the closing blade is restrained by the solenoid. Light passes from the lens through the aperture wheel and the hole in the opening blade to the negative. At the end of the timing period (as explained before) TR1 conducts, TR2 cuts off, the solenoid releases the closing blade which snaps over, thus terminating the exposure.

In order to control shutter speed over the full range there are several different timing capacitors selected by a switch on the aperture wheel.

Shortly after the release of Polaroid's camera, Yashica introduced their own electronic camera with between-the-lens shutter as shown in Fig. 4. Shutter speeds available are from 1/500sec to a full 30 seconds making photography possible under the most adverse lighting conditions. Unique warning arrows are visible in the finder, 'Yellow' signals a slow shutter speed, and 'Red' warns against over-exposure. The aperture is adjusted until both arrows are extinguished.

ELECTRONIC FOCAL PLANE SHUTTERS

Electronic control may be applied to focal plane shutters as well as between-the-lens shutters and a typical example of this is the Yashica TL Electro-X.

A diagram of the shutter control system is shown in Fig. 8 from which the control circuitry can be seen to be the same as that discussed previously. Adjusting the speed dial varies capacitor charging time as does illumination changes on the cadmium sulphide (CdS) photocell. Thus the metal focal plane is electronically controlled for speeds from 1/1000 sec to 2 seconds. One can preselect either aperture or speed and then vary the other to obtain correct exposure indication by the viewfinder arrows.

The above semi-automatic operation has proved to be very popular and there are many cameras in the middle-price bracket which feature this system. The Canon range has been particularly successful with the QL series. Now that public acceptance of electronic control has increased, several manufacturers are introducing (or already have) fully automatic control on the higher priced cameras in their range. Cameras typical of this trend are, as mentioned before, Pentax ES and the Yashica Electro AX. These cameras have the essential feature of automatic or manual shutter selection which is demanded by serious amateurs and professionals. The Pentax has an interesting feature in a special dial to compensate for problem lighting conditions. It allows preset modification of exposure from half to four times normal whilst still retaining the automatic action.

Both the Pentax ES and the Yashica AX offer an automatic shutter speed range of 8 seconds to 1/1000 seconds, a valuable range previously unobtainable with mechanical systems.

It seems that this is the way all better quality cameras will go. The automatic shutter offers speeds unobtainable by conventional methods and the incorporation of electronics allows a host of other features to be built in at relatively small cost. Facilities such as automatic flash, when fitted, make these cameras ideal for universal, calculation-free, photography, The Minolta Hi-matic F is a typical medium priced camera that features automatic flash exposure control in addition to normal automatic operation, Fig. 10.

INSTANT PHOTOGRAPHY

Ever since the days when they struggled with massive cameras and took shots in broad daylight with the aid of one second exposures and half a pound of magnesium powder, photographers have dreamed of a fully automatic camera where one merely had to press a button and a fully developed perfectly exposed colour photograph emerges from the camera.

Now Polaroid have done just that – they have introduced a new camera, the SX70, which automatically ejects a self developing colour print 1.3 seconds after the exposure button is pressed.

As a young student at Harvard University Edwin H. Land became extremely interested in experiments on polarizing light. He became so involved in these experiments that he abandoned his degree course in order to devote his full time to them. In 1928 at the age of 18 he succeeded in polarizing light with acetate sheet and certain forms of iodine. After a further 9 years spent developing the polarizing process he founded the Polaroid Land company which during the second world war made considerable profit from the sale of anti-glare goggles to the armed forces, and subsequently, polaroid sunglasses to the general public.

Then in 1943 Land conceived the "Instant photography" process and subsequently introduced the first

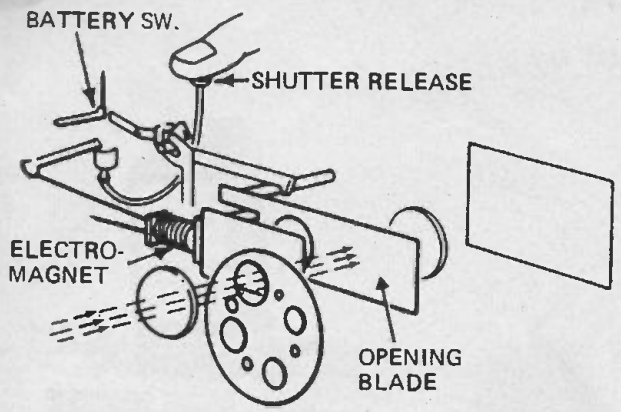


Fig. 6a. The Polaroid Land shutter just prior to release. The opening blade prevents light from reaching the film.

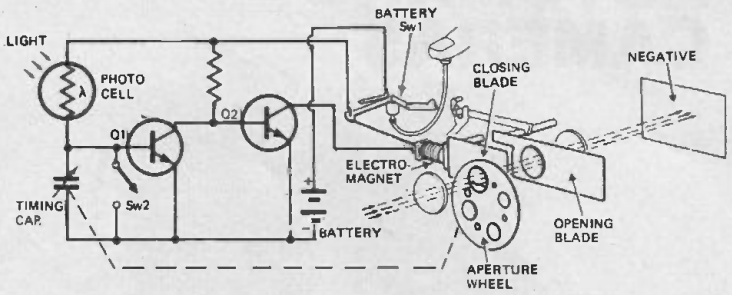


Fig. 6b. The Polaroid land shutter after release. The opening blade now allows light to reach the film via the lens and aperture wheel. At the end of the timing period the closing blade will be released by the electromagnet and terminate the exposure.

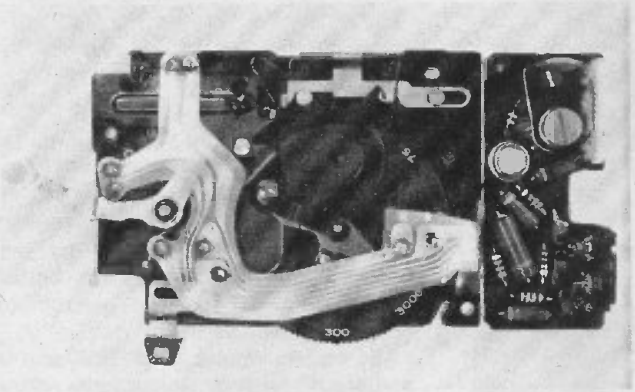


Fig. 7a. The Polaroid Land shutter from the front. The transistor timer is on the right.

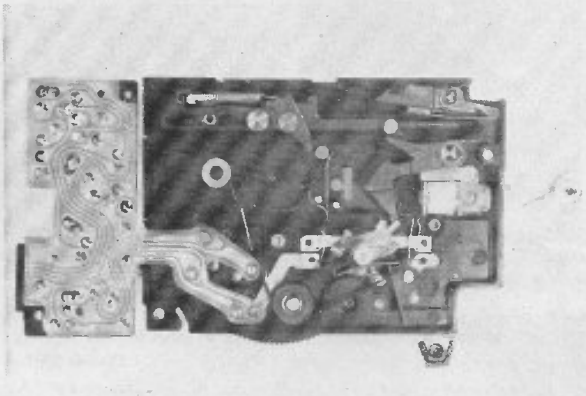


Fig. 7b. Rear view of the Polaroid shutter. The electromagnet can be seen at middle right.

Polaroid-Land model 95 camera in 1947. In this camera the negative is first exposed, and then brought into contact with a positive. Both sheets are drawn through a pair of rollers which rupture a pod attached to the positive and squeeze the jelly-like substance from it across the sheet. After 10 seconds development, the sheets are separated, the negative discarded, and the fully developed print treated with a fixing chemical.

Although many improvements have been made to both camera and film in the ensuing years, the basic process remains the same for all cameras in the range till now. Polaroid has marketed some 26 million cameras and it is claimed that they sell more cameras in the $50 and over class than all other companies in the world combined.

THE SX70 CAMERA

And now another breakthrough – a revolutionary new camera and film have been introduced by Polaroid. The new system produces a developing picture, hard, dry and sheathed in unscratchable plastic, just 1.3 seconds after the user touches the red electric shutter button. The pictures develop outside the camera even in the brightest sunlight. They are of much

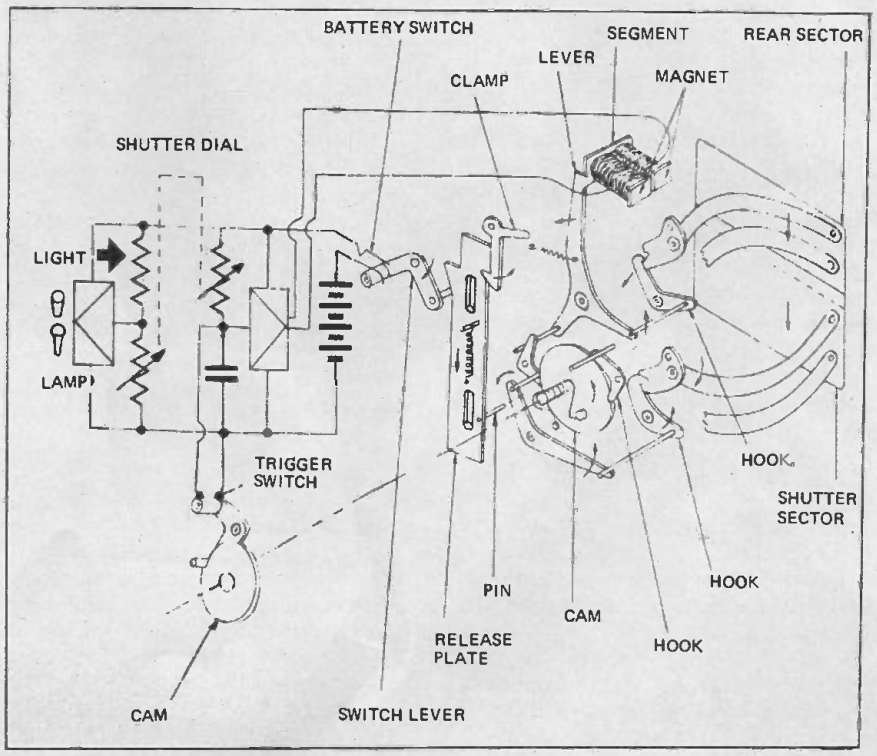


Fig. 8. The metal focal-plane shutter and electronic control of the Yashica TL Electro X.

AUTOMATIC CAMERAS

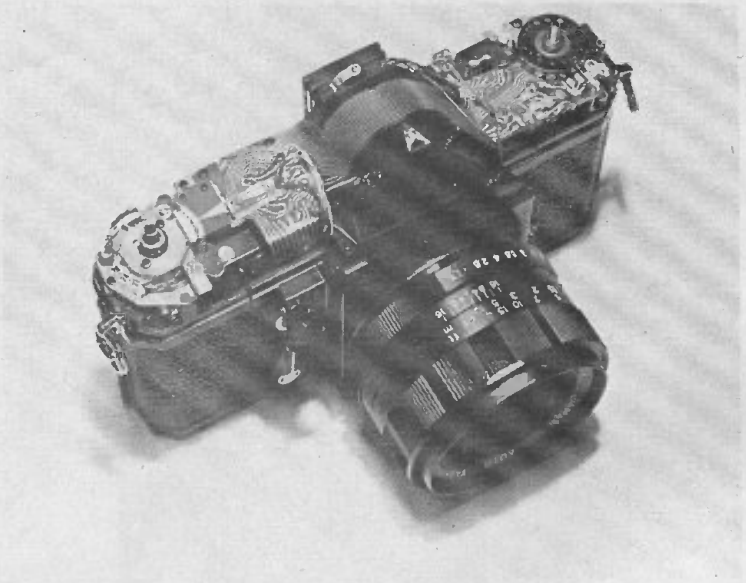


Fig. 9. The Yashica Electro AX is a fully automatic SLR with manual override. The camera has a flexible printed circuit wiring harness which can be seen at top.

Fig. 11. The Polaroid SX 70 camera in use showing how the film is automatically ejected from the camera.

Fig. 10. The Minolta Hi-Matic F is a medium priced automatic with electronic flash control.

better quality than offered by the older Polacolor film, have better colour saturation and no perceptible grain structure.

The camera retails for $US180 and is a unique folding single lens reflex which when closed, measures 7 x 4 x 1 inches. It weighs only 24 ounces, less than the lens alone on many conventional 35mm single lens reflex cameras. It is opened to its operating position by simply pulling the viewfinder housing upward (Fig. 12). When opened, the camera's profile is roughly triangular, with the viewfinder a smaller triangle above.

The film pack, costing about $US6.90 for 10 colour shots, is inserted from the front of the camera (Fig. 14). When the pack is inserted the camera automatically ejects the top dark-slide cover of the film pack which is then ready for the first exposure.

The lens of the SX70 camera is capable of an extremely broad range of focus. It will in fact focus down to 10.2 inches to give a 1:2 magnification. This is achieved by moving only the front element of the lens, which travels less than one-quarter of an inch. The lens is therefore so compact that even with the front element fully extended for close ups, the camera may be folded shut.

The reflex view system employs a mirror-folded light path through the camera, rather than the bulky penta-prism of a conventional single lens reflex. For many years the usefulness of folding the light path between lens and film has been recognised but not considered practical.

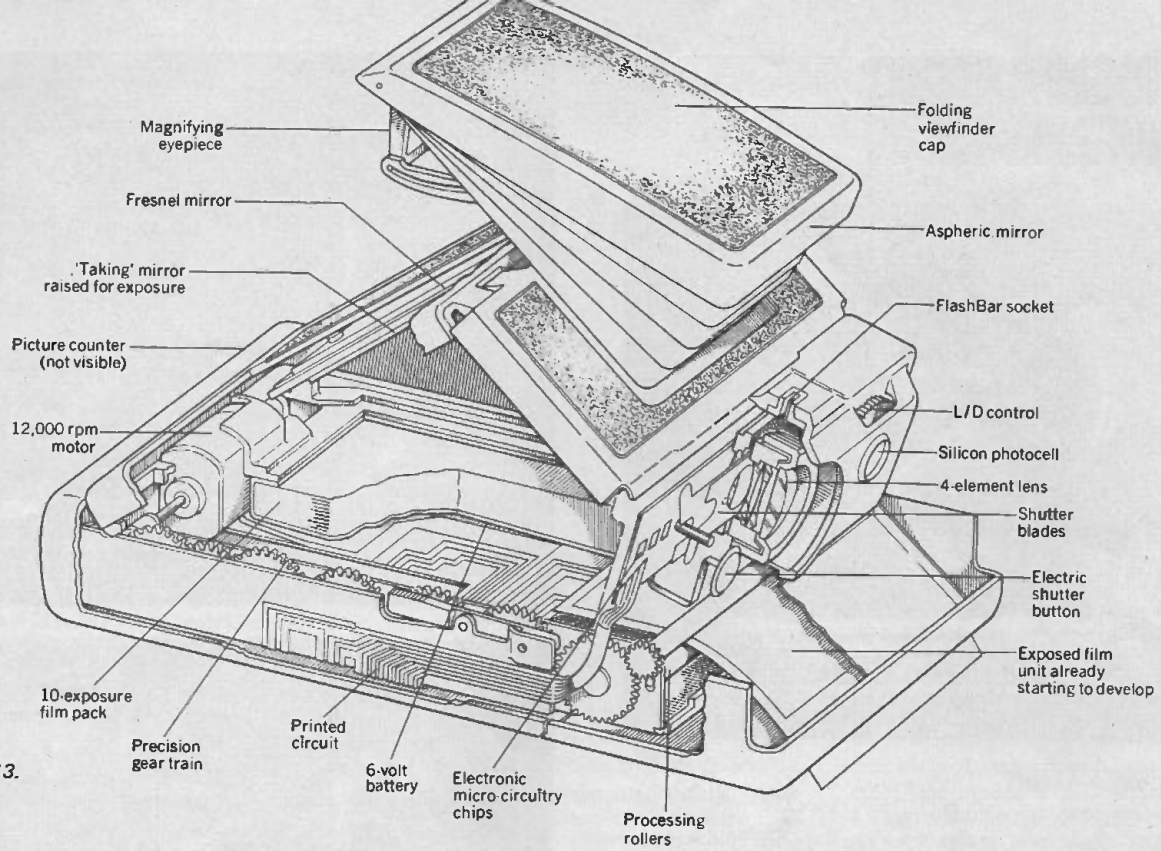


Fig. 13.

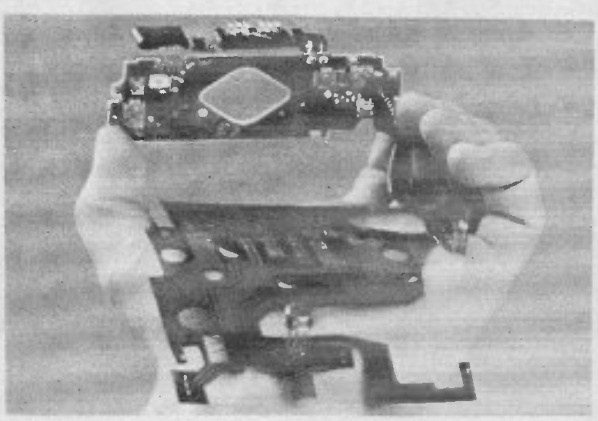
A mirror permits a longer focal length lens for a given film size, and a more compact camera. There are two principle objections to using such a mirror. Firstly it provides a reversed image, and secondly, using conventional lens, shutter and control mechanisms a compact camera could not be built. The first of these objections was invalidated by the requirement of the new film pack for a reversed image. The second objection was overcome by designing special lens, shutter diaphragm, control mechanism and solid-state electronic control for the new camera.

Fig. 13. Cutaway drawing shows location of principle components of the Polaroid SX 70 land camera.

Fig. 14. The camera is loaded by inserting the film pack from the front. Film-pack dark slide is automatically ejected.

Fig. 15. The solid state module and the printed circuit card shown in the relative positions they occupy in the camera.

Fig. 12. The Polaroid SX 70 camera shown here in both open and closed positions, snaps open when the viewfinder housing is lifted.



AUTOMATIC CAMERAS

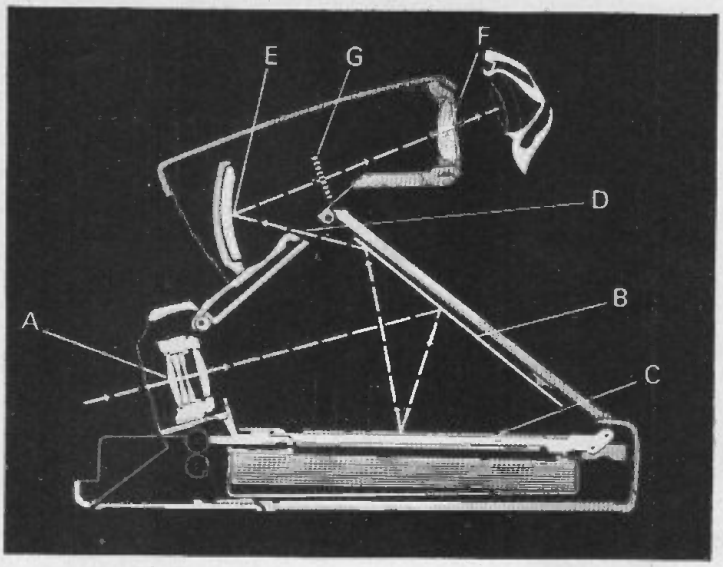


Fig. 16a.

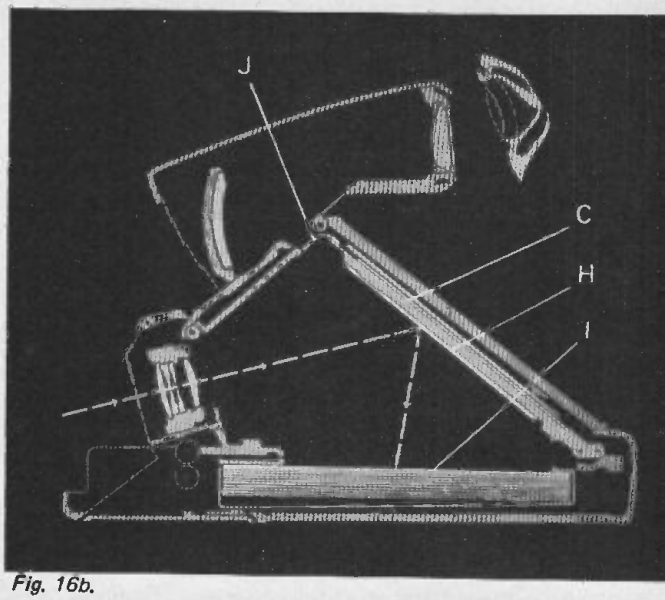


Fig. 16b.

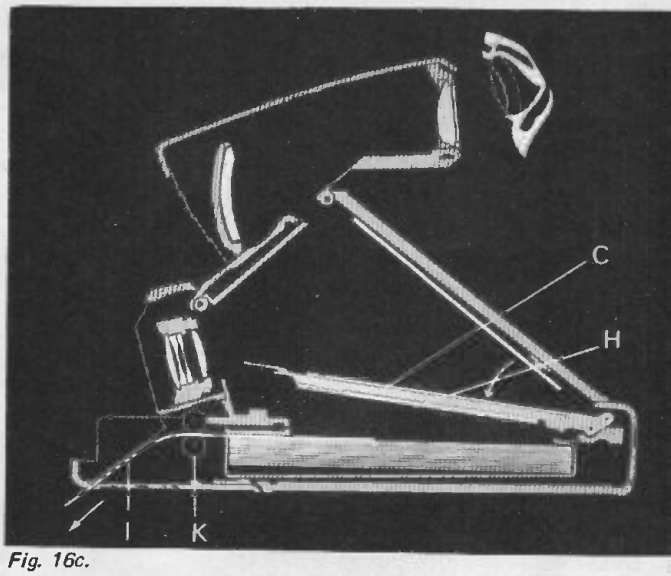


Fig. 16c.

Fig. 16a. Camera in the viewing mode.
Fig. 16b. Arrangement at instant of film exposure.
Fig. 16c. Operation after exposure.

CAMERA OPERATION

Light enters the camera through a four-element glass lens (refer to Fig. 16a) at (A) strikes a permanent viewing mirror of aluminized glass (B) and reflects down onto a special, plastic, 200 groove per inch Fresnell mirror (C), the surface of which is roughened to provide a ground glass screen effect. The mirror gathers all light, incident on it, into an off-centre beam and projects it out of the camera through a one-tenth inch diameter exit-hole. The emergent light beam strikes a concave, aluminized, aspheric (not spherical) mirror (E). As the light rays strike this mirror from below its centre line, a special shape is required to correct image distortion. The actual shape is a section of an ellipsoid and its design is said to have consumed a full 2½ years of computer time. The aerial image formed by this mirror at (G) is viewed by means of a magnifying aspheric eyepiece at (F) and comes to focus again just behind the pupil of the viewer's eye. The scene is presented right side up and correctly positioned left to right. Focus is easily achieved as the image is very bright despite the maximum aperture available of f8.

To make an exposure, the photographer simply touches a red electric shutter button whence the following sequence is initiated (refer Fig. 16b). The shutter closes and an electric motor drives the Fresnel mirror (C) up against the back of the camera bringing a trapezoidal 'taking' mirror on its under surface into the light path.

This mirror reverses the image into the correct left-to-right orientation as it reflects it down onto the now uncovered negative (I) in the film pack. A small rubber flap (J), attached to the pivoting carrier which holds the Fresnel mirror and 'taking' mirror, seals the exit hole at the top of the camera to prevent a light leak during exposure. The required exposure is determined by a sensitive silicon photo cell the output of which controls, by means of logic circuitry, the combination of shutter speed and aperture to be used. The aperture is variable from F8 to F90 and the shutter from 1/100th of a second to about 20 seconds. A total of five integrated circuits containing 260 transistor functions are used to control exposure and the sequential camera operations.

Operation of the SX70 shutter is basically similar to that of earlier models. The same blade type shutter blades are mounted between the 3rd and 4th elements of the lens. The new shutter incorporates wider speed range than previous models and integrated, rather than discrete, control circuitry.

After exposure the film unit (I, Fig. 16c), is automatically driven through two small rollers (K) which rupture a pod of reagent and spread it between the film unit's positive and negative sheets to begin the developing process. Simultaneously, the pivoting Fresnel and 'taking' mirror assembly swings down to cover the film pack and the camera returns to the viewing mode for the next picture.

It takes a mere 1.3 seconds from pressing the red electric button till the emergence of the turquoise-green exposed film from the front of the camera. Power for the camera logic circuits and drive motor is derived from a battery built into the film pack. Thus the photographer need never be concerned about flat batteries, the battery is renewed each time a new film pack is inserted and has sufficient reserve power to handle 150 shots even though there are only 10 per pack.

THE FILM

Although the camera itself is remarkable and revolutionary, the film is even more so and represents a daring

AUTOMATIC CAMERAS

and costly gamble on the part of Dr. Land – for the film and camera were seven years and 250 million dollars in the making. Pollution conscious Land was determined to reduce the garbage and sticky fixing chemicals associated with previous film and the only way around the problem seemed to be to have the film self-developing outside the camera in ordinary lighting.

Land is never one to think small and he merely ordered his chemists to come up with an opacifier which would block out light rays until the development process was complete. A team of 25 chemists worked for 4 years before a successful opacifier was developed.

Well now how does this chemical marvel operate? The film card contains no less than 17 chemical layers. The negative, a mere three-hundredth of an inch thick, contains eight such layers, some of them are only as thick as a red-light wavelength, i.e. one fifty-thousandth of an inch. These layers are covered by a tough transparent-mylar film on front and an opaque, acetate backing-card.

After exposure the film card is fed automatically to processing rollers which rupture a pod containing three separate chemicals which are spread between the positive and negative layers as the film card is ejected from the camera. Most of the chemical contained in the pod is titanium dioxide (about 50%), an intensely white pigment, which forms a background for the colour dyes which would otherwise form a transparency under the clear mylar film.

The characteristically turquoise colour of the freshly ejected print is due to the presence of an alkaline opacifier which together with the titanium dioxide, shields the development process now under way. It in fact shields the negative from light millions of times brighter than that required to expose it. The third constituent of the pod is a developing agent which oxidizes light-exposed dye layers. Unoxidized dyes diffuse upward towards the positive film layer and the colour image starts forming almost immediately. Development is complete in about 10 minutes, but a useful image is visible after only one or two minutes.

Whilst development and dye migration is in progress the alkaline opacifier gradually dissolves a plastic layer between itself and another acidic layer. When the two encounter, the opacifier immediately becomes transparent and the full colour image is revealed. At this stage development is also complete and we now have a very colour-stable print which requires no further treatment and is impervious to rough handling – even during the development process. Film speed is approximately 100 ASA and the resolution approximately 40 lines. There is in fact no perceptible grain structure.

Fig. 17. A print from the SX 70 as it appears during the development phase which takes 10 minutes.

FLASH PHOTOS

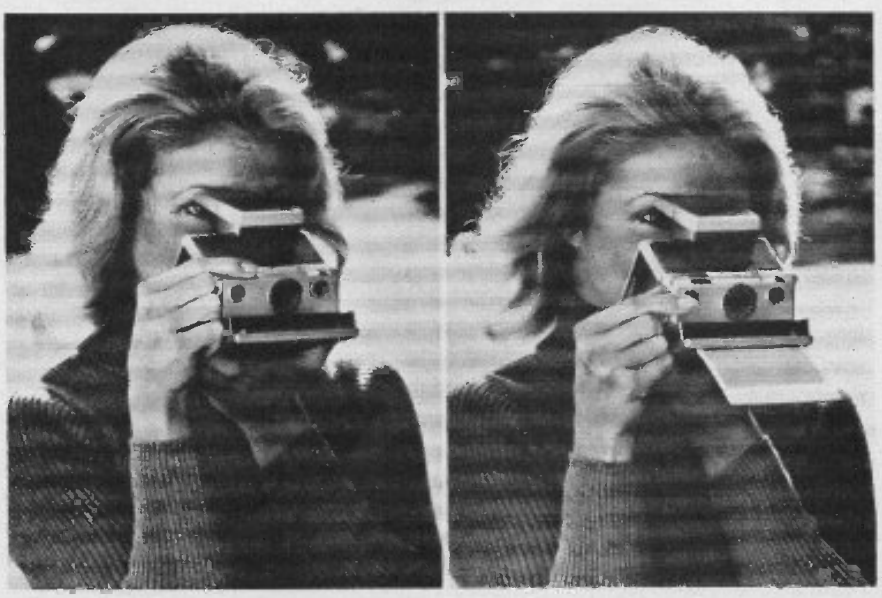
General Electric in co-operation with Polaroid, have developed a special plug-in flash bulb unit for the SX70. The unit is called the Flashbar 10 and has 10 bulbs in all, five on each side. Flashbar operation is controlled by part of the camera logic circuitry which selects the next good bulb and skips over bad or previously exposed bulbs. Operation is also inhibited when the camera is empty or being loaded.

The Flashbar 10 clips into the top of the camera's shutter mechanism and automatically engages the follow-focus mechanism, thus there is no need to calculate enposure with distance.

The new SX70 provides far better colour prints than the old Polaroid system but they are more expensive than those produced by conventional colour photography. It is still difficult to duplicate prints and to make enlargements, and further, the new Polaroid film does not have the exposure latitude of Kodacolor. However, no-one can deny that the new camera/film technology goes a long way towards answering photographers dreams.

One sad note – the camera is as yet on limited sale in the US and will not be available in this country in any quantities for sometime. ●

The Polaroid SX70 is not yet available in Britain but when it arrives we guess it will be a real winner.
On the left is shown a second before triggering; on the right a second after with the film already appearing.



The 10p difference.

We admit it – BASF cassettes are more expensive than ordinary cassettes.

About 10p more expensive, or if you prefer, 20% more expensive.

But there are several good reasons why we ask a little more.

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There's nothing to guide the tape accurately on to the reel. So the wind goes a little out of true, or a loop may come out of the reel, which can leave you with a damaged or torn tape – even a completely jammed cassette.

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And all BASF SM cassettes have an unconditional no-holds-barred free replacement guarantee.

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But they very rarely do. That's the 10p difference.

Send the coupon and 40p for Heinz Ritter's 126 page book called 'Tape Questions – Tape Answers'. It tells you everything you'll ever want to know about tape recording.

You can't spare 40p? Then send the coupon back for the complete BASF price list and full technical data.

BASF—the best tape, the best cassettes in the world.

ET12

☐ Here's 40p. Please send me Heinz Ritter's book. Quickly.

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ETI MASTER MIXER

Part 2 of the series gives constructional details and circuit descriptions of the preamplifiers and mixer/equalizer boards.

IN OUR introductory article to this project last month the design philosophy and overall circuit description of the 8-channel master-mixer were provided. This month we commence construction of the preamplifiers and the mixer/equalizer boards.

There are four preamplifier boards each having two channels. Assemble the components to each board in accordance with the circuit diagram and component overlay provided. Take care not to damage the ICs with excessive heat (use a lightweight iron, and solder quickly) and pay particular attention to the orientation of the TAG tantalum capacitors.

Printed circuit boards will be available from kitset suppliers. However for those who prefer to etch their own boards, a full size pattern is provided. Details of the connections between the preamplifier boards and their associated controls are given in Fig 1. It is suggested that leads of adequate length are connected to the boards first. The boards may then be fixed in position and the leads routed to their respective controls.

After the preamplifier boards are assembled, we can assemble the main mixer – equalizer boards of which there are two. The winding data for the inductors associated with this section is given in Table 1.

The coils must be layer wound with care. Jumble winding will almost certainly prevent the full number of turns fitting on the bobbin.

The only remaining printed circuit board accommodates the power supply – echo mixer, overload and meter circuitry, The construction of this board will be covered next month, together with full details of the wood and metalwork required.

HOW IT WORKS MAIN MIXERS – EQUALIZERS

As indicated last month, there are nine inputs to each main mixer IC. This IC is connected in an inverting amplifier configuration, with the gain controlled by varying the negative feedback. This gives a control range from zero output to about 30dB gain.

The output from the main mixer is direct coupled to the input of the equalizer stage. This stage is a little unusual, since the equalizing networks are arranged to vary the negative feedback. If we consider one section with the others disconnected, at the resonant frequency of the series LCR combination the impedance of the entire network will be equal to 680 ohms. Either side of resonance the impedance of the network will increase (with a slope dependent on the Q of the network), due to uncancelled inductive reactance above resonance and uncancelled capacitive reactance below resonance. We can therefore represent the equalizer stage with equivalent circuits as reproduced below. These circuits consider only one network is in circuit, the input signal frequency is the resonant frequency of the network, and the resistance of the inductor is negligible.

With the slider of the potentiometer at the top end (Fig. 2a) we have 680 ohms to the zero volt line from pin 2 of IC2, and a 1k ohm between pin 3 and pin 2. The IC will act due to the feedback to keep the potential between pins 2 and 3 virtually zero, thus there is zero current through

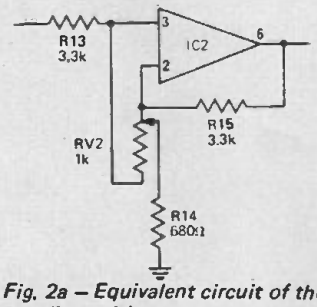


Fig. 2a – Equivalent circuit of the equalizer with potentiometer set for maximum boost at the resonant frequency of the network.

RV2. The voltage on pin 3 (IC2) is therefore equal to the output of the mixer since there is virtually no current through and no voltage drop across R13.

The output of IC2 in this case is approximately the input signal times (R15 + 680)/680 ohms, indicating a gain of about 15dB. If the slider is at the other end of the potentiometer (Fig 2b) the signal appearing at pin 3 and thus also at pin 2 is about 0.2 of the output of the previous stage due to the voltage division of R13 and the 680Ω. There is still zero current through RV2 and also zero current through R15 since there is no path. The output voltage is therefore the same as that at pin 2, which happens to be about 0.2 times the output of the previous stage. The gain is therefore 0.2 or –13dB.

With all networks in circuit, the maximum boost and cut will be reduced, but a range of ±10dB is still available. With the wiper of the potentiometers set midway – Fig 2c, the gain will be unity regardless of frequency, due to the symmetry of the entire network.

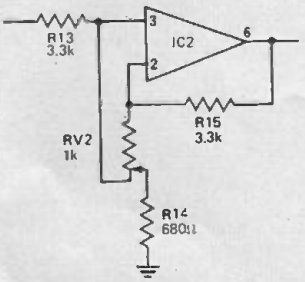


Fig. 2b – Equivalent circuit of the equalizer with the potentiometer set for maximum cut at the resonant frequency of the network,

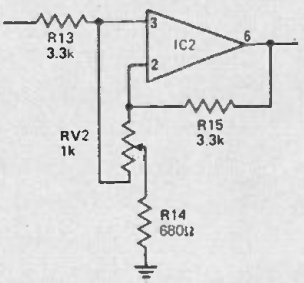
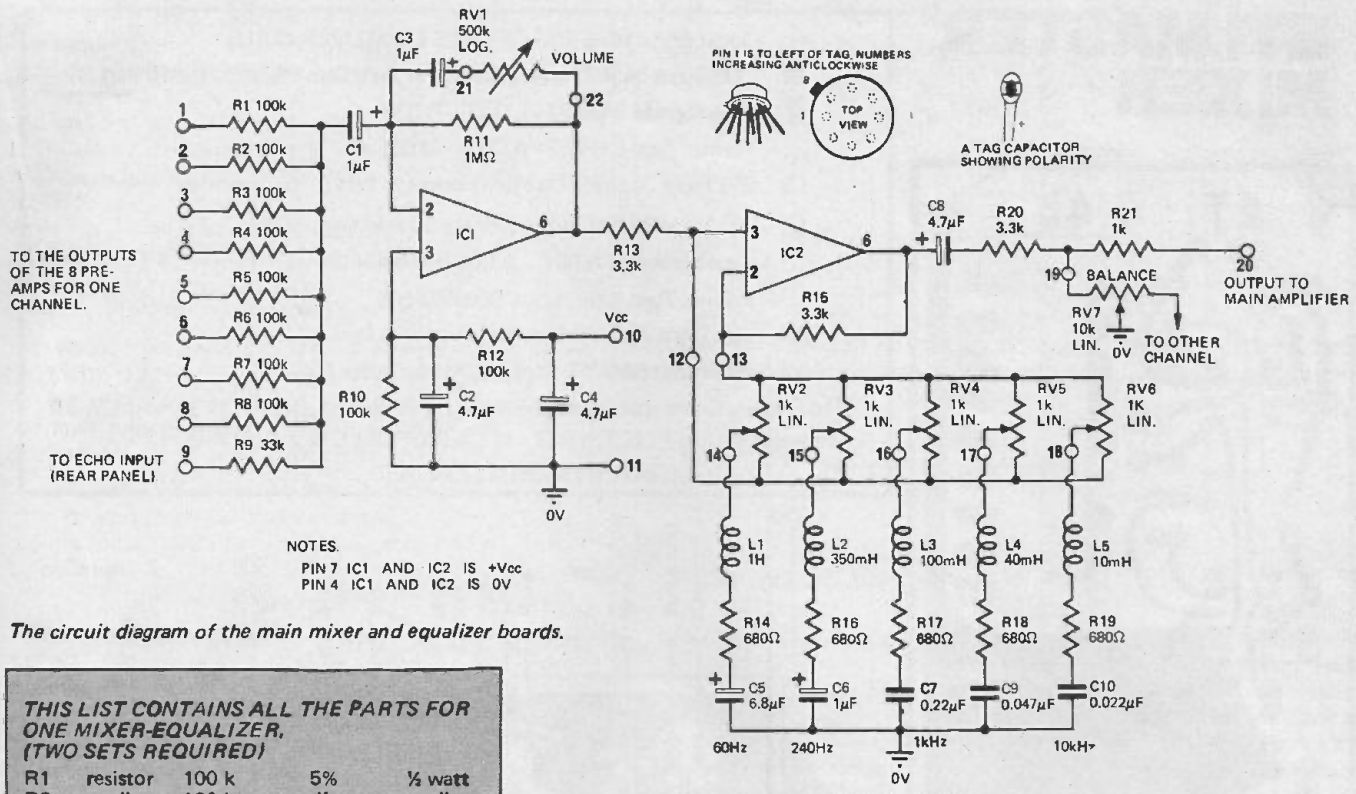


Fig 2c – Equivalent circuit of the equalizer with the potentiometer set for unity gain regardless of frequency.



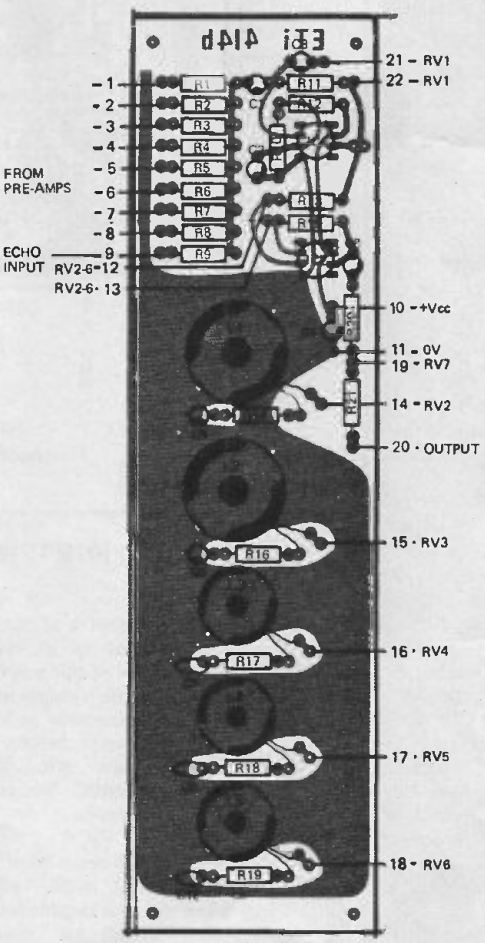
NOTES.
PIN 7 IC1 AND IC2 IS +Vcc
PIN 4 IC1 AND IC2 IS 0V

The circuit diagram of the main mixer and equalizer boards.

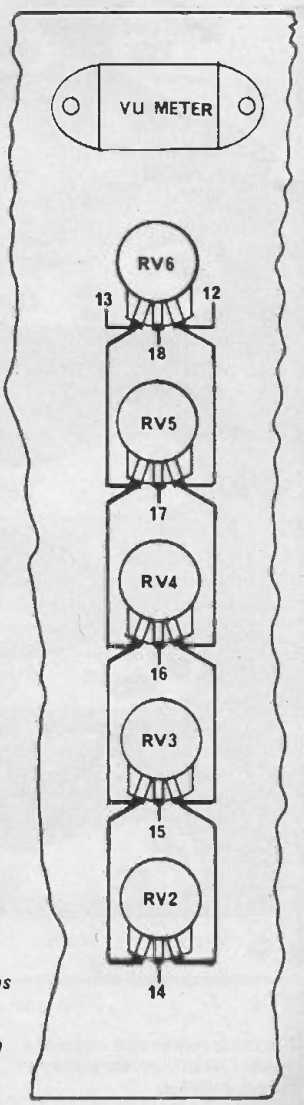
THIS LIST CONTAINS ALL THE PARTS FOR ONE MIXER-EQUALIZER. (TWO SETS REQUIRED)

R1	resistor	100 k	5%	½ watt
R2	"	100 k	"	"
R3	"	100 k	"	"
R4	"	100 k	"	"
R5	"	100 k	"	"
R6	"	100 k	"	"
R7	"	100 k	"	"
R8	"	100 k	"	"
R9	"	33 k	"	"
R10	"	100 k	"	"
R11	"	1 M	"	"
R12		100 k	"	"
R13	"	3.3 k	"	"
R14	"	680 ohm	"	"
R15	"	3.3 k	"	"
R16	"	680 ohm	"	"
R17	"	680 ohm	"	"
R18	"	680 ohm	"	"
R19	"	680 ohm	"	"
R20	"	3.3 k	"	"
R21	"	1 k	"	"
C1	capacitor	1µF	35V TAG tantalum	
C2	"	4.7µF	35V "	"
C3	"	1µF	35V "	"
C4	"	4.7µF	35V "	"
C5	"	6.8µF	25V "	"
C6	"	1µF	35V "	"
C7	"	0.22µF	polyester	
C8	"	4.7µF	35V TAG tantalum	
C9	"	0.047µF	polyester	
C1	"	0.022µF	polyester	
L1	audio choke	1H	(see winding data table 1)	
L2	" "	350 mH	"	
L3	" "	100 mH	"	
L4	" "	40 mH	"	
L5	" "	10 mH	"	
IC1	integrated circuit	uA741.LM307 (metal can or mini dip only)		
IC2	" "	uA741,LM307 (metal can or mini dip only)		
*RV1	potentiometer	500 k ohm LOG dual		
RV2	"	1 k LIN		
RV3	"	1 k LIN		
RV4	"	1 k LIN		
RV5	"	1 k LIN		
RV6	"	1 k LIN		
*RV7	"	10 k LIN		

*ONE ONLY REQUIRED FOR COMPLETE UNIT
PC Board ETI 414B
5 knobs
4 1" spacers

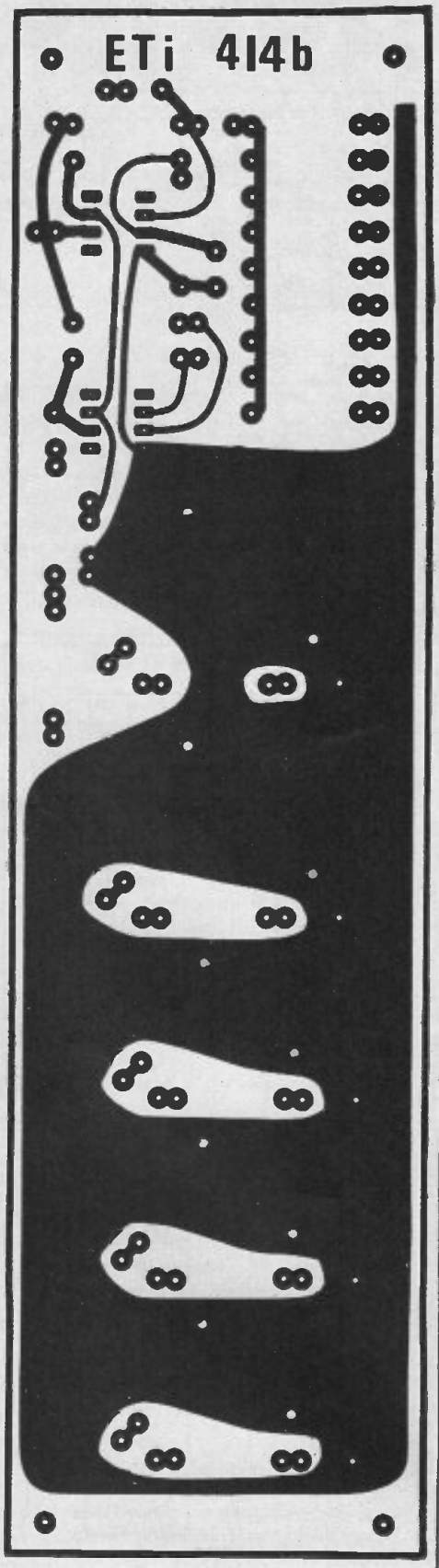


Component overlay for main mixer and equalizer.



This diagram shows the connections to the potentiometers associated with the equalizers. The numbers correspond one-to-one, to those on the main mixer – equalizer circuit and overlay diagrams.

ETI MASTER MIXER



The main mixer and equaliser printed circuit board pattern — shown full size.

TABLE 1:— WINDING DETAILS EQUALIZER COILS

L1 1000 Turns 34 SWG enamelled copper wire. Core Siemens 26 x 16 mm.
Type number B 65671 - L 0000 - R 030
Former Type B 65672 - A 0000 - M 001

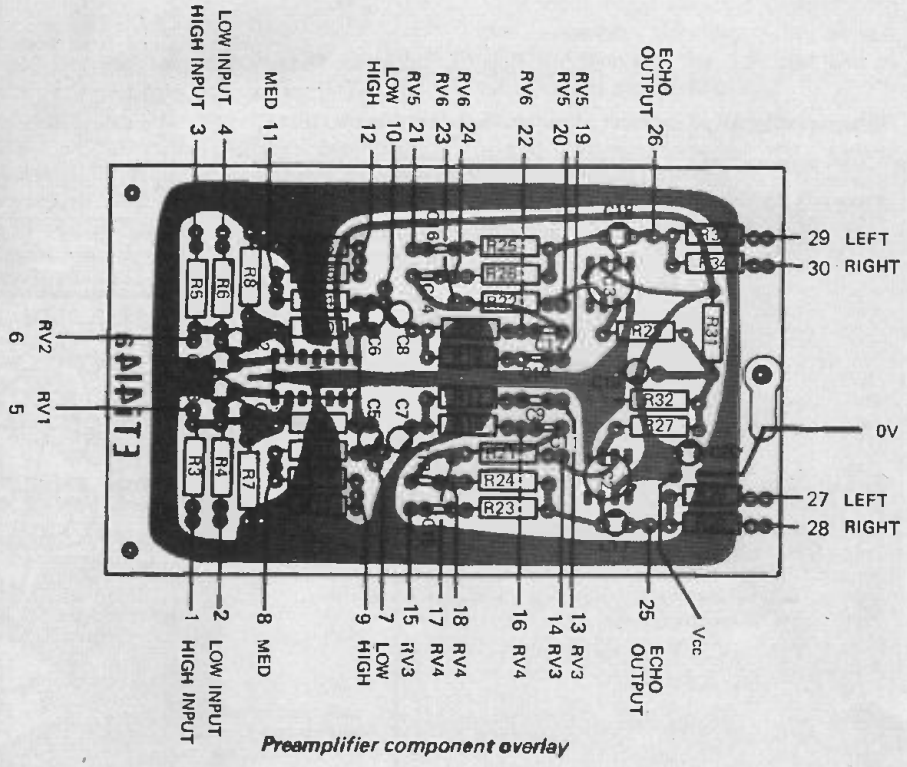
L2 650 Turns 34 SWG. Core and Former as for L1

L3 300 Turns 34 SWG. Core Siemens 18 x 14 mm.
Type number B 65561 - A 0000 - R 030
Former Type B 65562 - A 0000 - M 001

L4 205 Turns 34 SWG. Core and Former as for L3

L5 100 Turns 34 SWG. Core and Former as for L3

The Siemens Cores mentioned above and the integrated circuits LM 307 and LM 381 are available from ELECTROKIT, 12 LAUDERDALE ROAD, LONDON W9.
The LM 307 is 49p and the LM 381 is £2.46



Preamplifier component overlay

HOW IT WORKS — PREAMPLIFIERS

Considering channel 1 of the board only, IC1 is wired as an inverting amplifier. The gain of this amplifier is varied by RV1 – the volume control, and set at high, medium or low by SW1 – the sensitivity switch. These controls vary the gain of the amplifier by adjusting the negative feedback. More feedback, less gain, and vice-versa.

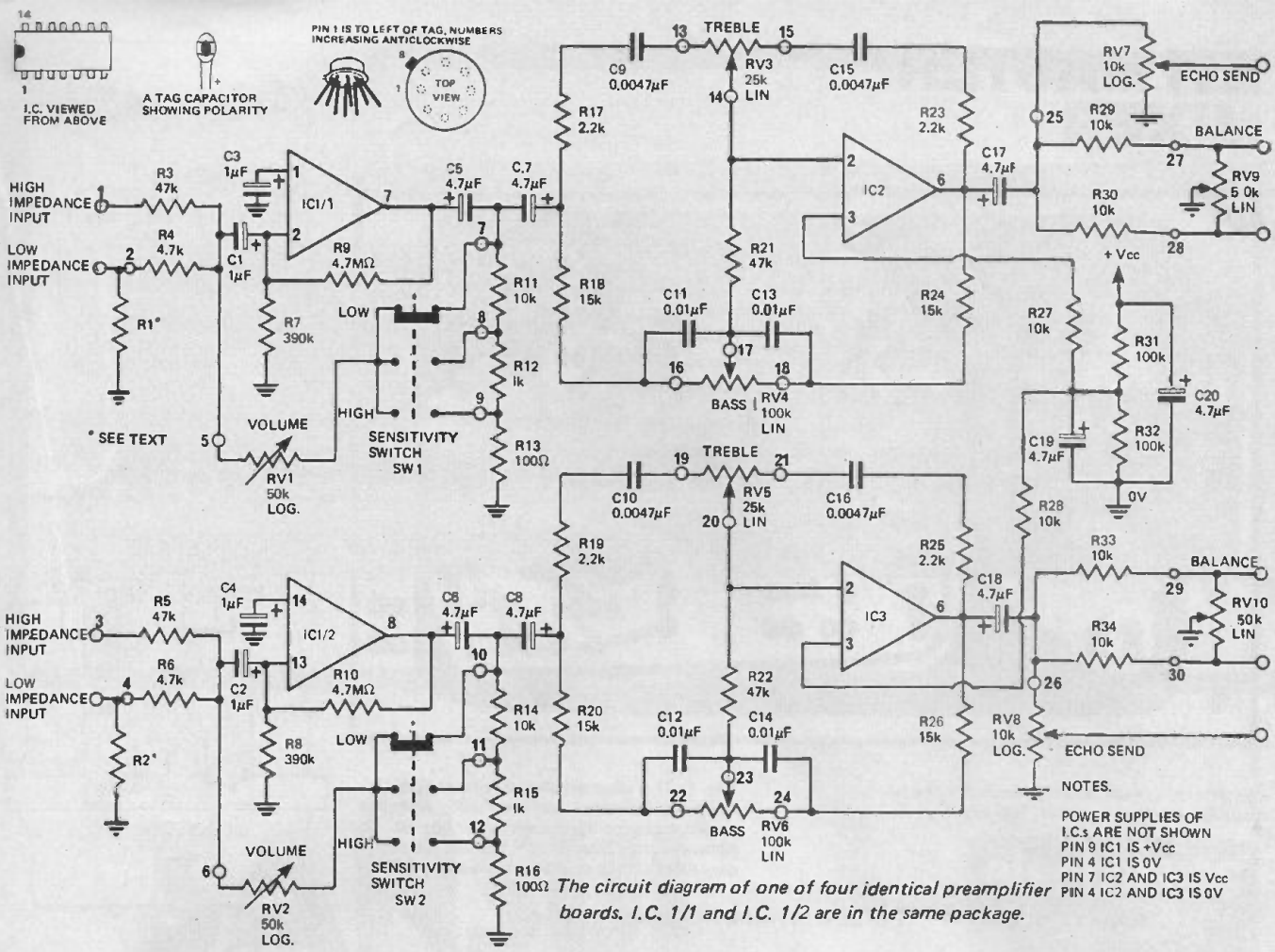
SW1 changes the range of RV1 for maximum gains of 20dB, 40dB and 55dB when the low impedance input is employed. With the sensitivity switch at low the minimum output of this stage is virtually zero, while a minimum gain of 6dB is realised when the sensitivity is set at either medium or high. Gains when the high impedance input is employed are all 20dB lower than those given above.

The input impedance to the IC is virtually zero, when used as an inverting amplifier. Therefore the input impedance to the preamplifier is determined by R3 for the high impedance input, and by R1 in parallel with R4 for the low impedance input. R9 and R7 set the bias of the IC. The tone control stage is a conventional feedback type.

Note that where different input impedances from those specified are required, the values of R1 (or R2) required may be calculated by the following formula

$R = (4700 \times Zin)/(4700 - Zin)$

where Zin is the desired input impedance.



The circuit diagram of one of four identical preamplifier boards. I.C. 1/1 and I.C. 1/2 are in the same package.

THIS LIST CONTAINS ALL PARTS EXCEPT METAL WORK, FOR A COMPLETE PREAMPLIFIER AND TONE CONTROLS. FOR AN 8 CHANNEL MIXER FOUR SETS OF COMPONENTS ARE REQUIRED

PARTS LIST (PREAMP)

R1*	RESISTOR	200 ohm	5%	½W
R2*	"	200 ohm	"	"
R3	"	47k	"	"
R4	"	4.7k	"	"
R5	"	47k	"	"
R6	"	4.7k	"	"
R7	"	390k	"	"
R8	"	390k	"	"
R9	"	4.7M	"	"
R10	"	4.7M	"	"
R11	"	10k	"	"
R12	"	1k	"	"
R13	"	100ohm	"	"
R14	"	10k	"	"
R15	"	1k	"	"
R16	"	100ohm	"	"
R17	"	2.2k	"	"
R18	"	15k	"	"
R19	"	2.2k	"	"
R20	"	15k	"	"
R21	"	47k	"	"
R22	"	47k	"	"
R23	"	2.2k	"	"
R24	"	15k	"	"
R25	"	2.2k	"	"
R26	"	15k	"	"
R27	"	10k	"	"
R28	"	10k	"	"
R29	"	10k	"	"
R30	"	10k	"	"
R31	"	100k	"	"
R32	"	100k	"	"
R33	"	10k	"	"
R34	"	10k	"	"

C1	CAPACITOR	1µF	35V	TAG tant.
C2	"	1µF	35V	" "
C3	"	1µF	35V	" "
C4	"	1µF	35V	" "
C5	"	4.7µF	35V	" "
C6	"	4.7µF	35V	" "
C7	"	4.7µF	35V	" "
C8	"	4.7µF	35V	" "
C9	"	0.0047µF	35V	polyester
C10	"	0.0047µF		"
C11	"	0.01µF		"
C12	"	0.01µF		"
C13	"	0.01µF		"
C14	"	0.01µF		"
C15	"	0.0047µF		"
C16	"	0.0047µF		"
C17	"	4.7µF	35V	TAG tantalum
C18	"	4.7µF	35V	" "
C19	"	4.7µF	35V	" "
C20	"	4.7µF	35V	" "

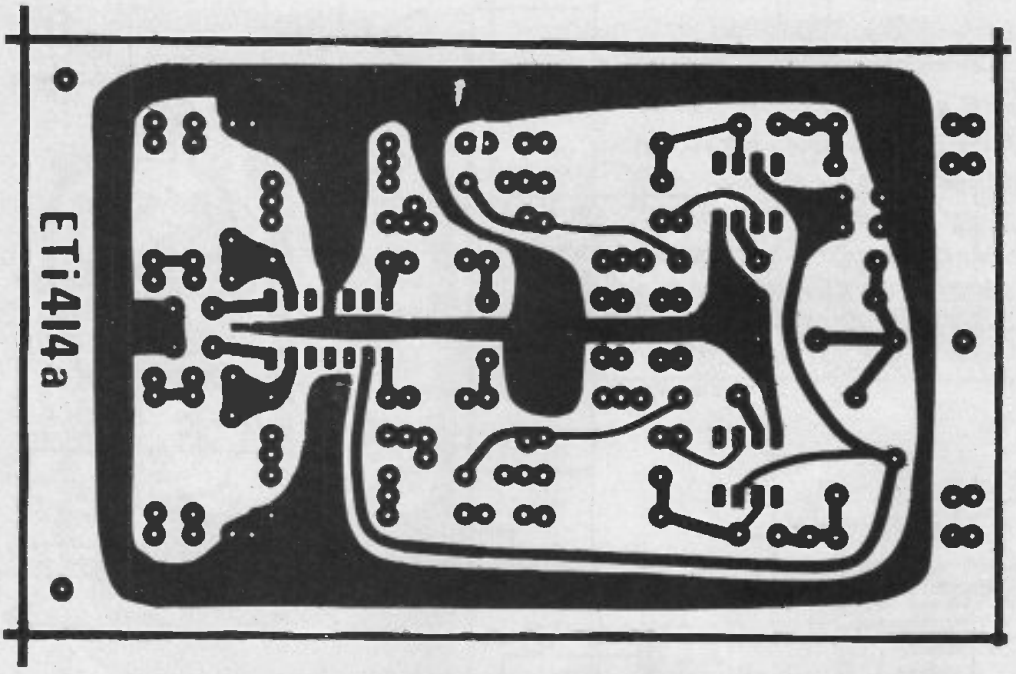
RV1	potentiometer	50 k LOG	slider pot
RV2	"	50 k LOG	" "
RV3	"	25 k LIN	
RV4	"	100 k LIN	
RV5	"	25 k LIN	
RV6	"	100 k LIN	
RV7	"	10 k LOG	
RV8	"	10 k LOG	
RV9	"	50 k LIN	
RV10	"	50 k LIN	

IC1 integrated circuit LM381
IC2 " " uA741, LM307 (metal can or mini dip only)
IC3 " " uA741, LM307 (metal can or mini dip only)

PC board ETI 414A
8 knobs for rotary potentiometers
2 knobs for slide potentiometers
2 3P-3T slide switches
3 1" spacers
4 6.5 mm phone sockets

* see text.

ETI MASTER MIXER



The printed circuit board pattern for the pre-amplifier sections – shown full size.

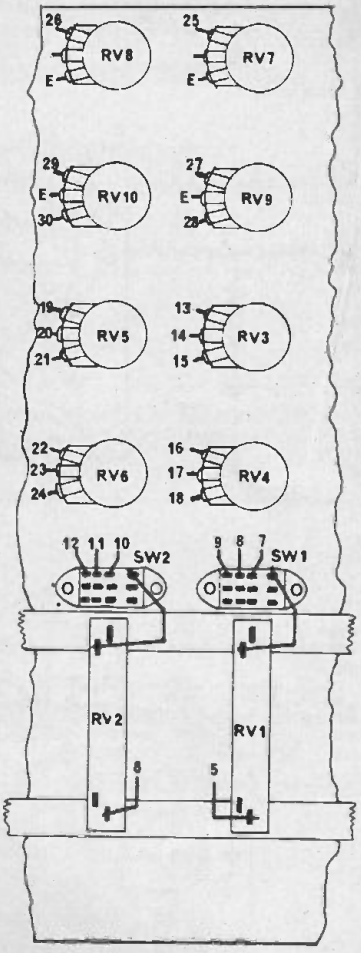
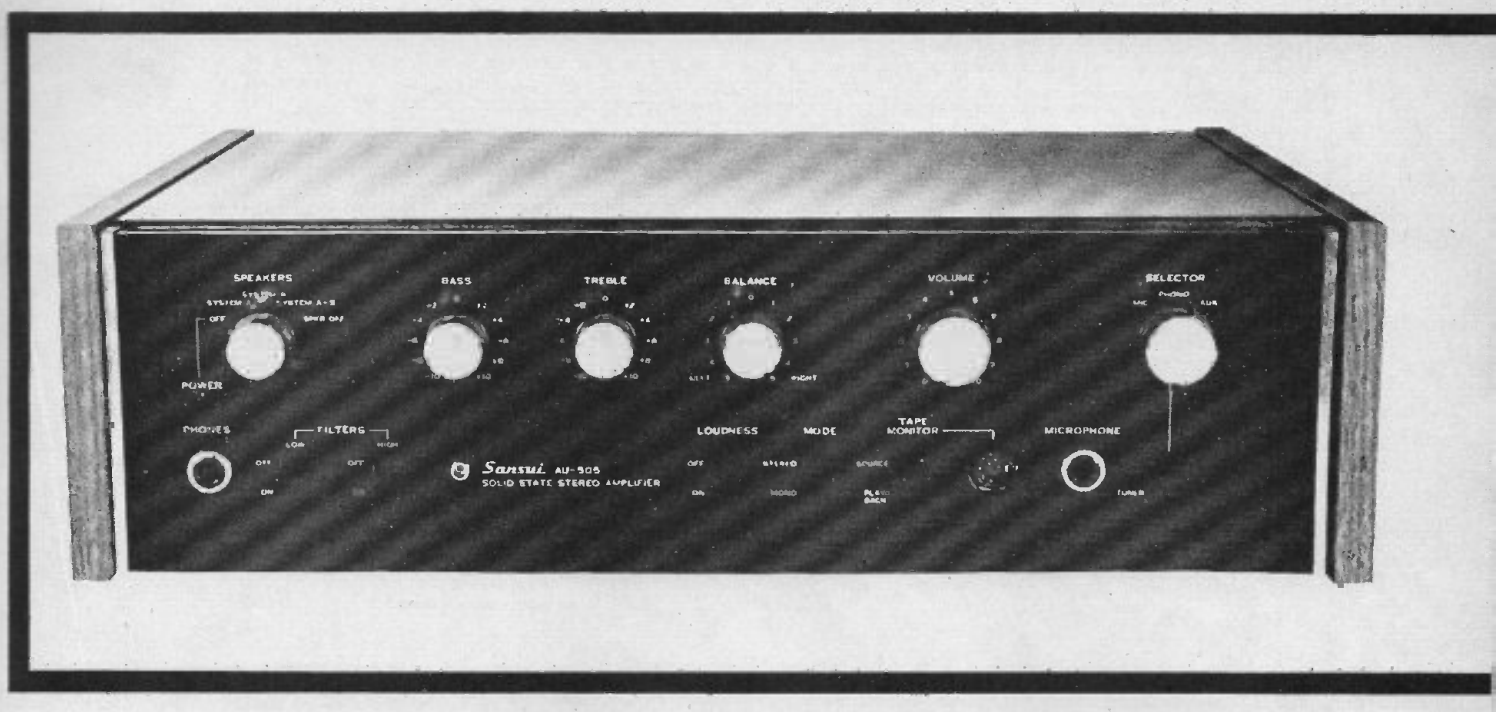


Fig. 1. This diagram shows connections to the potentiometers and sensitivity switches associated with the preamplifier boards. The numbers corresponds to those on the pre-amplifier circuit and overlay diagrams.

THIS FEATURE WILL CONTINUE NEXT MONTH



SANSUI AMPLIFIER AU 505

electronics TODAY INTERNATIONAL
product test

A medium-priced amplifier from Sansui producing 23W per channel

At first appearances the AU 505 is nearly identical to the AU 101 that we reviewed in the 1971 May issue. However power output of this new unit (at rated input level), is 23 watts whilst that of the AU 101 is 15 watts.

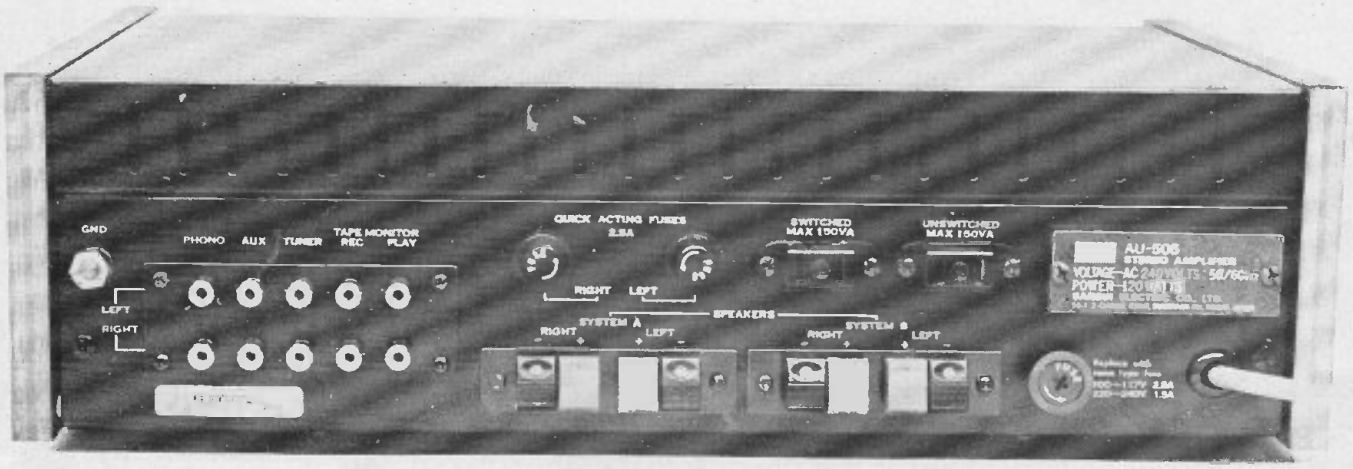
The only external difference is the addition of three level-switches and the changing of the rotary power "ON OFF" switch to a combined power/speaker selection switch.

The external appearance is traditionally Sansui, with a black front panel framed at each end by a chromed strip, and veneered timber side panels.

The top row of controls consists of four small chromed knobs and two large chromed knobs. These knobs provide the following facilities, from left to right:—

a) Mains "ON OFF" speaker select switch with five positions — mains OFF, speaker system A, speaker system B, speaker system A & B and speakers OFF.
b) Continuously variable bass control, with marked 2dB steps from -10dB to +10dB.
c) Continuously variable treble control, with marked 2dB steps from -10db to +10dB.
d) Balance control.
e) Volume control continuously variable, and marked from 0 to 10.
f) Source selection control with three positions: microphone, phono and auxiliary.

This arrangement of controls follows the general trend of some of the better quality amplifier manufacturers in that



the two most used switches, the power "ON OFF" speaker selection switch, and the source select switch, are located in the top left hand and right hand corners respectively. The amplifier therefore was very easy to adapt to and operation was straight forward.

The bottom row of controls are as follows from left to right:

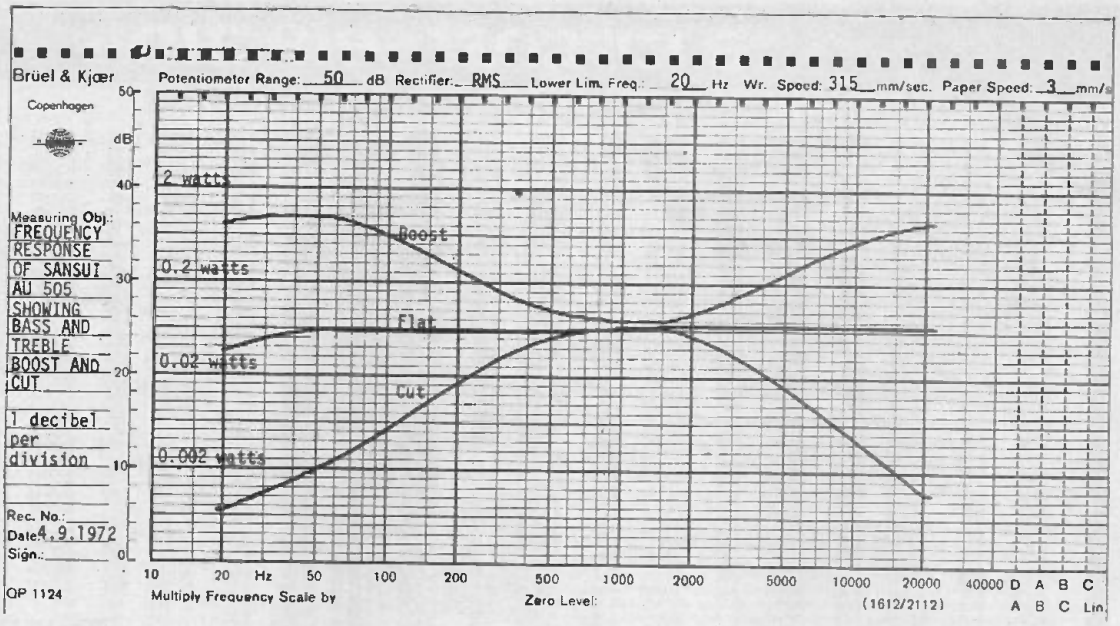
a) Ring tip and sleeve socket for headphones.
b) Black aluminium lever switch for low frequency cut off.
c) Black aluminium lever switch for high frequency cut off.
d) Small mains ON bezel.
e) Black aluminium lever switch for loudness control.
f) Black aluminium lever switch for stereo or mono mode selection.
g) Black aluminium lever switch for tape monitoring – source of playback.
h) Five pin DIN socket for combination tape-recorder, record playback DIN patch cord.
j) Tip and sleeve socket for microphone input to right channel only.
k) Black aluminium lever switch for tuner input select.

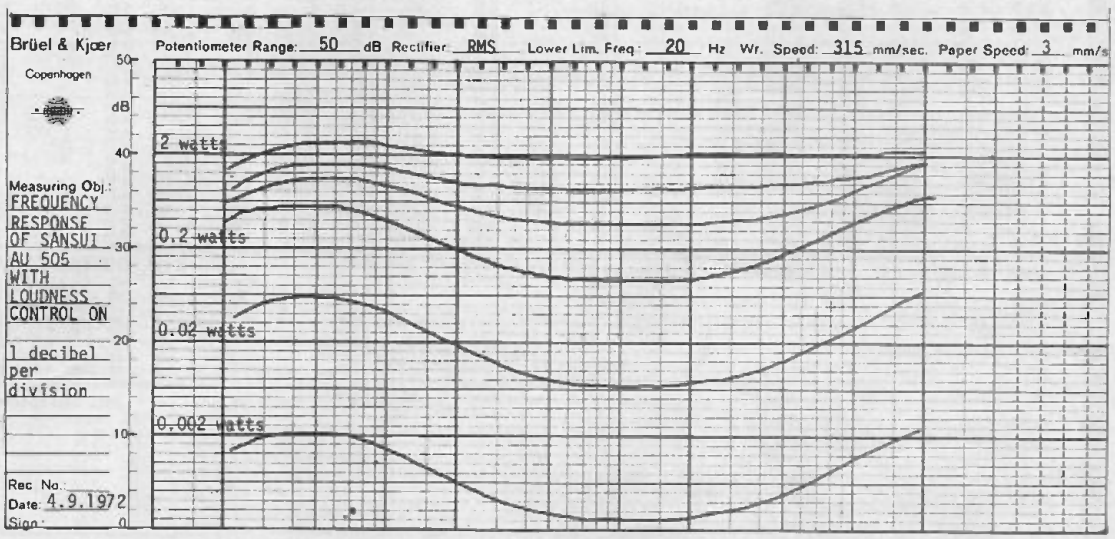
All other input and output facilities are located on the rear panel and consist of the following:

SANSUI AMPLIFIER AU505
MODEL AU 505 SERIAL NO. 022051203

Power Output		
(For rated input of 200 mV into 8 ohms)		
Both channels driven	20W	
One channel driven	25W	
Frequency Response	20Hz to 20kHz ± 1dB	
Channel Separation		
	100Hz	1kHz
Auxiliary input	50dB	45dB
Phono input	47dB	45dB
Hum and Noise		
(Unweighted with respect to rated power of 23W)		
Auxiliary	84dB	
Phono	64dB	
Input Sensitivities		
(For rated power – 23W)		
Phono input	2.9 mV	
Auxiliary input	205 mV	
Tuner	205 mV	
Total Harmonic Distortion		
(At rated output – 23W)	100Hz -0.39%	
	1kHz -0.55%	
	6.3kHz -1.2%	
Tone Controls		
Bass	12db Boost at 50Hz	
	15dB Cut at 50Hz	
Treble	10dB Boost at 10kHz	
	12dB Cut at 10kHz	
Loudness Control	8dB Boost at 50Hz	
	7dB Boost at 10kHz	
Filters		
High	9dB Cut at 10kHz	
Low	10dB Cut at 50Hz	
Dimensions	115mm x 407mm x 278mm	
Weight	8.0kg.	

SANSUI AMPLIFIER AU 505





Five pairs of RCA sockets for –

a) Phono input.
b) Auxiliary input.
c) Tuner input.
d) Tape recorder output.
e) Tape recorder monitor input.

Spring loaded terminals are used for the speaker outputs. Other features included on the back panel are one switched and one unswitched two-pin mains output sockets for powering auxiliary equipment, and a large ground terminal.

Three fuse holders are also located on the back. A 1.5A fuse is wired into the mains input and 2.5A quick acting fuses are inserted in each supply rail to the power amplifier stages.

A five pin DIN socket located on the front panel is a very practical arrangement. So often one needs to connect someone else's tape-recorder into one's own system and as a result has quite a problem making all the necessary interconnections. The difficulty is often compounded by the amplifier being located in a dark confined space.

Sansui's use of a front-mounted DIN socket is therefore very worthwhile. Had it been possible to switch select inputs from either the front DIN socket and the rear DCA sockets the arrangement would be of even greater value.

The internal layout is extremely neat and uncluttered and provides easy access to all components. The printed circuit boards are clearly marked with component numbers and eyelets labelled emitter, base and collector for each transistor. The power transformer is fully shielded and at the opposite end to the inputs and preamplifiers.

MEASURED PERFORMANCE

The measured performance was very good with most parameters meeting the manufacturer's specification. Hum and noise was unusually low – being -64dB on the Phono input and -84dB on the Auxiliary input.

The loudness control becomes effective below approximately two watts output. This is an ideal setting for the average domestic speaker/room combination. It is however rather abrupt in operation – going from a flat response to full treble and bass boost within 7dB.

Although within the manufacturer's specification, harmonic distortion was

(Turn to page 41)

The largest selection

BRAND NEW FULLY GUARANTEED DEVICES

AC107	0·20	AD162	0·83	BC148	0·10	BD137	0·45	BF188	0·40	OC19	0·35	2G371	0·16	2N2219	0·20	2N3054	0·46	2N4059	0·10
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	BF194	0·12	OC20	0·65	2G371B	0·12	2N2220	0·22	2N3055	0·50	2N4060	0·12
AC115	0·23	AD162 (MP)		BC150	0·18	BD139	0·55	BF195	0·12	OC22	0·38	2G373	0·17	2N2221	0·20	2N3391	0·14	2N4061	0·12
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17	2N2222	0·20	2N3391A	0·16	2N4062	0·19
AC122	0·12	ADT140	0·50	BC152	0·17	BD165	0·80	BF197	0·14	OC24	0·55	2G377	0·30	2N2368	0·17	2N3392	0·14	2N4284	0·17
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16	2N2369	0·14	2N3393	0·14	2N4285	0·17
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·60	BF222	0·95	OC26	0·25	2G381	0·16	2N2369A	0·14	2N3394	0·14	2N4286	0·17
AC127	0·17	AF116	0·24	BC157	0·18	BD177	0·65	BF257	0·45	OC28	0·50	2G382	0·16	2N2411	0·24	2N3395	0·17	2N4287	0·17
AC128	0·17	AF117	0·24	BC158	0·12	BD178	0·65	BF258	0·60	OC29	0·50	2G401	0·30	2N2412	0·24	2N3402	0·21	2N4288	0·17
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·85	OC35	0·42	2G414	0·30	2N2646	0·47	2N3403	0·21	2N4289	0·17
AC134	0·14	AF124	0·30	BC160	0·45	BD180	0·70	BF262	0·55	OC36	0·50	2G417	0·25	2N2711	0·21	2N3404	0·23	2N4290	0·17
AC137	0·14	AF125	0·25	BC161	0·50	BD185	0·65	BF263	0·55	OC41	0·20	2N388	0·25	2N2712	0·21	2N3405	0·42	2N4291	0·17
AC141	0·14	AF126	0·28	BC167	0·12	BD186	0·65	BF270	0·35	OC42	0·34	2N388A	0·55	2N2714	0·21	2N3414	0·15	2N4292	0·17
AC141K	0·17	AF127	0·28	BC168	0·18	BD187	0·70	BF271	0·30	OC44	0·15	2N404	0·20	2N2904	0·17	2N3415	0·15	2N4293	0·17
AC142	0·14	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28	2N2904A	0·21	2N3416	0·28	2N5172	0·12
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42	2N2905	0·21	2N3417	0·28	2N5457	0·32
AC151	0·15	AF179	0·50	BC171	0·14	BD190	0·75	BF274	0·35	OC71	0·10	2N527	0·49	2N2905A	0·21	2N3525	0·75	2N5458	0·32
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42	2N2906	0·15	2N3646	0·09	2N5459	0·40
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45	2N2906A	0·18	2N3702	0·10	28301	0·50
AC156	0·20	AF186	0·45	BC174	0·14	BD197	0·90	BFX84	0·22	OC75	0·15	2N696	0·12	2N2907	0·20	2N3703	0·10	28302A	0·42
AC157	0·24	AF239	0·37	BC175	0·22	BD198	0·90	BFX85	0·30	OC76	0·15	2N697	0·13	2N2907A	0·22	2N3704	0·11	28302	0·42
AC165	0·20	AL102	0·65	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24	2N2923	0·14	2N3705	0·10	28303	0·55
AC166	0·20	AL103	0·65	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35	2N2924	0·14 · 0·10	2N3706	0·09	28304	0·70
AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N705	0·08	2N2925	0·14	2N3707	0·11	28305	0·84
AC168	0·24	ASY27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09	2N2926 (G)	0·12	2N3708	0·07	28306	0·84
AC169	0·14	ASY28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12			2N3709	0·09	28307	0·84
AC176	0·20	ASY29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30	2N2926 (Y)	0·11	2N3710	0·09	28321	0·56
AC177	0·24	ASY50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35			2N3711	0·09	28322	0·42
AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BFX25	0·85	OC139	0·20	2N718	0·24	2N2926 (O)	0·10	2N3819	0·28	28322A	0·42
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50			2N3820	0·50	28323	0·56
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28	2N2926 (B)	0·10	2N3821	0·35	28324	0·70
AC180K	0·20	ASY55	0·25	BC184L	0·12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28	2N2926 (B)		2N3823	0·28	28325	0·79
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20			2N3903	0·28	28326	0·79
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20			2N3904	0·30	28327	0·79
AC187	0·28	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·25	2N914	0·14	2N3010	0·70	2N3905	0·28	28701	0·42
AC187K	0·20	AZ221	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·25	2N918	0·30	2N3011	0·14	2N3906	0·27	40361	0·40
AC188	0·22	BC107	0·09	BC209	0·13	BF152	0·55	BSY38	0·18	OC203	0·25	2N929	0·21	2N3053	0·17	2N4058	0·12	40362	0·45
AC188K	0·20	BC108	0·09	BC212L	0·11	BF153	0·45	BSY39	0·18	OC204	0·25	2N930	0·21						
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20						
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·23						
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14						
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14						
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17						
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17						
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21						
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21						
ACY29	0·35	BC120	0·50	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23						
ACY30	0·38	BC125	0·12	BCY70	0·14	BF184	0·40	C425	0·50	ST141	0·17	2N1309	0·23						
ACY31	0·28	BC126	0·18	BCY71	0·18	BF185	0·40	C426	0·35	T1843	0·30	2N1613	0·20						
ACY34	0·21	BC132	0·12	BCY72	0·14	BF187	0·22	C428	0·20	UT46	0·27	2N1711	0·20						
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32						
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45						
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37						
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·30	C450	0·22	2G304	0·24	2N2147	0·72						
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57						
AD130	0·38	BC140	0·30	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60						
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35						
AD142	0·48	BC142	0·30	BD132	0·50	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35						
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35						
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22						
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20						

DIODES AND RECTIFIERS

AA119	0·08	BY133	0·21	OA10	0·35
AA120	0·08	BY164	0·50	OA47	0·07
AA129	0·08	BYX38/300		OA70	0·07
AAY30	0·09		0·42	OA79	0·07
AAZ13	0·10	BYZ10	0·35	OA81	0·07
BA100	0·10	BYZ11	0·30	OA85	0·09
BA116	0·21	BYZ12	0·30	OA90	0·06
BA126	0·22	BYZ13	0·25	OA91	0·06
BA148	0·14	BYZ16	0·40	OA95	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·13	BYZ19	0·28	SD10	0·05
BY100	0·15	C062		SD19	0·05
BY101	0·12	(Eq) OA91		IN34	0·07
BY105	0·17		0·5	IN34A	0·07
BY114	0·12	C0651		IN914	0·06
BY126	0·14	(Eq) OA70-		1N916	0·08
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
BY130	0·16	OA85L	0·21	18951	0·06

FULL RANGE OF ZENER DIODES VOLTAGE RANGE
2-33V, 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

10 amp POTTED BRIDGE RECTIFIER
5n heat sink.
100PIV. 80p each

NEW LINE
Plastic Encapsulated
2 Amp. BRIDGE RECTS.
50v RMS 32p each
100v RMS 37p ,,
400v RMS 46p ,,
Size 15 mm × 6 mm.

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UT46. Eqvt. 2N2646. Eqvt. T1843. BEN3000 87p each. 25-99 25p 100 UP 20p.

CADMIUM CELLS
ORP12 43p
ORP60, ORP61 40p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8. BSY-27/28/96A. A.I.1 usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		8p
20	For	0·50
50	For	1·00
100	For	1·75
500	For	7·50
1000	For	13·00

SIL. G.P. DIODES 8p

300mW	30..0·50
40PIV(Min.)	100..1·50
Sub-Min.	500..5·00
Full Tested 1,000.	9·00

Ideal for Organ Builders.

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200	50	60	90
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T2	8 D1374	OC75
T3	8 D1216	OC81D
T4	8 2G381T	OC81
T5	8 2G382T	OC82
T6	8 2G344B	OC44
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U 6	60	200mA Sub-Min. Silicon Diodes	0·50
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Code No's. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

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Q6	5	OC 72 transistors	0·50
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Q28	2	Silicon power rectifiers BYZ 13	0·50
Q29	4	Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7	Silicon switch transistors 2N706 NPN	0·50
Q31	8	Silicon switch transistors 2N708 NPN	0·50
Q32	3	PNP Silicon transistors 2 × 2N1131, 1 × 2N 1132	0·50
Q33	3	Silicon NPN transistors 2N1711	0·50
Q34	7	Silicon NPN transistors 2N2369, 500MHz (code P397)	0·50
Q35	8	Silicon PNP TO-5, 2 × 2N2904 & 1 × 2N2905	0·50
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PIV	1A TO5	3A TO66	5A TO66	6A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0·23	0·25	0·35	0·35	0·47	0·50	0·53	1·15
100	0·25	0·33	0·47	0·47	0·50	0·58	0·83	1·40
200	0·35	0·37	0·49	0·49	0·57	0·61	0·75	1·80
400	0·43	0·47	0·56	0·56	0·67	0·75	0·93	1·75
600	0·53	0·57	0·68	0·68	0·77	0·97	1·25	—
800	0·63	0·70	0·80	0·80	0·90	1·20	1·50	4·00

SIL. SECTS. TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
50	0·04	0·05	0·05	0·07	0·14	0·21	0·60
100	0·04	0·06	0·06	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·86
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·38	0·67	0·75	—

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GENERAL PURPOSE GERM. PNP
Coded GP100. BRAND NEW TO-3 CASE. POSSIBLE REPLACE:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI2027-3028, 2N250A 2N456A-457A-458A, 2N511 A & B. 2O220-222, ETC. VCBO 50V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1-24	25-99	100 up
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TO-3 case. O.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHz.

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2N3055
115 WATT SIL POWER NPN 50p EACH.

SILICON 50 WATTS MATCHED NPN/PNP
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2N3819	35p	2N5458	50p
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2N3821	35p	BFW10	40p
2N3823	30p	MPF105	40p

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MIXED ELECTRONIC COMPONENTS
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SN7401	0·15	0·14	0·12	SN7451	0·15	0·14	0·12	SN74141	0·67	0·64	0·58
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SN7412	0·35	0·31	0·28	SN7481	£1·20	£1·15	£1·10	SN74162	£4·00	£3·75	£3·50
SN7413	0·29	0·28	0·24	SN7482	0·87	0·86	0·85	SN74163	£4·00	£3·75	£3·50
SN7416	0·48	0·40	0·38	SN7483	£1·10	£1·05	0·95	SN74164	£2·20	£2·15	£2·10
SN7417	0·43	0·40	0·38	SN7484	£1·00	0·96	0·90	SN74165	£2·25	£2·20	£2·15
SN7420	0·15	0·14	0·12	SN7485	£3·60	£3·50	£3·40	SN74166	£3·50	£3·25	£3·00
SN7422	0·50	0·48	0·45	SN7486	0·32	0·31	0·30	SN74174	£2·30	£2·20	£2·10
SN7423	0·50	0·48	0·45	SN7489	£5·50	£5·25	£5·00	SN74175	£1·50	£1·50	£1·40
SN7425	0·50	0·48	0·45	SN7490	0·67	0·64	0·58	SN74176	£2·50	£2·40	£2·30
SN7427	0·45	0·42	0·40	SN7491	£1·00	0·96	0·90	SN74177	£2·50	£2·40	£2·30
SN7428	0·70	0·65	0·60	SN7492	0·67	0·64	0·58	SN74180	£2·00	£1·60	£1·40
SN7430	0·15	0·14	0·12	SN7493	0·67	0·64	0·58	SN74181	£5·50	£5·00	£4·75
SN7432	0·45	0·42	0·40	SN7494	0·77	0·74	0·68	SN74182	£2·00	£1·80	£1·60
SN7433	0·80	0·75	0·70	SN7495	0·77	0·74	0·68	SN74184	£3·50	£3·25	£3·00
SN7437	0·64	0·62	0·60	SN7496	0·87	0·84	0·78	SN74190	£1·96	£1·90	£1·85
SN7438	0·64	0·62	0·60	SN74100	£1·95	£1·60	£1·55	SN74191	£1·90	£1·85	£1·80
SN7440	0·15	0·14	0·12	SN74104	0·97	0·94	0·88	SN74192	£1·95	£1·90	£1·85
SN7441	0·67	0·64	0·58	SN74105	0·97	0·94	0·88	SN74193	£2·00	£1·80	£1·75
SN7442	0·67	0·64	0·58	SN74107	0·40	0·38	0·36	SN74194	£2·70	£2·60	£2·50
SN7443	£1·30	£1·25	£1·20	SN74110	0·55	0·53	0·50	SN74195	£2·00	£1·90	£1·80
SN7444	£1·30	£1·25	£1·20	SN74111	£1·25	£1·15	£1·10	SN74196	£1·80	£1·70	£1·60
SN7445	£1·80	£1·77	£1·75	SN74118	£1·00	0·96	0·90	SN74197	£1·80	£1·70	£1·60
SN7446	0·97	0·94	0·88	SN74119	£1·35	£1·25	£1·10	SN74198	£5·50	£5·00	£4·50
SN7447	£1·00	0·97	0·96	SN74121	0·40	0·37	0·34				
SN7448	£1·00	0·97	0·95	SN74122	£1·40	£1·30	£1·10	SN74199	£5·50	£5·00	£4·50

The AL50 HI-FI AUDIO AMPL
50W pk 25w (RMS)

0·1% DISTORTION! HI-FI AUDIO AMPLIFIER

- Frequency Response 15Hz to 100,000—1dB.
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- Distortion—better than 0·1% at 1kHz.
- Signal to noise ratio 80dB.
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Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry conceived to fill the need for all your A.P. amplification needs.
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AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm × 105 mm × 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p.

TRANSFORMER BMT80 £1·95 p. & p. 25p

NUMERICAL INDICATOR TUBES

MODEL	CD66	GB116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41/14 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0-9 + Decimal point. All side viewing. Full data for all types available on request.

INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which include Functional and Part-Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C's and experimental work.

Pak No.	Contents	Price
UIC00	12 × 7400	0·50
UIC01	12 × 7401	0·50
UIC02	12 × 7402	0·50
UIC03	12 × 7403	0·50
UIC04	12 × 7404	0·50
UIC05	12 × 7405	0·50
UIC06	8 × 7406	0·50
UIC07	8 × 7407	0·50
UIC10	12 × 7410	0·50
UIC13	8 × 7413	0·50
UIC20	12 × 7420	0·50
UIC30	12 × 7430	0·50
UIC40	12 × 7440	0·50
UIC41	5 × 7441	0·50
UIC42	5 × 7442	0·50
UIC43	5 × 7443	0·50
UIC44	5 × 7444	0·50
UIC45	5 × 7445	0·50
UIC46	5 × 7446	0·50
UIC47	5 × 7447	0·50
UIC48	5 × 7448	0·50
UIC50	12 × 7450	0·50
UI351	12 × 7451	0·50
UIC53	12 × 7453	0·50
UIC54	12 × 7454	0·50
UIC60	12 × 7460	0·50
UIC70	8 × 7470	0·50
UIC72	8 × 7472	0·50
UIC73	8 × 7473	0·50
UIC74	8 × 7474	0·50
UIC75	8 × 7475	0·50
UIC78	8 × 7476	0·50
UIC80	5 × 7480	0·50
UIC81	5 × 7481	0·50
UIC82	5 × 7482	0·50
UIC83	5 × 7483	0·50
UIC86	5 × 7486	0·50
UIC90	5 × 7490	0·50
UIC91	5 × 7491	0·50
UIC92	5 × 7492	0·50
UIC93	5 × 7493	0·50
UIC94	5 × 7494	0·50
UIC95	5 × 7495	0·50
UIC96	5 × 7496	0·50
UIC106	5 × 74100	0·50
UIC121	5 × 74121	0·50
UIC141	5 × 74141	0·50
UIC151	5 × 74151	0·50
UIC154	5 × 74154	0·50
UIC193	5 × 74193	0·50
UIC199	5 × 74199	0·50
UICX1	25 Assorted 74's	1·50

Packs cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

STEREO PRE-AMPLIFIER TYPE PA100

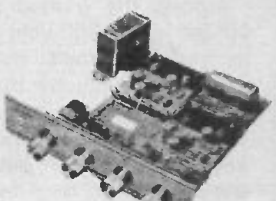
Built to a specification and NOT a price, and yet still the greatest value on the market, the PA1000 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates as less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION:

Frequency response	20Hz—20kHz ±1dB	Bass control	±15dB at 20Hz
Harmonic distortion	better than 0·1%	Treble control	±15dB at 20kHz
Inputs: 1. Tape head	1·25mV into 50KΩ	Filters: Rumble (high pass)	100 Hz
2. Radio, Tuner	35mV into 50KΩ	Scratch (low pass)	5kHz
3. Magnetic P.U.	1·5mV into 50KΩ	Signal/noise ratio	better than +65dB
All input voltages are for an output of 250mV.		Input overload	+26dB
Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.		Supply	+35 volts at 20mA
		Dimensions	292 × 82 × 35 mm

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23.00 FREE p.&p

only £11·95



The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak	Input 1 (Cer.) 300mV into 1M
Freq. res. 25Hz-20kHz	Input 2 (Aux.) 4mV into 30K
Harmonic distortion	Bass control ±12dB at 60Hz
typically 0·25% at 1 watt	Treble con. ±14dB at 14kHz

£12·25 free p. & p.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·50
C 2	200	Capacitors mixed values approx. count by weight	0·50
C 3	50	Precision Resistors 1%, mixed values	0·50
C 4	75	¼th W Resistors mixed preferred values	0·50
C 5	5	Pieces assorted Ferrite Rods	0·50
C 6	2	Tuning Gangs, MW/LW/VHF	0·50
C 7	1	Pack Wire 50 metres assorted colours	0·50
C 8	10	Reed Switches	0·50
C 9	3	Micro Switches	0·50
C10	15	Assorted Pots & Pre-Sets	0·50
C11	5	Jack Sockets 3·5 × 3·5mm 2 × Standard Switch Types	0·50
C12	40	Paper Condensers preferred types mixed values	0·50
C13	20	Electrolytics Trans. types	0·50
C14	1	Pack assorted Hardware—Nuts, Bolts, Grommets etc.	0·50
C15	4	Mains Toggle Switches, 2 Amp D/P	0·50
C16	20	Assorted Tag Strips & Panels	0·50
C17	10	Assorted Control Knobs	0·50
C18	4	Rotary Wave Change Switches	0·50
C19	3	Relays 6—24V Operating	0·50
C20	4	Sheets Copper Laminate approx. 10" × 7"	0·50

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

RTL MICROLOGIC CIRCUITS

	Price each 1-24	25-99	100 up
Epoxy TO-5 case µL900 Buffer	35p	33p	27p
µL914 Dual 2i/p gate	35p	33p	27p
µL923 J-K flip-flop	50p	47p	45p

Data and Circuits Booklet for IC's Price 7p.

DUAL-IN-LINE PROFESSIONAL IC's. TWO & NEW LOW COST.

PROF. TYPE No.	1-24	25-99	100 up.
TSO 14 pin type	30p	27p	25p
TSO 16	35p	32p	30p
LOW COST No.			
BP8 14	15p	13p	11p
BP8 16	16p	14p	12p

Ranges

LINEAR I.C.'s—FULL SPEC.

Type No.	Price 1-24	25-99	100 up
BP 201C—SL201C	53p	53p	45p
BP 701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	36p	34p	30p
BP 709P—µA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—µA711	45p	43p	40p
BP 741—72741	75p	60p	50p
µA703C—µA703C	28p	28p	24p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

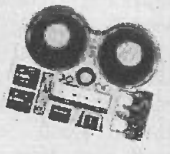
S.O.S. EA1000 £2·63

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1-24	25-99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

SYSTEM 12 STEREO



Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner. Further details available on request.

ONLY £16·95 FREE p. & p.

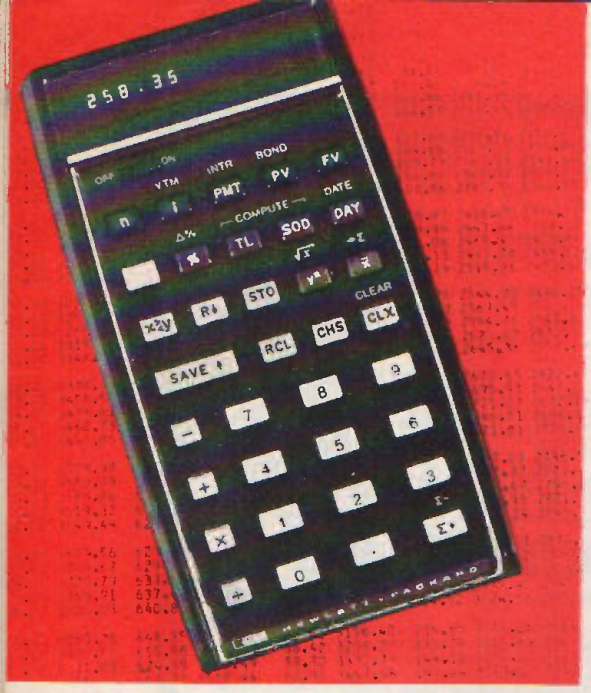
All prices quoted in new pence Giro No. 388-7006
Please send all orders direct to warehouse and despatch department

BI-PAK

P.O. BOX 5, WARE · HERTS

Postage and packing: Add 10p. Overseas add extra for airmail
Minimum order 50p. Cash with order please

Guaranteed Satisfaction or Money Back



Computer in your pocket?

An electronic calculator, small enough to fit into a shirt pocket, yet capable of performing the most complex business and financial calculations, has been introduced by Hewlett Packard.

THE NEW HP-80 Calculator, weighing only nine ounces, has a solid-state memory similar to that used in computers. Thus, its capability extends far beyond simple addition, substraction, multiplication and division.

With the HP-80, virtually all financial calculations involving the relationship between money and time can be done quickly and easily, according to John A. Warmington, of Hewlett-Packard.

For example, in less than a minute, the user can determine the bond yield between any two dates. There is no need to consult cumbersome financial tables, since the necessary data, including a 200-year calendar, are already stored in the calculator's memory.

Similar problem-solving capability is provided in such areas as compound interest, sinking fund, loan repayment, depreciation and amortisation, truth-in-lending calculations and investment analysis.

For most problems, the actual time of calculation by the user is less than 10 seconds. In more complex calculations, such as determining discounted cash flow, the HP-80 can save the user as much as 10 minutes. Although its calculating speed rivals that of a computer, the user need know nothing about computers to operate the machine effectively. A handy reference guide enables him quickly to put the machine to work.

The new calculator, with its 10-digit display, is accurate to within a cent in a million dollar transaction. Like larger, more expensive machines, it also has the capability to handle numbers as large as a 1 followed by 99 zeroes.

Although Hewlett-Packard is known widely as a manufacturer of electronic test equipment, in recent years the company has diversified into the computer and calculator fields.

Just a year ago, the company introduced its first pocket-sized calculator. Known as the HP-35, it is a machine designed for engineers and scientists.

While the HP-35 was designed to solve equations commonly used by engineers and scientists, the new HP-80 is aimed at providing the same problem-solving service for the financial community. It is an entirely new approach to handling financial calculations.

Among the unique features of the HP-80 is the 200-year calendar stored in the machine's memory. This is particularly valuable in projecting cost, interest, future value and other financial data. By pressing appropriate keys, the user can determine quickly the number of days between any two dates from January 1st, 1900 to December 31st, 2099. Or, given a date and a number of days, he can determine a past or future date.

HOW IT WORKS

The HP-80 is a pocket-sized business calculator. It differs from the HP-35 (Hewlett-Packard's original pocket-size scientific calculator) in its built-in programming. The HP-35 solves *functions* with a single keystroke: The HP-80 solves *equations* with a single keystroke. Typical of the functions solved by the HP-35 with one keystroke are: Log, Ln, SIN, COS, TAN and X^Y. Some of these functions are hard-wired into the HP-80 as subroutines within the single keystroke programs. In other words, the HP-35 has one level of programming, while the HP-80 has two levels. The most important equations used in banking, finance, accounting and real estate have been programmed into the HP-80. Data is entered, then a key is pressed for the unknown. The HP-80 executes the appropriate program, calling upon all the required functions, each of which is wired into the calculator as a subroutine. Thus, the HP-80 executes the entire program needed to solve an equation, including the necessary subroutines, all with one keystroke.

In a way, the operation of the HP-80 can be compared to that of a computer. A computer program stored on magnetic tape, discs, etc., is called by the operator when it is to be executed. But in the HP-80 each program is part of the hardware built into the calculator and called with one key press.

Four temporary memory registers used in the HP-80 are arranged in a stack, in the same way as in the HP-35 scientific calculator. Like the HP-35, the HP-80 also uses reverse Polish notation as the most efficient way known to computer science for evaluating mathematical expressions. This scheme helps achieve the goal of packing a great deal of calculator power into a very small space.

The operational stack consists of four registers, X, Y, Z and t. The stack stores intermediate results and the calculator automatically recalls them from the stack when required for further processing. This eliminates the need for manual intermediate notes or re-entry of intermediate answers. Only the contents of the X register is displayed on the solid-state display.

Numbers are entered into the stack from the bottom on a first in, last out basis. When a number is keyed in, it goes into the X register and is displayed. When "SAVE" is pressed, the number is repeated in the Y register. At the same time, any number

in Y moves up to Z, any number in Z moves up to t, and t is lost. When an operation is performed on data in the X and Y registers, the answer automatically appears on the display, and the entire stack drops.

Both the HP-80 and the HP-35 use specially-designed MOS/LSI circuits using a low-power, high performance ION-implantation process. The HP-80 uses seven read-only-memories versus three for the HP-35. The four additional ROMS handle logic needed to solve these complex equations.

Answers appear on a 15-character solid-state display. Each digit of the light-emitting diode (LED) display is of passivated monolithic construction made up of seven segments. The inherent ruggedness and long life of these monolithic solid-state devices contribute to the reliability of the HP-80. Use of one digit for the decimal point results in excellent legibility.

An unusual feature of the calculator is the "golden key". This key, immediately above the exchange X and Y key, operates like the shift key of a typewriter and allows eleven of the keys to perform a dual function. For example, pressing it before pressing the "%" key allows instant computation of the percentage difference between two numbers.

COMPLETE LIST OF THE HP-80'S CAPABILITIES

Beyond the basic four functions (+ – X ÷), the HP-80 is pre-programmed with 36 separate financial capabilities.

Constant storage
Selective round-off
Percentage calculation
Percent difference
Square root
Powers (exponentiation)
Running total (summation)
Mean (arithmetic average)
Standard deviation
Number of days between two dates
Future date given number of days
Future value of an amount compounded
Present value of an amount compounded
Effective rate of return for compounded amounts
Number of periods for an amount compounded
Future value of an annuity
Present value of an annuity
Effective rete of a sinking fund
Effective rate of a mortgage
Installment of en annuity given future value
Installment of an annuity given present value
Number of periods for a sinking fund
Number of periods for a mortgage
Add-on to effective ennual rate conversion
True equivalent annual rate
Linear regression (trend line) analysis
Sum-of-the-years'-digits depreciation emortization
Rule of 78's finance charge amortization
Discounted cash flow analysis
Accumulated mortgage interest calculation
Remaining principal on a mortgage
Accrued interest (360 and 365-day year)
Discounted notes (360 and 365-day year)
Discounted note yields (360 and 365-day year)
Bond price*
Yield-to-maturity of a bond*

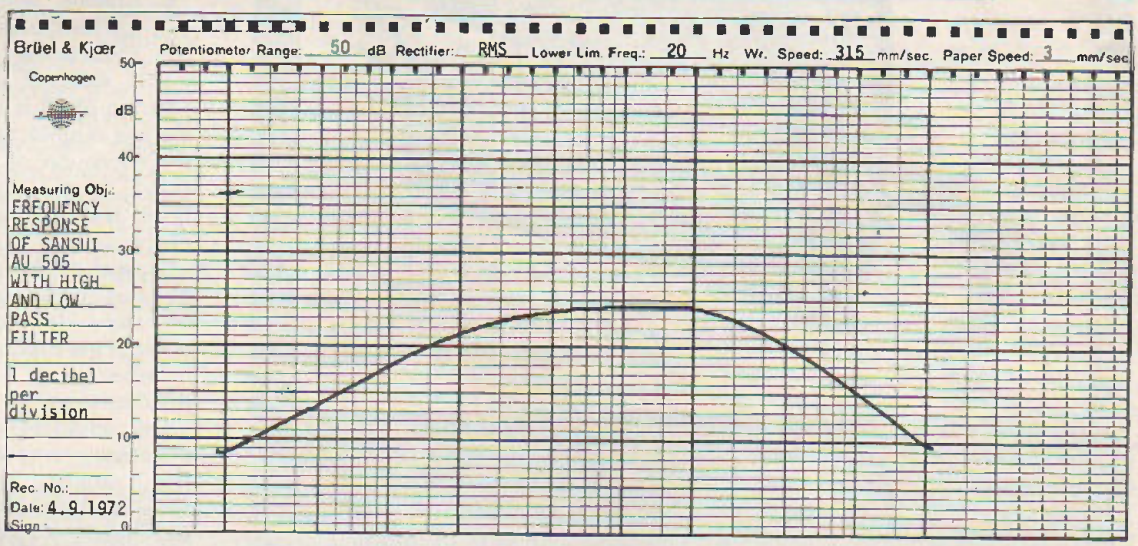
*Corresponds exactly to standard bond yield tables used in investment industry.

Each key has a touch similar to the action of an electric typewriter. A vapour barrier used between the keys and their contacts reduces environmental effects on the machine.

Rechargeable nickel-cadmium batteries with about five hours of operating time and an ac adapter-recharger are provided.

We were extremely impressed with the HP-35 when it came out 12 months ago and at that time thought that it was just about the ultimate in pocket calculators. We were wrong – it seems that with ingenuity such as that used in the design of this calculator, we soon *will* be able to carry a computer in our pocket.

SANSUI AMPLIFIER AU 505



higher than expected – exceeding 1% at 6.3kHz at rated output (23W with both channels driven).

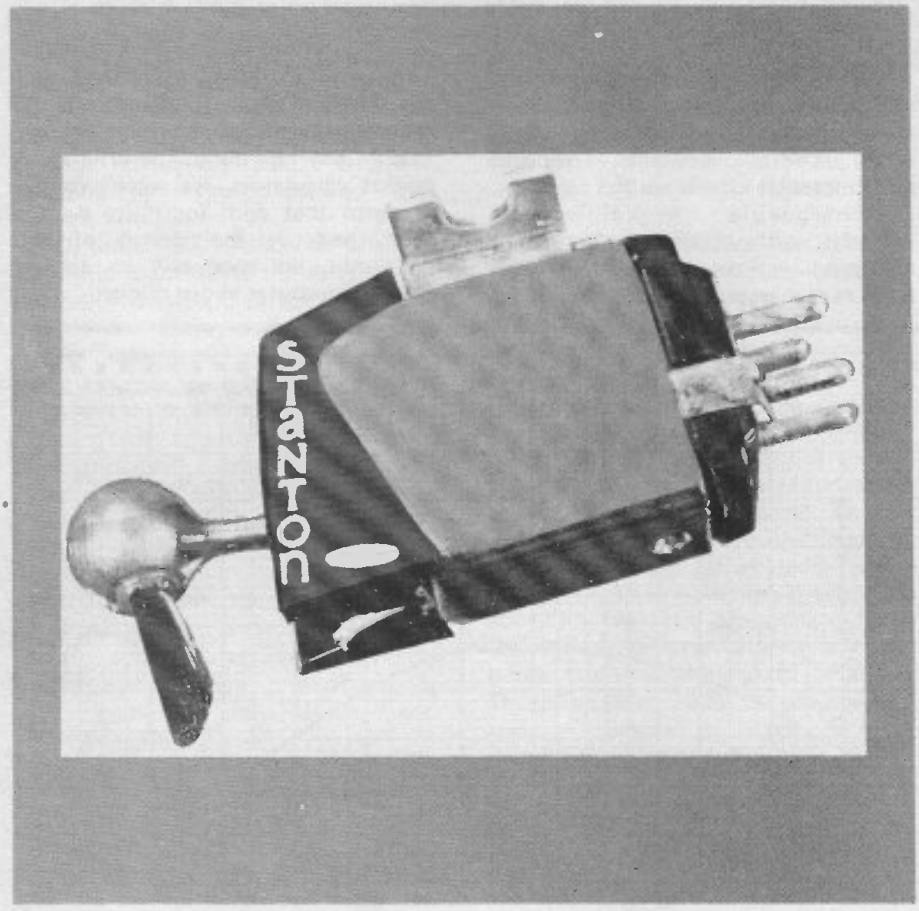
As with all Sansui equipment, a large plasticized operations card was supplied. Details of all the front panel control functions are shown on one side of the card and the other side shows how all the rear panel connections should be made, including making up patch cords with the R.C.A. plugs supplied with the amplifier. Also included with the card is a ten page "Operating Instructions and Service Manual", a Warranty card and a cloth for polishing the timber cabinet. The manual devotes most of its pages to wiring diagrams and component layouts on the printed circuit boards. Photographs in the manual are used to show the location of all the major components on the amplifier chassis.

The AU 505 amplifier is another example of the ability of the Sansui Electric Co. Ltd. of Japan to produce a top quality amplifier at a sensible price for the domestic market. It combines a pleasing external appearance which would match most decors with an adequate set of functions for various sources and modes of operation. ●

Recommended Retail Price
£81.42 + VAT

STANTON 681T PHONO-CARTRIDGE

Calibration-series cartridge has exceptionally linear response.



SINCE Stanton Magnetics Inc. started manufacturing cartridges in 1965, their products have been primarily designed for the professional market and in particular for recording and broadcast studios.

The company has placed especial emphasis on linearity of frequency response. This is particularly so with the 681 range, in fact Stanton classify them as their Calibration Standard Series.

Stanton also produce a 500 series which is intended for use in broadcasting studios.

This latter series is particularly interesting because of its unusual stylus bar shape which allows the cartridge to be backcued without damage or jumping of tracks.

The 681T reviewed in this article is a 681 cartridge available with either a spherical stylus (as type 681A) or an elliptical stylus (as type 681EE); the stylus type numbers incidentally are 6807A and 6800EE respectively.

The cartridge is supplied with a calibration chart (as are all Stanton cartridges) which gives the following performance data:—

A. Frequency response.
B. Sensitivity.
C. Channel separation at 1,000 Hz.
D. Dc resistance
E. Inductance.

The external appearance of the Stanton 681T is similar to many other moving magnet type cartridges — with the exception of the small hair brush fitted to the stylus assembly. This brush tracks some two grooves ahead of the stylus.

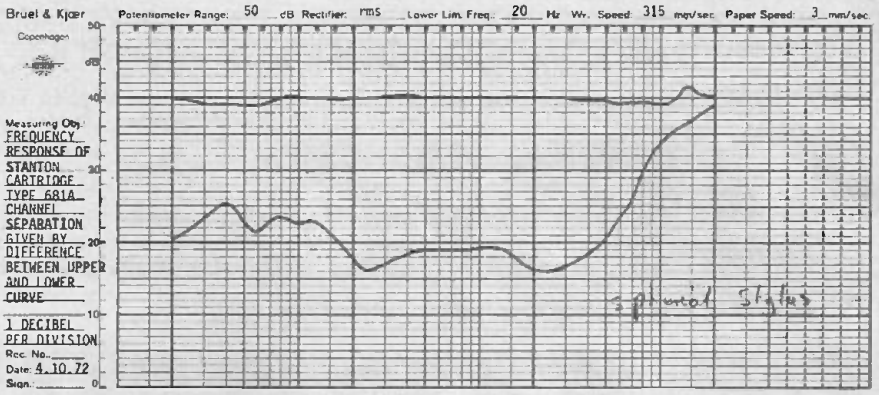
Because of the pivoting arrangement of this brush a 1 gram force is necessary to compensate for the upward lift produced by it. This has a number of advantages and disadvantages.

The advantages are that: It very effectively removes lint and dust from the record grooves. (This is particularly evident by the amount of built up on the end of the bristles).

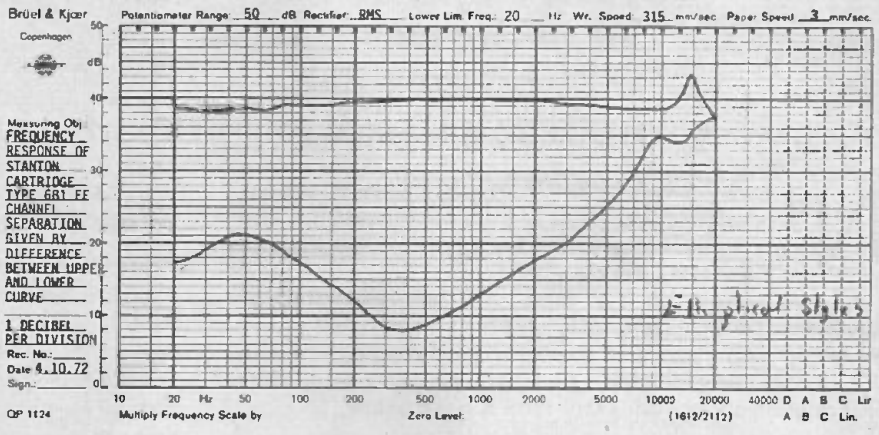
Apart from this it appears (subjectively) to very marginally improve the trackability of the cartridge on truly flat records. This is partly due to the anti-skating forces produced by the bristles.

Against this, the brush causes mistracking on slightly warped records due to the brush lifting the stylus out of the groove. Clearly it is unfair to fault a cartridge for a record manufacturer's problems, but regrettably, warped records are becoming ever more common.

Another minor problem is that on automatic record players with slow lift



Top graph shows Stanton 681T cartridge with a 6807A spherical stylus, lower graph shows the same cartridge, but this time with a 6800EE elliptical stylus.



and rise movements, the brush causes the stylus to traverse across the record possibly causing damage. However this is also a rather unfair criticism since the 681T is designed for a tracking force of 3/4 grams to 1½ grams and most automatic changers are only suitable for cartridges with tracking forces in excess of 1½ grams.

LISTENING TESTS

The subjective assessment of a cartridge is necessary to determine its overall performance. Laboratory measurements of its frequency response, channel separation, etc. do not indicate its performance on 'real' record material, neither do measurements of static and dynamic compliance and stylus mass give an accurate indication of trackability. (However measurements of trackability reveal a lot more information than do distortion measurements at selected frequencies and fixed velocities).

For the trackability test we used the second side of the first record in "The Tchaikovsky Ballet Album number 32BR 220302. Some slight mistracking occurred at the highest tracking velocities with bells, cymbols, triangles and piccolo, and resulted in a slight loss of the sharp attack characteristic of these instruments. This was particularly noticable in the climax in the Dance of the Mirlitons. The xylophone in the Dance of the Sugar Plum Fairy was extremely good – in fact it was possible to hear a squeak in the pedal mechanism! The bass drum, particularly at the end of the Dance of the Sugar Plum Fairy, and during the Final Waltz and Apotheosis from Act II, sounded rather blurred indicating some slight mistracking. On the other hand the kettle drums which are particularly predominant towards the end of the "Pas de Deux" were extremely good.

As expected the mistrackings observed with the elliptical stylus, were slightly more pronounced with the spherical stylus, particularly on the inner track.

The measured performance of the Stanton cartridge was very good. The frequency response is the flattest we have ever measured and agreed exactly with the calibrated performance.

Channel separation was the only parameter which did not agree with the calibration data supplied. It was 8dB less than the figure quoted.

The Stanton 681T cartridge is one of the best cartridges we have ever tested. Although a number of isolated mistrackings were heard they were of quite minor importance, and for the major part of the listening period was exemplary. ●

MEASURED PERFORMANCE OF STANTON CARTRIDGE 681T SERIAL NO: 0399X

Frequency Response	Elliptical Stylus 20Hz to 20kHz ±2dB Spherical Stylus 20Hz to 20kHz ±1dB
Sensitivity re 1kHz at 5cm/sec	3.3mV
Channel Separation at 1kHz	Elliptical Stylus 27dB Spherical Stylus 21dB
Cartridge Weight	6.37 Grams
Recommended Selling Price	681T £35.30 681EE £41.35

AUDIO COMPETITION

YOUR SECOND CHANCE TO WIN AUDIO EQUIPMENT WITH A TOTAL VALUE OF OVER £250

No reader can afford to miss this competition. We not only offer a first prize of a Linton system but also have three runner-up prizes: a pair of speakers, an audio amplifier and CrO_2 cassette tapes.

All you have to do is to place, in a descending order of preference, the characteristics of a hi-fi speaker, tell us in a few words why you placed them in your chosen order — and fill in the entry coupon. There are no entry fees. More information about your entry form is given below.

THE PRIZES

The main prize winner will receive a Linton audio system, donated by Rank Radio International and worth around £150. It consists of a Linton turntable, a Linton amplifier and a pair of 'Linton 2' loudspeakers. The plint-mounted turntable is fitted with a Shure M44-7 cartridge. The amplifier is equipped with switchable radio input facilities and two unswitched power outlets, one for energising the turntable and the other for a tuner if required. The speakers each have an 8" bass unit and a 2" treble unit, with infinite baffle bass loading and a maximum continuous power rating of 25W (20W nominal according to DIN 45-500). The four items are not only pleasing looking and excellent performers in their own right but, as a total system, they are beautifully matched in appearance as well as performance.

The first runner-up wins a pair of the new Keletron KS20 speaker systems donated by K & K Electronics Ltd. Each item (RRP £35.80) is a three-speaker system built on the infinite baffle principle, fully padded to damp out any panel resonance and housed in handsome slim-line cabinets, ideal for shelf or wall mounting; power handling rating is 20W rms.

The second runner-up wins a Teleton GA202 amplifier (RRP: £50) featuring push-button and slider controls and rated to deliver 2 x 16W rms. The stereo amplifier, finished in a smart wood cabinet, has four inputs (magnetic and crystal pickups, tape and an auxiliary input), high-cut, loudness and mono controls, tape output, and phone sockets.

The third and last runner-up wins £15 worth (retail value) of CrO_2 tape cassettes donated by BASF (UK) Ltd. The cassettes, known for their increased dynamic range, lower background noise, reduced head wear and longer tape life, come in three sizes, C60, C90 and C120 — all fitted with BASF's 'Special Mechanics' (SM) for anti-tangle and slip-free operation. The winner can mix his cassettes from the range or take all cassettes of the same type.

YOUR ENTRY

Choosing a loudspeaker is never an easy task as so many considerations have to be taken into account. It is to some extent a matter of individual taste as to what is required from a loudspeaker and what is believed to be the salient points of any one speaker system.

There are certain characteristics which every speaker system must possess. But the decision as to whether the point of prime importance is the appearance, the size or the frequency response is often a matter of the individual buyer's personal requirements.

The purpose of this competition is to find a sequence of priorities to act as a guide when buying a speaker system. We would like you to mark down the features we have listed in order of preference and then to write in thirty words or less why you have placed them in that order.

Wharfedale Linton system

Contest Conditions

All entries must be accompanied by the coupon from Electronics Today International. There is no entrance fee, but any entry not accompanied by a coupon will be deemed invalid by the judges.

The winners will be decided by a panel of judges appointed by the Editor of Electronics Today International. The judges' decision will be final and no correspondence will be entered into concerning the outcome of the contest.

All entries should be addressed to: Audio Competition, Electronics Today International, Whitehall Press Ltd., Wrotham Place, Wrotham, Sevenoaks, Kent.

Ensure that your name and address is printed clearly on your entry coupon.

Closing date for the competition is May 31st, 1973.

Keletron KS20 system

Teleton GA202 Amplifier

BASF Cassettes

Mark your order of preference in the boxes, i.e. 1 for first choice, 2 for second choice, etc.

- ☐ High efficiency
- ☐ Low distortion
- ☐ Wide frequency response
- ☐ Smooth frequency response
- ☐ Wide polar response
- ☐ Attractive appearance
- ☐ Reasonable size
- ☐ High power handling capacity
- ☐ Parts and labour warranty
- ☐ Moderate price
- ☐ Superior transient response

Explain in thirty words or less the reasons for your order of preference.

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ENTRY COUPON – 2

ELECTRONICS TODAY INTERNATIONAL
AUDIO COMPETITION

Herewith, please find my entry for your Audio Competition. I have read the rules of the contest and agree to abide by the judges' decision.

SIGNED . . . . . DATE . . . . . .

NAME (block letters) . . . . . .

ADDRESS . . . . . .

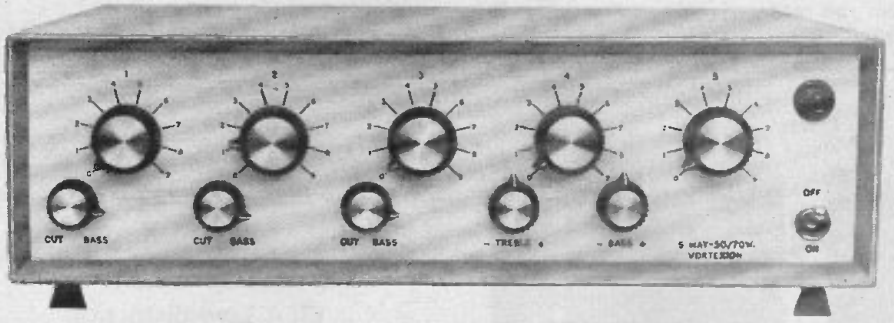
. . . . . .

A separate coupon must accompany each entry.
Closing date for the Audio Competition is May 31st, 1973.

Vortexion

50/70 WATT ALL SILICON AMPLIFIER

WITH BUILT-IN 5-WAY MIXER USING F.E.T.s



THIS is a high fidelity amplifier with bass cut controls on each of the three low impedance balanced line microphone stages and a high impedance (1·5 meg.) gram stage with bass and treble controls, plus the usual line or tape input. All the input stages are protected against overload by back to back low self capacity diodes and all use F.E.T.s for low noise, low intermodulation distortion and freedom from radio breakthrough.

A voltage stabilised supply is used for the pre-amplifiers making it independent of mains supply fluctuations and another stabilised supply for the driver stages is arranged to cut off when the output is overloaded or over temperature. The output is 75% efficient and 100V balanced line or 8-16 ohms output are selected by means of a rear panel switch which has a locking plate indicating the output impedance selected. The mixer section has an additional emitter follower output for driving a slave amplifier, phones or tape recorder, output ·3V out on 600 ohms upwards.

50/70 WATT ALL SILICON AMPLIFIER WITH BUILT-IN 4-WAY MIXER

(0·3% intermodulation distortion) using the circuit of our 100% reliable 100 Watt Amplifier with its elaborate protection against short and overload, etc. To this is allied our latest development of F.E.T. Mixer Amplifier, again fully protected against overload and completely free from radio breakthrough. The mixer is arranged for 2-30/60Ω balanced line microphones, 1-HiZ gram input and 1-auxiliary input followed by bass and treble controls. 100 volt balanced line output or 5/15Ω and 100 volt line.

100 WATT ALL SILICON AMPLIFIER

A high quality amplifier with 8 ohms-15 ohms or 100 volt line output for A.C. Mains. Protection is given for short and open circuit output over driving and over temperature. Input 0·4V on 100K ohms.

THE 100 WATT MIXER AMPLIFIER

with specification as above is here combined with a 4-channel F.E.T. mixer, 2-30/60Ω balanced microphone inputs, 1-HiZ gram input and 1-auxiliary input with tone controls and mounted in a standard robust stove enamelled steel case. A stabilised voltage supply feeds the tone controls and pre amps, compensating for a mains voltage drop of over 25% and the output transistor biasing compensates for a wide range of voltage and temperature. Also available in rackpanel form.

20/30 WATT MIXER AMPLIFIER

High fidelity all silicon model with F.E.T. input stages to reduce intermodulation distortion to a fraction of normal transistor input circuits. The response is level 20 to 20,000 cps within 2dB and over 30 times damping factor. At 20 watts output there is less than 0·2% intermodulation even over the microphone stage at full gain with the treble and bass controls set level. Standard model 1-low mic. balanced input and HiZ gram. Outputs available 8/15 ohms OR 100 volt line.

CP50 AMPLIFIER

An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs, and overload and short circuit protected outputs for 8 ohms—15 ohms and 100 volt line. Bass and treble controls fitted. Models available with 1 gram and 2 low mic. inputs, 1 gram and 3 low mic. inputs or 4 low mic. inputs.

200 WATT AMPLIFIER

Can deliver its full audio power at any frequency in the range of 30 c/s – 20 Kc/s ± 1 dB. Less than 0·2% distortion at 1 Kc/s. Can be used to drive mechanical devices for which power is over 120 watt on continuous sine wave. Input 1 mW 600 ohms. Output 100-120V or 200-240V. Additional matching transformers for other impedances are available.

F.E.T. MIXERS AND PPMs

Various types of mixers available. 3, 4, 6 and 8 channel with Peak Programme Meter. 4, 6, 8 and 10 Way Mixers. Twin 3, 4 and 5 channel Stereo, also twin 4 and 5 channel Stereo with 2 PPM's.

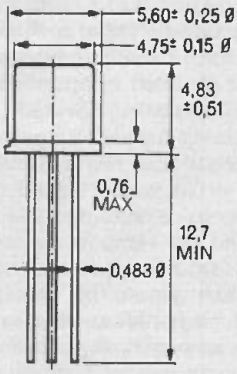
VORTEXION LIMITED 257-263 The Broadway, Wimbledon, SW19 1SF

Telephone: 01-542 2814 and 01-542 6242/3/4 **Telegrams: "Vortexion, London SW19"**

TERMS Retail mail order subject to £1·00 minimum order.
Cash with order only. Trade and educational establishments M/AC on application (minimum £5·00).
Postage 10p inland, 25p, Europe.
GUARANTEE: All goods carry full manufacturer's warranty. Get in touch today for a complete run-down of devices available from SCS (include SAE).

SCS COMPONENTS, P.O. Box 26, Wembley, Middlesex HA0 1YY
The 'Professional' Amateur Supplier

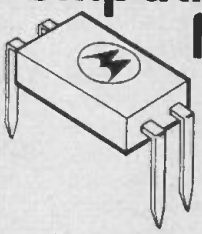
device of the month ZN414



The Ferranti ZN414 is a complete a.m. radio circuit which operates from 1.1 to 1.8 volts and requires only battery, earphones and antenna plus a tuning capacitor and two decoupling capacitors. The ZN414 features: medium and long waveband, good stability on assembly, no setting up of IF coils, plus much more.

a complete a.m radio circuit for just £1.20

compatible device MFC4000



The Motorola ¼-Watt Audio Amplifier is designed for the output stage of battery powered portable radios.

* 250 mW of Audio Output Power
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* Reduces Component Count in Portable Radios by Two Transformers and Two Transistors
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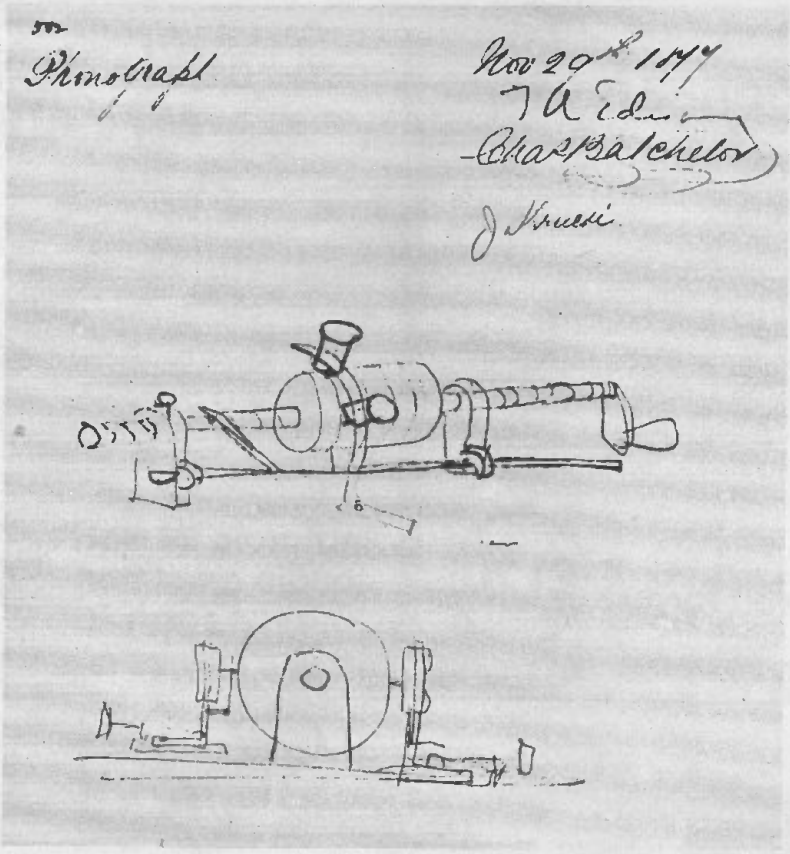
motorola 1/4 watt audio amplifier MFC4000 50p

Send S.A.E

THE PHONOGRAPH



Edison's first sketch of the Phonograph, recently discovered. Another "first sketch" incorrectly dated "August 1877" has since been found to be a copy, drawn from memory by Edison in 1894.

IN 1877, Thomas Edison was working on a telegraph repeater when the idea occurred to him that it might be feasible to record, not only dots and dashes of the Morse Code, but the actual sound of a human voice.

During previous experiments with the telegraph headphones he had observed, that when in operation, the receiver diaphram vibrated with sufficient energy to be felt quite easily with the finger tips. He reasoned that if a sharp point was attached to the center of a voice actuated diaphram and allowed to emboss a moving surface it would create a varying pattern which would be, in fact, a record of the original sounds.

The material eventually chosen for a recording surface was a sheet of tin foil. Edison had his chief mechanic make up a machine which consisted of a brass drum, 3½ inches in diameter mounted on a threaded axle, with a hand crank to revolve it. Each turn of the crank caused the drum to revolve, and move laterally one tenth of an inch. A recorder, consisting of a diaphram mounted in a mouthpiece with a stylus attached to the center of the diaphram was on one side of the drum. Opposite was the playback reproducer, similar to the recorder but with a more flexible diaphram.

Edison listening to his wax-cylinder phonograph after a marathon effort to improve its mechanism.

Famous opera singer recording on a tin foil Phonograph, 1878.

— a short history by Charles Slater

The world's first sound recording was produced on Dec. 6th 1877 when Edison wrapped a sheet of tin foil around the drum of this strange little machine, turned the handle and recited 'Mary had a little lamb'. The playback reproducer was then substituted for the recording mouthpiece and the machine cranked again. To the amazement of everybody present — including Edison himself — a recognisable reproduction of his voice spluttered forth.

The name Edison gave to this invention was 'The Phonograph'. (Those who know their Greek derivations will easily see why, the word means 'sound writer'.)

The Phonograph caused a sensation wherever it was demonstrated. It is difficult for us today, living as we do in a world of television, piped music and quadraphonic sound to imagine the impact that a 'talking machine' had on 19th century ears. Many at first thought it some kind of ventriloquist trick or a device of the devil, but before long it was being unanimously acclaimed as the 'wonder of the age'. To hear a machine reproducing the human voice, even very poorly, seemed nothing short of a miracle. The device however, was rather imperfect and its primary role was that of an amusing novelty. Hundreds were manufactured for use by showmen who were able to make a good living out of them during the early months of 1878.

As the novelty wore off, the crowds of spectators grew less and less and the tin foil phonograph gradually went into retirement eventually to become little but a scientific toy. In retrospect the reasons are obvious. Firstly, the quality was extremely poor, so much so that, unless one was present when a record was made, it was often impossible to recognise exactly what was being played back. Playing time was barely half a minute and each recording could only be played about five times before wearing out. Of what practical use could such an instrument be? Before long the phonograph went into eclipse, abandoned by all including its inventor, who by this time was busy perfecting the electric lamp.

No further phonographic progress was made for almost a decade. Then, in 1889, a new talking machine was exhibited before the public.

It was developed by two men, Chichester Bell — a cousin of the famous telephone pioneer — and an associate, Charles Tainter. Together they produced a machine which had far better performance than the Edison design. The new machine recorded on wax coated cardboard cylinders instead of tin foil, had an improved stylus arrangement, and could be operated by either electric motor or a foot treadle — instead of being hand cranked. Bell and Tainter named their instrument the Graphophone.

Upon hearing of the success of Bell and Tainter's efforts, Edison decided it was time to have another look at what he later called his favourite invention. In typical fashion he immersed himself in the project until, after a five day stint, he was able to announce his 'Improved Phonograph'.

The new machine was indeed an improvement over the Graphophone, using solid wax cylinders which could be shaved for re-use; a precision battery powered motor plus a more efficient recorder and reproducer.

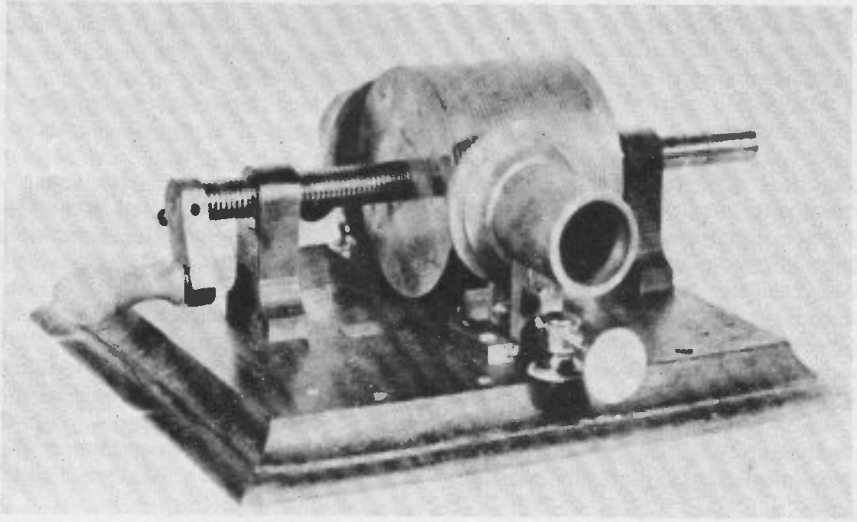
At this stage a complex legal battle between the Graphophone and the Phonograph interests flared up over patent rights. Eventually the two factions decided to pool their patents and started to sell their products. Their initial idea was to install them in offices as dictating machines but it was soon discovered, that there was more profit in setting up the machines as coin-in-the-slot entertainment devices.

So it was that 1890 saw the birth of the first juke boxes. By inserting a nickel, and donning stethoscope type ear tubes, it was possible for people to hear a popular song, a brass band selection or a humourous anecdote reproduced from a beeswax cylinder which played a little over two minutes.

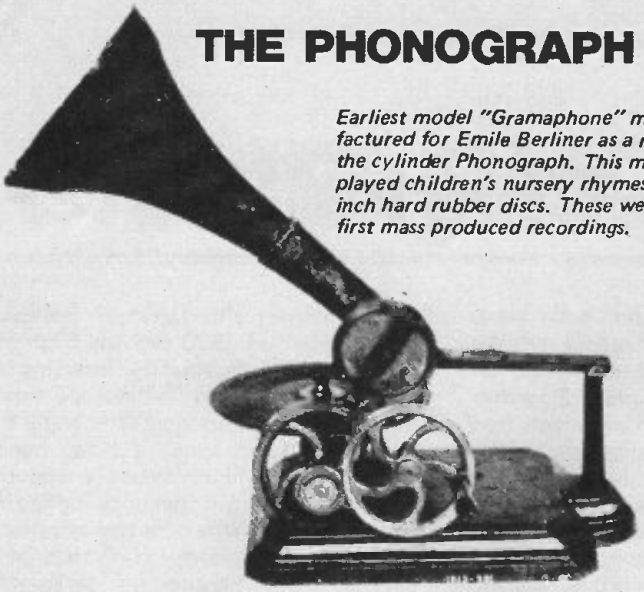
But the demand for recorded entertainment became so persistent that it soon appeared obvious that the most viable role for the Phonograph was not at the office but in the home and so domestic machines were developed employing a cheap and reliable spring motor to eliminate the cumbersome and messy batteries used in the dictating machines. By 1886 one could purchase either a Phonograph or Graphophone, suitable for home use, for about $50; still rather expensive but only a third of the price of the cheapest model of 1893. By this time the Graphophone was owned by the Columbia Phonograph Co. whose genealogy can be traced to the modern CBS Corporation. The infant record industry began to boom, and as sales improved, prices became lower. Just when the Phonograph and the Graphophone looked like becoming firmly established as the number one household entertainer, a third competitor appeared which was destined to relegate the cylinder to obscurity; this was the Gramophone.

Developed by Emile Berliner, a

Edison original tinfoil phonograph, the first recorder of sound.



THE PHONOGRAPH



Earliest model "Gramaphone" manufactured for Emile Berliner as a rival to the cylinder Phonograph. This model played children's nursery rhymes on five inch hard rubber discs. These were the first mass produced recordings.

Edison "Standard" Phonograph, one of the most popular record players of early times. This 1909 model featured a turnover stylus for playing either normal two minute or the finer grooved "Amberol" 4 minute cylinders.

young inventor who had emigrated to the U.S.A. from Hanover, the Gramophone struck right at the Achilles heel of the Phonograph. This was its inability to mass produce recordings cheaply, for at that time each Phonograph cylinder sold was an original! If an artist wanted to sell a thousand recordings of a song, he had to sing it that many times. Brass bands were slightly more fortunate as, due to their greater volume, a dozen or so cylinders could be cut at once, but it still made for a slow and costly recording procedure.

Berliner's Gramophone utilised a flat disc instead of a cylinder, and a method was evolved whereby these discs could be stamped out in almost unlimited numbers. Although Berliner first began experiments in 1887 it was not until 1894 that he had sufficient knowhow and financial backing to produce a commercially viable product.

The very first disc records appeared around November of that year pressed in hard rubber, they were seven inches in diameter and single-sided, with the title scratched in the centre (no paper label). They played for two minutes and were recorded at 70 r.p.m.

Another major difference was the use of laterally modulated grooves, that is the stylus vibrated from side to side while playing, as opposed to the hill and dale (or vertical modulation) movement employed for cylinders. Another significant improvement was that whilst with the Phonograph a feedscrew was required to enable the reproducer to reliably traverse the shallower grooves of the cylinder the soundbox of the Gramophone was propelled across the disc solely by the grooves in the record. Hence a machine to play disc records could be made more simply and cheaply than its cylinder counterpart. At this time most people could afford a 'talking machine', for the simplest Gramophone, admittedly hand cranked, sold for about $12. This was far lower than any cylinder machine, while records could be bought for 50 cents.

The Gramophone could not be used to make home recordings, (as was possible with the Phonograph) but this proved to be only a minor drawback as the public had already shown a preference for professionally 'pre-recorded cylinders', rather than their own inconsistent efforts.

More important was the fact that Gramophones were hand cranked and this invariably produced erratic speed. This drawback prejudiced the progress of the disc player for a while until a mechanical engineer, Eldridge Johnston, was given the task of designing a suitable spring motor to drive it.

Johnston not only succeeded with this project but soon found himself improving the fledgeling machine.

By 1897 he developed the 'Improved Gramophone' with a stronger motor and a revised soundbox. This model was to become the most famous talking machine in history. It is the one being listened to by Nipper the fox terrier in the well known 'His Masters Voice' trademark. It is interesting to note that the artist, an Englishman named Francis Barraud, originally painted a dog listening to 'his masters voice' at the horn of an Edison cylinder machine. A few years later a visitor noticed the painting and suggested it might look better if he painted a gleaming brass horn as used with the latest machines. Barraud approached the manager of the recently formed Gramophone Co., William Owen, for a loan of such a horn as a model. Upon seeing the painting Owen offered to buy it if the original phonograph was painted out and an 'Improved Gramophone' substituted. This was agreed to and before long Nipper replaced the 'Angel with a quill' trademark hitherto employed. In America he appeared on records produced by the Victor Co. which was formed as a breakaway from the Berliner group by Eldridge Johnston in 1901.

By now the disc record was providing healthy competition for the cylinder manufacturers who decided that something had to be done to improve their product. After much experimenting a method was evolved whereby cylinders could be mass moulded. A microscopic layer of gold was deposited on the master cylinder to make it electrically conductive. The record was next copper plated and then melted out, leaving a copper mould, the counterpart of the negative stamper used for disc pressings. Molten wax was then poured into the mould to create the copy which was kept hollow by means of a tapered cylindrical form inserted inside the mould. Upon cooling, the wax would harden and contract sufficiently to be withdrawn from the mould. It was then ready for use. The correct speed for cylinders was standardised at 160 rpm (it was previously around 120 to 144 rpm), thereby improving the sound quality — but limiting the playing time to a maximum of two minutes. The first of these improved 'Gold Moulded' cylinders appeared in 1901, but it was then already too late to win the battle against the disc manufacturers.

By the following year (1902), Enrico Caruso had recorded ten discs for the Gramophone Co. of England and these created something of a sensation

The "Graphophone" cylinder player made by Columbia Co. around 1899.

among music lovers the world over. The Columbia Co, seeing the writing on the wall, also began the manufacture of discs although the company continued to market cylinders until 1912. A further blow descended on the cylinder trade in 1904 when somebody realized that a disc had two sides. It seems extraordinary that this had not occurred sooner, but until then all discs were recorded on one side only, the other being blank or inscribed with trademarks, patent dates etc.

By 1908 most discs were double sided which implied that the average 10" record could provide up to six minutes of program material, whilst a similarly priced cylinder was still limited to two minutes only; moreoever the cylinder was more fragile and harder to store. All these facts resulted in a swing by the record-buying public to the disc system. (If this hadn't occurred, instead of radio disc jockeys 'spinning' a record, we would have perhaps cylinder jockeys 'revolving' them. If nothing else this would have made a request 'to play the flip side' rather difficult).

But despite this, Edison was still convinced that the cylinder was technically superior and, up to a point, he was correct. When playing a disc, the circumference of the grooves becomes progressively smaller as the pickup moves toward the label and the effective surface speed decreases accordingly. This causes a restriction of the available treble response towards the end of a disc.

Cylinder recordings do not have this limitation as the stylus tracks the groove at a speed that remains constant throughout the record.

Cylinder records also had the advantage of being played with an accurately ground elliptical sapphire, which caused less wear and lower surface noise than the expendable steel needles used for discs. Moreover the 'hill and dale', or vertical modulation method, referred to earlier, was in many ways more suitable for the acoustic recording methods then employed.

It was with these facts in mind that Edison decided to have another try at converting the wayward record buyer back to his beloved cylinder. A new four minute wax cylinder was introduced in November 1908 which Edison called the Amberol. The extra playing time was achieved by doubling the groove pitch from 100 to 200 per inch — about the same as the average microgroove LP of today.

A special phonograph called the Amberola was produced to play these new cylinders. It was equipped with a suitable feedscrew and finer stylus. The Amberola was the first Edison machine to be fitted with an internal horn, rather than the flamboyant external type which had often predjuced its appearance in the well furnished home.

To keep faith with past customers, ingenious conversion kits were supplied at low cost to owners of two-minute machines to allow them to play both standard and four-minute types. New machines were also supplied with a gear change to alter the feed screw speed to suit either type, and a turn-over stylus arrangement similar to that used nowadays for 78's and LP's, was featured.

An unbreakable celluloid four minute cylinder was marketed in 1912. This was known as the Blue Amberol but, although acoustically superior to its competitors, it failed to influence to any extent the buying habits of the average record collector.

In the same year that the Blue Amberol was introduced, Edison conceded to public taste and marketed his first disc records. However both Edison's records, and the diamond disc machines produced to play them, were completely incompatible with the standard gramophone type discs. For Edison had retained the 'hill and dale' modulation and shallow groove concept as used with his cylinders.

To overcome tracking problems, the players were fitted with a feedscrew device to guide the soundbox over the record, while the records themselves were made a quarter of an inch thick in order to minimise any warpage which might tend to throw the stylus out of the groove. These records were finely grooved — 150 to the inch — giving a playing time of up to four minutes per 10" side. The stylus itself was diamond tipped hence the designation 'Diamond Disc Records.'

This was not the first attempt to produce a 'hill and dale' cut disc. Six years earlier the French Pathe Co. began marketing discs using vertical modulation with very broad grooves and meant to be played with a sapphire 'ball' stylus of some 13 mils radius. To minimise treble losses due to this large stylus, discs were recorded at about 95 rpm. These Pathe discs were manufactured up until 1932, while the production of Edison Diamond Discs and Blue Amberol cylinders ceased in 1929, two years before the inventor's death.

Before leaving the Diamond Disc it is worth noting that in 1927 a long playing version of this system was marketed. The record played at the normal (80 rpm), but the groove density was increased to an amazing 450 grooves per inch enabling a 12" record to play 20 minutes per side. Unfortunately the public were not yet ready for LP records and the venture was a commercial failure.

Probably the greatest breakthrough in recording history came in 1925 when a system of electrical recording, using microphones and valve amplifiers instead of tin horns, was perfected. Until then singers and musicians had to record 'double forte' in order to register on the insensitive diaphrams. There was no room for subtleties, and some voices and instruments would not record at all.

Suddenly thanks to research at the Bell laboratories, a new sonic world was available to the record industry. Surprisingly enough the public was slow to appreciate the new electrical techniques — many disclaiming it openly — for by capturing a greater range of tones, they were hearing sounds to which they were unaccustomed. They were rather like someone who, having been short sighted all his life, tries wearing spectacles and claims that everything looks strange.

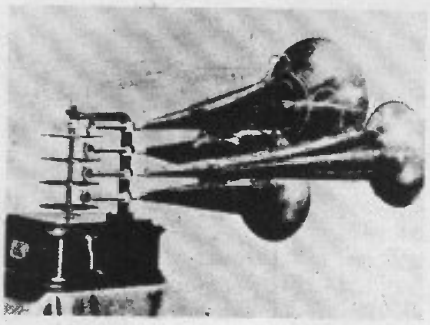
Similar sentiments were later to be expressed by many upon the arrival of the microgroove LP, the stereo disc and more recently, quadraphonic sound.

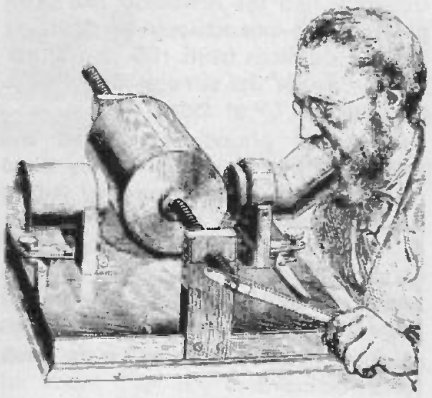
Nevertheless, eventually, most people began to appreciate the advantages of electrical recording and reproduction.

By 1927 the system was being put to use by the movie industry. The soundtrack used for early talkies consisted of a 16" disc record revolving at 33-1/3 rpm and mechanically coupled to the film projector. However an attempt in 1931 by RCA Victor to market a 12" 33-1/3 rpm record failed, just as Edison's earlier LP venture had. The 78 rpm record had become standard

THE PHONOGRAPH

ABOVE: A three-channel cylinder machine exhibited by Columbia in 1899.





Above right: Quadraphonic sound, 1904 style.

RIGHT: Large, demonstration tin foil Phonograph built by British engineer William Preece in 1878. (From a contemporary newspaper account).

and remained so until 1948 when Columbia first introduced its microgroove system. RCA countered with the 7" 45 rpm disc and for a while the two systems battled it out for supremacy. Finally they settled down to a peaceful co-existence, and by 1955 the 78 rpm shellac record was extinct.

In tracing the fortunes of Thomas Edisons brainchild it is interesting to note how many 'modern' innovations had distant ancestors. For example we have the elliptical stylus developed for cylinder machines and the LP fine groove records of the 20's. A three channel cylinder machine was exhibited by Columbia around 1900 and although it wasn't labelled stereophonic its makers termed it the 'Multiplex' Graphophone Grand.

The straightline tracking arm was in commercial use in over 65 years ago, and eight years before this an alternate method of recording was being demonstrated, using reels of steel wire and electro-magnetic recording heads. The 'tape' recorder was first developed in 1900, although its inventor, a Danish telephone mechanic by the name of Vladmir Poulson, was hampered by the lack of a suitable amplifier to make his invention practicable. The first stereo disc using the same 45/45 modulation method employed today was produced in 1933 by A.D. Blumlein, an engineer working for EMI in England. It was 24 years before its time. Perhaps a look back through the history of the gramophone record might enable us to foretell developments in the audio world that are still yet to come. ●

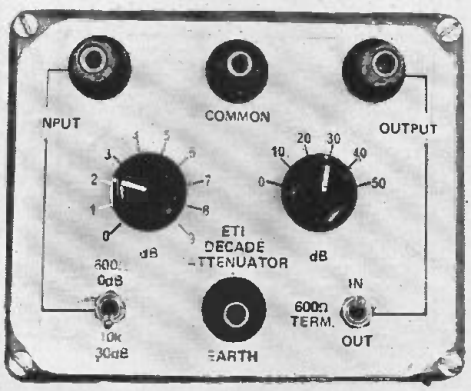
AUDIO ATTENUATOR

This useful audio attenuator project for the experimenter provides 0-59dB attenuation in one dB steps.

SPECIFICATION

Max attenuation	59dB
Resolution	1dB
Accuracy	±0.3dB
Frequency range	dc to 100kHz
Input impedance	600 Ω nominal
	10k switched (+30dB attenuation)
Output impedance	600 Ω nominal
Max input voltage	15 volt

Internal switched termination resistor for use with high impedance loads.



ACCURATE attenuators are required in a multitude of design, service, testing and measuring situations. These units are designed with varying degrees of accuracy and as many steps of attenuation as the designer feels necessary. They may be balanced or unbalanced and have whatever input and output or impedances the designer requires.

There are three common types of attenuator configuration, Pi, T or L. The latter is mainly employed where the output impedance is not required to be constant.

THE CIRCUIT

We have chosen Pi type sections for our unit. We could have connected the various sections in tandem to form a ladder attenuator, but this would have made more complex rotary switches necessary. Instead, we chose to employ a separate section for each step of attenuation, making only simple rotary switches necessary.

ETI PROJECT 112

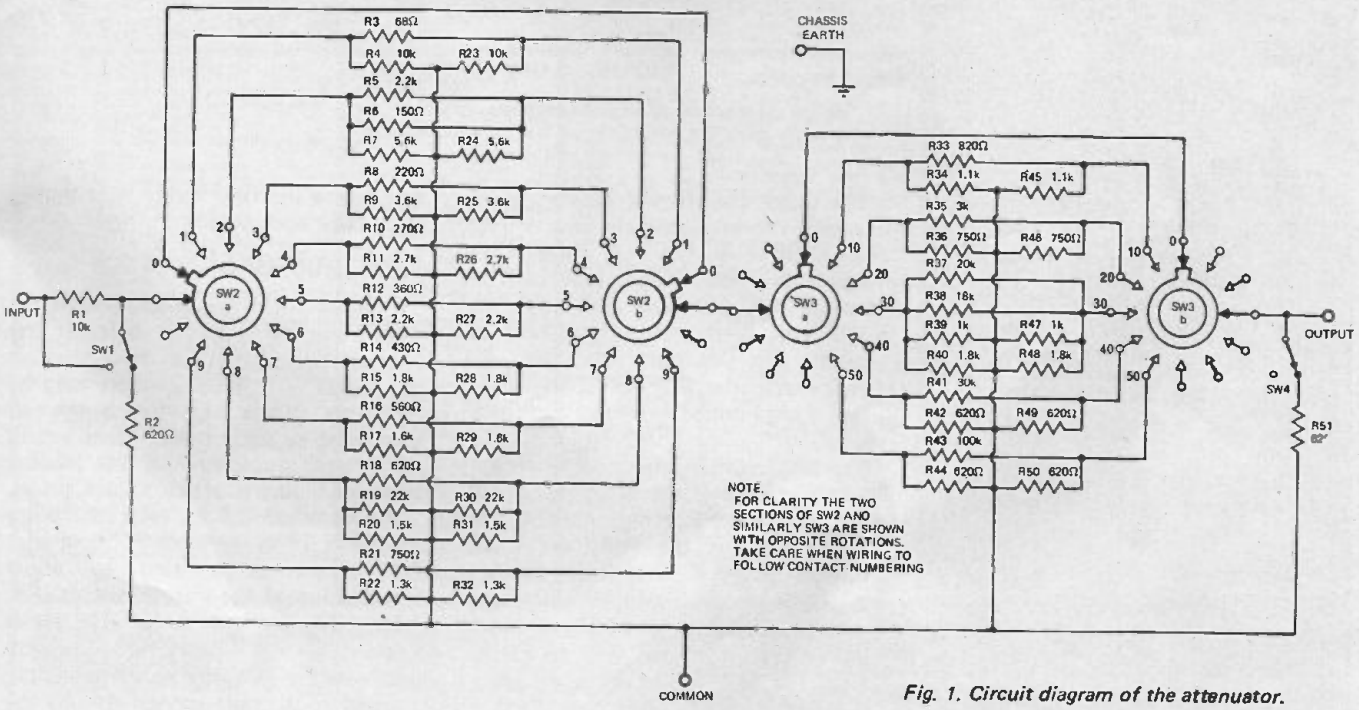


Fig. 1. Circuit diagram of the attenuator.

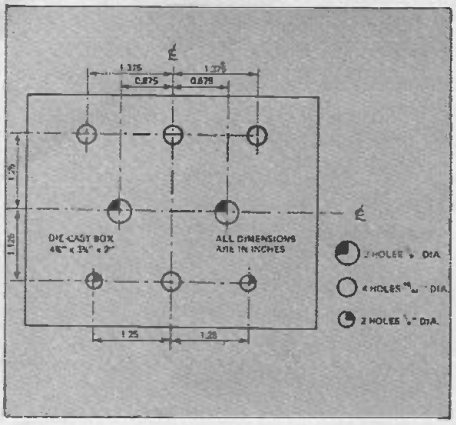


Fig. 2. Drilling details for the die cast box.

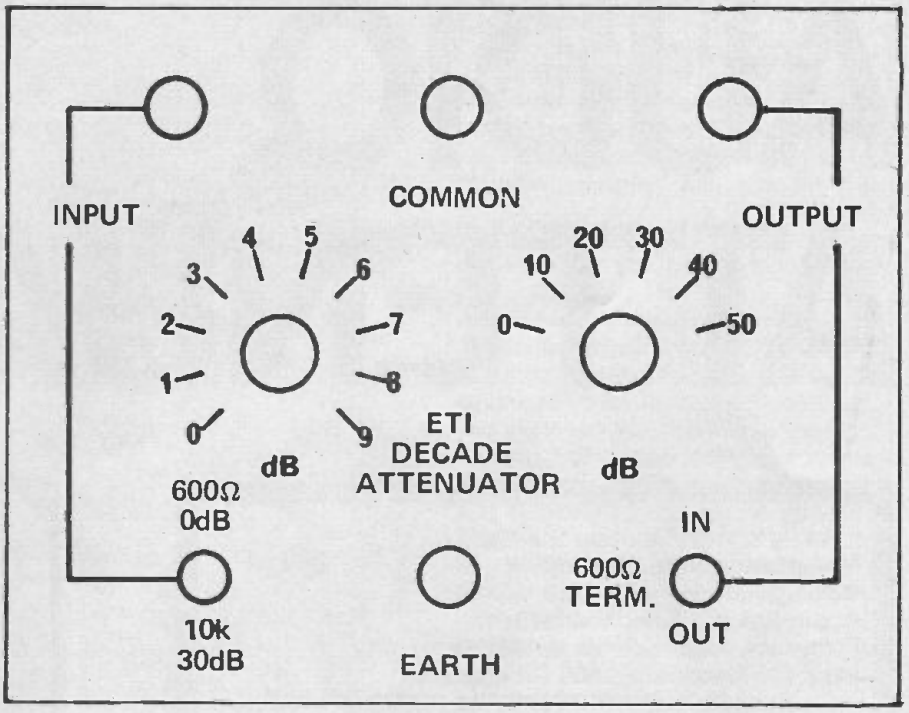
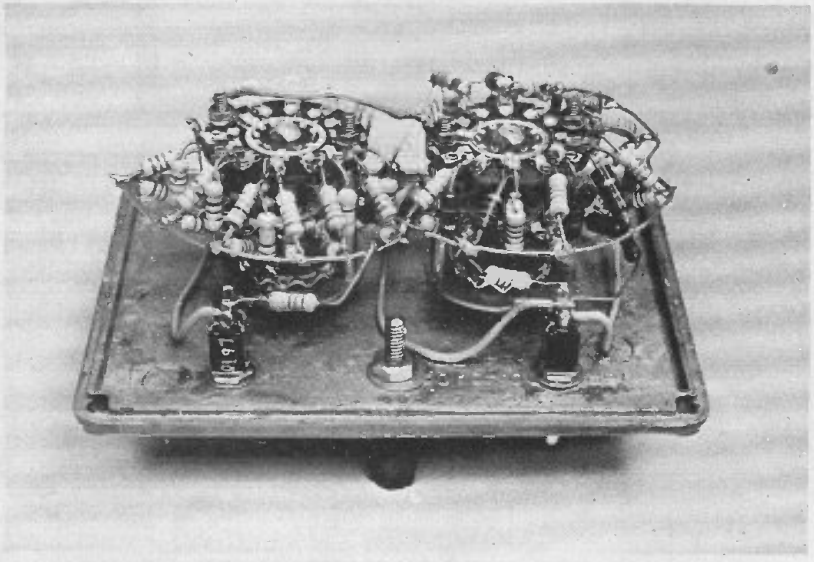


Fig. 3. Lettering and front panel artwork — full size.

PARTS LIST ETI 112

R1	Resistor	10k	2% ½W
R2	"	620Ω	" "
R3	"	68Ω	" "
R4	"	10k	" "
R5	"	2.2k	" "
R6	"	150Ω	" "
R7	"	5.6k	" "
R8	"	220Ω	" "
R9	"	3.6k	" "
R10	"	270Ω	" "
R11	"	2.7k	" "
R12	"	360Ω	" "
R13	"	2.2k	" "
R14	"	430Ω	" "
R15	"	1.8k	" "
R16	"	560Ω	" "
R17	"	1.6k	" "
R18	"	620Ω	" "
R19	"	22k	" "
R20	"	1.5k	" "
R21	"	750Ω	" "
R22	"	1.3k	" "
R23	"	10k	" "
R24	"	5.6k	" "
R25	"	3.6k	" "
R26	"	2.7k	" "
R27	"	2.2k	" "
R28	"	1.8k	" "
R29	"	1.6k	" "
R30	"	22k	" "
R31	"	1.5k	" "
R32	"	1.3k	" "
R33	"	820Ω	" "
R34	"	1.1k	" "
R35	"	3k	" "
R36	"	750Ω	" "
R37	"	20k	" "
R38	"	18k	" "
R39	"	1k	" "
R40	"	1.8k	" "
R41	"	30k	" "
R42	"	620Ω	" "
R43	"	100k	" "
R44	"	620Ω	" "
R45	"	1.1k	" "
R46	"	750Ω	" "
R47	"	1k	" "
R48	"	1.8k	" "
R49	"	620Ω	" "
R50	"	620Ω	" "
R51	"	620Ω	" "

SW1 Single pole change over minature toggle switch
SW2 2 pole 11 position rotary switch
SW3 2 pole 11 position rotary switch
SW4 Single pole change over minature toggle switch
Diecast box 4¾ x 3¼ x 2
4 Terminals type L1568/1S or similar
2 Knobs



As the photograph shows, the resistors are wired directly onto the wafers

The input and output resistances of the unit remain relatively constant at 600 ohms over the full attenuation range. The input impedance can be changed to 10k by SW1 but an additional 30dB of attenuation is added. The output can also be terminated internally by SW4 when using a high impedance load such as a meter.

The maximum attenuation when the input and output resistances are set at 600 ohms is 59dB. There are ten 1dB steps from 0dB to 9dB, via a 10 position rotary switch, and a further six 10dB steps from 0dB to 50dB via a six position rotary switch, giving a total of 60 steps from 0dB to 59dB. This range of attenuation is adequate for most purposes. Although further sections could be added, noise becomes a limiting factor in a simple attenuator such as this.

CONSTRUCTION

It is advisable to employ separate wafers for each switch pole. If the type of switch that has two poles on one wafer is employed, there may be problems at the high frequency end due to stray capacitance. This would be evident as spikes on the leading edges of high frequency square waves.

The common rail for each switch is a length of 18 gauge tinned copper wire formed into a ring to allow termination of the shunt resistors (R4, R23, R7 and so on). The series resistors are connected directly between the relevant switch contacts. Layout of the unit may be seen by the accompanying photographs. ●

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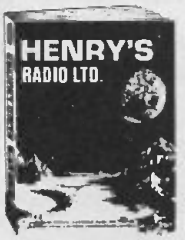

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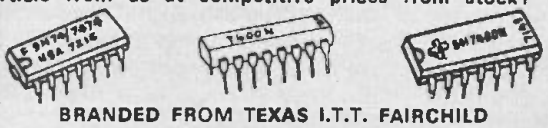

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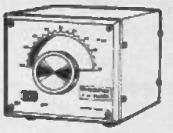

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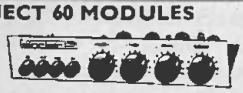

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CRS 3/20	200	35p	1 Amp
CRS 3/40	400	45p	
CRS 3/60	600	55p	T05
FIVE AMP (TO48)			
CRS 5/400	400	60p	
SEVEN AMP (TO48)			
CRS 7/100	100	80p	
CRS 7/200	200	85p	
CRS 7/400	400	70p	
CRS 7/600	600	85p	
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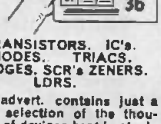

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Project SANGUINE

Submarine communications link will operate at 45Hz! Collyn Rivers reports.

THE US Dept. of Navy is actively planning an ultra-low-frequency communications system for transmitting command and control messages to submerged submarines.

Code-named 'Project Sanguine' the system will provide world-wide coverage from a single transmitting location in the United States.

The system has been designed to operate at the ultra-low frequency of 45 Hz (although an alternative frequency of 75 Hz is also under consideration). The reason for choosing such a low frequency is simply that in sea water the attenuation of radio waves is related to the frequency used. For example at 2 MHz the attenuation is 15 dB/ft, at 40 kHz it has fallen to 2.2 dB/ft and at 10 kHz it is a mere 1.1 dB/ft. Down at 75 Hz the attentuation has fallen to less than 0.1 dB/ft. No figures are available for 45 Hz but it is certain that the attenuation will be even lower than at 75 Hz.

The choice of such a low frequency has complicated antenna design – for to achieve reasonable efficiency – the antenna used must be a small multiple of one wavelength. When one wavelength is over six and a half thousand kilometres (6666 km to be reasonably precise), clearly there are geographic limitations to the length of antenna used!

Information about the actual length chosen is classified and cannot therefore be published, but unofficial reports say that a length of 22.5km will almost certainly be used. As a result, the antenna system will be extremely inefficient and nearly all the energy input will be dissipated as heat into the surrounding earth.

A very small portion will be radiated into the 'duct' between the earth's surface and the ionosphere, and, due to the wave 'tilt' of the propagated energy at the surface of the earth, some of this energy will penetrate beneath the earth's surface and be attenuated in accordance with the normal exponential laws of decay.

Unlike conventional radio transmission techniques, the Project Sanguine antenna cannot be regarded as radiating directly. At 45 Hz the distance between the earth's surface and the ionosphere is a mere 1/80th of the wavelength and because of this the ionosphere above the transmitter acts as a conductor that is coupled inductively to the antenna in the same way that the secondary winding of a transformer is coupled to the primary winding.

A GIGANTIC TRANSFORMER

In fact the whole Project Sanguine antenna and the space above it can be seen as a gigantic transformer in which the transformation ratio becomes an essential feature in coupling the 45 Hz power generator to the earth-ionosphere duct. In other words the antenna, together with the return circuit through the earth, is simply the primary winding of a matching transformer which induces current in the ionosphere above the antenna site, and it is this current that in effect launches the energy wave in the earth/ionosphere duct.

Information concerning the level of power to be transmitted has not been released, but some indication can be obtained from experiments undertaken at the US Navy's Project Sanguine test facility sited in the Chequamegon National Forest in Northern Wisconsin.

In this installation an antenna input power level of 600 kW is used to generate a current of 300 A into an orthogonal antenna (oriented North-South and East-West) mounted on poles 10 m above the ground. Each antenna arm is 22.5 km long and has extensive earthing arrangements at the ends.

Received power measurements were taken from this transmitter at field sites at Utah, Hawaii and Alberta. These sites are approximately two Mm, 6.5 Mm and 1.5 Mm (respectively) from the transmitter location in Northern Wisconsin.

Official reports state that the signal level received was extremely low and from this it is reasonable to assume that very much higher power levels will be used. Figures as high as 30 MW are being spoken of – if one authority is correct it could be as high as 3000 MW!

There is some controversy as to whether burying the transmitting antenna will attenuate the signal to any marked degree – the concensus of informed opinion is that it will not. However, one well known authority, Dr. C. W. Harrison Jr. in his 'Note relating to Project Sanguine Antenna for Communication with Submarines at Operational Depth' questions this and suggests that the power input to a buried antenna might have to be 100 times that of an above ground antenna.

At frequencies as low as those to be used, the dominant source of noise for a fixed antenna at surface level is atmospheric. Hence a receiver aboard a submarine will receive the atmospheric noise as well as the Sanguine signal.

The sea is a conducting medium and therefore has an attenuation for any given frequency that is exponential with the product of antenna depth and the square root of the frequency. Thus the sea above the antenna acts as a low-pass filter attenuating and linearly distorting both the Sanguine signal and the atmospheric noise.

Apart from the selectively attenuated Sanguine signal plus atmospheric noise, there will also be noise associated with the flow of the sea water over the antenna electrodes plus a noise component caused by the variability of motion of the antenna through the earth's magnetic field. On top of all this there will be internal noise generated by the receiver itself.

Thus the relative levels and characteristics of the Project Sanguine signal and the inevitable noise will determine the quality of reception, and ultimately it will be the speed and depth of operation of the submarine (or at least the sunmarine's antenna)

that will determine whether a signal can or cannot be usefully received.

From the facts currently available it is obvious that the received signal/noise ratio will be extraordinarily low — far less than unity — and because of this a very complex message coding and decoding technique will be employed.

THE CODING TECHNIQUES

The technique to be used requires that the receiver knows the exact phase of the transmitter at all times — whether a signal can be received or not. This will be done by using a stable crystal controlled oscillator (or possibly an atomic clock). Using such techniques, any limitations on timing are principally due to keeping track of the changing propagation delay due to day/night transition and of course changes in geographical position of the submarine. These delays are predictable from the navigation system of the submarine — or can be measured from the Sanguine transmissions, using very long integration times.

Thus by using these methods it will be possible to 'lock' the receiver in phase with the transmitted signal even though the signal is deeply burried in noise or not receivable at all. To decrease the risk of an enemy decoding the signals it is probably that the phase of the signal will be changed at predetermined times).

The transmitted 45 Hz carrier wave will be amplitude modulated, and at the receiving end, complex signal correlation techniques will be used to extract the signal from the accompanying noise. This recently developed coding/decoding technique enables the signal power needed to convey a message (with low probability of error) to be substantially reduced.

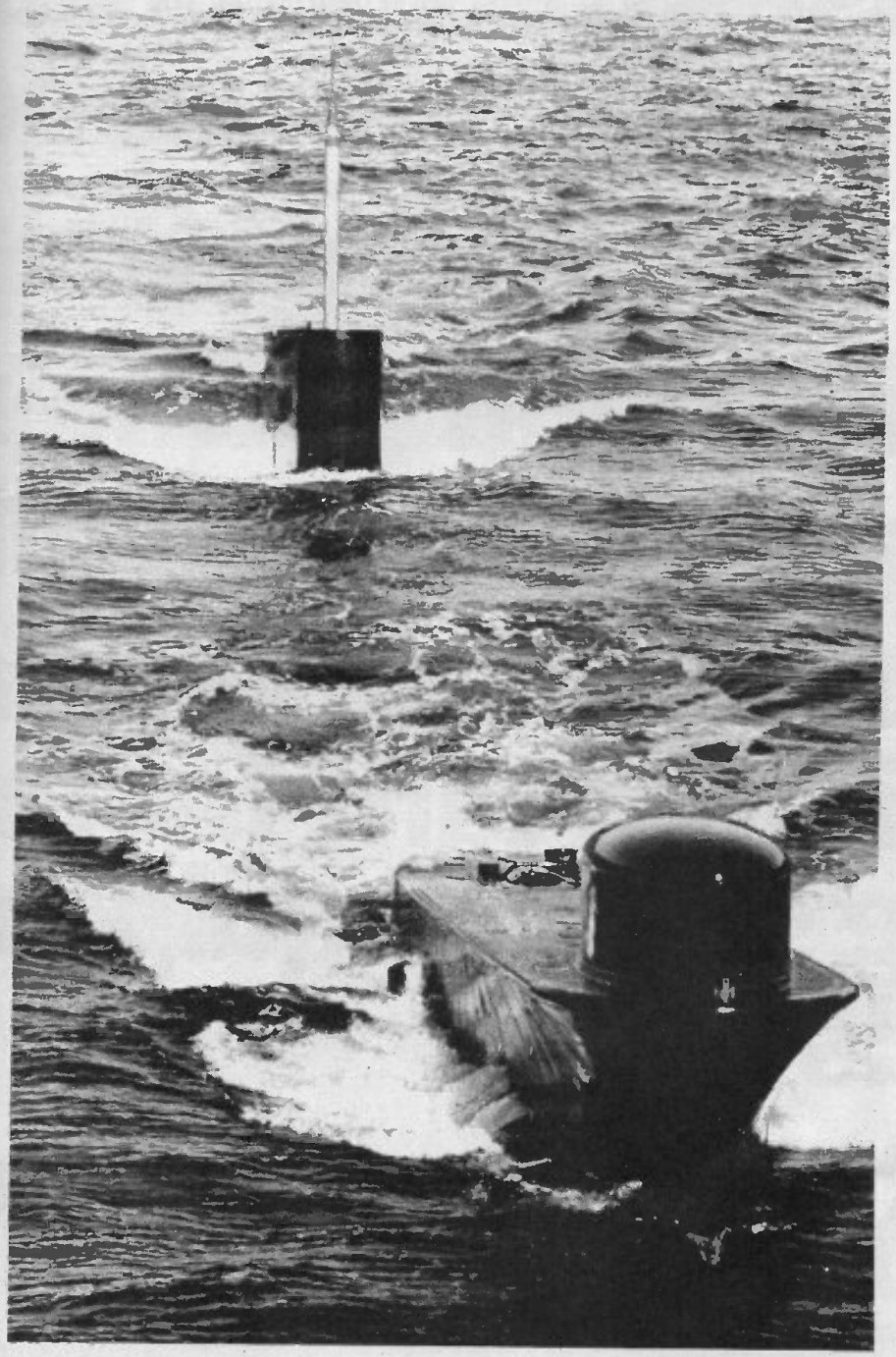
Data to be transmitted by Project Sanguine will be of a digital (binary) nature. The delivery times will be very long by normal communications standards due to the need for very long integration times per bit. In fact estimates of the time required to transmit one bit of information vary from one bit per second (Ad Hoc Panel on Sanguine — National Research Council 1972) to 1000 seconds per bit (McClintock et al, A Report on the Technical Feasibility of Project Sanguine).

Whilst these transmission times may seem very long it should be borne in mind that the messages will be in cipher form, hence complex messages can be sent using relatively few bits.

Like any other communications system, Project Sanguine is designed to operate in a specified maximum noise level and may fail if natural noise, or accidental or deliberate interference, raises the noise level substantially. Consequently, the Sanguine system can be overpowered by brute force noise, and the design of an effective communication system to resist enemy countermeasures will be aimed at forcing the interfering power to be widely dispersed. In this way only a very small fraction of the total interfering power can be effective in disturbing the communications system.

However the characteristics of the Sanguine system are such that for most forms of jamming to be effective, the radiated power of the jammer must be considerably more than ten times that of the radiated Sanguine signal in order to raise the effective noise level by a significant amount. Thus the effectiveness of the jamming transmitter depends largely on the resources devoted to it, and whilst practically any communications system can be jammed by a sufficiently determined enemy, the Project Sanguine system is not an easy mark.

One big question remains — and this is worrying quite a lot of Americans:— What are the ecological effects of dissipating such enormous quantities of electromagnetic energy into the earth? ●



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TRANSDUCERS IN MEASUREMENT AND CONTROL

Dr. Sydenham of New England's University's Dept. of Geophysics describes various techniques used to measure flow.

Fluids in motion range from low density gases, through liquids to slurries, pulps and particulate substances such as wheat or sand. And they often require to be monitored to provide information on the rate at which a volume of fluid is passing a given area, or the rate at which a volume of fluid is passing a given area, or the rate at which the mass of the fluid is moving, or to monitor the total amount that has passed in a given time-interval. Examples are: pulp flow in paper making, blood flow in medicine, power station cooling-water rate, air speeds in weather forecasting, the flow rate of highly reactive liquid sodium in nuclear reactors. Flow rate measurement is also often required for delivery of exactly metered quantities of a substance.

As with all sensors, no universally applicable device or principle suffices for all the various needs. Many principles are invoked, in a variety of ways, in order to provide a satisfactory measurement from both performance and cost points of view.

FLOW CHARACTERISTICS

In general, most fluids needing measurement are conveyed in enclosed pipes, although in some instances open channels are used. It is, therefore, useful to know something about fluid transmission in pipes. Assuming the fluid is incompressible – water and oil come close to the ideal – then the flow rate is a measure of the volume (volumetric flow rate), or mass (gravimetric flow rate) passing a point in a given time, depending on which is of interest. The greater the velocity, the greater the volume (or mass) passing. However, a strict correspondence does not exist, and the relationship depends upon how the flow takes place in the conduit, which leads us to the two main types of flow that can exist in a pipe.

If the particles of the fluid flow in a smooth streamline manner – imagine the flow as numerous ultra thin layers slipping over each other with greatest velocity in the centre – then this is laminar flow. Empirical observation plus dimensional analysis of the

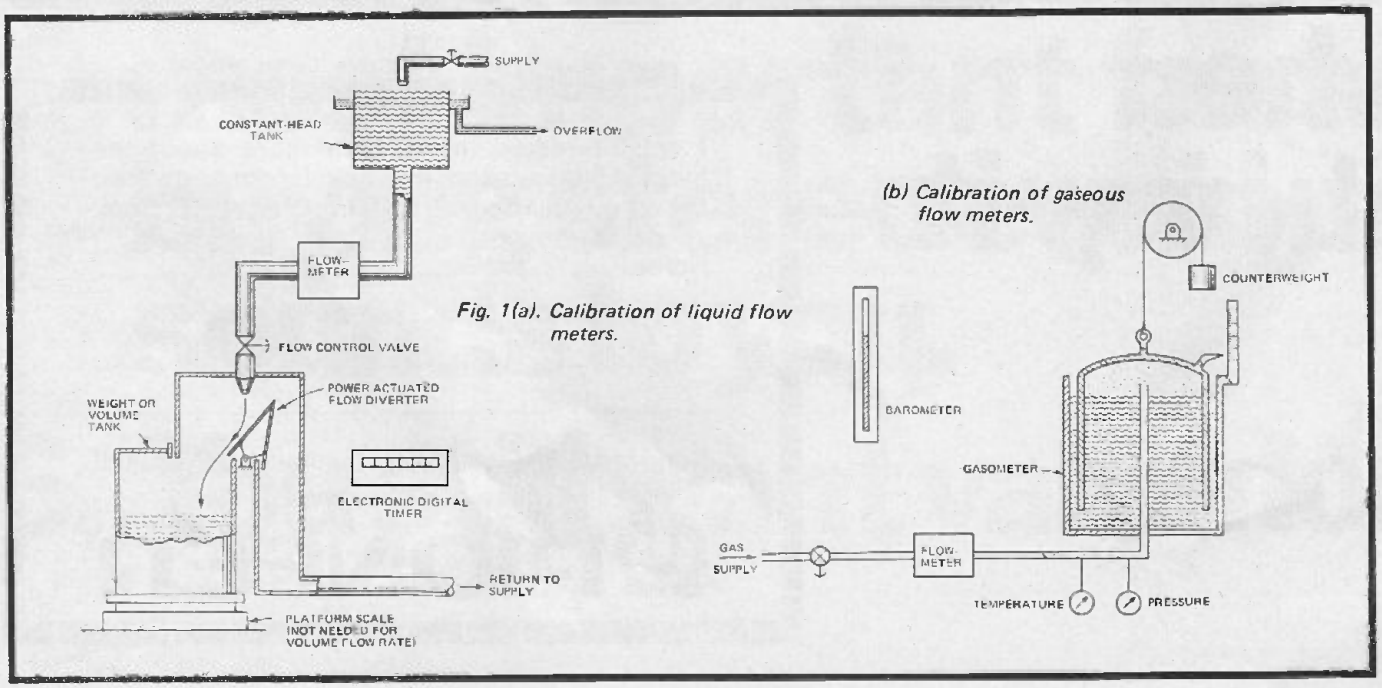


Fig. 1(a). Calibration of liquid flow meters.

relevant equations of fluid mechanics have yielded a very valuable characteristic number that depends upon the pipe diameter, fluid density and viscosity, and the flow rate. This Reynold's number (after O. Reynolds, 1883) will be around 2500 or less if the flow is laminar. We shall see later that correct flow measurement often requires that the flow through the transducer is laminar, so a section of pipe or straighteners are added to steady the flow before it enters the transducer.

If the flow is laminar, the velocity of the fluid particles will vary across the pipe section, the layer being stationary near the pipe-wall and fastest at the centre of the pipe section. The velocity gradient depends on the fluid and the pipe, so the average flow rate could be quite different from that indicated by a flow meter.

The other distinct flow type is called turbulent because the velocity at any point in the flow is random and no streamline flow exists. A Reynold's number greater than 4000 usually indicates turbulent flow. In between the two numbers, the flow depends upon the pipe-work system used. Obviously, rough edges, surfaces and steps in the pipe will cause turbulence for some distance down stream. Flow meters are therefore usually installed away from elbows, joints and valves.

To add to the problems, flows are often pulsating due, perhaps, to the use of a gear or piston pump. In recent years considerable research effort has been devoted to the study of pulsating flows. If possible, the rule is to circumvent pulsation problems by smoothing the flow with a storage tank, (which acts as an integrator), or by mounting the meter some distance away from the source of pulsation. Some flow meters operate without significant errors in pulsating conditions, but not all.

Flow, therefore, is a challenging variable to measure. Extreme care is needed in the selection of the method, and its application. A good understanding of basic fluid mechanics is essential.

Other factors that must be considered are that the components of the transducer will not be corroded by errosive chemical or cavitation forces. They must also be able to withstand the temperatures involved.

The majority of flow meters are designed to operate with a specified flow direction only, their principle will not work correctly the other way.

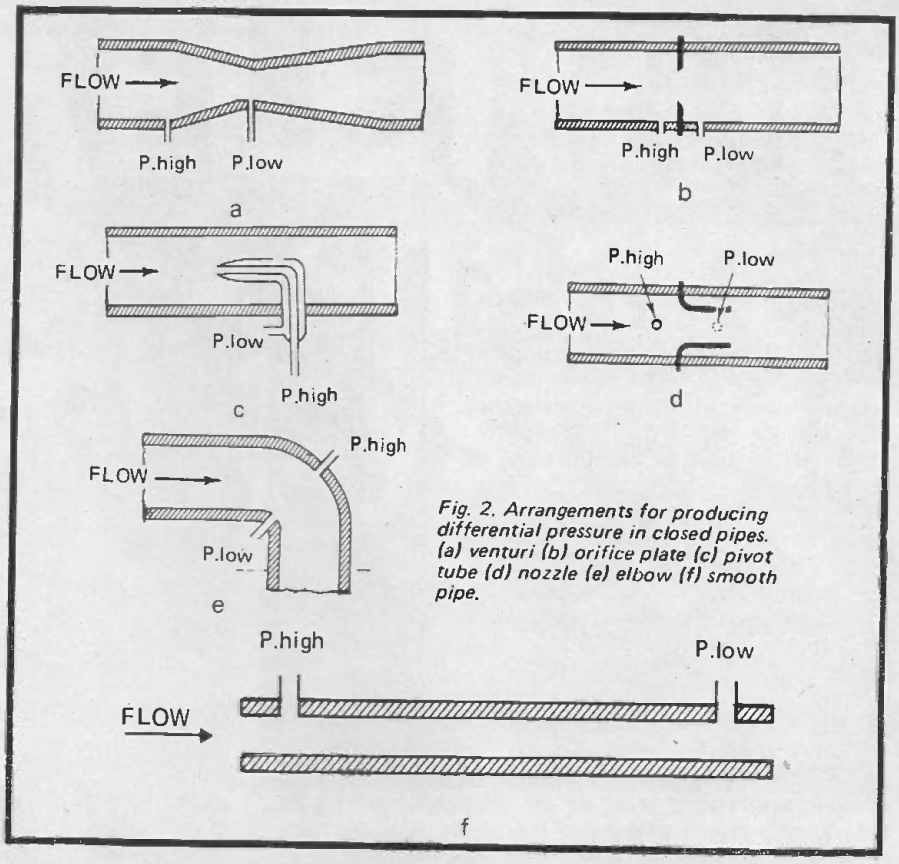


Fig. 2. Arrangements for producing differential pressure in closed pipes. (a) venturi (b) orifice plate (c) pivot tube (d) nozzle (e) elbow (f) smooth pipe.

CALIBRATION AND TESTING

In theory, flow (being mass or volume passing a given area in a given time) can be defined in terms of the fundamental mass, length and time units. The only satisfactory basic standard procedure is to pass steady flow through the device, collecting the fluid in a suitable weighing or volume measuring enclosure and measuring the time of flow. Schematics of gravimetric and volumetric test setups are shown in Fig. 1. Flowmeters so calibrated may then be used as substandards (the absolute methods are time consuming) to calibrate other flow meters in continuously flowing closed-circuits. An essential requirement with absolute methods is that the pressures to and from the transducer are maintained constant to ensure an even flow rate. Closed-circuit systems are used but pressure control is also needed. It is not always necessary to measure the entire flow in the pipe – shunts are often used to bypass a known percentage of the main flow through a parallel mounted, smaller, flow-meter circuit.

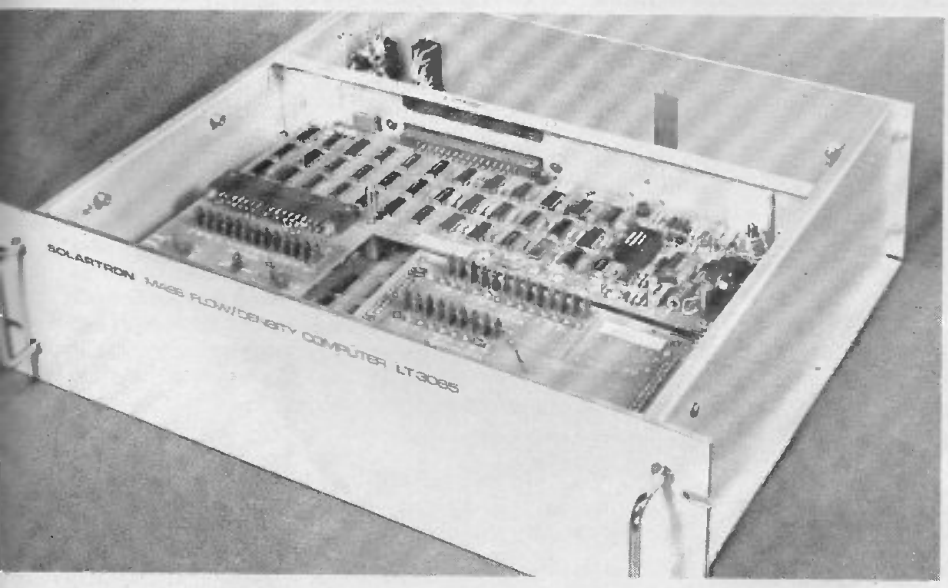


Fig. 3. Solid-state mass flow and density computer for use with differential pressure devices.

Having dealt with this background, we can now examine specific designs.

DIFFERENTIAL PRESSURE (d.p.) SENSING OF FLOW

In the middle 1700's, Bernoulli studied the ideal case for steay flow of an incompressible fluid in a frictionless pipe. He was able to relate the variables of a flow between two points – viz, pressure difference between the two points, velocity of flow and difference in pressure head – using a general energy-balance equation that now bears his name. If flow is restricted by narrowing down a short section of pipe, it can be shown from this equation, and from consideration of continuity of flow, (the mass leaving the restriction equals that entering it) that there will be a pressure difference between a point upstream and a point in the restriction. A cross-section of such a venturi device is shown in Fig. 2a. (Carburettors and spray guns use this principle to draw vapour into the air flow passing through the venturi). Flow rate, therefore, can be transduced into an intermediate secondary variable, pressure difference, which can be monitored with pressure transducers. Flow, however, is proportional to the square root of this pressure difference and linearization is needed. Pulsating flows are not indicated correctly, due to this non-linearity.

A simple way to invoke the same situation is to insert a plate, having a small hole in the centre, in the flow stream. These are called orifice plates (Fig. 2b). Again flow velocity is dependant (pressure difference) $^{1/2}$. The actual relationship depends critically upon the hole diameter, its profile and the fluid constants of viscosity and density. Every combination has a slightly different discharge coefficient. Standards have been established to ensure accurately related flows with the measured pressure differences. Orifice plates are available commercially. Other devices using the same concept in different ways are the Pitot tube and nozzles (shown in Fig. 2c and 2d).

A pressure difference is also produced between the outside and inside of a bend in the pipe work, (Fig. 2e), due to centrifugal force, and this is often used as a metering method. Again certain criteria must be adhered to, especially the use of a 'calming section' preceding the bend. Individual calibration is necessary.

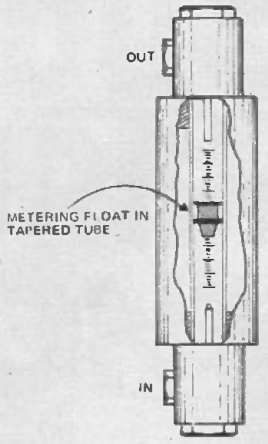
Yet another pressure difference device makes use of the pressure drop developed along an even-bore pipe by fluid friction effects (Fig. 2f). Although providing a smooth bore to flow, the resistance needed to develop enough pressure difference may be a disadvantage. To shorten the length whilst retaining smooth flow, one manufacturer offers a pipe filled with glass spheres for the same purpose.

The basic low cost, reasonable reliability and installation ease, made d.p. methods popular. Many instrument companies offer equipment that linearizes the d.p. signal to indicate flow or mass on a linear scale. An electro-mechanical system was described in the July, 1972 issue of Electronics Today International. A solid-state equipment is shown in Fig. 3.

Pipe sizes from hair size to many metres in diameter can be instrumented this way.

Obvious disadvantages of such methods are the need to maintain the restricted area free of debris and solid contaminants. The method is not used for highly viscous or particulate substances.

Fig. 4. Cross-section of a simple variable-area rotameter.



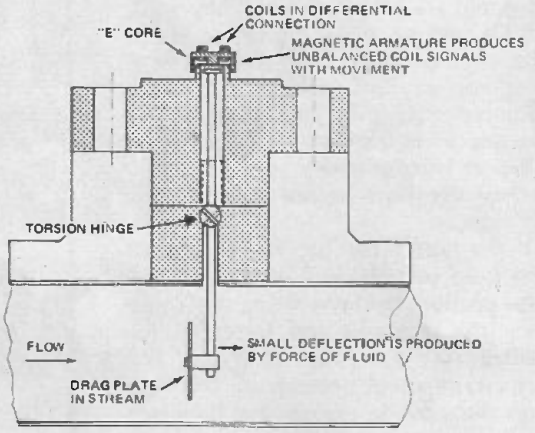


Fig. 5. Schematic of a drag-plate flow-meter having fast response, made at the National Engineering Laboratory.

DISPLACEMENT DEVICES

An object placed in the fluid stream experiences a force attempting to move it along. Many devices make use of this fact to provide an intermediate stage by which a linear or rotary displacement sensor is actuated.

The simplest meter uses a spring-loaded horizontal or vertically suspended object in a tube such that movement of the object alters the area through which the fluid is restricted. These variable area meters, in fact, produce a varying size orifice which maintains a constant pressure drop – in contrast to the constant area of the differential pressure methods. Inexpensive units visually indicate flow as the position of the float against an engraved scale (as shown in Fig. 4). By suitable design, the movement can be made linear with flow rate. They also cover a wider range of flows (10:1 is possible) than differential pressure methods. To obtain an electrical signal, the movement is measured with displacement transducers such as the inductive sensors or potentiometers.

Another displacement type is the turbine meter. If accurate metering of valuable fluids is needed, the blades are designed with seals that slide to ensure minimum bypass of fluid past the blades. (Often the pump is designed to act as the flow meter. The disadvantage then is the need to provide energy to move the rotor, and this resistance to flow may be intolerable).

Where flow is established and reasonably steady, the blades need not be close fitting as some slip is allowed. The essential features of a turbine flow meter is a freely spinning turbine that couples closely to the flow, a flow straightener preceding it to avoid errors due to already rotating flows, and a non-contacting sensor to detect turbine rotation. Most flow meters use magnetic detection. A small magnet is inserted in the blade and the external sensing coil produces a pulse for each pole of the magnet passing it. Other sensors utilize capacitance/resistance changes; several designs also operate an

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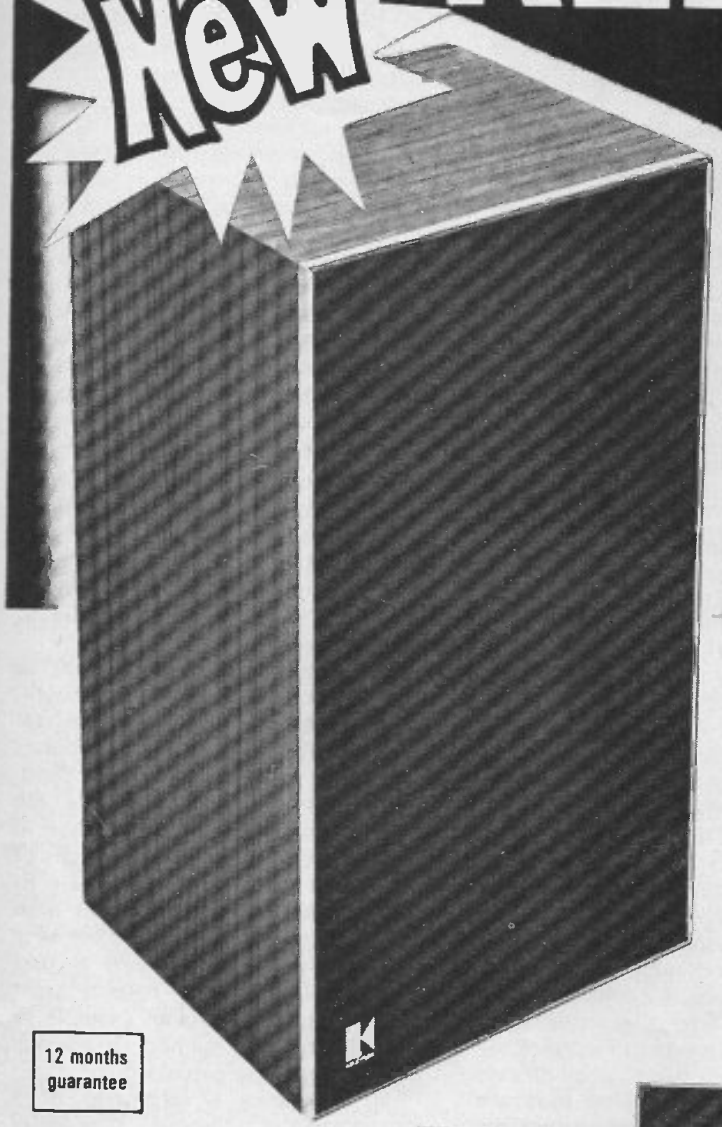

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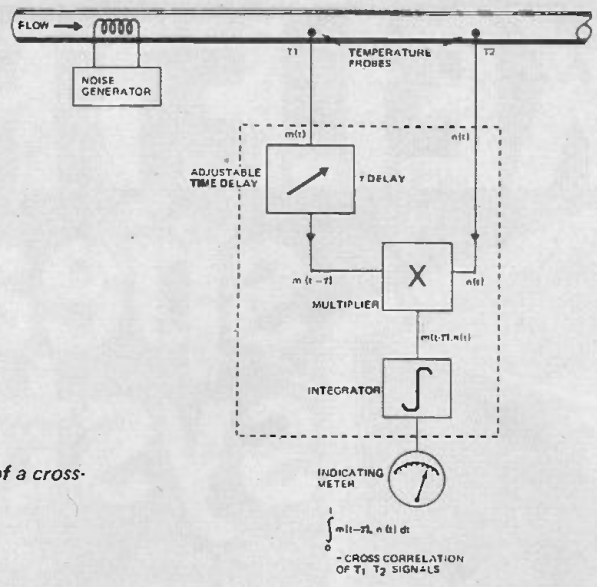


Fig. 6. Principle components of a cross-correlator thermal flow-meter.

indicating meter with a mechanical link.

Turbines can provide a linear output but because the indicated flow depends upon the (diameter)^2 they are made as a complete unit calibrated for the bore used. The output is a frequency variable pulse signal. This aids reliability and ensures compatibility with digital equipment. Such devices have been developed to measure liquids and gases, covering a range of flows of 15:1. Using different size turbines, gas flows from 1m^3/hr to 50,000m^3/hr can be measured.

In a good design, the mechanical (rotational) inertia is made small and the resistance to rotation (damping) negligible. This fact, associated with close coupling in most fluids, enables turbine meters to follow rapidly changing flows. Responses are of millisecond order so that transients and low frequency pulsating flows can be followed faithfully.

In air speed measurement, the rotating-cup anemometer (this term is usually reserved for air flow meters) works on the same principle. Shaft rotation provides signals via magnetic sensing. A recent version uses a magneto-resistor to sense the movement, as this has greater sensitivity. It has already been stressed that flow is difficult to measure accurately and tests of anemometers and more advanced instruments indicate that the rapidly changing nature of wind can lead to considerable errors in the former.

Drag-plate flow meters use a plate suspended in the stream. This is constrained by springing, for example by means of a torsion hinge, cantilever or spring-loaded lever. Its movement is monitored by a displacement transducer. A recent unit made in the National Engineering Laboratory in Britain is shown in Fig. 5. If the spring system is stiff, movements will be small but response high. The unit shown moves only 100μm and can follow pulsating flows to 100 Hz.

There are other ways to make use of the momentum of the fluid. One intriguing device uses it to alter the precession torque of a gyroscope. The liquid is piped through a loop made in a plane perpendicular to the axis of flow (that is, the fluid moves in a circle where the flywheel would normally be). The flow through the loop acts as the flywheel, producing angular momentum in the same way as a flywheel. If the loop is rotated, the gyro torque output is a measure of flow rate so the developed instrument nods the loop about a mean position to develop the torque as an ac signal which is then converted to dc form.

Another device uses two turbine blades of differing pitch that are joined together on common bearings by a torque spring coupling. They rotate in unison in the flow but as each experiences a different torque because of the blade pitches, they take up a relative angular position different to that at zero flow. Sensors at both blade positions deliver two trains of pulses. Their phase difference is a measure of mass flow.

TIMING SYSTEMS

When only a single measurement of flow rate is needed, the simplest way is to drop an identifiable marker in the stream. A ship's log is used at sea in this way to measure relative speed. Similarly, in channels or pipes a tracer can be injected. Common salt is often used in clean rivers. In polluted waters lithium salts may work. The gulp method dumps the tracer into the flow. Downstream samples are collected at known time intervals and analysed for salt concentration. Plotting values against time shows when a maximum is reached and this plot is related to flow rate. Suitable tracers are chemicals, dyes or isotopes, the latter having limited use due to health hazards.

When continuous measurement is needed, such tracers are usually impracticable, but the concept can still be used with heat or motion bursts that are generated in the fluid. Although the principle is simple, the signal levels are small and they exist in the presence of severe noise signals of the same form. The use of cross-correlation techniques has been proven capable of measuring the time delay for heat perturbations to pass between two points despite poor signal/noise ratios. As an example of this very recent method, a thermal flow meter is now explained.

Fig. 6 shows a schematic of a cross-correlator thermal flow-meter showing the major fluid and electronic components. At a convenient point in the flow is a small heater which is energized by a signal generator providing a pseudo-random noise signal. This imparts to the fluid relatively small quantities of heat in a time sequence resembling random heating. (In practice this generator is binary in nature providing only two levels of signal to the heater but in a continuing random time sequence – it is termed a pseudo-random binary sequence, P.R.B.S. generator). Down stream are two, fast-response, temperature sensors a metre or so apart, so that each receives the same thermal fluctuations but at different times. Merely examining the temperature sensor signals would reveal little more than a noise signal with no clear definition of the original input to the heater. Therefore a

process of correlation is used to recover the buried signals.

Correlation can be visualized by considering two identical complicated optical patterns formed on film transparencies. When the two are exactly overlaid, the maximum amount of light transmission occurs. If we now misalign the patterns, the transmission attenuates rapidly as the degree of misalignment is increased. In the correlation of electrical signals the signals are time variables rather than space variables. In essence, the two signals are multiplied together and the multiplicand signal then averaged. This is repeated many times with different time delays. At a processing time-delay equal to that of the time taken for the fluctuations to travel from one probe to the next, the correlation output will peak quite sharply. In Fig. 6, m(t) and n(t) are the two temperature signals. The multiplier unit produces m(t-) .n(t) which is integrated to produce the output signal. The time-delay unit provides delay increments. In continuous signal monitoring, the delay unit is tracked to keep the cross-correlation output maximized.

Commercial correlators are available, but being general purpose instruments, they are usually expensive. Less expensive units (such as that shown in Fig. 7) can be made to suit specific cases such as this example.

Any signal that can be made to perturb the existing state of the fluid and then be detected may be used, the essential factor being that the pseudo-random signal marking the flow must retain its spatial form between the markers. In slurries and gaseous suspensions there is often no need to add a signal since the medium has inbuilt patterns due to voids or denser particles. In these cases, it is only necessary to sense the effect at two places using capacitive sensors for

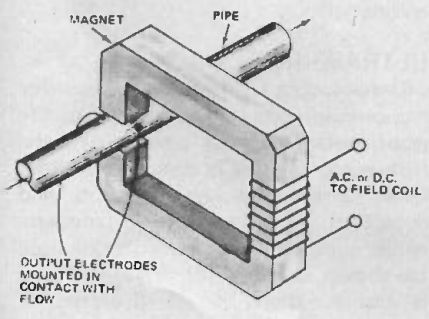


Fig. 8. Principle of the electromagnetic flow meter (an iron circuit is not always used).

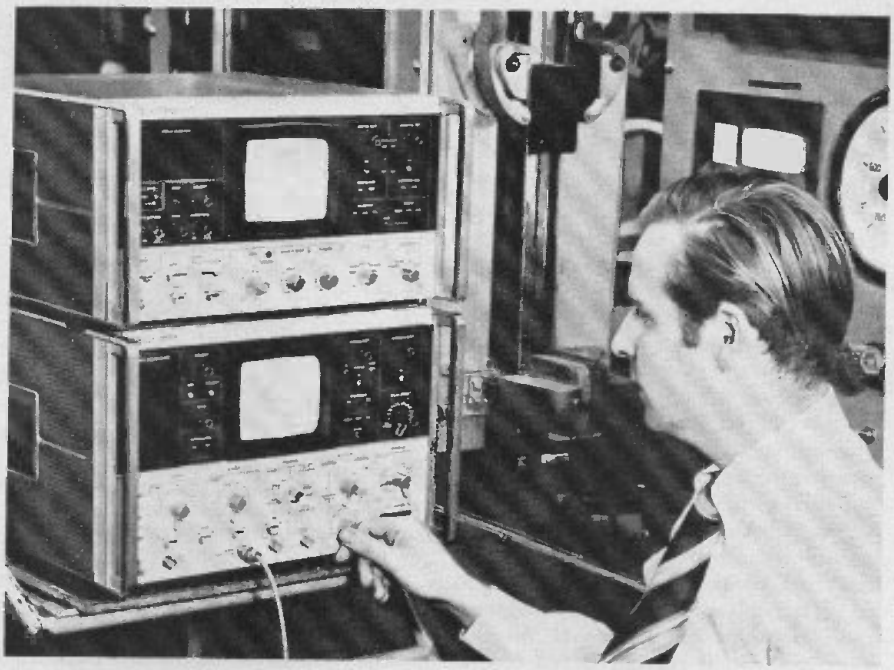


Fig. 7. Multi-purpose correlator unit (Hewlett Packard 3720A).

example. (Surface velocity is similar to flow measurement, surface irregularities providing the signal. For example, in aerial photography the aircraft ground speed is needed. One solution is to cross-correlate the appearance of the ground seen by two sensors viewing at different places along the flight path). A decade ago correlation methods were novel and in the experimental stages. Today they are used extensively as a routine procedure.

ELECTROMAGNETIC FLOW METERS

To understand the operation of electromagnetic, E.M. for short, flow meters, it is necessary to look at the findings of the 19th century scientist – Faraday. The Faraday principle states that an electrical conductor cutting a magnetic field experiences a force acting upon it that is proportional to the rate at which lines are cut. In E.M. flow transducers, use is made of the voltage generated when a field is cut by a current carrying conductor. Referring to Fig. 8, the coil magnetizes the pole piece and the liquid (the conductor) moves through the field produced in the air gap of the iron. Some E.M. flow meters use two coils laid on the pipe walls. Electrodes are placed at the positions shown for that is where the generated voltage appears. Regardless of the state of the flow, the method indicates accurately for it relies on the bulk electrical and magnetic properties of the fluid in a given volume.

When electrolysis problems might occur, the field is excited with ac, either from mains excitation using a transformer, or from an inbuilt signal source as shown in the schematic of a flow meter in Fig. 8.

E.M. meters have found use in the measurement of the flow of liquid sodium, saline solutions, seawater, blood, mercury, electrolytes such as plating solutions and, of course, water. A general guide is that the conductivity of the fluid must be greater than 10^{-7}mho/cm^3 for satisfactory signal generation. Tap water has a conductivity of about 2 10^{-4}mho/cm^3

The design of the coil and electrode shape is important. The field produced should be at least three pipe diameters in length so that the electrical shunting conductivity of the fluid just outside the field boundaries is made insignificant. The pipe of the meter must be non-magnetic – and have insulated readout electrodes (plastic is an obvious choice). If possible, the pipes either side of the meter should be non-magnetic and insulating for a short distance each way. In precision installations, the meter should be calibrated. Signal levels are small (order of millivolts) but the use of ac achieves good signal/noise ratios as the thermoelectric and electro-chemical potentials are not amplified in the detection equipment.

E.M. flow meters have been commercially available since 1950. Ranges available cover 3mm to 2000mm diameter pipes. The smooth bore design makes them suitable for slurries, pastes and liquids having solids in suspension.

TRANSDUCERS IN MEASUREMENT AND CONTROL

ENERGY BALANCE DEVICES

Hot wire or hot film anemometers consist of a fine resistance element suspended so as to make good contact with the gas flow. The element is heated and its resistance measured in a Wheatstone bridge circuit. Convective losses from the element, due to the gas flowing over it, depend on the velocity of the flow so the temperature of the element will stabilize at a value where the energy lost to the flow equals that supplied to the sensor.

Three basic forms are in use – constant current through the element, constant temperature of the element or, less common, constant resistance ratio between two elements. In the first, a constant current is fed to the elements (see Fig. 9a), so the element temperature drops as the flow increases. Flow is measured indirectly as the resistance of the element which depends upon its temperature. The second method alters the current so as to maintain the element of a constant temperature (as shown schematically in Fig. 9b), and the current is a measure of the flow rate.

If the flow does not have a steady temperature, but fluctuates, the above methods will not be accurate since energy loss depends on gas temperature. The constant resistance-ratio method is a way to reduce temperature errors. It has two elements, each fed with a different current. Their voltage ratio is maintained constant with a feedback system where voltage is taken as a measure of the flow rate.

The elements must be small to obtain a fast response; an example is tungsten wire, 40μm in diameter. Deposited films are also used. In turbulence studies, the system response needs to be as high as 50 kHz. Hot-wire anemometers have been developed that easily cover the need – having response times of 10μs. Obviously, such delicate probes can only be used where the flow is clear of particles and contaminants that may alter the convective film coefficient and it is necessary to calibrate these devices in-situ.

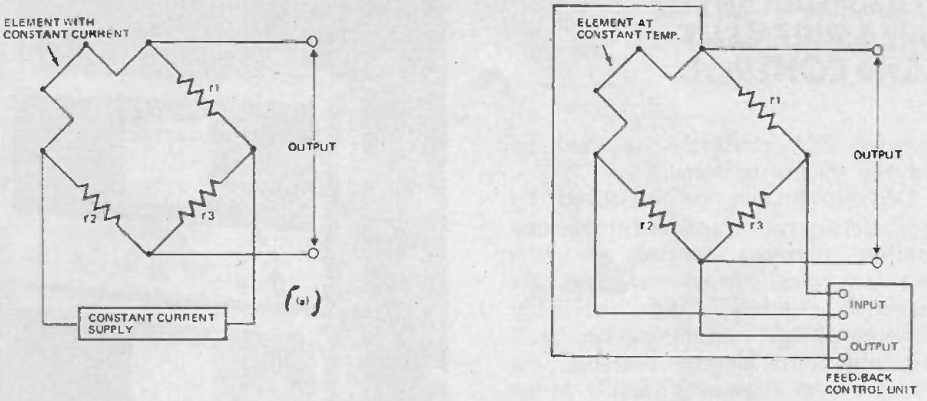


Fig. 9(a). Constant current hot-wire anemometer bridge. (b) Constant temperature operation requires feed-back to hold the element temperature constant.

The boundary-layer flow meter also makes use of heat transfer and energy balance but in a very robust way – no delicate probes are used but the gain is at the expense of response. A heating coil is wound around a thin heating pipe as shown in Fig. 10. This produces a temperature profile across the cross-section of fluid in the pipe. Fluid near the wall is the hottest because this, the boundary layer, is not moving. The temperature drop across the layer is related to its thermal conductance which, in turn, depends upon the (mass flow rate)$^{0.8}$. One probe, therefore, measures the wall temperature, the other the fluid temperature on the other side of the layer. It is not necessary to place a probe in the stream for the centre temperature can be measured up-stream before the heater. In use, the heater is adjusted to keep the temperature drop constant. In this mode, heater power level is a reasonably linear measure of mass flow rate.

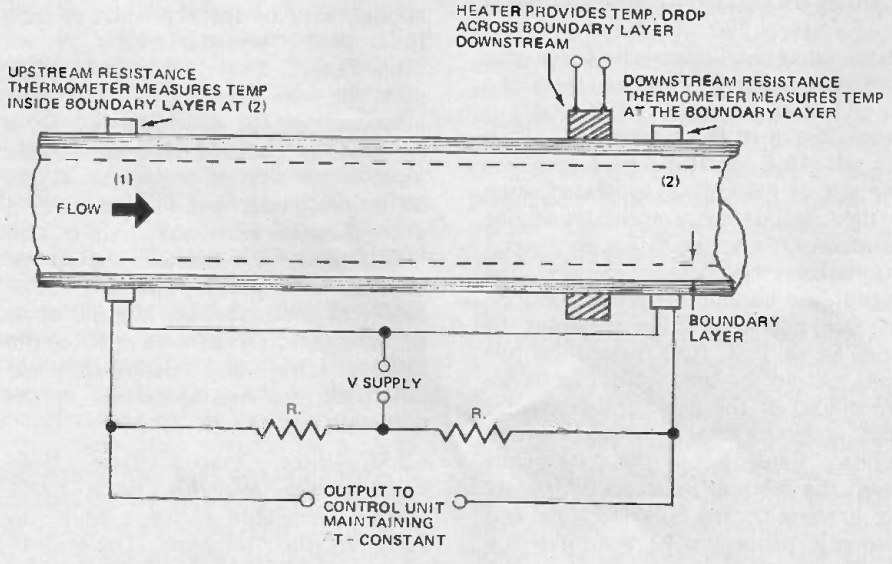


Fig. 10. Cross-section through a boundary-layer flow meter.

DOPPLER FLOW METERS

Energy radiated through a fluid in motion will reach a given point elsewhere at a later time depending upon the rate of energy propagation and the velocity of the fluid in the same direction. Another significant phenomena is that the frequency of the received signal will be altered from that of the sending source due to the doppler effect. This can provide greater resolution than straight transit-time measurement. Ultrasonic, radar and laser radiation are employed but the hardware differs in each system due to the different wavelengths.

ULTRASONICS

Piezo-electric crystals, one for transmission and one for reception, are positioned in the wall of the flow-meter aligned in direction of fluid flow. These provide radiation and detection of the acoustic pressure waves that are launched into the fluid (as shown in Fig. 11a). When the fluid is liquid, there is no problem in obtaining an efficient energy coupling, but for gases, it is a more formidable problem.

In the simplest arrangement (Fig, 11a), the upstream crystal transmits a

TRANSDUCERS IN MEASUREMENT AND CONTROL

burst of high frequency (at typically 10 MHz) that is received down-stream. The transit-time will vary in relation to fluid velocity but this measurement also depends upon the (acoustic velocity)^2 so variations in the speed of sound greatly affect the accuracy. Furthermore, the delay time can be very small, making it hard to obtain resolution. Usually a more complex arrangement is used which has two systems acting in opposite senses, as shown in Fig. 11b. Each loop resonates because the received signal is used to send the next pulse burst (called the sing-around technique). When the fluid is stationary, the frequencies will be the same but with flow movement one frequency goes down, the other up. The beat frequency formed by comparing one with the other is a direct measure of flow velocity.

More recently developed methods make use of the frequency shift due to the doppler effect. Energy received elsewhere (or sent back) to the source will be of different frequency to the source, so frequency comparison similar to the above gives flow rate. A blood velocity ultrasonic doppler meter is shown in Fig. 11c; note the gel used acoustically to couple the crystals to the artery wall.

Before leaving ultrasonics, it is worth mentioning that ultrasonics can be used to detect leaks in pipes. Gas passing very small orifices tends to resonate in the range 30-40 kHz. Ultrasonic detectors will detect this, often at a considerable distance.

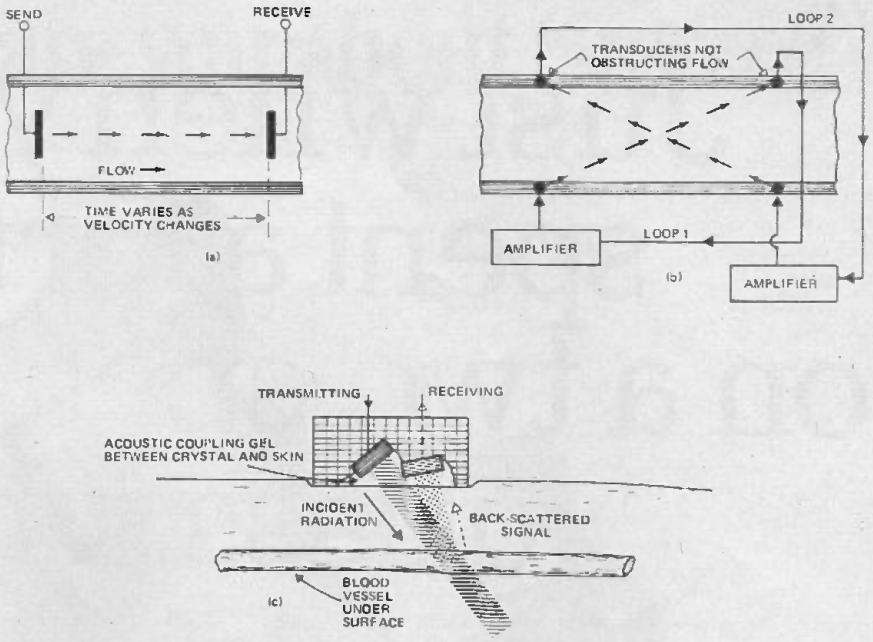


Fig. 11(a). Simple ultrasonic transit-time variation method of determing flow rate. (b) Double resonant-loop method reduces errors. (c) Ultrasonic doppler used to monitor blood flow.

RADAR

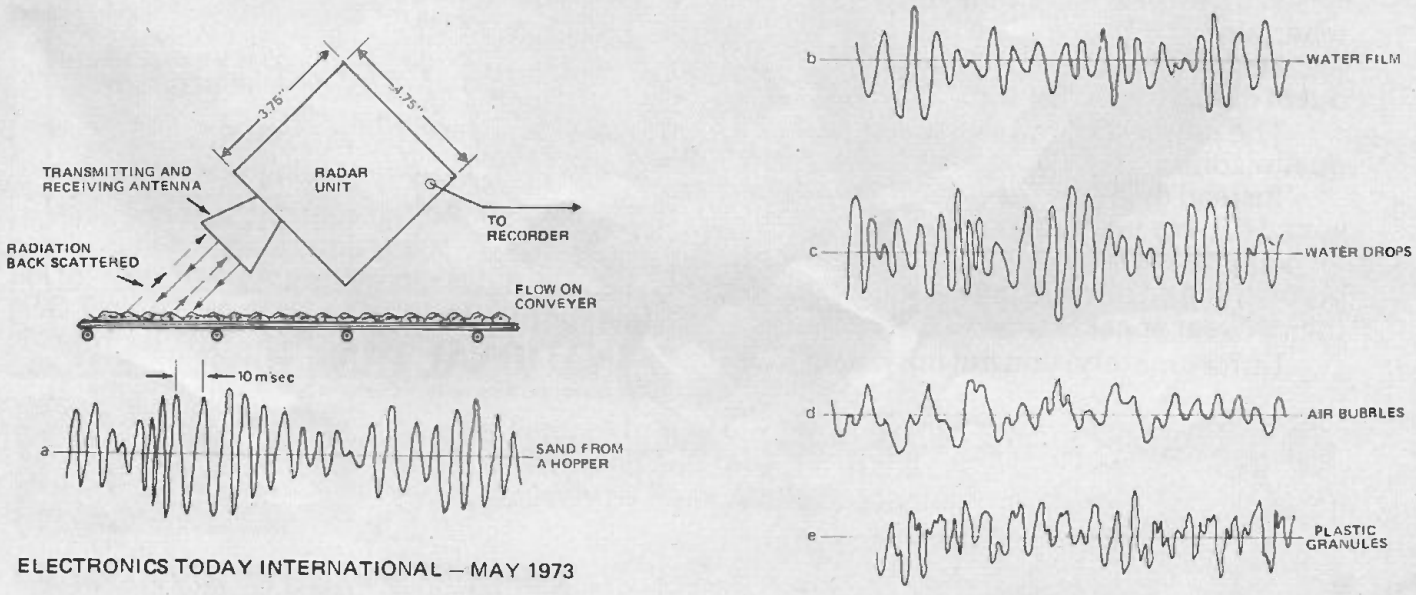
The doppler principle has also been applied with radar sources in order to provide a frequency variable signal related to flow. The availability of miniature self-contained C.W. radar sets (such as the Royal Radar Establishment unit which is camera size and runs from batteries) has made radar doppler a reality in industry. The unit is arranged to look at the flow at a slight angle (sand, water, films, granules, liquids with air bubbles water drop sprays and surfaces of sheet material have been measured). The same antenna acts as a radiator and receiver detecting back-scattered energy which is compared with the source frequency. The signal does not have constant amplitude nor does it exist continuously, hence reasonably sophisticated electronic equipment is needed to determine the frequency difference. Fig. 12 shows a schematic of the instrument in use – along with typical waveforms from various materials as published by the Institute of Measurement and Control. Filtering is used to improve the signal/noise ratio but it has been found that the best results are achieved by using a plastic zone plate (a disk having annular rings turned in it) between the instrument and the surface, rather than using electronic filters after the detector.

LASER VELOCIMETERS

One of the applications of laser sources is for measuring velocity with great accuracy and large dynamic

(Turn to page 70)

Fig. 12. Doppler radar unit compares reflected signal and source frequency to provide frequency variable signal related to flow rate. Waveforms from a number of materials are shown.



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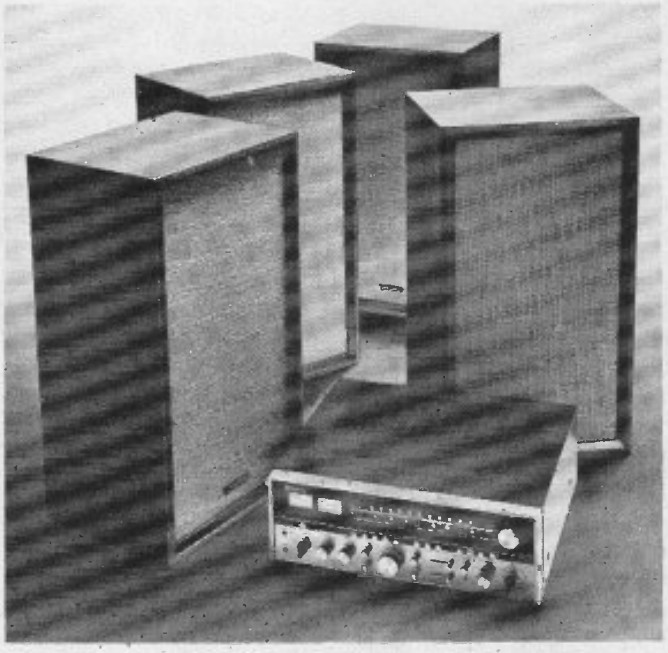

It isn't planned obsolescence, it's progress.

With four speaker hi-fi you get stereo wherever you sit in a room.

Did we say "stereo"? The very word is out of date. So is the sound.

The new word, and the new sound, is quadrasonic.

Instead of giving you two channels of sound it gives you four channels.

So you get the reflected and reverberated sound of a live performance through the two rear speakers.

Unfortunately, you not only need four speakers, you need a four channel amplifier, as well.

This is what you see in the picture. The National SA6800X.

It comes with an FM/AM tuner and a little joystick that lets you balance the four speakers from your armchair.

And its recommended retail price is £330.

We'd be happy to send you a brochure with a full specification. Meanwhile, these few details may whet your appetite.

Amplifier Section:	300 Watts at 4ohms
IHF music Power:	200 Watts at 8ohms
RMS Power	4×30 Watts into 4ohms 4×25 Watts into 8ohms
Harmonic Distortion: (at 1 kHz and rated output):	0.5%
Input Sensitivity and Impedance:	
Phono	3 mV/50 kohms
Aux	200 mV/50 kohms
Tape Monitor 1, 2, 3,	200 mV/50 kohms
Mic	2 mV/50 kohms
Frequency Response	20–50,000 Hz-3dB.
Residual Hum and Noise:	1.5 mV
Signal to Noise Ratio at rated output:	
Phono	73 dB IHF 60 dB DIN
Aux	85 dB IHF 80 dB DIN
FM Tuner Section	
Usable Sensitivity (IHF)	1.8 uV.
AM Tuner Section:	
Usable Sensitivity (IHF)	1.8 uV.
Image rejection @ 98 kHz	85 dB
IF rejection " " "	85 dB
Capture ratio	1.5 dB

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To: Akai, Rank Audio Products, P.O. Box 70, Great West Road, Brentford, Middlesex TW8 9HR.

AKAI

Akai equipment is made in Japan by Akai Electric Co. Ltd., and is distributed and serviced in the UK exclusively by Rank Audio Products.

TRANSDUCERS IN MEASUREMENT AND CONTROL

(Continued from page 67)

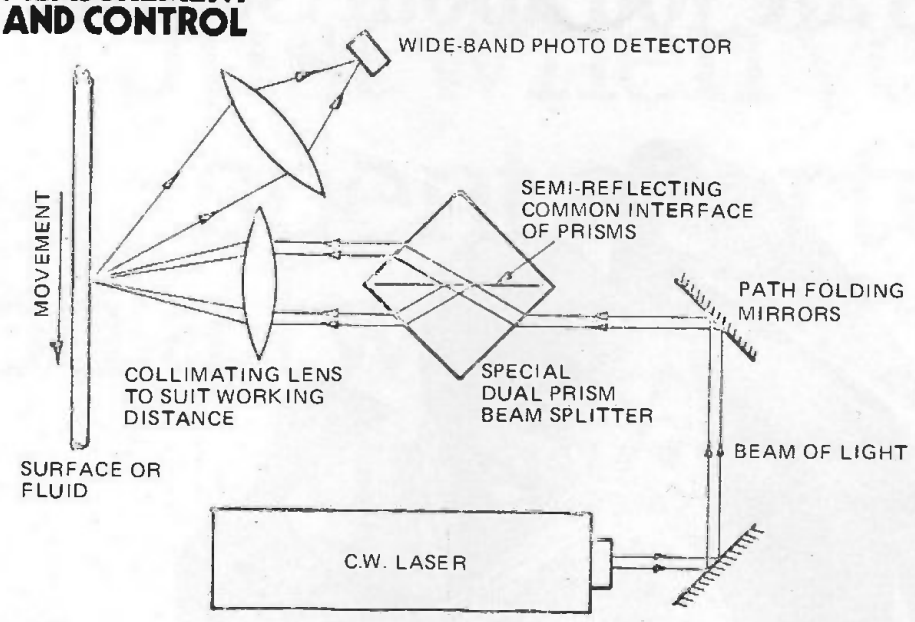

Fig. 13. Laser velocimeter. The laser beam is split to provide two coherent sources that interfere optically at point where velocity measurement is required.

range. (In principle, it is possible to monitor a range of 10^7:1). Since the early 1960's, the technique has been improved and is now commercially available (E.T.I. August, 1972). The laser beam is split (see Fig. 13), to provide two coherent sources that interfere optically at the point where velocity is to be measured. (It is necessary to make an optical comparison since interference is not possible electronically, and we do not, as yet, have detectors for such high frequencies). A sensor viewing this point sees a small circular fringe pattern that varies in amplitude as scattering changes. If the medium is moving across the field of view, the sensor detects passing fringes and produces short bursts of signal. The period of the cycles in a burst is a measure of the velocity. Extensive electronic processing is needed to produce accurate flow measurements on such vague signals. The main advantage of laser flow meters is that the velocity of a volume of fluid only $10^{-3}mm^3$ is viewed. The method is most useful in turbulence and profile studies. It is essential that some, but not many, scattering particles exist to provide a signal for the detector. Often air bubbles or a colloidal solid are injected to enhance the signal strength.

MISCELLANEOUS METHODS

In a cryogenic flow meter, the gas is made to flow through a thin flexible mesh held across the stream and parallel to an insulated electrode. As the mass flow velocity increases, the mesh is pushed closer to the electrode, changing the capacitance between the two. This is used to alter the frequency of an oscillator providing a frequency output form of signal.

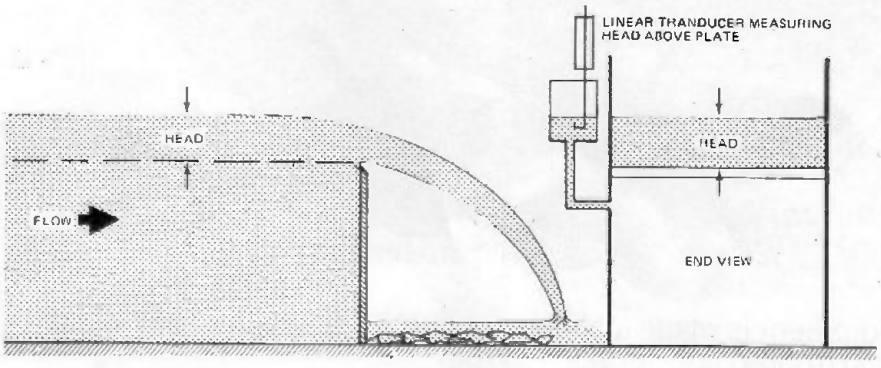

Fig. 14. This technique may be used to measure large volume flow in open channels.

When large volumes of liquid move in open channels, flow can be monitored by lowering a flow meter into the stream, but there is a simpler way to permanent installations. Theoretical considerations of the shape of flow across plates or weirs leads to equations that relate flow rate to the shape of obstruction, fluid constants and height of water above the plate. This is the same concept as orifice plates, etc. but the obstruction is a continuous circle. The relationship is not linear (quantity depends on height $^{3/2}$) and shape is vital. Standards are available so that channels built to specification (one is shown in Fig. 14), can be made that give a known calibration. A float is arranged to operate a linear or rotary displacement transducer. Plates and weirs can also provide differential pressures.

The oscillating-fluid flow meter is the last to be discussed. If fluid passes through a cavity of the correct design, it will oscillate at a frequency related to velocity (and temperature – remember the fluidic temperature sensor). Oscillation is induced into the stream entering the flowmeter by passing the fluid through vanes arranged to impart a swirl inside the cavity. Oscillation frequency is detected by monitoring the fluid temperature at a point in one commercial unit. This method has a fast response – 1000 Hz is claimed and is linear to about 1% of chosen full-scale range. It operates both with gases and liquids providing they are homogenous and the cavity is designed to suit the fluid to be used. ●

FURTHER READING:

"Handbook of transducers for electronic measuring systems", H. N. Norton, Prentice-Hall, 1969.

"Measurement systems: application and design", E. O. Doeblin, McGraw-Hill, 1966.

"Symposium on the measurement of pulsating flows", April 1970, Institute of Measurement and Control, London.

Extensive bibliography (to May, 1972) of blood flow measurements available from Parks Electronics Laboratory, Beaverton, Oregon, U.S.A.

"Fluid mechanics", V. L. Streeter, McGraw-Hill, 1958. (Background text for basics of fluid flow).

"Symposium on measurement and process identification by correlation and special techniques" January 1973, Institute of Measurement and Control, London.

Part II will deal with measurements of force, weight, pressures and torque.

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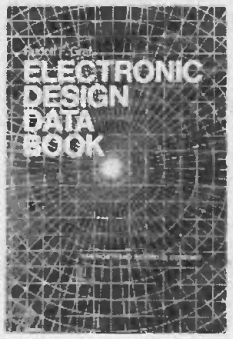
BOOK REVIEWS

REVIEWER: Brian Chapman



ELECTRONIC DESIGN DATA BOOK By Rudolf F. Graf. Published by Van Nostrand Reinhold Company Ltd 1971. Review copy supplied supplied by publisher. Hard cover, 312 pages 11" x 8½". Price £9.00

In the world of electronic circuitry the amount of data, formulae and tables required by the practising designer is truly staggering. Indeed it is no longer a question of the designer knowing all the relevant data and formulae – but of his knowing where to find them.

Mr. Graf, in his dual role as distinguished engineer and writer, has seen the need for a collation of available design data in the form of nomograms, tables etc and has produced this book as a result.

Unquestionably the author's aim has been achieved and the work surpasses anything previously available for similar purposes. Naturally individuals will find things missing that should be included, and things included which in their opinion should be left out. But no-one could say that it is not an extremely useful book.

To assist the reader find the data he seeks, the book has been divided into six functional sections which are organized and indexed in such a fashion that any specific information required is quickly located. The sections are:–

1. Frequency data
2. Communications
3. Passive components and circuits
4. Active components and circuits
5. Mathematical data, formulae, symbols
6. Physical data.

As an example of the treatment, the section on high pass filter design begins with a brief summary of factors affecting choice of type and methods of reading the nomograms. Diagrams of the various filter types are given together with their relevant design equations and four pages of nomograms cover all possible requirements.

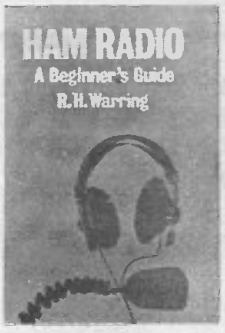
An essential purchase for designers whether amateur or professional. – B.C.

TRANSISTOR AUDIO AND RADIO CIRCUITS – SECOND EDITION. Published by Mullard Limited 1972. Review copy supplied by the publisher. Hard covers, 285 pages 8" x 5¾". Price £1.80

The first edition of this book was very popular amongst amateur constructors and this new edition will certainly be no less so.

It is a manual of established and practical circuits for a wide range of audio equipment and includes portable radios, fm tuners, audio amplifiers from one watt to 50 watts, loud speaker systems and test equipment plus a useful amount of theory, charts and nomograms. Many new circuits have been added for which full details and parts lists are supplied. No details are given of actual construction so the book would not be suitable in this respect for beginners wishing to obtain a source of projects. They would, however, definitely find the book a good source of knowledge about audio circuits.

Excellent value for the home constructor. – B.C.



HAM RADIO – A BEGINNER'S GUIDE. By R.H. Waring. Published by Lutterworth Press 1972. Review copy supplied by publishers. Hard cover, 152 pages 8" x 5¾". Price £1.60

Any book intended for beginners in electronics should be checked and proof read until it is certain that all errors, inconsistences and misleading phraseology have been eliminated as far as reasonably possible. This does not appear to have been applied at all in the production of this book – although Mr. Warring would certainly seem to know what he is talking about, he does not seem to have done much checking.

For example we quote (in slightly paraphrased form):– "The primary requirements (for good Morse transmission) remain:–

1. Accuracy
2. A steady and uniform rate of sending
3. Even spacing
4. Poor technique in use of codes

Even the experienced operator can be guilty of one or more of these faults . . .". Just what are we talking about – faults or requirements?

Again – "Thus sensitivity (of a radio receiver) can be expressed directly in terms of signal-to-noise ratio. the higher this ratio the better the selectivity possible." – Selectivity?

Errors such as those above are coupled with numerous incidences of poor phraseology which could only lead a beginner into the utmost confusion. In addition there are errors such as that on page 53, where in three separate instances we have the micro symbol, μ, in place of the mega symbol, M.

Thus we have this pearl:–

"When used in conjunction with a general coverage receiver, a100μHz crystal is usually adequate for checking frequencies up to 4μHz." Some crystal – it would vibrate at one cycle every 12hrs and at a wavelength exceeding 10 miles! Perhaps he means a 4MHz crystal can be used up to 100MHz

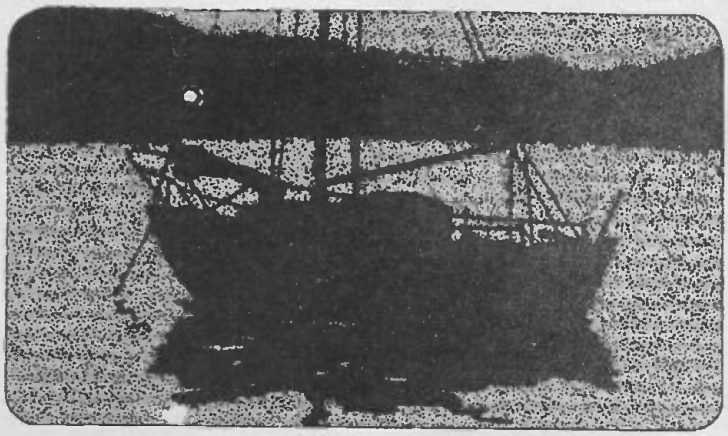
One wonders whether we should review a book such as this at all, as any review, good or bad, seems to encourage sales. We can only hope that those seeking to learn amateur radio theory will choose some other source. – B.C. ●

FREE

Semiconductor WALL CHART

An invaluable coloured chart giving semi-conductor parameters and base connections.

Special features this month...



Automatic Anchor Light

Great for boat owners! This anchor light turns itself on at dusk and off at dawn — thus saving battery power.

Workshop Components & Tools

An article describing a suggested stock of components and tools that will enable the constructor to set up a useful workshop. Useful testgear is also detailed.

Intercom

A simple, easily connected two way intercom.

everyday electronics 15p

May issue out Thursday April 19

EQUIPMENT NEWS

PRINTER FOR COUNTERS

AMF Venner have just announced the introduction of Digital Printer Model 765, a low-cost unit which is fully compatible in its standard form with Venner's '77' series electronic counters. Alternative versions are also available for use with outer counters or for specialized applications.

Capable of printing up to eight characters per line in standard form, Model 765 has a maximum printing speed of 3 lines per second. Its printout is on 3½in wide roll or fan-fold paper with a line spacing of five lines per inch. The printing mechanism is based on a continuously-rotating character drum with on-the-fly actuators to ensure high standards of legibility and reliability. Inking is via a readily available half-inch red/black typewriter ribbon.

The standard model accepts the four-line serial BCD signals from the Venner '77' series counters equipped with 'Option Y' Data Output. With counters so equipped, the numerical data output is in 1-2-4-8 code on a single four-wire data highway, the digits being scanned sequentially, beginning with the least significant. Additional wires carry a sequence-start signal, a clock pulse signal, and a print-command signal respectively. The logic circuits in the printer for entering the serial coded signal into the printer's store are all carried on a single printed circuit board which can be interchanged at the factory with an alternative board carrying circuits which accept parallel BCD coded signals on four wires per digit.

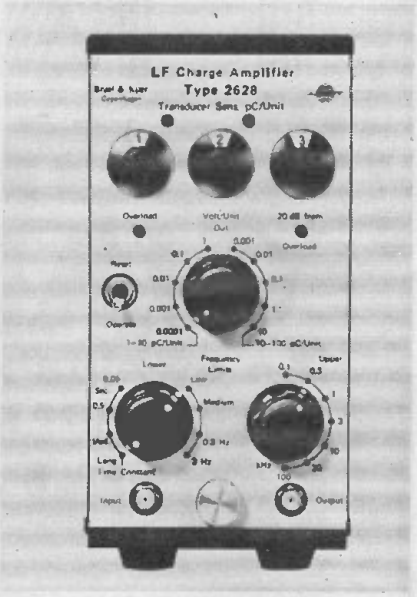
Venner, AMF International Ltd, Kingston By-Pass, New Malden, Surrey.

NEW LF CHARGE AMPLIFIER

B & K Laboratories Ltd. have announced a new low frequency Charge Amplifier for use with piezoelectric force and vibration transducers. Known as the Type 2628, it is particularly suitable for handling very low frequency and quasi-static signals, and depending on its gain setting, it has time constants of up to 100,000 seconds. This corresponds to a low frequency limit of 2μHz, the upper frequency limit being 100 kHz.

These frequency limits are adjustable by step controls of HP and LP filters, the active LP filter being incorporated so that unwanted higher frequency signals can be suppressed.

A 3-digit variable sensitivity conditioner is provided in dial form and can be used to adjust the Charge Amplifier to the exact sensitivity of the transducer being used. The



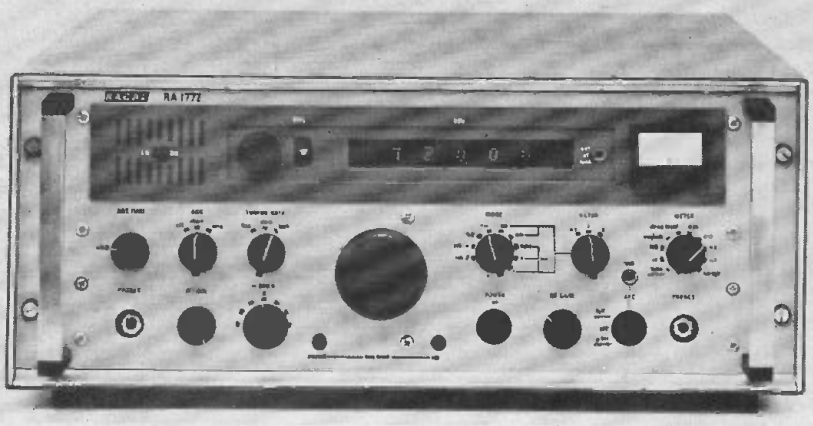
adjustment range is between 1 and 110 pC/unit, and the position of the decimal point is automatically indicated by signal lights. This feature greatly simplifies the calibration and reading of a measuring system using transducers with varying sensitivities and the input of the 2628 itself automatically eliminates errors due to long connecting cables.

Stage gain is step controlled and allows the signal output to be varied from 0.0001 V/unit to 10 V/unit.

Two signal indicators are provided. The first indicates overload at the input or output stage and the second lights when the signal level is within 20dB of the full output, thus indicating the best output signal level for minimum noise.

B & K Laboratories, Cross Lances Road, Hounslow, Middx.

SOLID-STATE RECEIVER



Details of the second in its 1770 series of advanced all solid-state receivers have just been announced by Racal Communications Ltd. A new synthesized HF communications receiver for professional use in the low, medium and high frequency bands, the RA. 1772 features an unique 'free-tuning' synthesizer for frequency selection. This Racal development enables rapid tuning across each 1MHz band in 10Hz steps with all the 'feel' and smoothness of a conventional VFO yet retaining the accuracy and stability of the chosen frequency standard.

Facilities are available to electronically select either of two tuning speeds or a 'lock' position whilst the tuned frequency is displayed on a flicker-free digital readout. These features provide the RA. 1772, which is suited to all modes of reception, with unbroken search capability over the equipment's wide frequency range of 15kHz – 30MHz. A choice of high-stability frequency standards is available to user's requirements.

The latest circuit techniques are employed throughout giving this new receiver what is said to be an unsurpassed signal path performance, intermodulation products being typically better than 90dB. The RA. 1772 includes provision for the ready incorporation of such optional facilities as ISB, FSK and AFC and can also be supplied as free-standing units or for rack-mounting.

Racal Communications, Western Road, Bracknell, Berks.

PPM

The Peak Programme Meter (generally known as the PPM) was originally developed by the BBC for checking modulation depths, signal levels etc. and the modern derivative (which meets BS4297) is widely used in the fields of broadcasting and sound recording. The British Standard defines the attack and decay times and logarithmic scaling with positive and negative peak deflection.

The PPM has distinct advantages over the VU meter in that it displays the relevant information quickly. The needle on the meter rises to signal a peak very quickly but the decay is slow. This makes it just as accurate but the effect is much more restful on the eye.

Surrey Electronics have introduced a drive unit for such a PPM suitable for mating with a 1mA left hand zero meter. It is available either as a kit or ready built and aligned. The prices are £8 and £12 respectively.

Surrey Electronics, 24 The High Street, Merstham, Redhill, Surrey.

Continued on page 77

Beware—Tiers could have you in tears!

Beware of imitations! Audio T—inaugurated the three-tier price system for amplifiers and tuner-amplifiers. This has met with great success because our customers have been given a much wider choice in their purchasing. People have been enabled to decide for themselves if after sales service is required.
For example, an electronics engineer would not require after sales service as he could probably repair an amplifier himself. We believe that he should therefore be able to effect a saving through this ability. Others would have a different set of priorities, with consequently, different requirements.
We have noticed recently that other companies have begun operating selling policies similar to our three-tier purchase system. If you read our three-tier purchase system (on the right) carefully, you will notice that some amplifiers and tuner-amplifiers are sold only at Cash and Carry prices. This is because we do not wish to guarantee equipment in which we have no confidence, for obvious reasons. Discovering which items are in this category, we believe, should be your first priority before making your purchase. *We should point out, at this stage, that a fair number of the amplifiers and tuner-amplifiers we sell are faulty when we receive them!* You see, it is no good having a guarantee if you are constantly going to have to invoke it because this means that you are continually without your equipment whilst it is being repaired.
When you purchase at Discount-Plus prices, we know and you know that the equipment is in good working order. It has been checked on our own test equipment and, what's more, a short report on it is issued by us. It is then, in the great majority of cases, unlikely to go wrong. And if it should develop a fault, our Service Department is at the ready!

SATURDAYS

On Saturdays we have in attendance a well known audio expert who will be waiting to discuss any problem with you. Also available for callers to inspect are copies of our own test reports so that you may check your equipment for consistency.

NO PACKAGE SYSTEMS

All systems suggested are for individual requirements which is why we ask you to tell us the size and shape of your listening room and how it is furnished
If you want After-Sales-Service we are not the cheapest. However, if you're not worried about this, then we say, pay Cash-and-Carry AND COMPARE OUR PRICES!

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We should point out at this stage that certain items are *not* available at Cash & Carry prices, whereas others are *only* available at Cash & Carry prices.

② DISCOUNT PLUS

You get the manufacturers guarantee **PLUS** the Audio T guarantee of free labour for 12 months from date of purchase. If you have any trouble after this period, still bring it back to us and we'll get it repaired for you at a small charge. **All amplifiers sold at Discount Plus prices have an individual test certificate on several important performance parameters, taken on our test equipment. As mentioned earlier, there are some makes which we will not supply under our Discount Plus scheme and only at a Cash & Carry price. These items will not normally be on demonstration.**

③ SELECT SERVICE

For those who buy at full retail prices amplifiers which we also sell under the Discount Plus arrangement, we offer two years FREE parts, labour and carriage charges incurred in the repairing of a unit which is faulty. The item must be returned to us in the original packing and must not have been obviously physically wrecked. After two years, after sales service reverts to the Discount Plus system.

Example 1	Goodmans 1–10 stereo tuner/amplifier		
	Price	V.A.T. rate	Total
Cash & Carry only	£88	£8.80	£96.80
Discount Plus	£98	£9.80	£107.80
Select Service	£119.46	£11.95	£131.41

Example 2	Pioneer SA 500A amplifier		
	Price	V.A.T. rate	Total
Cash & Carry only	£32.50	£3.25	£35.75
Discount Plus	£37.50	£3.75	£41.25
Select Service	£48.10	£4.81	£52.91

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Philips have used advanced technology to develop one of the world's finest integrated audio systems.

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You can select any of six preselected FM stations instantly by just laying a finger on any of six controls that are sensitive to the touch. They make ordinary pushbuttons seem clumsy. There's a switch to silence inter-station noise when tuning on FM, and another for Automatic Frequency Control to ensure stable FM reception. Variable bandwidth on AM gives a wider range of tones where reception conditions allow, or increases even further the tuner's remarkable ability to separate crowded stations. You can connect two pairs of loudspeaker enclosures, perhaps in separate rooms, selecting either pair for stereo, or all four in one room for Philips STEREO-4 surround-sound.

The GA212 'electronic' record deck sets new high standards in record reproduction, with touch-sensitive speed selectors, photo-electronic switch-off, strobe for precise speed adjustment, electronic brain to keep speed constant during play, SUPER M magneto-dynamic cartridge, and many other top-quality features.

The RH405 enclosures each have three loudspeakers... for low, middle and high notes independently... giving beautiful full-frequency reproduction.

For a free 36-page Audio Guide, write to Philips Electrical Limited, Dept SP, Century House, Shaftesbury Avenue, London WC2H 8AS.

PHILIPS

We want you to have the best.

EQUIPMENT NEWS Continued from page 74

NEW PROCESS TIMER

Further development work by Thorn Automation has resulted in a new low-cost process timer – the Series PCT 5 – designed to meet the majority of industrial timer applications.

The new PCT 5 unit comprises a CR Timer Circuit with relay. Initiation of the timing period may be made by mains supply connection, closure of external contacts or by application of a suitable input pulse. The output state of the internal or delay timing period is indicated by a lamp located on the front of the unit.

Five standard ranges are available from 0.1 to 500 seconds in spans of 10:1. For applications which require two internal recycling time control, two PCT 5's can be connected together. Construction of the PCT 5 is simple yet rugged. The unit is designed for panel mounting and fits DIN standards 92 mm x 92 mm cut-out, panel depth is 210 mm. The panel arrangement provides for easy installation and maximum packing density. Flanged sliding panels allow easy access to the internal circuitry. Wiring is by 'fast on' connectors.

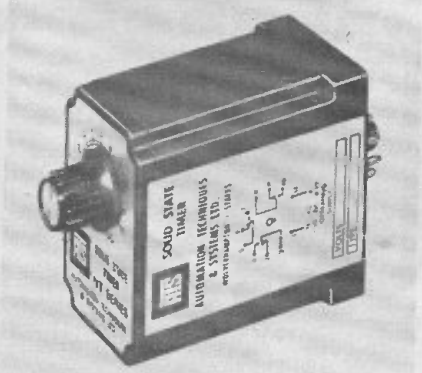
Maximum contact-current rating for the output relay is 15A and the maximum contact voltage is 440V. Switching capacity of the relay is 3KW and relay is 1 million operations minimum. Repeat accuracy is ± 1%.

Thorn Automation Ltd, Rugeley, Staffs.

SOLID STATE TIMERS

A new range of Solid State Timers, the 'UT' Series, from Automation Techniques & Systems Ltd, is claimed to provide reliable timing and control, with excellent tolerance to wide variations in temperature and applied voltage. Standard timing ranges available between 20mSec and 12 minutes at prices from £4. Special timers are available up to 120 hours. All timers are available with either solid state output, or 3 sets of changeover contacts (in any combination of instantaneous and timed contacts).

Automation Techniques & Systems Ltd, Pensnett Trading Estate, Brierley Hill, Staffs.



HAND HELD DECIBEL METER TYPE 1008

A robust and versatile decibel meter with the added advantage of small size is the Hatfield Hand-Held Decibel Meter Type 1008, a reliable and comprehensive test instrument for transmission and general level measurements.

Using taut band meter, the 1008 provides a range of +21 to –60dBm and versatile input arrangements (75, 140, 600, 900 and 1200 ohms bridging and terminated, balanced and unbalanced) at a frequency rnage of 20Hz to 150KHz.

Power comes from two internal batteries providing a life in excess of 50 hours.

Advanced circuit techniques, including an 'active balance' input, have contributed in providing a wider range of measuring facilities than larger, more costly models.

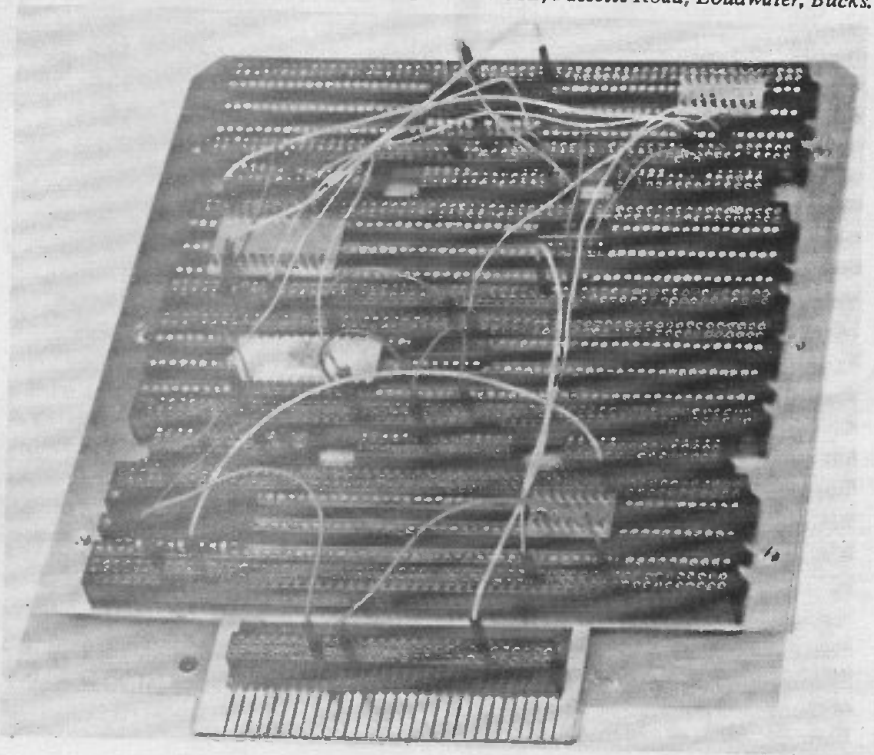
Hatfield Instruments, Burrington Way, Plymouth.

UNIVERSAL PC BOARD FOR DIL AND IC DEVICES

New from OEC, and obtainable through UECL at Loudwater is a universal mounting board for DIL and IC devices. As illustrated the board comprises a series of ready-mounted single-way connectors arranged to accept both 0.3" and 0.6" DIL devices of 0.1" contact pitch.

A main distribution socket connects to the p.c. edge pads, and connections to and between devices are made via twin-plug feeders. This particular model comprises two-way distribution blocks and single-strip IC supports arranged in four sets, but other configurations are available to order. IC's and DIL's can be mixed to form temporary circuits for system evaluation trials by simply slotting into the chamfered-entry sockets. For certain high-density boards the UECL system offers a ready means of device substitution replacing the somewhat costly alternatives available.

UECL, Fassetts Road, Loudwater, Bucks.



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D81	10	Reed Switches. Reed Relay inserts 1¼" long	50p
D88	200	Mixed Capacitors. Approx. quantity, counted by weight	50p
H4	250	Mixed Resistors. Approx. quantity, counted by weight	50p
H7	40	Wirewound Resistors. Mixed types and values	50p
H40	20	BFY50/2, 2N696, 2N1613 NPN Silicon uncoded TO-5	50p
H9	2	OCP71 Light Sensitive Photo Transistor	50p
H39	10	Integrated circuits. 6 Gates BMC 962, 4 Flip Flops BMC 945	50p
H30	20	1 Watt Zener Diodes. Mixed Voltages 6.8–43V.	50p
H35	100	Mixed Diodes. Germ. Gold bonded etc. Marked and Unmarked.	50p
H28	20	OC200/1/2/3 PNP Silicon uncoded TO 5 can	50p
H38	30	Short lead Transistors, NPN Silicon Planar types.	50p
H41	2	Complimentary Pnwer Transistors. BD131/BD132	50p

UNMARKED UNTESTED PAKS

B55	150	Germanium Diodes Min. glass type	50p
B83	200	Trans. manufacturers' rejects all types NPN, PNP, Sil. and Germ.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B96	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
B88	50	Sil. Trans. NPN, PNP equiv. to OC200/1 2N706A, BSY95A, etc.	50p
B1	50	Germanium Transistors PNP. AF. and RF.	50p
H6	40	250mW Zener Diodes DO-7 Min. Glass Type	50p
H34	15	Power Transistors, PNP, Germ. NPN Silicon TO–3 Can. P & P 5p extra.	50p
H17	20	3 Amp. Silicon Stud Rectifiers. Mixed volts	50p
H18	30	Top Hat Silicon Rectifiers. 750mA Mixed volts	50p
H16	15	Experimenters' Pak of Integrated Circuits. Data supplied	50p
H26	40	NPN Sil. Planar Trans. 2N3707-11 range. Low noise amp	50p

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TYPE "G" NPN Silicon, similar ZTX300 range.
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8 RELAYS FOR VARIOUS TYPES P. & P. 25p. **£1**

VALUE ADDED TO YOU On orders of £4 or over. See below:

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We will give a discount to customers who send in an order for £4 or over. This discount will be equal to the V.A.T. rate current at this time. If your order does amount to £4 or over, all you need to send is the total cost of goods and postage as stated in this advertisement. No addition for V.A.T. is needed.

V.A.T. for orders under £4:—
If the total cost of goods plus postage and packing is less than £4, kindly add 10% (10p in the £) to your remittance. Incorrect amounts will delay your order.

NPN/NPN will be supplied if not otherwise requested.

A CROSS HATCH GENERATOR FOR £3.50

YES, a complete kit of parts including Printed Circuit Board. A four position switch gives X-hatch, Dots, Vertical or Horizontal lines. Integrated Circuit design for easy construction and reliability. This is a project in the September edition of Practical Television.

This complete kit of parts costs £3.50, post paid.

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Our famous P1 Pak is still leading in value for money.

Full of Short Lead Semiconductors & Electronic Components, approx. 170. We guarantee at least 30 really high quality factory marked Transistors PNP & NPN, and a host of Diodes & Rectifiers mounted on Printed Circuit Panels. Identification Chart supplied to give some information on the Transistors.

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10p P & P on this Pak.

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for TRANSISTORS, RECTIFIERS, DIODES, INTEGRATED CIRCUITS AND FULL PRE-PAK LISTS

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NOW IN TWO RANGES

These are 40W and 90W Silicon Plastic Power Transistors of the very latest design, available in NPN or PNP at the most shatteringly low prices of all time. We have been selling these successfully in quantity to all parts of the world and we are proud to offer them under our Tested and Guaranteed terms.

Range 1. VCE.	Min 15.	HFE.	Min 15.
	1–12	13–25	26–50
40 Watt	20p	18p	16p
90 Watt	24p	22p	20p
Range 2. VCE.	**Min 40.**	**HFE.**	**Min 40.**
	1–12	13–25	26–50
40 Watt	20p	28p	26p
90 Watt	35p	33p	30p

Complementary pairs matched for gain at 3 amps, 10p extra per pair. Please state NPN or PNP on order.

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We stock a large range of I.Cs at very competitive prices (from 10p each). These are all listed in our FREE Catalogue, see coupon below.

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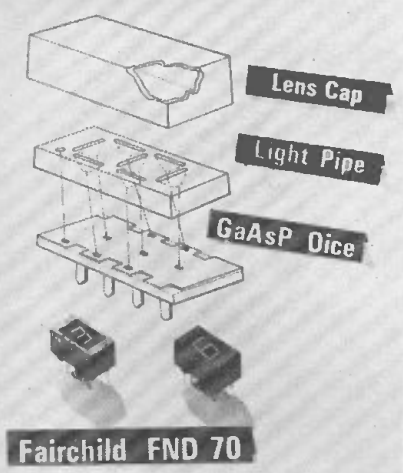
COMPONENT NEWS

NEW BRILLIANT LED DISPLAY

The FND70 now available through Gothic Electronic Components is a ¼in solid-state LED display. It comprises 8 chips of gallium-arsenide phosphide mounted on a single metal base which are covered by a light-pipe assembly. The final package is red plastic on a 10-lead DIL. The actual character is 7 x 4mm.



The metal lead frame and die mounting platform gives precise alignment of the dice and acts as an effective heat sink. Each segment requires a recommended 12 to 20mA operating current, so that any high-current decode-driver can be used to drive FND70. Tests over better than 2½ million device hours without failure indicate a 300-year life reliability !

The FND70 incorporates a contrast enhancing filter, giving a higher on/off visibility ratio. The character style is pleasant for extended viewing, and devices are matched for intensity to obtain uniform brightness. Its package style enables closer stacking of digits – space saving to the manufacturer and easier interpretation for the reader.

Further details from *Gothic Electronic Components Ltd, Beacon House, Hampton Street, Birmingham 19.*

785 AMP THYRISTORS

Two new 785 Ampere r.m.s. Hockey Puk Power Thyristors with high ratings and excellent surge capability have been announced by International Rectifier.

Available in a ceramic housing as 500PA or in a plastic case as 501PA series, each has an T^2t of 420,000A^2s and peak single cycle surge current of 9160 Amperes.

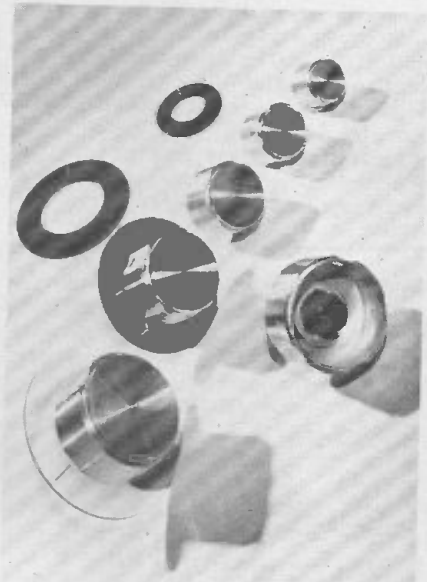
A voltage range from 50 to 600V V_{RRM}/V_{DRM} is released making the product suitable for low and medium voltage d.c. motor control applications, metal treatment processes, plating and d.c. welding operations.

The devices are available as separate units or pre-assembled into air or water cooled heat exchanger or to form complete rectifier assemblies.

International Rectifier, Hurst Green, Oxted, Surrey.

INSTRUMENT KNOBS

Realising the existing limitations of choice of ready made instrument knobs, where both ergonomics and good looks are concerned, West Hyde Developments are now entering the knob market. The ranges to be marketed by them will cover most requirements and will all be under their existing trade name Contil. All will have good contemporary styling and will have a number of unique features.



The smart new instrument knobs from West Hyde Developments

Illustrated is the new range of Contil Insulated Aluminium Knobs. Styled with a glossy turned finish, they have carefully designed flutes for maximum grip and diamond turned edges further enhancing the appearance. Insulation is by means of a bush between the body of the knob and the shaft, to comply with German VDE standards.

West Hyde Developments Ltd, Northwood Hills, Northwood, Middx.

INTEGRATED FM DETECTOR AND LIMITER

A unique method of FM detection by a new technique of linear gating is featured in the ULN2111 monolithic integrated circuit, which is now available in quantity from Signetics, according to Derek Bell, responsible for the Company's linear and consumer product. This linear device comprises a three-stage limiter and a balanced product detector. Applications for the ULN2111 device include TV sound channels, FM receivers, a.f.c. systems, and communication receivers. Other applications for the ULN2111 device are in the more sophisticated circuitry in telemetry receivers, automatic control systems, and servo amplifiers.

Any outstanding feature of the ULN2111 is that only one, simple, low-cost, single winding coil is required for tuning. Consequently, only one screwdriver adjustment is required to tune a detector employing the ULN2111. The frequency range of the ULN2111 extends from 5kHz to 50MHz. Outputs of 0.6V with a total distortion of less than 1% and a limiting threshold voltage of 400 microvolts are typical. Another feature is a high voltage gain of 60dB.

Signetics International Corporation, 63 Croydon Road, London SE20.

HIGH-RELIABILITY ELECTROLYTICS

Collaboration between chemists at Advance Filmcap and Seco Novea of France has produced a new electrolyte. The result is a range of high reliability electrolytic capacitors which have a temperature range extending from –55°C to +100°C.

The range, Prosec 100C offers units with operating voltages from 10V to 63V. The

A fistful of capacitance!

COMPONENT NEWS

Prosec E 100C has the same 100°C capability but with an extended range of capacitance values. Total coverage ranges from 2,200μF to 220,00μF with specifications which include the ripple current ratings at 100°C. The Prosec E 100C offers the same CV/volume as the Prosec E 85C which showed an increase up to 50% over the standard range.

As an example of size of the new capacitors, a 220,000μF unit, 10V working, measures 73mm in diameter by 123mm high including terminals.

Advance Filmcap Ltd, Rhosymedre, Wrexham, Denbighshire.

UHF 500MHZ TYPE D FLIP-FLOP

Motorola Semiconductors Ltd have added a 500MHz type D flip-flop to their MECL-3 family of integrated logic circuits. This is the fastest flip-flop ever produced by Motorola as a standard product.

A type D flip-flop is a single storage element which has a wide variety of applications in digital control systems and instrumentation. As well as being used as a high-speed storage latch, the MC1690 can be employed in prescalers, dividers, serial-to-parallel and parallel-to-serial converters, synchronous and ripple counters, shift register delay lines for radar systems, data compressors and multiplexers, and high-speed samplers.

To ease logic system design problems and to reduce the package count, the MC1690 is provided with two gated D input lines and two gated clock input lines.

Although 500MHz is the specified operating frequency, this is a *minimum* figure and typical devices can be expected to toggle at all clock frequencies up to 550MHz.

The MC1690, which has identical power supply requirements and is directly compatible with other members of the MECL-3 family, consumes 200mW.

Over the guaranteed operating temperature range of 0 to 75°C, the MC1690 has output rise and fall times of typically 1.3nsec and a set-up time of only 330psec.

Motorola Semiconductors, Ltd Empire Way, Wembley, Middx.

M-O V PRODUCES AN HCN LASER

The M-O Valve Company Ltd, working in collaboration with the National Physical Laboratory, has introduced an HCN laser, type HCN2175, into its range of products. This type of laser is the most powerful source of coherent radiation in the 0.1–1.0mm wavelength region and is a valuable tool in physical research. It is particularly suitable for measurements on plasmas having an electron density of 10^{19} –10^{21} –m^{-3}, and can also be used for measurements of the transmission characteristics of power radiated at 337μm, eg through fog or through insulating materials.

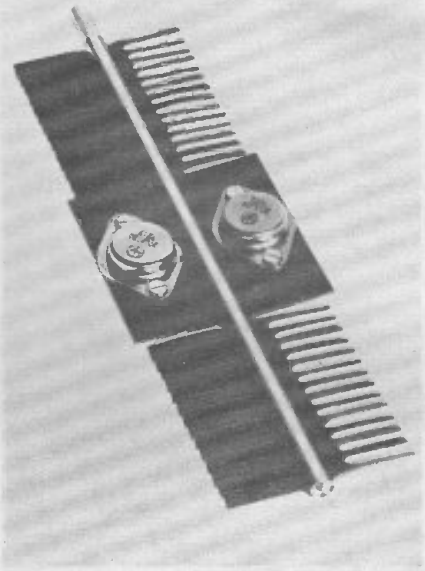
The HCN2175 consists of a discharge tube through which flows a methane-nitrogen gas mixture. Two internally fitted mirrors, separated by an integral number of half wavelengths, constitute a Fabry Perot resonator. Radiation builds up inside the cavity until eventually the system oscillates and give out measurable power. The exact spacing is obtained by the axial movement of one mirror which is mounted on a micrometer, and the radiation is emitted either through a hole in the other mirror or by partial reflection from a beam divider.

Special attention has been paid to the problem of output power stability and silica spacers are used to determine the mirror separation.

The laser, which is 2 metres long by 75mm diameter, is enclosed in a cabinet to provide electrical safety and reduce thermal drift. The HCN2175 gives typically 1mW of output at a wavelength of 337μm.

The M-O Valve Co Ltd, Brook Green Works, London W6.

HEAT SINKS



Conventional high performance heat sinks are large and heavy. Flat plate heat pipes are one solution, but generally an expensive one. Where size and weight are of importance, the Redline series provide an efficient, economical alternative. They comprise an assembly of twisted vane surfaces mounted on a tubular heat pipe thereby combining the advantages of both. The result is a small, lightweight heat sink capable of high performance in any altitude. Attachments are available for a range of devices, including DIL IC's.

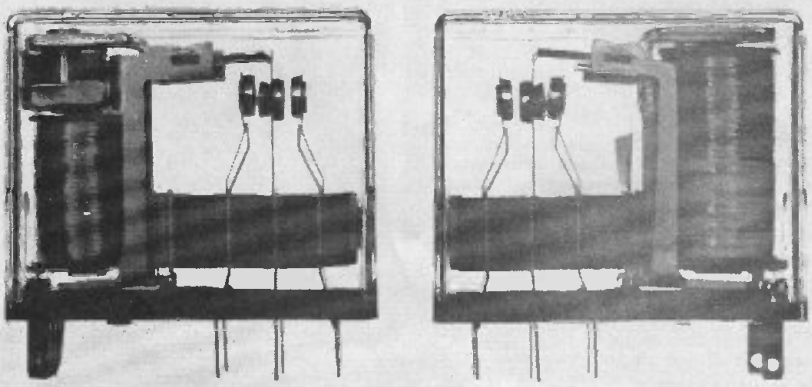
Redpoint Associates Ltd, Cheney Manor, Swindon, Wilts.

SMALLEST 20-AMP LATCHING RELAY

The smallest 20A, 240V a.c. magnetic latching relays in the world has just been launched in Great Britain by B & R Relays. It has been designed and manufactured by Siemens to meet a demand for simple, small relays with one heavy-duty changeover contact.

This is an extension to the company's V23003 range. In addition, the standard V23054 range has been extended to cover this contact arrangement.

B & R Relays Limited, Temple Fields, Harlow, Essex.



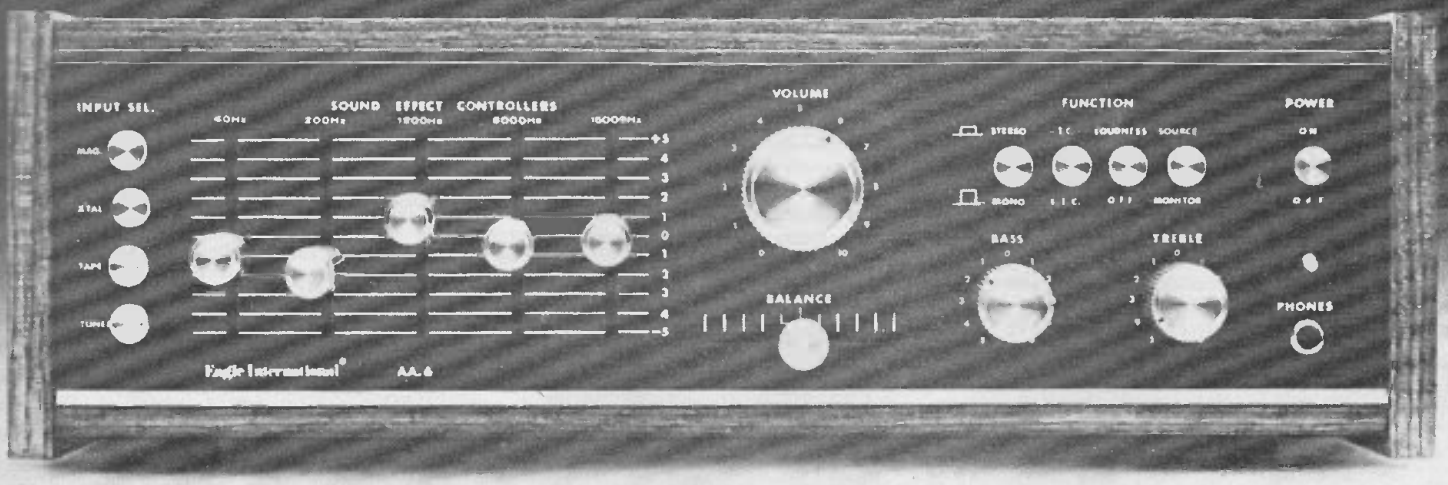
The 20A, 240V magnetic latching relays from B & R Relays

POWER TRANSISTOR CHIPS FOR HYBRID CIRCUITS

A complete range of power transistor chips are now available from Motorola Semiconductors for use in hybrid circuits. The chips are identical to the chips used in Motorola's standard range of packaged power transistors and meet the same electrical specifications.

Parameters such as Safe Operating Area and Maximum Power Dissipation are not specified because they depend on the method employed by the user to mount the chips. However, special test methods are used to ensure that all parameters which depend on the thermal characteristics of the mounting correspond with similar packaged units.

(Continued on page 82)



To boost the violins, slide the fourth knob from the left upwards.

To boost the bass trombones, slide the first knob upwards.

To get Gigli or Sinatra to sing out, slide the third knob upwards. It gives the human voice more 'presence'.

We could go on, but by now you'll take the point.

With the new Eagle AA6 amplifier, you have complete control over the sound you hear.

Much more than you ever had with normal Bass and Treble controls.

Why?

Because the five slide controllers allow you to boost or cut five separate sectors across the whole frequency range, around 40, 200, 1,200, 6,000 and 15,000 Hz.

As opposed to ordinary Bass and Treble controls which simply give you 'blanket' cut or boost, generally around 100 and 10,000 Hz.

The difference is amazing.

With the AA6, you can literally pick and choose what you hear.

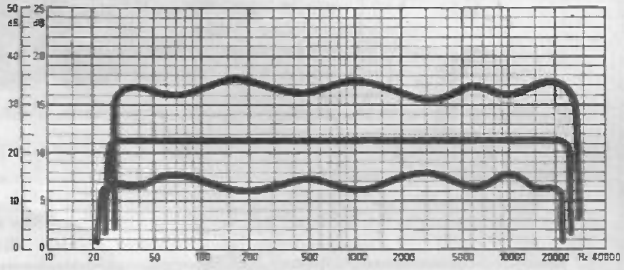
You can create entirely new balance by 'mixing.'

Or you can compensate for poor room acoustics.

Or poor recordings.

Or quirks in your other hi-fi components.

And when you're not listening so critically, you can revert to simple Bass and Treble controls merely by pushing a button.



Graph shows degree of control throughout frequency range with Sound Effect Controllers in maximum and minimum positions.

Now there's something you must do. Visit your Eagle dealer and ask for a demonstration.

More than any other amplifier, you need to have the Eagle AA6 demonstrated.

To hear it. And to experiment with the controllers.

Alternatively, you could send for our free instruction booklet. (For this or any other Eagle amplifier or tuner.)

That way, you'll be able to see exactly what you're getting.

Not what the salesman chooses to tell you you're getting.

Eagle International

Eagle International Precision Centre Heather Park Drive
Wembley HA0 1SU Telephone 01-903 0144

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- ☐ TSA 149 7 + 7 watts amp. – £31.00
- ☐ AA8 Stereo Tuner – £50.00
- ☐ TST 152 Stereo Tuner – £36.30

(All prices are exclusive of VAT)

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Wembley HA0 1SU Telephone 01-903 0144

ET2

COMPONENT NEWS

(Continued from page 80)

The power chips, which can be both passivated and mesa types as well as power Darlingtons, are available in four basic styles.

Many of the unmounted chips can be supplied with a gold or chrome-silver coating on the mounting face for either eutectic or solder preform bonding.

For users who do not have wire-to-chip bonding equipment the 'power pill' is available. This consists of a power transistor chip bonded to a molybdenum pad which is in turn brazed to a copper button. Wires from the chip are linked to two isolated areas on the copper button and may be connected to external circuitry using conventional soldering.

The chips can also be supplied mounted on copper buttons without isolated connecting areas or the naked chips can be obtained with aluminium connecting wires attached.

All of the power chips undergo the same quality assurance procedure employed for the normal encapsulated power transistors supplied by Motorola.

Motorola Semiconductors Limited, York House, Empire Way, Wembley, Middx.

GENERAL PURPOSE OP AMP

A high gain operational amplifier, type CA3741T, is now available, singly or in quantities, from Sasco.

Housed in an 8-lead TO-5 package, the device is output short-circuit protected and offers latch-free operation. Wide common-mode and differential-mode signal ranges plus low-offset nulling are other features of this general purpose device.

The internal circuitry comprises a differential input amplifier driving a gain and level shifting stage. Output is via a complimentary emmitter-follower. The device has internal phase compensation.

Maximum ratings are: d.c. supply voltage, 44V; differential input voltage, ±30V; d.c. input voltage ±15V. There is no limit on output short-circuit duration.

Sasco Limited, P.O. Box 2000, Gatwick Road, Crawley, Sussex.

SINGLE CIRCUIT DISPLAY DRIVER

An MOS LSI microcircuit that incorporates in a single package all the counting, buffer storage and decoding functions needed to drive a four digit seven segment display has been developed by General Instrument Microelectronics.

Using the new AY-5-4007A sub-system, a dozen bipolar MSI packages can be replaced by a single MOS microcircuit consuming one eighth the power and occupying one tenth the board area. Such is the reduction in power consumption that many mains powered instruments including frequency counters, digital voltmeters event counters, temperature meters and multimeters could be powered by internal batteries. This makes it possible to design a family of portable digital display instruments.

For Nixie displays, requiring a higher driving voltage than can be provided by MOS microcircuits GIM have developed the AY-5-4057. This sub-system incorporates four decade counters together with four stores and can easily be interfaced with a bipolar one-out-of-ten decoder capable of driving a four digit ten filament Nixie display directly.

General Instrument Microelectronics, 57 Mortimer Street, London W.1.

VIDEO DELAY LINES

Matthey Printed Products announce a new range of equalised video delay lines, 'Silver Star Video Delay Lines – 10MHz Range', designed for use as 75M cable replacements in colour television broadcasting studio equipment.

They are recommended for use where the ripple in the pass band must be within 0.3dB up to 4.2MHz, 0.4dB up to 8MHz, and less than 1dB at 10MHz. Studio equipment is often designed so that signals pass several times through the delay lines. These '10MHz Range' modules are ideal for this application.

There are five delay lines in the '10MHz Range' : 50ns, 100ns, 200ns, 500ns and 1,000ns, and they can be cascaded to give intermediate delay times. They can be supplied as modules for use on PCB's or in boxes with BNC connectors.

Matthey Printed Products Limited, William Clowes St, Burslem, Stoke-on-Trent ST6 3AT.

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		£ p	£ p	£ p	£ p
5"	900' Long Play	0·94	1·29	1·19	1·06
5¼"	1200'	1·21	1·45	1·42	1·33
7"	1800'	1·69	2·11	1·94	1·89
8½"	2400"	(*only 3600')	—	2·56	—
10½"	4200'	4·11*	—	—	4·15
5"	1200' Double Play	1·27	1·45	1·54	1·26
5¼"	1800'	1·87	2·11	2·09	1·86
7"	2400'	2·59	2·61	2·69	2·43
5"	1800' Triple Play	—	2·11	2·32	1·94
5¼"	2400'	—	2·61	2·75	2·37
7"	3600'	—	3·27	3·18	3·16

COMPACT CASSETTES	PHILIPS £ p	BASF £ p	BASF CrO_2 £ p	SCOTCH £ p	TDK (S.D.) £ p	TDK CrO_2 £ p	AGFA £ p
C60	0·43	0·45	0·92	0·42	0·81	1·09	0·39
C90	0·63	0·64	1·19	0·54	1·09	1·54	0·54
C120	0·89	0·92	1·51	0·80	1·54	—	0·65

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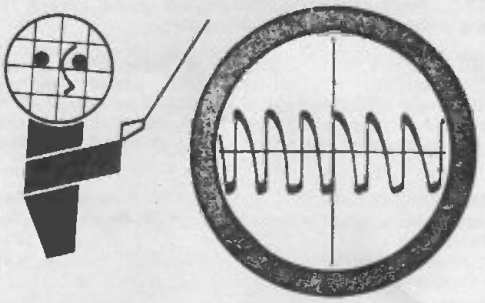

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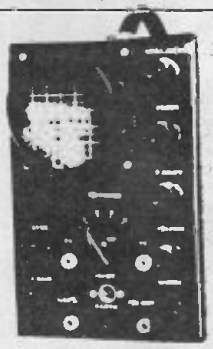

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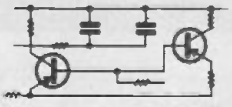

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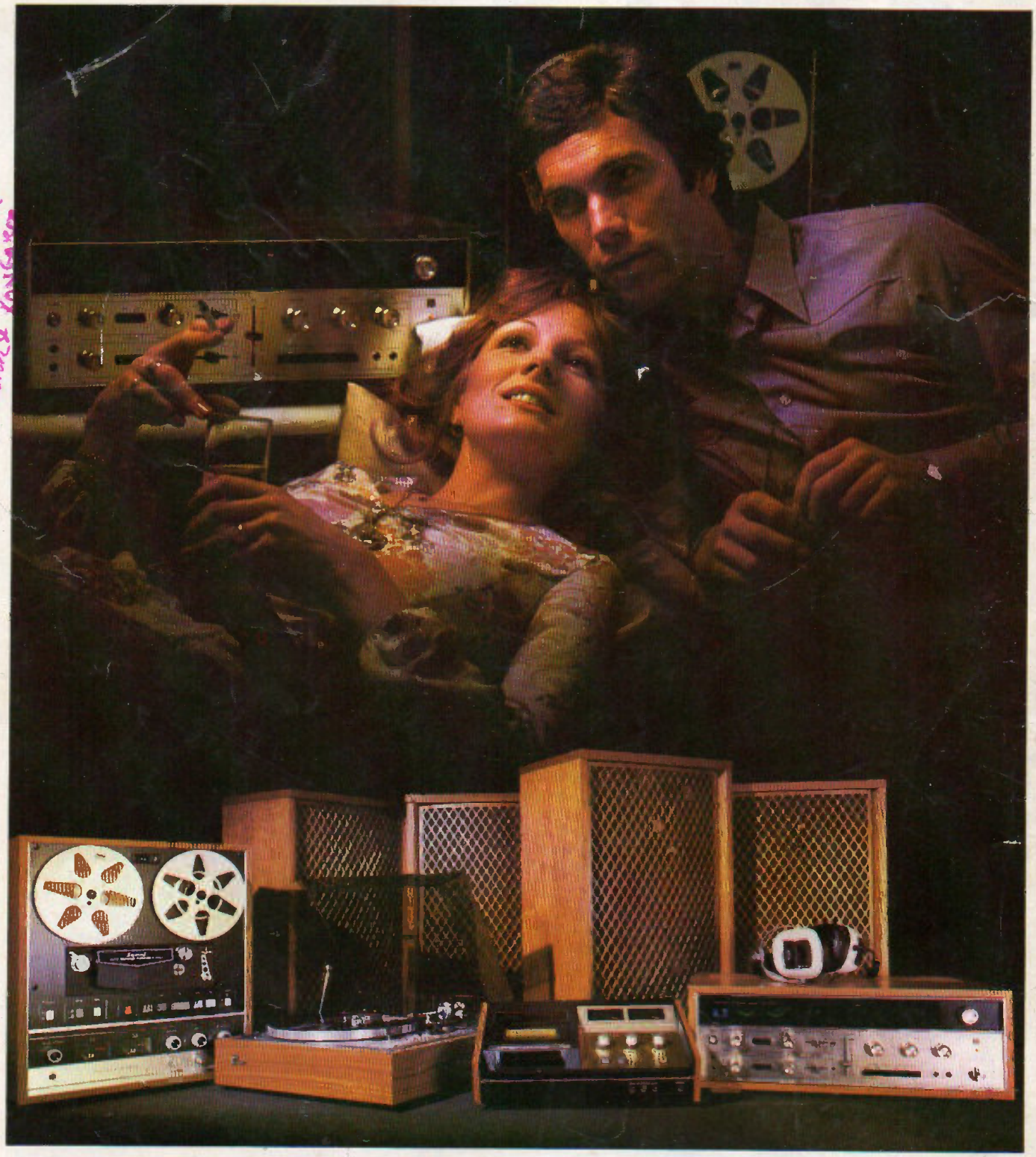

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