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Commentary

THE 'Brain Drain'! How the national press loves these catch phrases and with what enthusiasm they can turn almost any occurrence into a national crisis. In this they are ably supported by those who are constantly on the look out for anything which they can turn into political capital. In some cases this leads to a good deal of misinformed comment by those who should know better and by those who do know but, to put it kindly, have a 'mischievous' turn of mind. This, of course, is fair enough in its way: it may all seem a little quaint to observers from some other countries but it is part of the British way of life and there are probably few, even among those who are emigrating, who would want to change it.

It would be equally wrong to underestimate the danger of what could prove to be a serious matter. A country such as this, which is practically devoid of natural resources, needs to make the utmost use of the talents which its inhabitants have to offer. If a large scale migration of the country's best brains took place this would be a very serious, indeed catastrophic, situation. But this is hardly the case at present and the current comings and goings need to be kept strictly in true perspective. For many years, centuries in fact, highly qualified persons have moved from country to country: some have remained in their adopted countries but many have returned to their native lands with their minds broadened and their experience enriched by their travels. With the present day ease of travel and communication it is natural that this interchange of people should be accelerated, but it must be emphasized that it is an interchange and is by no means a one way traffic. While it is difficult to obtain precise figures it seems fairly certain that, taken on a global basis, this country is acquiring more qualified people, in both the arts and sciences, than it is losing. It is only with the U.S.A. that it has an adverse balance of personnel movement and this is really the point that is causing the present outcry. But here again it must be emphasized that it is not entirely a one way traffic and neither is it exactly anything new. As Lord Shawcross, Chairman of the Medical Research Council, said in a recent speech, "I suppose the process really started with the Mayflower".

If it becomes apparent that we are losing considerably more brain power than we are recruiting there are two simple questions that must be answered: how serious is it and what can be done to prevent it? The answers, unfortunately, are far from simple to formulate.

With regard to the first question it may be argued with some justification that for the overall good of mankind, and providing that knowledge is equally shared (as ultimately it always is), it does not greatly matter where research is carried out. For example, if a cure, or prevention for cancer could be found it does not seem to matter all that much whether it is discovered in Britain, America or elsewhere. This, however, is somewhat of an over-simplication of the matter for in the world as it is today the economic gains which result from research and discovery must be evaluated; this includes direct benefits such as new manufacturing processes, products etc., and also indirect gains such as national prestige and morale.

So far as direct gains are concerned, and particularly taking a long-term view, the origin of a discovery is of little importance: no one country has made any great direct gain from the work of such men as Ohm, Ampère, Faraday or Doppler. On a much shorter term basis it is doubtful if the U.S.A. has gained a proportionate advantage from the invention of the transistor at the Bell Telephone Laboratories. In many ways it would seem more important quickly and efficiently to apply the results of basic research than actually to make the discoveries, and this is a sphere in which for many years Great Britain has been woefully weak. In this context the loss of able engineers appears rather more serious than the loss of their more academic brethren—though it is of course appreciated that the former cannot work without the latter.

From the point of view of the advantages that accrue from national prestige and leadership in the world of science it is impossible to be dogmatic. The stakes here are as much national morale and political influence as economic gain and it is a factor which doubtless is of more importance now than at any time in history.

Whatever weight may be given to the various factors involved it seems fair comment to say that while a global interchange of personnel is beneficial to all concerned it is highly necessary for the well being of a country such as Great Britain that it should be able to attract and retain at least as many good brains as it loses.

As regards what can be done to retain our top scientists and engineers, and perhaps attract others from overseas, there are a number of fairly obvious courses that must be pursued. Better facilities must be provided and scientists must be freed from menial and clerical tasks. More emphasis needs to be placed on research in universities instead of judging or planning their expansion merely on the increased number of undergraduate places. But probably most important of all is a requirement for national rethinking on the social position and status of scientists of all grades for, whatever may be said to the contrary, including statements made by some of those who emigrate, status and standards of living are just as important to the scientist as to anyone else and are among the most compelling incentives that any country has to offer.

Waveform and picture storage instruments embodying half-tone tubes are then discussed, and some applications are described.

The article continues with a description of the operation of electrical/electrical tubes, and of an instrument embodying such a tube for large screen picture storage. The transmission of television pictures along telephone lines by slow-scanning a stored picture is discussed.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 213)

FOR a general purpose oscilloscope there are available commercially to the designer a number of direct view storage cathode-ray tubes of two predominating types: the bistable tube (sometimes called the Haeff[1] tube), and the half-tone tube (also known as the grey-scale or multi-level tube).

The tubes incorporate a secondary emitting electrode, and store by charge control. The construction is relatively costly. Tubes using special phosphors have been used for providing long storage. The Skiatron tube using a potassium chloride screen is an early example[2]. Phosphors from which energy may be released by infra-red rays have been employed, permitting previously written information to be viewed for a long period.

Recently tubes have become available having a performance somewhere between storage and special phosphor types, embodying simpler targets. These are less costly but perform adequately for less exacting applications.

As charge-storage tubes of both the direct view type (electrical/visual) and electrical/electrical type employ secondary emitting targets, the modes of operation will be considered.

Charge Storage Tubes—Operating Principles

Consider an apparatus consisting of a cathode, a metallic plate having secondary emission properties, and a collector electrode. The geometry is such that if the cathode is connected to the plate through a battery (plate positive) the plate will be bombarded by electrons; the collector is sited clear of the cathode-plate beam, but is arranged so that it will collect all secondary electrons emitted from the plate, when connected to the cathode through a battery such that its potential is always positive with respect of the plate.

The cathode-plate potential is now increased through the range 0 to 600V, and the ratio of collector (secondary) current to cathode (primary) current (d_e) is measured.

Near zero volts, most of the electrons are reflected from the low potential plate to the collector; the secondary/primary current ratio is near unity. At a few volts positive some electrons will flow to the plate instead of to the collector as hitherto, and this trend will augment as the plate potential is further increased, the current ratio becoming less than unity.

As the plate voltage is further increased the energy of plate bombardment is enough to cause appreciable secondary emission. At about 50V, almost as many secondary electrons are emitted by the plate as there are primaries arriving; the contribution of primaries to the secondary current, by direct transit to the collector, has become small. The secondary/primary current ratio is again unity, but it will be noted that the mechanism is different from that giving rise to unity near zero volts. A further increase of plate voltage causes secondary emission to increase until at some maximum, the secondary/primary ratio approaches 2. Above about 200V the bombarding electrons penetrate more deeply into the plate surface, so that the dislodged secondaries are recaptured within the plate by its positive field before being emitted, and the secondary emission gradually decreases with an increase of plate voltage.

The voltages given above are typical, but will depend on several factors, in particular the material of which the plate is constructed.

A curve of plate voltage versus secondary/primary current ratio (d_e) takes the form *ABCD'* (Fig. 1).

Points *B* and *D'* where $d_e = 1$, are referred to as first and second crossover. As previously stated the curve *ABCD'* is obtained with the collector potential high enough to collect all emitted secondaries. At lower collector potentials the curve will become significantly altered.

For instance if $V_c = +200$V, the section *ABC* will be as previously, but as the plate voltage is increased until its potential approaches that of the collector, the latter will repel some of the emitted secondaries. At some slightly higher plate voltage, the collector will be negative relative to plate, and there will be a sharp reduction of collector current, which is still further reduced as the plate voltage is further increased. The curve then assumes the form *ABCDEF*. If the collector was fixed at 400V, the curve would assume the form *ABCGF*.

Direct View Tubes

In charge-storage tubes the metal plate is replaced by a fine metal mesh coated with a dielectric material having secondary emission properties, usually on the side facing the cathode, the whole being called 'the target'. When bombarded, the dielectric will assume some surface potential due to the loss or gain of electrons, and depending on the potential of the metal mesh there will be a charge held in the dielectric surface-to-mesh capacitance.

If the cathode-mesh voltage is set anywhere between 0 and 50V, and the surface and mesh potentials are the same (target discharged) d_e will be according to the section *AB* of the emission curve, that is there will be a flow of elec-

* *Amplivox Ltd, formerly Cawkell Research & Electronics Ltd.*

trons on to the dielectric surface, which, being an insulator, will shift negatively until it reaches zero volts, and the dielectric 'cathode-stabilizes' at contact potential.

If the cathode-mesh voltage is set anywhere between about 50 and 200V, the bombarding energy is intense enough to cause more electrons to leave than arrive (secondary emission) and the surface charges positively, until, coming under the influence of the collector, the rate of charging decreases, d_e becoming unity at *D*, where the surface 'collector stabilizes', at a potential slightly positive with respect to the collector.

For cathode-mesh voltages above the collector stabilizing potential, collection of primaries occurs (as in the section *AB*), and the target charges negatively to again become 'collector stabilized'.

If the collector is taken to a potential above second crossover (*D'*), and the mesh potential is such that the dielectric surface resides at a potential between crossovers, the dielectric surface will move positively 'sticking' at second crossover; if the dielectric were initially above second crossover, the surface would charge negatively, again 'sticking' at second crossover. Under these conditions collector stabilization cannot occur.

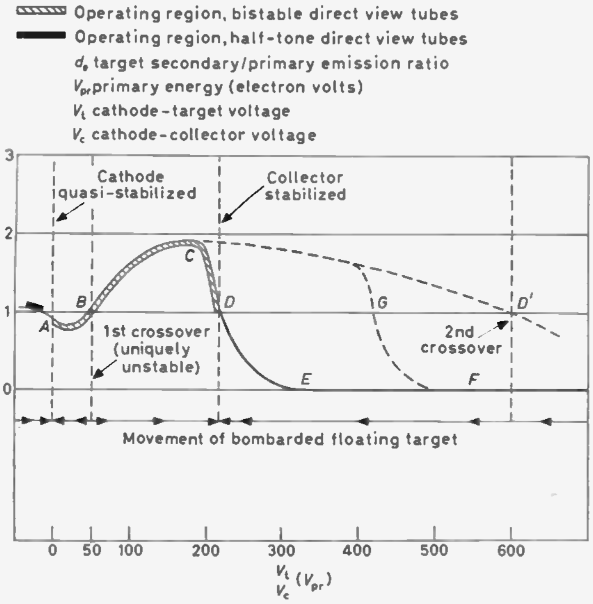


Fig. 1. Curve for secondary emission ratio

If the dielectric surface were taken, by adjustment of the mesh voltage, to a potential negative relative to cathode, then it cannot charge by an emission process. Positive ions will be attracted to the mesh surface gradually charging it positively. The correct title for point *A* on the curve (Fig. 1) is 'cathode quasi-stabilized', because the positive and negative charging influences are different. These potential shifts of the dielectric surface are denoted by arrows on Fig. 1.

The above behaviour has been described in detail by Knoll and Kazan[3].

In bistable and half-tone direct view storage tubes, the passage of a continuously-emitted large area flow of electrons from a flood-gun through the target mesh to a display phosphor, is controlled by the charge pattern on the target. The pattern is created by the action of a writing gun whose beam is deflected in accordance with signal potentials; the flood electrons are collimated so that a projection of the mesh on to the screen is obtained.

Bistable Direct View Tubes

In bistable tubes, the flood-gun holds the dielectric near zero volts relative to flood-gun cathode in readiness for writing. The target operates at about 2kV positive with respect to the writing gun cathode, and during a single sweep of the beam, electrons upon arrival at the target cause copious secondary emission. The weak opposing forces below first crossover are overcome and the dielectric charges positive, being assisted by the flood-gun electrons above first crossover, and becomes 'collector stabilized' at around 200V relative to flood-gun cathode.

The mesh structure of the target is such that at a dielectric potential of zero volts, flood electrons cannot penetrate it, while at about +80V a maximum number penetrate; they then come under the influence of the screen, held several kilovolts positive, and cause fluorescence with maximum brightness.

After writing, charge boundary migration gradually occurs, and the trace usually fades positive after a very long period, the whole screen becoming uniformly bright. Bistable tubes are particularly applicable if very long storage is required, as the flood beam will hold 'black' areas at zero volts, and 'white' areas at the collector stabilized point.

Half-tone Direct View Tubes

With half-tone tubes the mesh is more open, the dielectric thinner, and the electrode spacing different, so that the flood beam transmission characteristic is different. To prepare for writing, the dielectric is cathode stabilized near zero volts as previously, and the metal mesh is then taken from +10 (relative to flood-gun cathode) to +2, the dielectric surface following from 0 to −8V by capacitive coupling.

To display half-tones, energetic electrons ($V_{pr} = -2$kV) from the writing gun bombard the surface and cause secondary emission, the potential settling somewhere between −3 and zero volts according to beam intensity modulation (this small operating region is shown in Fig. 1). The transmission characteristic in a typical case is such that a charge of −3V permits flood electrons to produce 'near black', through grey-scale potentials to 'white' at near zero volts; because of a lack of uniformity in the background of the display when the dielectric is at some nominally uniform potential, a resolution of between 5 and 8 discrete tones is usually obtained.

At these low target to flood-gun potentials no flood electrons are attracted by the unwritten target surface, so 'white' represents a very bright picture. As a charge through only some 3V is required for the transition from black to white, faster writing can be obtained than with bistable tubes, where a charge through about 80V is required.

Deterioration of the charge pattern in half-tone tubes is by accumulation of positive ions, the dielectric gradually moving towards zero volts; brighter tones fade to white first. Methods of enhancing storage time, and providing variable persistence have been described elsewhere[4], although deterioration will always be faster than with bistable tubes.

Half-tone Tubes—Writing Speed and Storage Times

The writing speed and storage time capabilities of half-tone direct view tubes are illustrated in Fig. 2. CSF type TE1 603 tubes are capable of producing useful information at writing speeds in excess of 30cm/μsec, but to achieve such speeds target capacitance has been reduced to a very low value and storage time is reduced. This may be observed by comparing the writing speeds and storage times of the CSF and the experimental English Electric

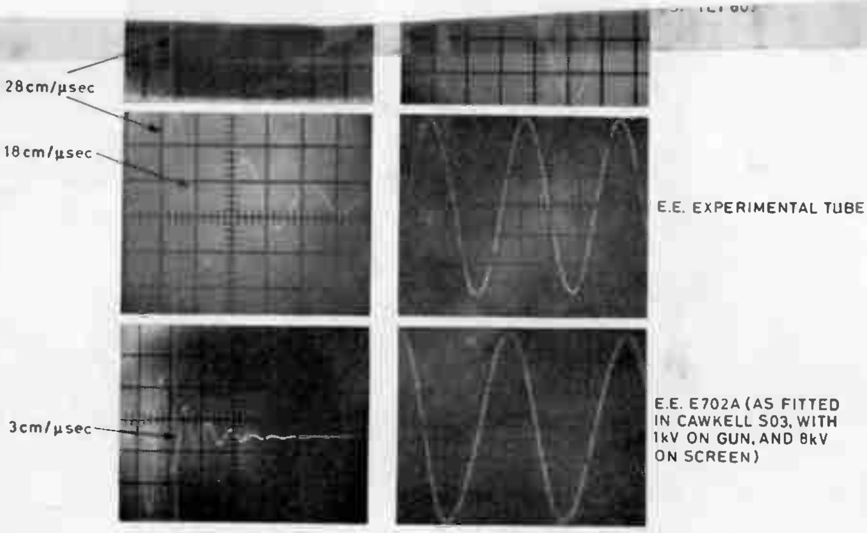


Fig. 2. Writing speeds and storage times of direct view half-tone tubes

tube, which shows performance compromise. The factors influencing writing speed and storage time have been described in the literature[5]. Writing speeds adequate for many purposes can be achieved using less expensive tubes and circuits, and this is shown in Fig. 2(c).

Bistable and Half-tone Tubes—Terminology, Erasure

The operation of bistable tubes as described, is sometimes called 'bistable writing with holding beam, and grid controlled reading' for obvious reasons. The operation of the half-tone tube is sometimes called 'non-equilibrium (potential) writing with grid controlled reading'. By 'equilibrium potential' is meant that potential (usually relative to collector) that a dielectric will take up when bombarded, for a given V_{pr}. As in half-tone tubes the target does not operate at an equilibrium voltage (it is taken below zero volts where emission cannot occur), the description is self-evident. More information about storage tube terminology has been given elsewhere[6].

In bistable tubes, erasure is usually carried out by taking the collector below first crossover, the target being compelled to follow, so that all areas assume zero volts, any previous pattern of charge being erased.

The collector is then slowly shifted positively to its normal operating level, so that restoration of the surface to zero volts by flooding is maintained, in spite of the tendency to pull positive by capacitive coupling. In the half-tone tube, erasure is usually effected as previously described. In both types of tube erasure takes a quarter of a second or less.

British Storage Oscilloscope

A British storage oscilloscope[4] embodying an English Electric E702A 5in direct view storage tube was developed during 1959 from experience gained on equipment developed for storing transients during thermo-nuclear fusion experiments[7].

Some of the more interesting features of the instrument include: writing speed 2 to 4cm/μsec; viewing time (aided by persistence pulses) 10min, and by flood-gun variable duty ratio on-off pulsing, 2 hours; storage (retention) time

reproduce transients at the maximum writing speeds. The time-base embodies features essential for the display of transients such as triggering from first edge regardless of polarity, and automatic lockout.

In another version the detachable time-base and vertical amplifier are replaced by appropriate units to convert the instrument into a picture storage monitor. The time-base control circuits may be set to accept from 1 up to 5 frames and then lockout; 405, 525, or 625 line operation may be selected by a switch.

Recently the instrument has been redesigned in the light of experience gained, to offer much the same facilities with simplified or more elegant circuits and strictly functional mechanical design, resulting in a smaller, lighter, and much less expensive instrument. A range of plug-in amplifiers includes an amplifier/trace-shifter, the latter section enabling the trace to be automatically shifted by an adjustable amount at the end of each sweep, so that a family of traces may be stored at intervals and viewed together.

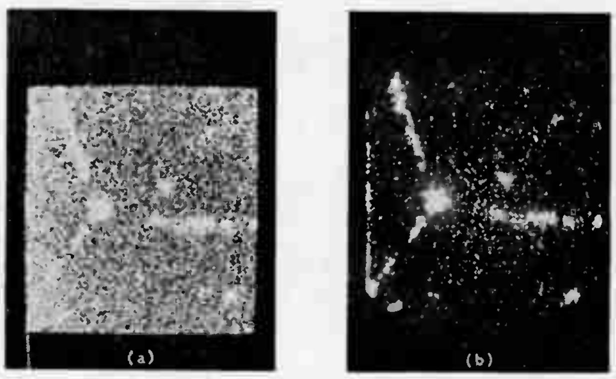
Storage Applications

There are many obvious requirements for the storage of transient waveforms[8]: for example to display switch and relay characteristics, shock waveforms, engine impulses, insulation breakdown discharges[9], and so on.

One interesting application[10] is the display of vector-electrocardiograms, using apparatus described by Burger and Klein[11].

Another concerns X-ray micro-analysis, where the integrating properties of an oscilloscope embodying a half-tone storage tube can be used to provide better pictures than can be obtained by using a conventional oscilloscope with photographic integration[12]. Fig. 3 shows pictures built up during a 15min period by the two methods. With the storage oscilloscope, tube operating conditions can be adjusted such that signal modulation produces a just perceptible change of charge, which after repeated over-

Fig. 3. Integration with a direct view storage tube
(a) Conventional oscilloscope; photographic integration—15-minute period
(b) Storage oscilloscope—storage tube integration; appearance on screen 15 minutes after start



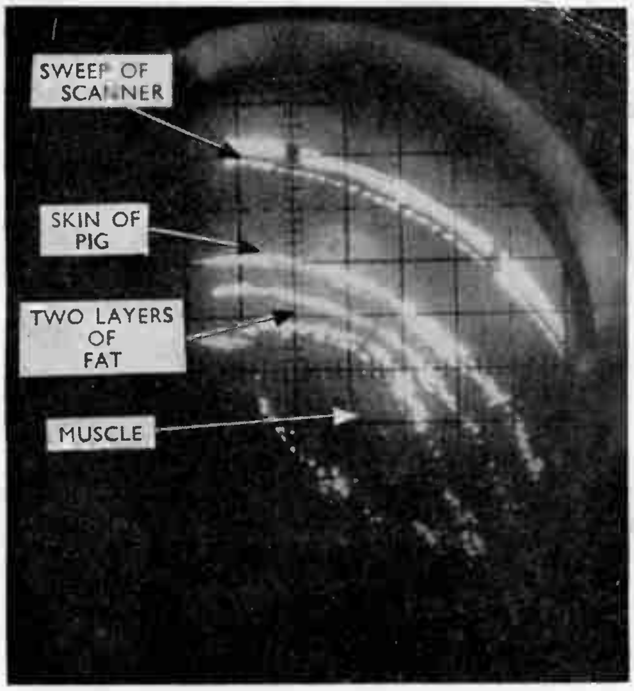


Fig. 4. Stored B-scan presentation showing cross-section of part of an animal, obtained by reflection of ultrasonic waves with traversing transducers

writing is adequate to provide a stored display. Noise voltages are usually inadequate to produce a display.

Fig. 4 shows a stored B-scan presentation obtained by traversing a transducer generating an ultrasonic beam of vibrations, across the skin of an animal. A cross-section of the layers of the tissue is built up from wave reflections at interfaces. Measurements can be made of fat layer thickness of live animals.

Picture storage monitors have also been used to solve inspection problems. In one such installation a rotary transfer machine carrying the objects which require to be remotely inspected, stops periodically, but for an insufficient time for inspection. The inspection period is prolonged by using two picture storage monitors to each of which a picture of every other object is conveyed via a television camera. Two inspectors observe the objects for twice the resting interval.

These monitors have also been used in a different inspection problem where steel strip is in high speed production[13]. In this case the image is arrested by a synchronized rotating mirror, and a picture of a strip of the material at right-angles to its direction of motion is televised and stored. An adjacent strip from the next unit length is stored beneath the first, and eventually a complete picture of a unit length is stored.

Electrical/Electrical Storage Tubes

A limitation of direct view tubes is the screen size and the resolution, normally about 50 lines/in (20 lines/cm), although tubes with over 100 lines/in are available. Fig. 5 shows a store photographed from the 4in screen of the E... Electric E.702C direct view tube.

Large screen direct view tubes having screen diameters of up to 21in are becoming available, and although very costly, these have their uses.

To obtain high resolution large screen television-type pictures, and for other applications to be described, a range of electrical/electrical storage tubes are available[14].

The writing and storage is similar in principle to that described for direct view tubes, but the information is read out electrically not visually, so further processing is necessary to obtain a visible picture.

Tubes available include the Radechon[15] barrier grid tube, the Graphecon[16] scan convertor, the Nesotron island storage tube, the Recording storage tube, and others[17,18,19].

The instrument to be described has been designed around the Raytheon recording tube type QK.464 (resolution 600 lines) or type QK.685 (resolution 1000 lines).

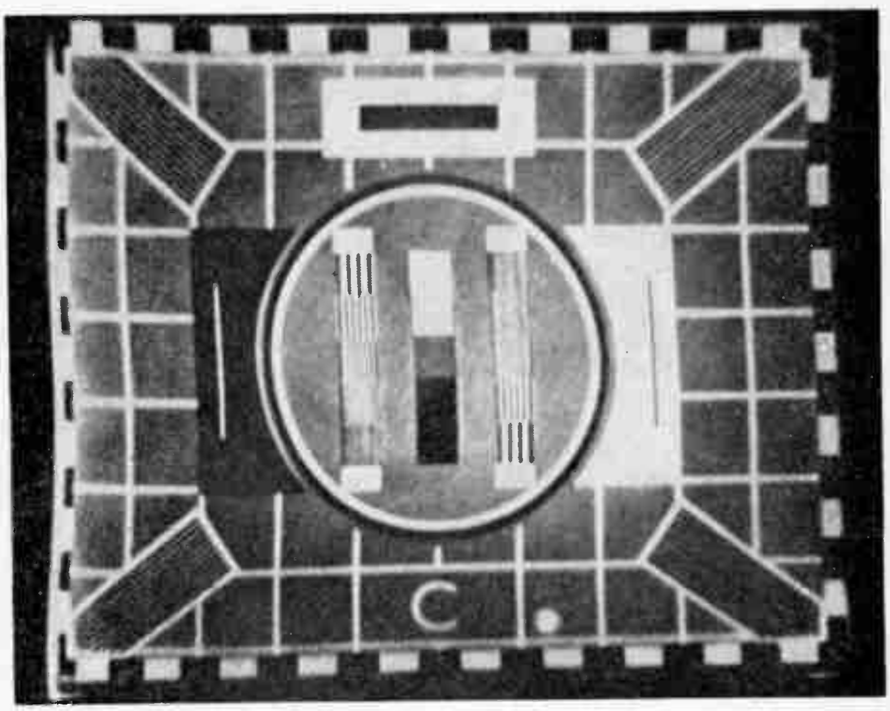
This tube embodies a writing gun, a collimating lens system, a screening grid, and a metal mesh coated on the cathode side with a secondary emitting material; parallel to the target at the end of the tube there is a flat metal plate—the signal electrode. There is no flood-gun.

To erase, the mesh and screening grid are taken to +300V relative to cathode, and the surface is scanned with the unmodulated beam. As the dielectric is operating above first crossover, the surface moves positively to the mesh potential of 300V, all parts of the target becoming discharged. There is no 'collector-stabilization', so the curve *ABCD'* of Fig. 1 applies.

To prime, the mesh is taken to +20V, the surface is scanned by the unmodulated beam, and as it is now operating below first crossover, moves to 0V, the target becoming charged. The beam is then switched off and the tube is put in the 'ready to write' condition, by taking the mesh to +300V with the beam off, the surface following with its 20V charge, to +280V.

The beam is now switched on, is modulated by signal

Fig. 5. Image of test card 'C' stored on a direct view storage tube



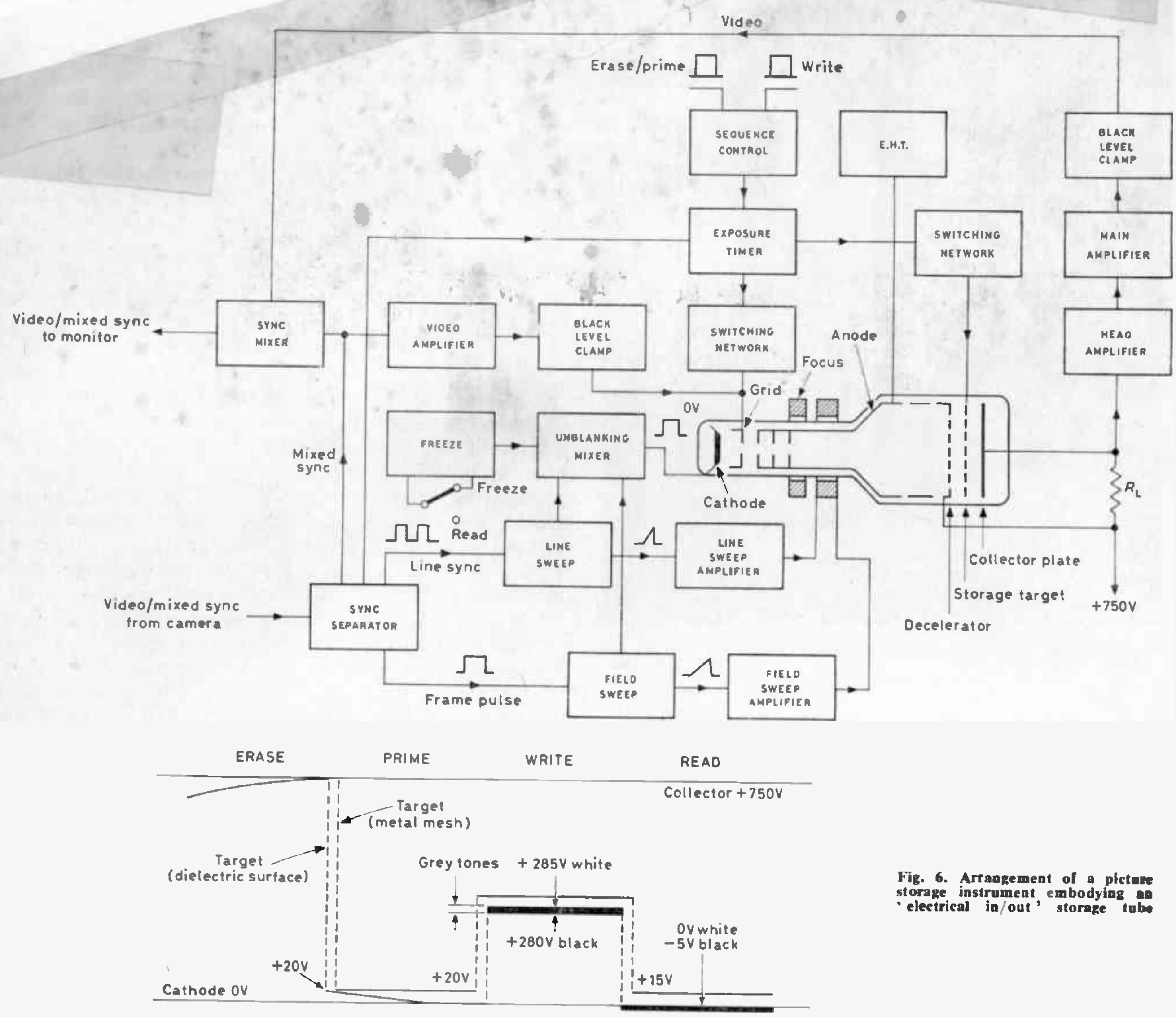


Fig. 6. Arrangement of a picture storage instrument embodying an 'electrical in/out' storage tube

voltages, and scanned across the target. As the latter is now operating above first crossover the surface moves positively in the places scanned proportionally to the beam current, in the range 280 to 285V.

To prepare for reading, the mesh is taken down to +15 with the beam off, so that the surface potential of those areas containing information lies between about −5 ('black'). and 0 ('white') relative to cathode.

To read, an unmodulated beam is scanned across the surface, and electrons can penetrate the mesh through to the signal plate (held at +350V) according to the local charge, an amplitude modulated current flowing in the plate load. Those parts of the dielectric surface carrying significant information are less negative with respect to cathode, electrons pass through the mesh without disturbing the charge, and the target can be repetitively scanned some 30 000 times.

Deterioration during read-out is mainly due to the accumulation of positive ions, (the quantity of which is minimized by good evacuation and continuous gettering) and the surface moves positively, the charge pattern gradually assuming a uniform state.

The image may be made visible by deflecting the reading beam at conventional television frame and line rates, synchronizing with a television monitor, and applying the signal electrode currents as modulation.

During development work with the tube, it was observed that when pictures received from the BBC were stored and displayed, the resolvability of grey-black tones was superior to that obtaining when a picture derived from a high quality closed circuit television was used.

It will be recalled that gamma correction is often used in television systems to correct for luminance distortion arising in picture tubes due to the non-linearity of the modulation—brightness curve. Such correction is included in the BBC transmission but was not included in the closed circuit system. This is particularly important in X-ray picture storage[20], where degradation arising from contrast distortion cannot be tolerated.

Very little information is available about the transfer characteristics of electrical in/out tubes. Accordingly measurements were taken by writing with linear sawtooth modulation, and observing the read-out modulation. While the individual read-in and read-out characteristics are not known, no appreciable transfer function non-linearity could be observed within the normal working range. Accordingly appropriate measures were taken externally to correct for the gamma distortion present in the monitor tube, connected to the electrical in-out tube for viewing, when pictures were derived from the closed circuit system.

A self-explanatory diagram of the complete instrument is shown in Fig. 6. The potentials on the electrodes of the storage tube for different operating modes are also shown.

Fig. 7 shows two 625-line monitors displaying a picture direct from a camera, and a stored picture from the same source; there is only a small difference.

Fig. 8 shows the appearance of the stored picture 5min (7 500 read-outs) after storage, to illustrate the mode of degradation. The number of read-outs which can be obtained before information is lost varies considerably between tubes.

Fig. 7. Picture storage: (right) Picture from monitor connected direct to television camera. (left) Picture from monitor carrying read-out stored picture, one minute after receiving one field from camera

Television by Telephone Wires

The concern here is with 'information' pictures such as price quotations, race starting prices, drawings, bank statements and the like, rather than 'entertainment' pictures.

Such information may be sent by facsimile, or in a simple case by pulsing remote digital indicators; other methods have been described elsewhere[21]. Television techniques for data transmission have certain advantages as follows:

(1) Information can be presented to a television camera for transmission in its original form, which form can be extremely diverse.

(2) The received presentation on a monitor is convenient and acceptable to a conditioned public.

(3) The whole field of the information can be seen at a glance.

(4) Closed circuit television equipment is now inexpensive and reliable. In the case of a 'multiple-viewer' installation—that is where a number of persons require the information at the remote point (as for instance in an office block)—the cost is that of the line terminal equipment, plus about £70 per viewer for a monitor—and there can be an extremely large number of viewers.

The most readily available link at a reasonable cost is the G.P.O. (or in the United States The Bell schedule 4A) private telephone circuit. The bandwidth is about 2·5kc/s—obviously inadequate to convey a television picture.

Methods of sending low definition pictures along lines have been described [22,23]. To send and receive a bright high definition picture the Vistastore may be used; other systems using storage tubes have been described... 1/25th second field is accepted from a television camera, stored, and scanned out into the line at a rate such that no component will exceed the bandwidth of the line. Thus, if the highest modulating frequency is 3Mc/s when one field is transmitted in 1/25th of a second, it will take 90sec to transmit the field if the highest modulating frequency is limited to 2·5kc/s, or about 45sec if vestigial sideband transmission is used (assuming a noise free channel).

This time will be acceptable for many applications where the information changes every few minutes. However, in other instances the delay would be intolerable; moreover private lines may be subjected to noise, and possess characteristics which will break up or distort the picture.

Methods of decreasing the transmission time, and combating noise will now be briefly discussed. Space will preclude any detailed treatment of information theory, and the reader is referred elsewhere[25,26] for more information.

Picture Information and Channel Capacity

The information in a television picture is conveyed by the position and brightness of the spot; the picture may be represented by elements, the modulation amplitude being regarded as the limiting case of brightness level quantization.

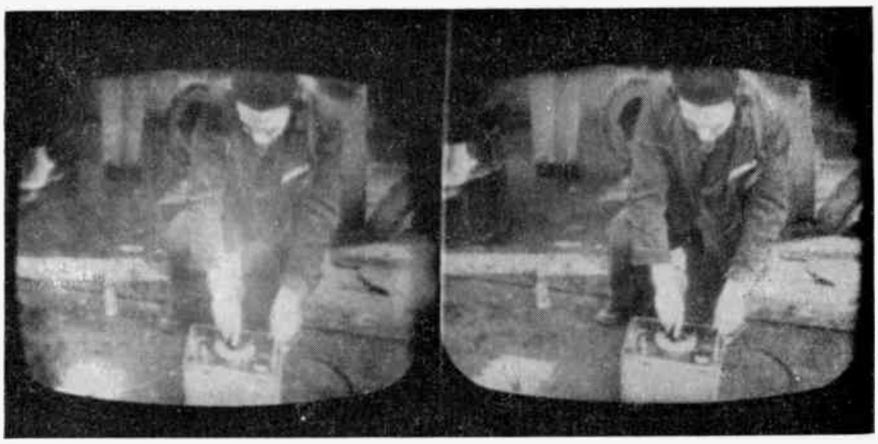


Fig. 8 (right). Picture from monitor connected direct to television camera. (left) Picture from monitor carrying read-out stored picture, 5 minutes after receiving one field from camera

(Note central area fading white due to discharging effect of positive ions)

One television line is represented in Fig. 9, as consisting of in-line rectangles approximating to one spot width, and stacked rectangles corresponding to brightness levels. A maximum of five levels (tonal gradations) is shown.

A frequency f is transmitted depending on the spacing of the elements. f_{max} is transmitted when a 'chequer board' pattern is scanned, as at the right-hand side of Fig. 9. It will be observed that one cycle of f_{max} can be considered as two 'bits', i.e. black and white, transmitted, for instance, as '0' or '1'; thus $2tW$ bits can be transmitted in a time t through a channel of bandwidth W.

However, the brightness of a picture element is conveyed by an amplitude composed of n steps of E volts, and $n =$

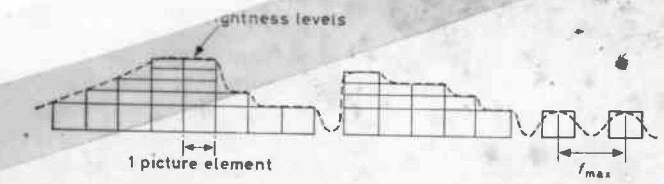


Fig. 9. Diagrammatic representation of the picture elements of a television line

$(1 + S/E)$ where S is the maximum amplitude. The number of bits representing the brightness level will thus be $\log_2(1 + S/E)$. Combining this with the number of picture elements:

$$R = 2W \log_2(1 + S/E) \text{ bits/sec} \quad \ldots\ldots\ldots (1)$$

where R = Rate of transmission*

The information capacity of a system is the number of possible 'pictures' which can be formed, when successive brightness levels are independent: i.e., when l is the number of resolvable brightness levels, and e the number of picture elements. Thus, in a 405-line picture with 377 active lines, 500 elements per line, and 100 resolvable brightness levels, the total number of alternatives is 100^{188500}, of which some minute fraction will be meaningful.

The information content of a picture (or system) is usually stated in binary digits or 'bits', and concerns the probable number of states that there will be in any picture, when successive pictures are independent.

$$H = -K \sum_{i=1}^{i=n} pi \log_2 pi \quad \ldots\ldots\ldots\ldots (2)^{27}$$

where H = Entropy of a set of probabilities

K = a constant

pi = the probability of the i^{th} state

When sending pictures through a noisy channel, the noise will limit the number of levels which can be sent. It is not difficult to visualize that well separated levels are less likely to be confounded by noise than levels with fine separation—that is the signal-to-noise ratio will be a limiting factor.

These conditions have been stated in the well-known Shannon-Hartley[28] law; for the case where the transmitter is limited by mean power and/or some arbitrarily small error:

$$C = W \log(1 + P/N) \text{ bits/sec} \quad \ldots\ldots\ldots (3)$$

where C = Channel capacity

P = R.M.S. mean power

N = R.M.S. noise power

Coding

From equation (3) it will be observed that if data is being sent at the maximum rate $2tW$, but the amplitude levels being used are below the limit, there exists the possibility that the picture or signal can be coded such that some of the information responsible for the rate limitation can be conveyed as levels. This is but one example (high level coding) of an advantage to be gained by coding; much ingenuity has gone into the derivation of codes for signal, data, and picture transmission.

By such means C can be more nearly realized, but cannot be attained due to processing imperfections such as the response of filters, shape of pulses etc.[29]. In the equation (3) it is assumed that noise is random. Often it is not; the case of dialling pulse crosstalk in telephone lines is an example. Filtering may assist in such cases[30].

One other method of coding which deserves special mention is the well-known pulse code modulation (p.c.m.), one of the most efficient which has been devised.

The waveform is sampled by pulses generated at intervals of t seconds such that $t = 1/2W$, where W is the channel bandwidth. The number of sampling levels is decided upon, and these are expressed in binary form. The binary number is transmitted as pulses and spaces. This method considerably reduces the effects of noise and other adverse characteristics in the channel[31], at the expense of the rate of transmission; the information which is conveyed is proportional to the bandwidth.

Characteristics of Telephone Lines

Considerable information exists[22,33,34], about the facilities available and the characteristics of telephone lines. The characteristics of private loop lines have been studied at the author's laboratories. Noise and interruptions were thought likely to be serious, in particular noise due to dialling impulses; in fact noise was found not to be as serious as was expected, but to vary considerably with the day and time of day. The information given by Smith *et al*[33], is the result of tests on many lines in the U.K. and Europe.

The length of bursts of interference is usually less than 1msec but long exponentially decaying bursts are occasionally encountered; intervals between bursts usually exceed 5sec. Line noise statistics—obtained by recording for long periods—are needed when the method of coding is being decided upon, as codes can be devised which combat noise other than white noise.

The Post Office telephone network is composed of a variety of circuits comprising loaded and unloaded cables, amplifiers, compandors etc.; the interconnexions and equipment on private lines between subscribers may be changed from time to time by the Post Office. While speech is only slightly affected by complex interconnecting paths, the effect on pictures could be disastrous unless precautions are taken to combat variations in attenuation and phase characteristics of the line. P.C.M. is particularly useful in this respect. The Post Office publishes regulations covering requirements for equipment to be connected to their lines, and specifies the nature of permissible signals.

Picture Transmission

During the transmission of typical entertainment pictures, the channel is being used much below its capacity for most of the time, and for only some small fraction of the time is picture detail present which is resolved at f_{max}. In the case of data pictures there are likely to be large areas containing little information.

These facts have lead to a volume of work on the possibility of reducing the bandwidth—for instance by arranging that picture information is processed and sent out at a uniform rate, instead of some times rapidly (necessitating a wide bandwidth), and sometimes slowly.

Cherry and Gouriet[35], have suggested that as most of the information in a picture is contained in edges and boundaries, which occupy only a small part of the total picture area, a variable velocity scanning system might be used such that fast scanning is employed in areas of little information, and slow scanning in areas of detail. It was found that only rarely did entertainment pictures contain detail exceeding 5 per cent of the detail requiring f_{max} to resolve it. This being so, bandwidth compression could be achieved by virtue of a reduction of the redundancy in the average picture.

Subsequently under Professor Cherry more sophisticated systems were developed[36,37,38], demonstrated[39], and are now being further developed.

* *This rate does not include 'system' information, e.g. sync.*

Based on the statistical analysis of many pictures, a method of coding has been devised whereby a detail detector controls the sampling interval at t, $3t$ or $9t$, corresponding to regions of high, medium, and low detail, where $t = 0{\cdot}166\mu$sec [$t = (1/2n)\mu$sec, the Nyquist interval for a picture where n Mc/s (in this case 3Mc/s) is required to resolve the 'chequer board' pattern]. These rates are evaluated as a 2 bit binary number, and the amplitude at the sampling point is quantized into one of 128 possible levels and evaluated as a 7 bit binary number, so that a total of 9 bits completely defines an element. The 7 bits enter a store at one of the three rates, and are extracted at the $3t$ rate. The information is then transmitted via a digital to analogue convertor as two waveforms. These 'video' and 'position' signals are supplied to the receiver, the position signal controlling variable-velocity scanning at three alternative rates. The transmitting equipment is relatively complex, but the receiver is simple. Further details of this system will be published by Cherry *et al.*

Seyler[40] has suggested that because of the inability of a viewer to respond to certain types of visual information, certain picture components could be discarded with a corresponding bandwidth reduction. Element-run coding is discussed (also by Pine[38]) which depends on the correlation between adjacent picture elements. Inter-frame coding is described, in which only 'frame difference signals' are transmitted; because successive frames often resemble each other, less information is thereby transmitted.

A critical examination was carried out[41] by the BBC to assess the merits of the 'quantized-video', the 'quantized-highs'[42] and the 'synthetic-highs'[43] systems. In the latter two systems, low-frequency components are transmitted unquantized, while high frequency components are quantized. The two components are added at the receiver. In the conclusions and discussions which followed the paper, it was thought that the net advantages of these particular systems were doubtful for entertainment pictures, but that for industrial or military use they should be feasible.

Methods of modulation, coding and transmission, of slow scanned pictures utilizing some of the principles previously outlined are being developed for the transmission of industrial and data still pictures, mainly in an endeavour to reduce the transmission time. Considerable advantages are expected with data pictures where there is usually substantial redundancy.

Having speeded up the transmission by an amount compatible with equipment complexity, given picture resolution, noise and line characteristics etc., it is likely that further measures will be required, particularly at the receiving end, to obtain pictures repeating at a fast rate, without the use of expensive receiving equipment. To this end experimental work has been carried out on the subjective assessment of the performance of modified standard monitors. Pictures repeating at intervals of from 1 to 10sec have been reproduced by using special scanning systems in conjunction with tubes having medium persistance, in order to off-set unacceptable flicker. Variations of 'Pseudo-Random Scanning'[23] have been tried with some success.

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A New Radio Telescope for Research

A new steerable radio telescope is to be built by the Ministry of Public Building and Works for the Radio Research Station of the Department of Scientific and Industrial Research. It will be erected on the site of the old Chilbolton Airfield near Stockbridge, Hampshire.

The aerial will be used by the Radio Research Station for studying radiation from the sun and radio stars, and receiving radio waves from transmitters on the earth's surface.

The bowl of the aerial will be 82½ft in diameter and have a parabolic form which has to be manufactured to very fine limits to enable research work on the 10Gc/s (3cm wavelength) range to be carried out.

The angle of inclination of the bowl will be variable through 125°—5° below the horizontal to 30° past the zenith—and the bowl will rotate full circle and beyond, 500° in azimuth. The maximum rate of elevation will be 1°/sec with an acceleration rate of 1°/sec^2; the rotation speed will be up to 3°/sec with a maximum acceleration of 2°/sec^2.

It will be possible to operate the instrument by either manual or automatic control, the latter method being by a system of punched tape and electronic gear to the power drive. Information on the aerial's actual position will be continuously fed back for comparison with the information on the tape.

The Ministry, which is responsible for the engineering of the project through all its stages from design to final commissioning, has given a contract to Associated Electrical Industries Ltd. of Trafford Park, Manchester, for the detailed design, preparation of working drawings, manufacture and erection of the radio telescope.

Gain Controlled Band-Pass Amplifiers

A New Approach Using Integrated Circuit Video Amplifiers

(Part 1)

By M. D. Wood*, M.A.

Part 1 of this article reviews the difficulties of gain controlling h.f. tuned transistor amplifiers. The particular problems associated with high Q circuits and neutralization are discussed in this context, along with the conventional methods used to overcome them. Various methods of gain control are then outlined and discussed, with specific reference to their effect on the tuning of the amplifier. A few general points about gain control are considered which may impose their own limitations on the amplifier design.

In the second part the idea of using a video amplifier with tuned input and output stages to define the band shape is introduced and developed. It is shown that the integrated circuit video amplifier which is described, not only overcomes these difficulties, but has additional advantages to offer.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 213)

PROBABLY the most undesirable feature of transistors when considered as amplifiers is the fact that they are not unilateral devices: they have internal feedback from collector to base (grounded emitter configuration will be assumed unless otherwise stated). In tuned amplifiers this has more serious implications in that any change in the load impedance is reflected back as a change in the transistor input impedance, and any change in the source impedance alters the output impedance. These input and output impedances are in parallel with, and therefore form part of, any input and output tuned circuits.

Consider the transistor grounded emitter Y-parameters:

$$[Y] = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix}$$

in conjunction with a source impedance $Y_s = g_s + jb_s$, and a load impedance $Y_L = g_L + jb_L$ as shown in the equivalent circuit, Fig. 1. If the source and load impedances are not connected, it can be shown that the transistor input and output impedances are given by:

$$Y_{IN} = Y_{11} - \frac{Y_{12}\,Y_{21}}{Y_{22}}$$

and:

$$Y_{OUT} = Y_{22} - \frac{Y_{12}\,Y_{21}}{Y_{11}}$$

However, if the source and load impedances are connected:

$$Y_{IN} = Y_{11} - \frac{Y_{12}\,Y_{21}}{Y_{22} + Y_L} \quad \text{............} \quad (1)$$

and:

$$Y_{OUT} = Y_{22} - \frac{Y_{12}\,Y_{21}}{Y_{11} + Y_s} \quad \text{...........} \quad (2)$$

from which the effect of Y_L and Y_s on the input and output impedances can be calculated.

Tuning Difficulties

These difficulties first come to light when one starts to align a tuned amplifier. Consider the synchronously tuned amplifier (all stages tuned to the centre frequency f_o) shown schematically in Fig. 2. A valve-voltmeter or other high impedance detector is connected to the output; L_2, C_2 is heavily damped and a signal generator loosely coupled (e.g. through a small capacitor) to the base of VT_3. L_3, C_3 is tuned to peak at f_o. The damping and signal generator are moved back a stage, and L_2, C_2 is tuned to f_o. In doing so, however, the source impedance to VT_3 is changed, and this is reflected through and detunes L_3, C_3 which must be re-peaked at f_o. This, however, may have slightly detuned L_2, C_2. The process, however, converges rapidly. The damping and signal generator can then be moved back a further stage, and so on. In practice one would roughly tune each stage to f_o, and then repeat the process once or twice, tuning each stage to give maximum output at f_o—Hetterscheid[1] gives a full treatment of this and other alignment procedures.

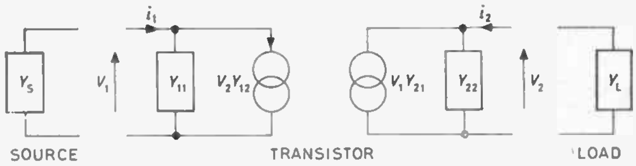


Fig. 1. Transistor Y-parameter equivalent circuit

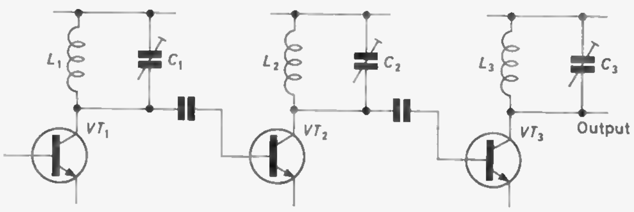


Fig. 2. Amplifier tuning arrangement

In the above process, however, nothing has been done about the damping, or Q, of the tuned circuits, and the overall bandwidth may be far from that desired. If a sweep signal generator and oscilloscope display are available, the bandwidth of a synchronously tuned amplifier is probably most easily adjusted by the cut-and-try method of changing the damping resistors on one or more of the tuned circuits until the desired bandwidth is obtained.

However, when dealing with more complicated pass-bands, involving high Q tuned circuits or stagger tuning, the above method of alignment is quite impractical. In such circuits each stage must have its designed centre frequency and Q if the desired overall band-shape is to be obtained. It is virtually impossible to arrive at this condition by a cut-and-try method if the design values have been upset by internal feedback effects. Something must be done from the design point of view to reduce or eliminate the effect of this feedback, and also to reduce the rather uncertain value of the transistor input and output impedances (these will vary with the Y-parameters from transistor to transistor).

Neutralization, Etc.

Perhaps the simplest method is to reduce the effect of the changing transistor parameters by making the damping

* *Ferranti Ltd.*

resistors sufficiently small, and the tuning capacitors sufficiently large to swamp the input and output impedances altogether. Since for a parallel tuned circuit:

$$Q = \omega_0 CR$$

the two requirements of small R and large C do not conflict as far as the circuit Q is concerned. However, a large C does mean a small inductance to resonate with it at $\omega_0 = 2\pi f_0$, and at high frequencies, especially in production, a smaller coil allows of less tolerance and winding error. In addition, a low value damping resistor is wasteful of power and hence of circuit gain.

A similar method is to mismatch[2,3] the coupling between stages: optimum power transfer occurs when the output impedance of one stage equals, or is transformed to equal, the input impedance of the next stage. If the coupling is mismatched deliberately, there is a loss of gain, but changes in the input and output impedances due to internal feedback, change of transistor, etc., have only a second order effect on the tuning.

More often than not, however, it will be considered desirable to eliminate or cancel the feedback rather than merely reduce its effect. This process is called neutralization or unilateralization[4,5,6]. Very simply, this involves feeding back from collector to base a signal of equal amplitude but opposite phase to that fed back internally. If the cancellation is exact one has unilateralization; if the cancellation is approximate, in particular when only the capacitive feedback is cancelled, one has neutralization. It is normally only necessary to neutralize.

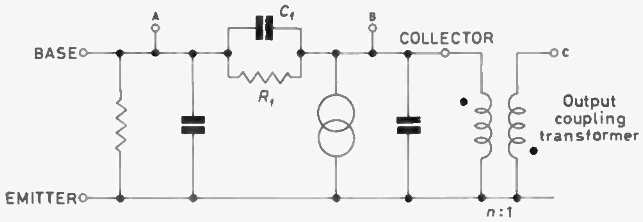


Fig. 3. Equivalent circuit illustrating internal feedback

Consider the equivalent circuit in Fig. 3. Internal feedback from collector to base takes place through R_f and C_f in parallel. Neutralization can be effected in three ways:

(1) An inductor is connected between A and B to 'tune out' C_f. R_f can be neglected because $R_f > 1/\omega C_f$. This method tends to be very frequency sensitive.

(2) A capacitor and resistor are connected in parallel between A and C. The transformer is phase reversing, and if the step down ratio is n:1, the unilateralizing components must be of value $C_n = nC_f$, $R_n = R_f/n$.

(3) A capacitor only is connected between A and C. R_f can be neglected because $R_f > 1/\omega C_f$. The capacitor must be of value $C_n = nC_f$. This method is usually a sufficiently good approximation to (2) above.

It is the third method which is most often used. Phase reversal to C_n is always necessary and can be obtained either from an interstage transformer, Fig. 4(a), or from a tapped tuned coil, Fig. 4(b).

In terms of the transistor Y-parameters (which are only valid under the quoted conditions of frequency, voltage and current):

$$Y_{12} = g_{12} + jb_{12}$$

is the reverse transfer admittance corresponding to R_f and C_f in parallel in Fig. 3. ($g_{12} = 1/R_f$ and $b_{12} = \omega C_f$). The figure which is usually quoted in data sheets is the value of C_{OB}—the output-to-base capacitance or C_f. C_{OB} varies with collector voltage but not with emitter current, and shows little change with frequency. It is this capacitance which must be neutralized. Consider again the input admittance equation:

$$Y_{IN} = Y_{11} - \frac{Y_{12}Y_{21}}{Y_{22} + Y_L} \quad \ldots\ldots\ldots\ (1)$$

If an admittance $-Y_{12}$ is connected in parallel with Y_{12} which is effectively what is done when an out of phase voltage is fed back through an admittance $+Y_{12}$, then $(Y_{12} - Y_{12}) = 0$ and the equation reduces to:

$$Y_{IN} = Y_{11}$$

In other words, the input impedance is now a constant, depending only on the transistor and its operating conditions, and is not affected by the value of the load Y_L. Similarly, Y_{OUT} becomes independent of Y_s.

When using transistors with an f_T of 500Mc/s or more, whose C_{OB} is only a few picofarads, it is often sufficient to use fixed neutralizing, or even not to neutralize at all, when working at much lower frequencies, say less than 10Mc/s. At higher frequencies or with lower frequency transistors, and especially where high Q tuned circuits are

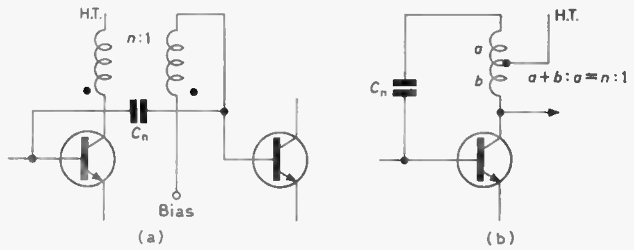


Fig. 4. Methods of neutralizing
(a) Transformer feedback (b) Tapped coil feedback

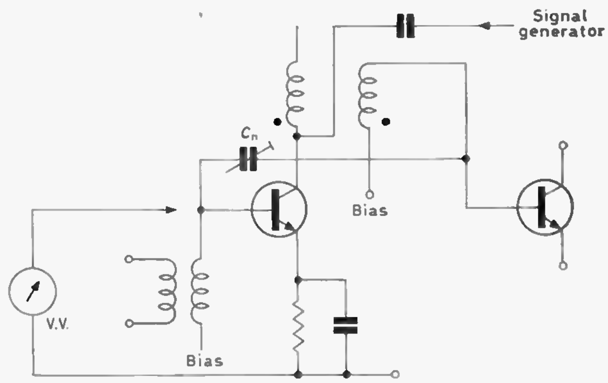


Fig. 5. Neutralizing procedure

being used, exact neutralizing will probably be necessary. With reference to Fig. 5, the procedure is as follows: with the circuit connected to its power supplies, a signal of about 0·5V r.m.s. at the operating frequency is applied via a capacitor to the collector. A sensitive valve-voltmeter or other indicating instrument is connected to the base and C_n is adjusted for minimum reading on the meter.

Neutralization, however, is never easy; if done exactly it is a complicated adjustment on every stage, while fixed neutralization is only an approximation to the average value, but may be useful if C_{OB} is small.

The Cascode Circuit

An alternative to neutralization is the cascode circuit[7] of Fig. 6. VT_1 is a grounded emitter stage, VT_2 is a grounded base stage. The (emitter) input impedance of VT_2 forms the collector load of VT_1, and because it is a very low input impedance this collector-to-emitter connexion is a gross mismatch. Accordingly any change in the load on VT_2 has very little effect on the input impedance of VT_1, and vice-versa the source impedance has little effect on VT_2 output impedance. In terms of the Y-parameters, using Y for grounded emitter and y for grounded base:

$$Y_{IN(G.B.)} = Y_{11} - \frac{Y_{12}\,Y_{21}}{Y_{22} + Y_L} \quad \dots\dots\dots\dots (2)$$

$$y_{IN(G.B.)} = y_{11} - \frac{y_{12}\,y_{21}}{y_{22} + y_L} \quad \dots\dots\dots\dots (3)$$

and therefore:

$$Y_{IN(cascode)} = Y_{11} - \frac{Y_{12}\,Y_{21}}{Y_{22} + y_{11} - \dfrac{y_{12}\,y_{21}}{y_{22} + y_L}} \quad \dots\dots\dots (4)$$

in which $Y_L = y_{IN(G.B.)}$

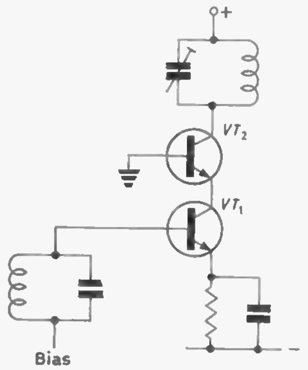
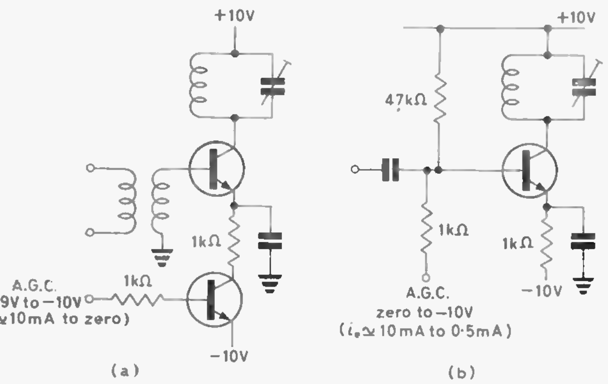


Fig. 6 (left). Cascode circuit

Fig. 7 (below). A.G.C. by varying i_e

(a) Varying emitter supply

(b) Varying base bias



From equation (4) it can be seen that any change in the load y_L on VT_2 only has a second order effect on the cascode input impedance.

Similarly:

$$Y_{OUT(cascode)} = y_{22} - \frac{y_{12}\,y_{21}}{y_{11} + Y_{22} - \dfrac{Y_{12}\,Y_{21}}{Y_{11} + Y_s}} \quad \dots\dots\dots (5)$$

The cascode circuit may be treated as a composite stage, and its Y-parameters, denoted by primed values, evaluated in terms of the individual grounded emitter or base parameters[7]. Thus:

$$[Y'] = \begin{bmatrix} Y_{11}' & Y_{12}' \\ Y_{21}' & Y_{22}' \end{bmatrix} \equiv \begin{bmatrix} Y_{11} & Y_{12}\,(y_{12}/y_{21}) \\ Y_{21} & y_{22} - \dfrac{y_{21}\,y_{12}}{y_{11} - Y_{22}} \end{bmatrix} \quad \dots\dots\dots\dots (6)$$

The value of Y_{12}' is found to be only 0·01 or 0·02 of $Y_{12(G.E.)}$. In other words, internal feedback through the cascode pair is very much less than through a single transistor, and neutralizing is not necessary.

Gain Control

So far the difficulties in fixed gain tuned amplifiers have been reviewed briefly. In considering gain controlled tuned amplifiers, the difficulties are increased because the action of varying the gain changes the transistor input and output impedances. The most common method of varying the gain (reverse a.g.c.) is to vary the d.c. emitter current and thereby to vary Y_{21}. The matched power gain of a unilateralized grounded emitter stage is given by:

$$G = \frac{|Y_{21}|^2}{4G_{11}\,G_{22}}$$

and the effect of varying Y_{21} is calculable. More simply:

$$Y_{21} = -|i_{OUT}/v_{IN}| \;\; (v_{OUT} = \text{constant}) = -g_m = (\alpha_0/r_e) \simeq (1/r_e)$$

$$r_e \simeq (26/i_e) \;\; (i_e \text{ in mA})$$

and, voltage gain $= R_L/r_e \simeq (R_L i_e/26)$ which gain is calculable.

Two simple methods of varying the emitter current are illustrated in Fig. 7(a) and 7(b).

By way of illustration, some results are given in Table 1 for the change of input and output admittance parameters with emitter current. The results are the mean of measurements taken on transistors type ZT708 (2N708) at 15Mc/s.

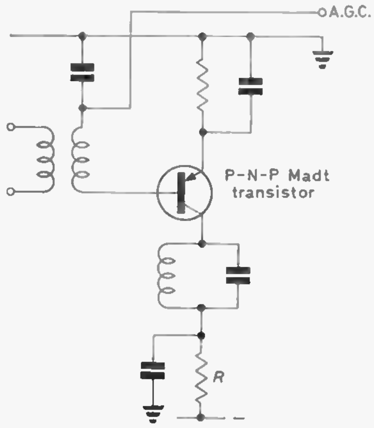


Fig. 8. (left). A.G.C. by varying VC_e

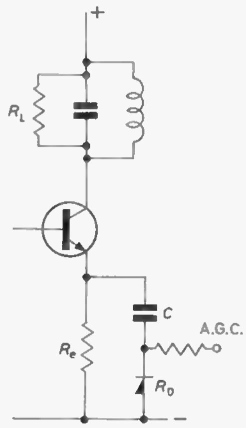


Fig. 9 (right). By variable emitter decoupling

While this is specifically a switching transistor, it was until recently one of the few v.h.f. devices readily available at reasonable cost, but it is representative of planar devices with an f_T of 300Mc/s (min).

If the transistor is neutralized, these would be the actual input and output impedances of the device, otherwise equations (1) and (2) apply. The main variation with emitter current, however, is still the change of Y_{11} and Y_{22}. The effect is two-fold: a change in centre frequency due to the change of input and output capacitance, and a change in bandwidth due to the change of input and output resistance.

The methods of overcoming these effects are the same as those used to reduce the coupling between stages when

TABLE 1

Variation on Input and Output Admittance with Emitter Current (ZT708, 15Mc/s. V_{cE} = 10V)

	i_e (mA)	0·25	0·5	1·0	5·0
Y_{11}	R (Ω)	1400	1100	830	330
	C (pF)	17	18	20	39
Y_{22}	R (Ω)	20000	8000	3300	300
	C (pF)	6	7·5	10	20

tuning, i.e. swamping the effect with a large tuning capacitance and low damping resistance, and/or mismatching. Neutralization is a help only in so far as it eliminates the coupling between tuned circuits: it is a nuisance in so far as Y_{12} may vary with the gain and hence reduce the effect of the neutralization.

Various methods have been proposed to cancel these impedance changes, e.g.:

(1) Compensation of the change of transistor input and output impedances by using a shunt diode[8] whose impedance is made to vary in an inverse manner to that of the transistor.

(2) A cascode circuit in which the current through the lower transistor only is varied[9]. This maintains the output impedance constant, but not the input impedance. This may be useful where gain control can be applied to the first stage of an amplifier with an untuned or heavily damped input circuit.

(3) A cascode circuit with a diode by-pass on the centre emitter/collector connexion[10]. This method has been found useful up to about 20dB reduction of gain, beyond which the impedance changes are significant.

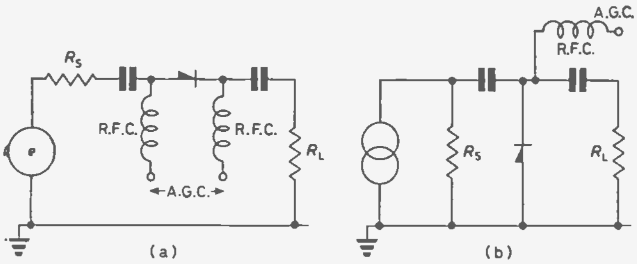


Fig. 10. A.G.C. by diode attenuators (a) series (b) shunt

Other methods of gain control are possible. For instance, on some types of transistor, particularly M.A.D.T., the gain can be varied by changing the collector-to-emitter voltage (forward a.g.c.)[11]. A typical circuit is given in Fig. 8, in which it will be seen that the total series collector-to-emitter resistance has been increased by the decoupled resistor R. When the a.g.c. bias is taken more negative, the emitter current increases, and because of the large value of R, the collector-emitter voltage is reduced. With suitable transistors the gain (expressed in decibels) decreases linearly with the collector voltage over a range of 20 to 30dB. Forward a.g.c. has no advantages over reverse a.g.c. as far as changes in impedances with gain are concerned, in fact C_{OB} varies largely with V_{CE} making neutralization impossible. However in some circumstances it does show a definite advantage as regards overload signal level, which tends to increase at lower gains, whereas the overload level decreases as i_e is decreased in reverse a.g.c.

A second method is to vary the gain by changing the a.c. rather than the d.c. condition of the amplifier. For instance, variable decoupling of the emitter resistor can be employed as in Fig. 9. The voltage gain of this circuit at band centre is given approximately by:

$$G = R_L \Big/ \left(r_e + \frac{R_e R_D}{R_e + R_D} \right)$$

Where R_D is the forward resistance of the diode, and can be varied from say 10Ω to 10kΩ by the bias, leading to a gain control range of 30dB or more. Again, there is no advantage as regards change of impedances with gain: input and output impedances vary with the unbypassed emitter resistor in a complex manner.

As a passing note of interest, it has been found that a small unbypassed emitter resistor of 10 to 33Ω only reduces the gain by a few decibels, but does appreciably increase the transistor input impedance. This can be useful in reducing the effect of further changes of input impedance as the gain is varied

A third method, which will be returned to in Part 2 is to use a diode or transistor as a variable attenuator between stages[12]. The diode a.c. resistance is varied by the d.c. passing through it. Figs. 10(a) and 10(b) illustrate series and shunt diode attenuators respectively. A series attenuator is most effective with a low load and a low (voltage) source impedance, while the shunt attenuator is most effective with a high load and a high (current) source impedance.

When gain controlling transistors various general points must be borne in mind:

(1) The a.c. signal which appears across the gain controlling element should never be greater than 10 to 20mV, preferably less. This is because the element has a curved characteristic, i.e. a slope resistance which is varied by the d.c. through it (or the d.c. voltage across it). If the a.c. signal is too large, the slope resistance will vary through the sine wave cycle applied to it and produce distortion, harmonics, and in extreme cases limiting or biasing-off. This applies equally whether the element is the r_e or Y_{21} of a transistor, or any form of diode circuit.

(2) This determines which stages cannot be gain controlled, e.g. output or pre-output stages with large signal inputs.

(3) If a stage is required to give a certain output voltage across its load resistor, then if the current through that stage is reduced to decrease its gain at large input levels, there may be insufficient current to develop the required output voltage. In practice this again means no a.g.c. on output or high signal level stages.

(4) If the gain of an input stage is reduced to near or less than unity, the noise generated in the second stage will be added to that of the first stage. This means no a.g.c. on low noise input stages unless the control is delayed until the signal-to-noise ratio is large enough that amplifier noise is no longer significant.

(5) In some situations where a large a.g.c. range is required it may be necessary to introduce additional stages with a maximum gain of little more than unity. These may be controlled to give a gain of perhaps −20dB, (i.e. an attenuation) in order not to overload any of the controlled stages, and can then be followed by fixed gain stages to give the required output.

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(To be continued)

A Wide-Range Audio-Frequency Pulse Modulator

By M. E. Bryan*, B.Eng., Ph.D., and W. Tempest†, B.Sc., Ph.D.

A two-channel audio frequency pulse modulator is described in detail. Each channel will modulate an audio frequency signal to provide a pulse of 0·5msec to 5sec length in either of two envelope shapes; the rise and fall times of the pulse are independently variable in the range of 0·3msec to 100msec. The level of hum, noise, and harmonic distortion in the pulse and in the period between pulses is more than 50dB below the pulse level. The two channels can be used to provide an A-B-A-B- ...... sequence of pulses in which the characteristics of pulses A and B are independently variable.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

ONE of the techniques used in the study of the human ear is to determine the subjective response to pulsed tones. In work of this kind there are two basic types of experiment.

The first type is one in which the subject is asked to state whether a particular pulse, or a certain feature of a pulse, is audible or not. An example of this experiment is the determination of the threshold of hearing in which the subject states whether or not he can hear a pulsed tone whose intensity is being varied from pulse to pulse. From the listener's replies the minimum audible sound pressure, under the particular conditions of the experiment, can be deduced.

The second type of experiment presents the subject with two stimuli and asks him to state whether they are identical in all respects, or possibly whether they are similar in some particular such as loudness. An example of this type of experiment is the determination of the loudness level of a sound in which the subject is presented with the test sound and a standard 1 000c/s tone; the relative intensities of the sounds are varied and at each stage the subject states which is louder. When the two sounds are adjudged equally loud the loudness level of the sound in phons is equal to the intensity of the 1 000c/s tone (measured in decibels above a sound pressure of 0·0002 dyne/cm^2).

Extensions of the work outlined above include experiments on the audibility of pulsed tones as a function of frequency, harmonic content, pulse duration, rise and fall time, and pulse shape, and in the course of such work a requirement arose for a flexible pulse modulator to provide audio frequency pulses of the required types.

The aim of the design was to cover as wide a range of uses as possible and the specification chosen is set out below.

Frequency range	50c/s to 15kc/s
Pulse length	0·5msec to 5sec
Pulse interval	0·1sec to 10sec
Rise and fall	0·3msec to 100msec (rise and fall to be independently variable)
Pulse shapes	natural' and 'smoothed', see Fig. 1
Hum and noise	more than 50dB below pulse level
Signal between pulses	more than 50dB below pulse level
Harmonic distortion	more than 50dB below pulse level

It was also necessary that the modulator should be able to supply a series of pulses in the form *A-B-A-B* where the characteristics of pulses *A* and *B* can be independently controlled.

With reference to the pulse shapes the term 'natural' is used to describe a pulse of the envelope shown in

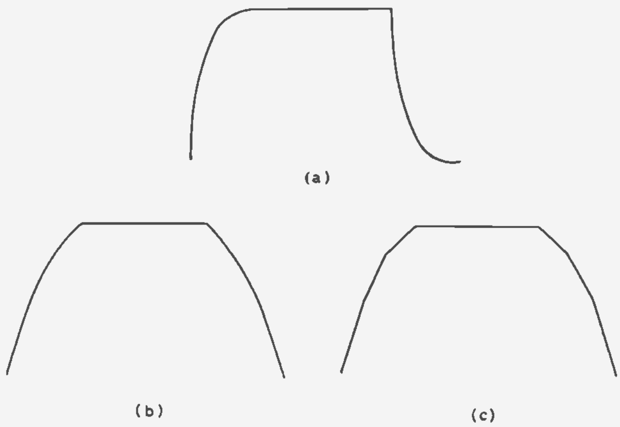

Fig. 1(a). 'Natural' pulse shape measured
(b). 'Smooth' pulse shape measured
(c). 'Smooth' pulse shape calculated

Fig. 1(a) and corresponds approximately to the shape produced when a rectangular pulse is passed through a single tuned circuit band-pass filter; in this case, however, there is the added requirement that the rise and fall times should be independently variable. The 'smoothed' shape shown in Fig. 1(b) is an arbitrarily chosen shape in which the rate of rise of the leading edge of the pulse is halved at equal intervals of time, the trailing edge of the pulse being the inverse of this. The calculated pulse shape is shown in Fig. 1(c) together with the rather smoother measured shape in Fig. 1(b), the difference between Figs. 1(c) and 1(b) is due to the non-ideal characteristic of the diodes used in the shaping networks.

Schematic of the Design

A schematic of the whole circuit is shown in Fig. 2. The pulse interval generator produces pulses at an interval variable from 0·1 to 10sec and these are used to trigger the bistable circuit which delivers alternate triggering pulses to the two identical pulse length generators. The pulse length generators produce gates of length 0·5msec to 5sec which are each fed into a pair of shaping circuits. In the 'smoothed' shaping circuit the gate is integrated into a trapezium with the rise and fall rates independently adjustable and the trapezium is then smoothed by a four diode shaping network to the shape shown in Fig. 1(b).

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In the 'natural' section of the shaper the input gate is used to simultaneously turn on and off a pair of complementary transistors which alternately charge and dis-discharge a capacitor through two variable resistors; in this way the shape shown in Fig. 1(a) is obtained, and since the charge and discharge paths are different the rise and fall times are independently variable.

The modulator has a linear characteristic and modulates the audio frequency input to the pulse shape provided by the previous stages. The filter is of the feedback parallel-T type and has a half-power bandwidth of 0·6 octave. It serves to 'clean up' the signal by reducing noise, harmonic distortion, and any transients introduced by unbalance in the modulator.

Practical Circuit

The complete circuit of the pulse modulation system is shown in Fig. 3; the circuit of the power supplies is shown in Fig. 4. Since the two channels are identical only one is shown.

Power Supplies

The power supplies are conventional and provide stabilized lines at $-7{\cdot}5$, $-6{\cdot}3$ and $+6{\cdot}3$V, it was found necessary to provide independently stabilized positive lines for each pulse length generator and for each modulator in order to avoid troublesome interactions.

Pulse Interval Generator

The pulse interval generator consists of a direct coupled integrator ($VT_2 - VT_5$) connected to a Schmitt trigger circuit (VT_6 and VT_7). The output of the trigger circuit is amplified by VT_1 and returned to the input of the integrator. In operation the output from the integrator (at the collector of VT_3) rises linearly with time until the Schmitt trigger operates; at this point the input to the integrator (the collector of VT_1) changes polarity and the integrator output then falls linearly until the trigger circuit operates a second time and the circuit is returned to its original condition. Thus the integrator will generate a triangle waveform at the collector of VT_3 while a square wave is produced at the collector of VT_1. The period of the oscillation is about 1·4 (R_iC_i) where R_iC_i is the integrating time-constant. With the component values shown the period is variable between 0·1sec and 10sec by the controls S_1 and RV_1. The preset potentiometer RV_2 controls the operating levels of the trigger circuit.

The emitter-follower VT_8 provides a low impedance signal from the pulse interval generator to trigger the bistable (VT_9 and VT_{10}). The two further emitter-followers VT_{11} and VT_{12} provide low impedance outputs from the bistable to operate the pulse length generators.

The Pulse Length Generators

The pulse length generator ($VT_{13} - VT_{17}$) is of the self gating 'Miller' type in which the time interval is controlled by a linear rundown. It is similar to that described elsewhere[1] with the addition of the two emitter-followers VT_{16} and VT_{17}. VT_{16} increases the input impedance of the transistor VT_{15} and therefore permits the use of a larger timing resistor. VT_{17} reduces the flyback time of the circuit and, since any variability in the fly back will alter the timing period, improves the stability. The controls S_3 and RV_8 provide a continuous range of pulse length from 0·5msec to 5sec. The negative gate is available at the emitter of VT_{13} to operate the shaping circuits.

Pulse Shaping Circuit (a) 'Natural'

The negative gate at the emitter of VT_{13} is amplified and inverted by VT_{18} and applied to the bases of a pair of complementary silicon transistors VT_{19} and VT_{20}. The bias and drive impedance levels of these two transistors are chosen so that each transistor switches between cut-off and bottomed conditions and they therefore operate as switches connecting the capacitor C_n alternately to potentials of $-3{\cdot}2$ and $-6{\cdot}3$V via the variable resistors RV_4 and RV_5 respectively. The resulting waveform across C_n is as shown in Fig. 1(a), the rise depending on the setting of RV_4 and the fall time on RV_5. Any resistive loading of C_n will affect the level of the pulse across this capacitor and it was, therefore, necessary to follow C_n by a double emitter-follower (VT_{21} and VT_{22}) to minimize this loading. The network between VT_{22} and VT_{23} allows both the amplitude and d.c. level of the pulse to be independently adjusted and the latter emitter-follower reduces the impedance to a value low enough to operate the modulator.

Pulse Shaping Circuit (b) 'Smoothed'

The transistors $VT_{24} - VT_{26}$ amplify the input from the pulse length generator and provide a gate of 12V amplitude with equal positive and negative excursions. This gate is then applied to the integrator ($VT_{27} - VT_{28}$) through the variable resistors RV_8 and RV_9, the silicon diodes in series with RV_8 and RV_9 respectively make the former operative when the input gate is positive and the latter

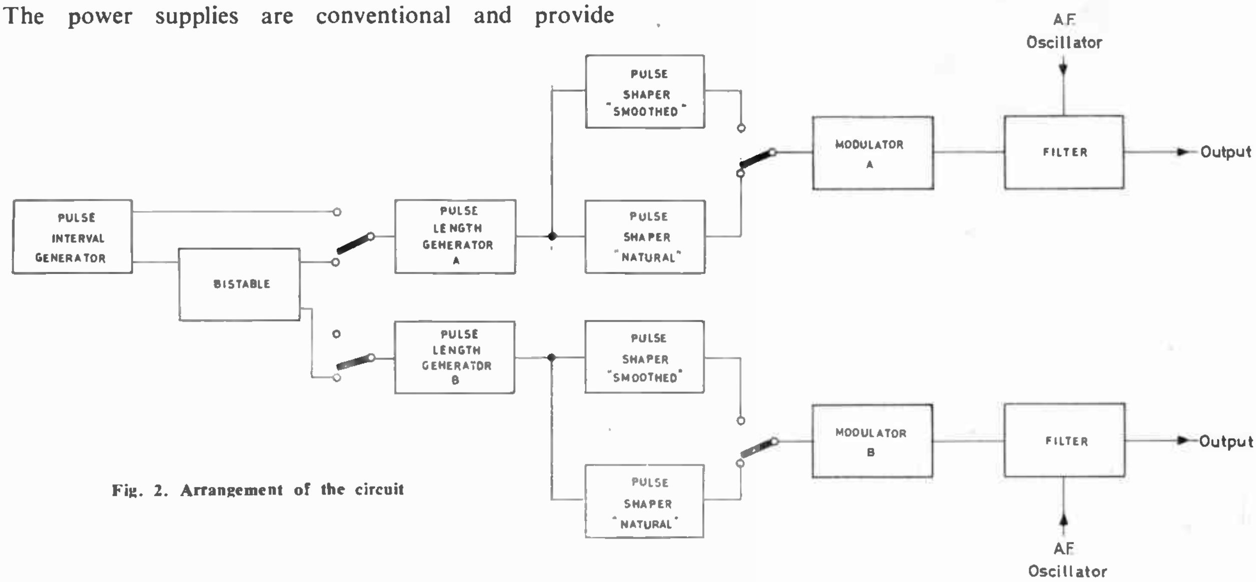

Fig. 2. Arrangement of the circuit

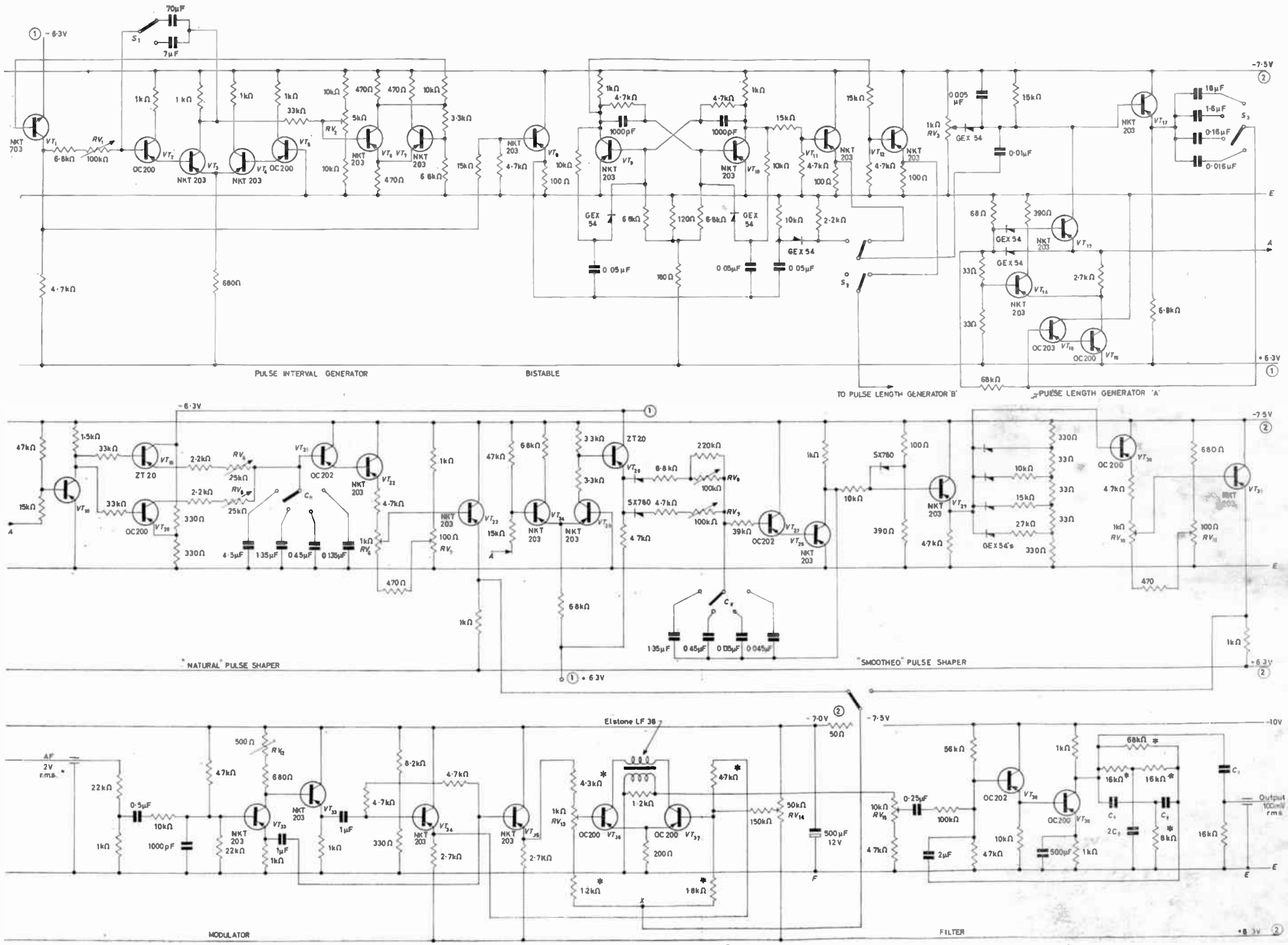

Fig. 3. Complete circuit of two-channel pulse modulator

** High stability carbon. All timing capacitors and capacitors of the twin-T bridge in the filter are 1 per cent tolerance*

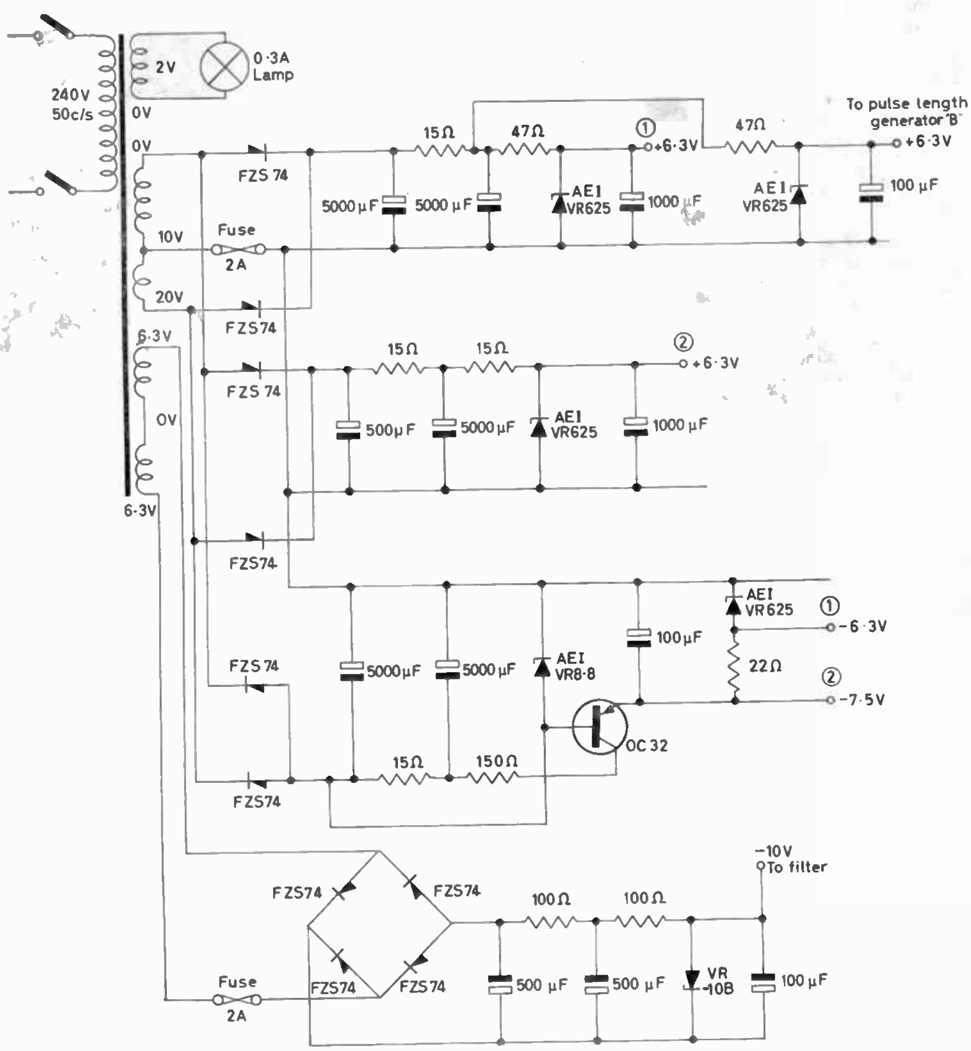

Fig. 4. The power supplies

when it is negative. The output from the integrator is in the form of a trapezium, the rise rate depending on RV_8 and C_8 while the fall rate is controlled by RV_9 and C_8. The trapezium waveform is then limited to remove the spike on its negative level produced by the negative-going edge of the input gate and is shaped by the four-diode limiter. This shaper is designed to halve the slope of the rising voltage as each successive diode conducts, the levels being such that this occurs at equal intervals of time; the fourth diode serves as a second limiter on the maximum level of the signal. Fig. 1(b) shows the waveform at the output of the shaper, since the levels at which successive diodes conduct are only 0·3V apart the curvature of their characteristics effectively smooths out the pulse shape. The transistors VT_{30} and VT_{31} with the associated resistive network match the shaped pulse to the modulator and allow for adjustment of its amplitude and bias level.

The Modulator

The main requirements of the modulator are that it should provide an audio-frequency output with sufficiently low harmonic distortion, and that the ratio of maximum to minimum output should be at least 50dB. It is also necessary that the balance of the modulator should be good enough to avoid any audible gating transients in the output which could arise if the output pulse were not symmetrical. In contrast to these fairly stringent requirements a departure from linearity of up to say 10 per cent in the modulation characteristic would be tolerable.

In the development of the modulator circuit it was found that the operating conditions of the modulating transistors were quite critical if an optimum performance was to be obtained. In particular the two requirements of minimum distortion of the audio frequency signal, and good balance stability were to some extent exclusive since the former demanded small signal levels while the latter required as large a signal as possible. The final design was quite adequate as regards distortion, but the balance of the modulator was found to drift slightly from day to day in use. For this reason a band-pass filter was added to the system to effectively eliminate any transients arising in the modulator, and also to reduce the magnitude of any hum, noise and harmonic distortion.

In the modulator the transistors $VT_{32} - VT_{35}$ provide two audio-frequency signals of equal amplitude and opposite phase which are applied via resistive networks to the bases of the output transistors VT_{36} and VT_{37}. VT_{36} and VT_{37} are a selected pair of silicon transistors chosen for equal collector current at a fixed emitter-base voltage which corresponds to the conditions existing in the modulator. The modulating pulses are also applied to the bases of the output transistors through the resistive network. The two preset potentiometers RV_{13} and RV_{14} permit an exact adjustment of the relative amplitude and d.c. level of the pulses at the bases of the output transistors and in this way allow the balance of the circuit to be adjusted.

The audio frequency signals are of 60mV r.m.s. amplitude at the inputs to the resistive network and the modulating pulse required to vary the output from zero to 400mV is about 0·5V (measured at the point x on Fig. 3). As the modulating voltage is varied over this range the gain of the output stage changes approximately linearly with modulating voltage. Fig. 5 shows the modulator output, measured as a function of modulating voltage at point x in the circuit, it is clear that in the region up to 400mV output the operation is linear except for slight curvature at very small inputs.

The performance of the modulator was entirely satisfactory in all aspects except the stability of the output stage balance, where it was found that occasional adjustment of the balance controls (RV_{11} and RV_{12}) was needed to maintain a pulse showing no visible unbalance on a

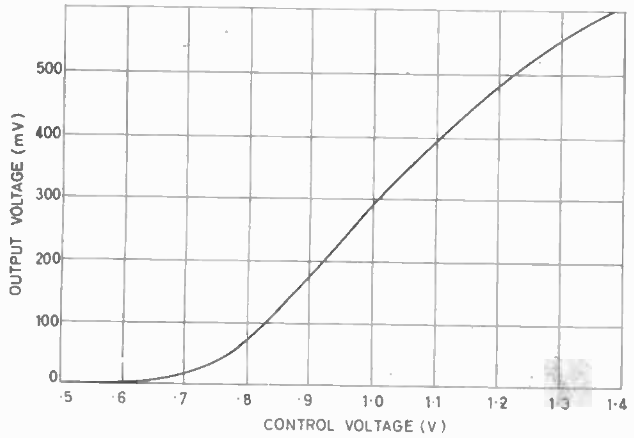

Fig. 5. The modulator output

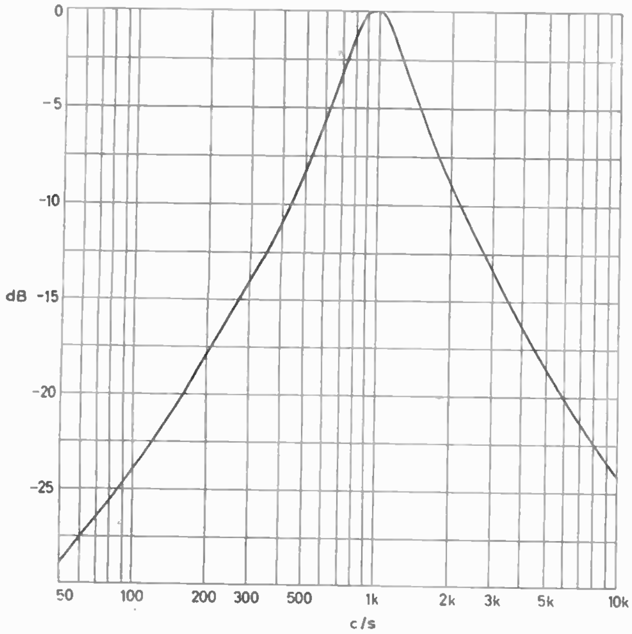

Fig. 6. Filter response

cathode-ray oscilloscope. Since the audible effect of unbalance transients was not known it was necessary to eliminate them. Experimental work on the modulator itself showed that the effects of drift on balance could only be reduced by increasing the signals to a level at which non-linearities became excessive, or (possibly) by mounting part of the circuit in a temperature controlled enclosure.

It was, therefore, decided that the best way to eliminate the effects of the drift was to filter the output to remove any transients present. This was at first achieved using standard octave and 1/3 octave filters but in view of the large bulk (and cost) of such filters a simple band-pass filter of 0·6 octave bandwidth was added to the system.

The Filter

The filter is of the feedback parallel-T type, with a damping resistor, across the parallel-T to increase the bandwidth. In its simplest form a filter of this type has a skewed band-pass characteristic, but the addition of a simple high-pass *RC* network to follow the main filter produces an overall response which is symmetrical for a decade on each side of the peak. The measured response of the filter in the 1 000c/s position is shown in Fig. 6.

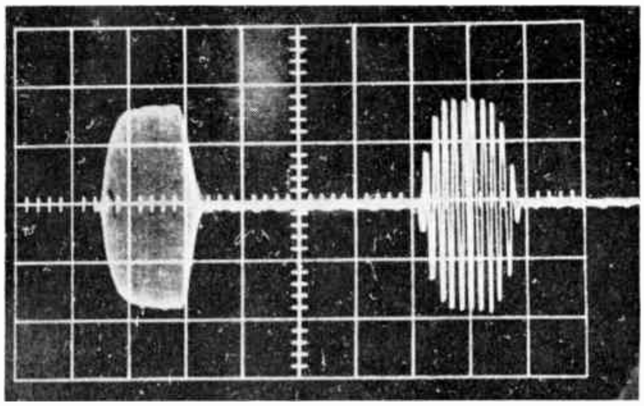

Fig. 7. Photograph of cathode-ray oscilloscope trace of modulator outpot on two-channel operation. Chaonel A provides a 'natural' pulse of 2 000c/s and channel B a 'smoothed' pulse of 125c/s

The values of the switched capacitors C_t which control the band-pass frequency of the filter may be calculated from

$$C_t = 12{\cdot}5/f \quad \text{in microfarads}$$

where f is the frequency of maximum gain.

Construction

The complete two channel modulator was built in two units. The first contains the pulse interval generator, the bistable, two pulse length generators, and one set of pulse shaping and modulating circuits, while the other unit contains a pulse interval generator, a pulse length generator, and a set of pulse shaping and modulating circuits. In this way each unit can be used independently as a single channel pulse modulator, or the two can be connected together for two channel operation. In this latter case the pulse interval and pulse length generators of the second unit are inoperative. The band-pass filters were built as separate units.

In the construction of the units the only feature of the layout which was critical was the positioning of the output transformers, which had to be orientated to minimize hum pick-up from power transformer fields.

Conclusions

The overall performance of the modulator without the filter corresponds closely to the original specification; the figures for the noise levels etc. are set out below,

	(measured at 1 000c/s)
Total hum and noise	66dB below pulse level.
Signal between pulses	60dB below pulse level.
Total harmonic distortion	0·3 per cent or 50dB below pulse level.

The overall frequency response was flat within 3dB from 50c/s to 18kc/s.

The overall stability was such that, after a warming up period of at least 10min, the output level did not drift by more than 1dB and the pulse length and pulse interval did not vary by more than 5 per cent.

To illustrate the operation of the circuit Fig. 7 shows the sum of the pulses from the two channels photographed on the cathode-ray oscilloscope. In Fig. 7 channel A was providing a 'natural' pulse at 2kc/s and channel B a 'smoothed' pulse at 125c/s.

REFERENCE

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A General-Purpose Phase-Sensitive Detector

By E. A. Faulkner*, M.A., Ph.D., and R. H. O. Stannett*

This phase-sensitive detector has been developed in the form of a general-purpose laboratory instrument, intended particularly for use in reducing the bandwidth in measurements involving modulation techniques. The response is 'flat' from 10c/s to 100kc/s without adjustment, d.c. drift has been reduced to a very low level, and the performance is good enough to enable the instrument to be used in conjunction with an untuned amplifier in typical applications.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

THE phase-sensitive detector is being used to an increasing extent in the laboratory as a means of improving signal-to-noise ratio by reducing the bandwidth in measurements involving modulation techniques. The modulation frequencies range from 10c/s for infra-red spectrometers employing thermal detectors to 100kc/s for electron spin resonance spectrometers.

Basically the phase-sensitive detector consists of a two-way switch operated by a reference voltage obtained from the modulation oscillator (Fig. 1). Let the reference voltage be represented by $V_r \sin \omega t$; then if the signal voltage contains an 'in-phase' component $V_s \sin \omega t$ the switching action gives full-wave rectification of this component and a d.c. voltage proportional to V_s will appear at the output terminals. Components of the signal input at other frequencies (apart from harmonics of ω) will give at the output terminals an a.c. voltage at the difference frequency; thus the response of the system to noise in the signal will depend on the time-constant T of the d.c. measuring device, and the phase-sensitive detector acts as a selective rectifier of noise bandwidth $1/T$. If the third and higher odd harmonics are not excluded from the signal, they will give rise to additional voltages at the output which in the case of a flat noise spectrum will reduce the output signal-to-noise ratio by about 1dB.

Mathematically, the operation performed by the phase-sensitive detector corresponds to multiplying the signal by a square-wave: that is, by a function $Kf_2(t)$ where K is a constant and:

$$f_2(t) = \sin \omega t + \tfrac{1}{3} \sin 3\omega t + \dots$$

so that if the signal input voltage is $V_1 f_1(t)$ the output is:

$$V_{out} = KV_1 \int_0^T f_1 f_2 dt.$$

Thus the phase-sensitive detector performs a Fourier analysis of $f_1(t)$ and extracts the component corresponding to $\sin \omega t$ (and, with less sensitivity, to its odd harmonics).

It is not essential for the switching circuit to be double-ended as in Fig. 1; the required operation may be performed by a single-pole on-off switch connected to a single load resistor. In this case the effective integrating time is reduced to $T/2$ with a consequent deterioration of 3dB in the output signal-to-noise ratio.

Design Considerations

In an actual phase-sensitive detector the rejection of out-of-phase voltages will be less than the ideal, because of three factors:

(a) Imperfections in the switching action, particularly those which result in the switching action being not quite independent of the input signal.

(b) Non-linearity in the switching circuit when the switch is 'on'.

(c) D.C. drift at the output.

Factors (a) and (b) result not only in excess (a.c.) noise voltages at the output but also in a non-linear relation between the d.c. output voltage and the in-phase component of the signal input; even in the absence of an in-phase component in the signal input there may be a d.c. output voltage whose magnitude is dependent on the noise level.

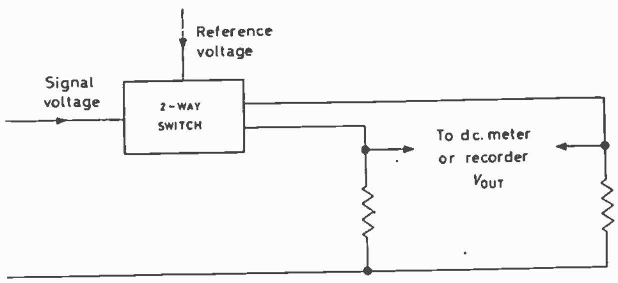

Fig. 1. Operation of a phase-sensitive detector

Although these effects can in principle be reduced by reducing the magnitude of the signal input voltage, the existence of d.c. drift at the output sets a lower limit to the signal input that can be used, below which the signal-to-drift ratio at the output becomes unacceptably poor. The traditional method of dealing with faults in the operation of the phase-sensitive detector is to present it with as good a signal-to-noise ratio as possible at the input, by the use of a selective signal amplifier. However, this is an undesirable procedure, partly because of the difficulty of obtaining satisfactory narrow-band amplifiers in the audio-frequency range, but mainly because it destroys the essentially 'lock-in' nature of the narrow-band system (the term 'lock-in' implies a selective system whose frequency response is always locked to the modulation frequency) and makes it necessary to provide a modulation oscillator of high stability. When considering the effect of frequency drifts it is necessary to bear in mind that although the rate of change of gain with respect to frequency is zero at the centre of the pass-band of a tuned amplifier, the rate of change of phase-shift with respect to frequency has its maximum value at this point.

Circuit Details

In this article a phase-sensitive detector is described which was developed as a general-purpose laboratory instrument for use in the frequency range 10c/s to 100kc/s without adjustment of any kind. A good deal of development work was put into the circuit with the aim of giving it a good enough performance to enable it to be used, in typical applications, in conjunction with an untuned

* *J. J. Thomson Laboratory, University of Reading.*

amplifier without loss of overall performance. After experiments with diodes and transistors it was decided to use triode valves as the switching elements; the final circuit is shown in Fig. 2.

It will be seen that the mixing circuit is similar in layout to that described by Schuster[1]. However, the method of operation is different because the switching valves V_{2B} and V_{3B} act as cathode-followers in the positive-going half of the grid cycle, so that grid current does not flow at any part of the cycle. A triode rather than a pentode is used as the signal valve V_{1B}; the negative feedback from the cathode load provides the requisite high output impedance, stabilizes the d.c. component of the current through the valve, and linearizes the response to signal is obtained. The designed maximum output is $-1{\cdot}0$V $\pm$ 0·5V at each terminal, out of a linear resistance of 1kΩ; thus the balanced (double-ended) output is $\pm$ 1·0V out of a resistance of 2kΩ.

No provision is made in the circuit for adjustment of the reference phase. A simple phase-shift network is suitable only for sinusoidal reference voltages, which are the exception rather than the rule; and because of the absence of phase-shift in the circuit itself, phase adjustments are unnecessary in many applications provided that the signal amplifier does not introduce a phase-shift into the system. In optical applications employing a chopped beam, the reference phase is usually adjusted by altering the position of the reference photocell.

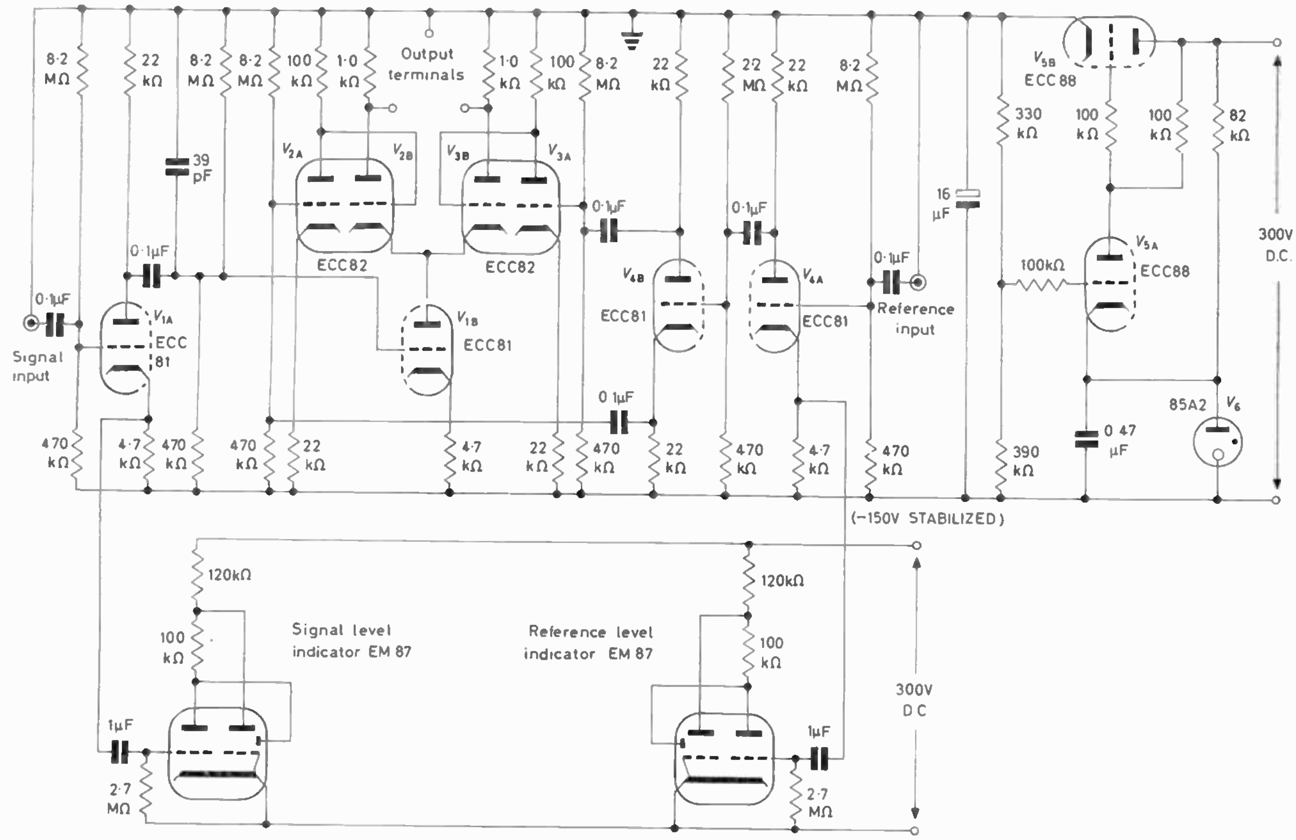

Fig. 2. The complete instrument

voltages. Care has been taken to ensure that the operation is not critically dependent on component values or valve characteristics; the circuit is assembled with ordinary 5 per cent resistors (apart from the output resistors which are selected to be equal within 1 per cent) and without selection of valves, and there are no controls or pre-set adjustments.

The reference input is 6V peak-to-peak sine or square wave, the correct level being shown by an indicator tube on the front panel. The level is not critical, the shift in the output voltage due to a 20 per cent change in the reference voltage being about 1 per cent of full scale. The maximum input signal level is also 6V peak-to-peak, and overloading is shown by another indicator tube on the front panel. There is negligible phase-shift between the signal channel and the reference channel over the whole frequency range, so the instrument can be tested simply by connecting the signal input terminal and the reference input terminal together to a signal generator giving 6V peak-to-peak, under which conditions a full-scale output

It has also been found best not to include any integrating circuits for the d.c. output. In some applications it is sufficient to connect a capacitor across each output resistor; low-voltage electrolytic capacitors are suitable because both output terminals are always slightly negative with respect to earth. (When the instrument is used to drive a pen recorder a resistor of the order of 100Ω is usually connected across the output terminals to lower the output voltage and impedance to optimum values, and the required value of integrating capacitor will depend on the value of this resistor.) However, in many applications it is important to filter out the reference frequency from the output, while still keeping a reasonably short response time; this is particularly the case when a low modulation frequency is used, also when a potentiometric pen recorder is being used in conjunction with a modulation frequency which is near to the chopping frequency of the recorder or to a harmonic of it. In these cases a multiple-stage *RC* filter is needed which must be carefully designed in relation to its particular function.

Performance

Linearity

No departure from linearity between d.c. output and in-phase signal input (up to the specified maximum input of 6V peak-to-peak) could be detected with the measuring equipment available, and this put an upper limit of 1 per cent on any non-linearity. Intermodulation measurements indicate that the true figure may be about ten times better than this.

Rejection of Out-of-Phase Voltages

In order to measure this parameter, a reference voltage of the correct value is supplied by one signal generator and the signal voltage is supplied by another signal generator whose frequency differs from that of the first by 20 per cent. The signal amplitude is adjusted to the level (in this case 3V peak-to-peak) which would be sufficient to give a half-scale output in the case of an in-phase signal. The ratio of the resulting d.c. output to the half-scale output is a measure of the out-of-phase rejection.

A typical figure for this rejection factor is 200 for single-ended operation. Although this figure has been found to be adequate in use, it can be considerably improved by selection of valves, etc.

D.C. Drift

The residual unbalance in a typical instrument is 40mV, equivalent to 2 per cent of full-scale balanced output. Typical values of drift are 0·25 per cent of full-scale per hour after a warm-up time of 1min, and 0·05 per cent per hour subsequently. Since these figures are well within the zero adjustment range of a d.c. meter, no zero control is fitted to the instrument.

Frequency Response

The instrument shows no significant deterioration in performance over the frequency range of 10c/s to 100kc/s. The lower limit is set by the time-constants of the coupling circuits and can easily be extended, but at the upper end the oscillograph shows that the switching waveform begins to deteriorate because of valve capacitances, and at 150kc/s overloading begins at a signal level of about 3V peak-to-peak, compared with over 6V in the specified frequency range.

Conclusion

These instruments have proved very useful in this laboratory over the past twelve months. Although most of them are used in optical and magnetic resonance spectrometers of various kinds, they have also been used in a.c. measurements of Hall effect, in measurements of contact potential by the vibrating-capacitor technique, and in experimental work at radio and microwave frequencies. They have also been used as phase discriminators in a.c. servo systems (in which application, since voltage output is usually more important than linearity, the output resistors are increased to 10kΩ). But the most important effect of the introduction of these instruments has been that the phase sensitive detector has come to be regarded as a normal and easily available piece of laboratory equipment, and this has resulted in greater scope in the design of research apparatus. The mixing circuit, which is the subject of British Patent Application 10128/63, is being used in a commercially available instrument.

REFERENCE

1. Schuster, N. A. A Phase Sensitive Detector Circuit Having High Balance Stability. *Rev. Sci. Instrum.* 22, 254 (1951).

An Alpha-Numeric Display System

With work output increasing and equipment becoming more complex, the closest possible supervision of industrial processes is vital. With this in mind AEI has developed a high speed method of data presentation known as the Alpha-Numeric Display Type '1200'. It enables operating data transmitted at high speed from many points in a plant or installation to be instantly presented by a versatile, easy-to-read system of character display on a cathode-ray tube.

The type '1200' display is built up of a series of alphabetical, numerical or special characters positioned according to instructions from a 64 × 64 address core store. This defines the scope of the system—namely, that a maximum of 4096 characters and random spaces may be displayed within a format on the c.r.t. of 90 characters or spaces horizontally, and 64 lines vertically. Presentation of information in terms of letters and figures is ideal for most known applications.

In many industries it is desirable to keep instrumentation displays as compact as possible. For example, in the power generation field unit control desks are often over 40ft long and it is difficult for an operator to supervise effectively the operation of the plant under his control. And in the design of large panels it is often necessary to compromise with the grouping of instruments, thereby losing valuable comparative information because an operator cannot readily observe a number of related instruments simultaneously. The type '1200' overcomes this difficulty by a variant in its display in the form of a bar graph.

The ordinary pointer instrument with which present day control desks are equipped has a two-fold purpose. It gives an indication of the numerical value of the quantity being measured and the position of a pointer—in relation to the end of a scale—quickly provides an approximate indication of a value without having to read the value itself. Both these properties must be reproduced by a c.r.t. display if pointer instruments are to be replaced.

The type '1200' does this. The format of the display is such that legends or codes appear at the left of the tube in column form, each followed by the associated numerical value. Occupying most of the tube face is a series of bars whose lengths are analogues of the numerical values. These bars start from the same position on any one line and, in the simplest case, the full-scale lengths represent the full-scale values measurable by the individual plant transducers. Such a display produces a characteristic pattern on the tube face which an operator will recognize without having to read actual numerical values.

Another simplified pattern for an operator to work from can be created by making all analogue bar lines of the same length when quantities are at their normal steady-state values. A departure from the pattern could be easily recognized and reference to numerical values would allow action to be taken.

Again, another pattern can be included where, when the value of a particular quantity falls outside specified limits, the numerical indication is shifted to one side to attract an operator's attention.

In basic form the system consists of a cubicle containing a core store, character-generating circuits, some organizational equipment and a display console. The electronic cubicle can be used to drive more than one display tube, all showing the same information or each displaying smaller amounts of different information.

The basic application of the equipment is to display on a single tube the values of a number of variables in tabular form. Up to about 250 indications and readings—together with identifying legends—can be displayed on the 21in tube.

A number of variants can be derived from the basic display:

(1) The same display can be repeated on a number of other display tubes situated around an installation. Sometimes, however, this could result in a number of display positions receiving unwanted information.

(2) Another arrangement divides the display between a number of tubes in various positions so that the operator at each position will see the data which concerns him alone.

(3) Yet another arrangement is where the display can be divided into a number of sections but, instead of displaying the whole of the available information continuously, only one tube is used. Each section of the display can be shown on the tube by switching methods, and the tube can have repeaters elsewhere in the installation.

Regulator Elements Using Transistors

By J. W. McPherson*, B.Sc., A.M.I.E.E.

This article discusses some of the shortcomings of the paralleled transistor approach to the design of high power regulator elements and discloses some new circuit arrangements which can result in the use of fewer power transistors, smaller heat sinks and reduced standing losses.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

TRANSISTORS are frequently used as regulators for the control of voltage or current in stabilized power supplies and in many such applications the power which the regulator elements may be called upon to handle may be considerably in excess of the ratings of individual transistors. In such circumstances the usual technique is to use a number of transistors in parallel to obtain the necessary power rating. Due to the variation of characteristics of individual transistors it is necessary to take some action to ensure that each transistor carries approximately the same current. This action could be the matching of transistors or the inclusion in the emitter leads of small resistances as shown in Fig. 1. The first course,

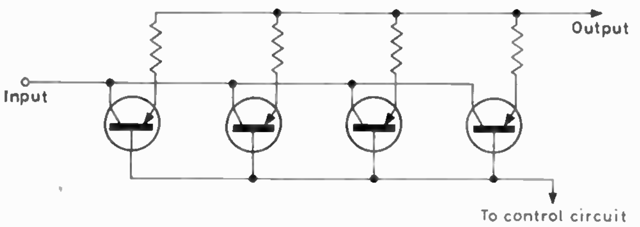

Fig. 1. Emitter feedback used to equalize emitter currents

matching, is regarded as being somewhat risky since aging effects could result in matched transistors becoming mismatched with consequent risk of failure. The second course, the use of emitter resistances, is the one usually adopted.

It is very desirable in most cases that the value of these resistors should be kept as low as possible to avoid the dissipation of a large amount of power when the current through the regulator has its maximum value. To determine the minimum value of resistor which will result in satisfactory performance it is necessary first to know the likely variation in the V_{be} — I_c characteristics for the transistors in question. Unfortunately, these are rarely given in manufacturers' information and may have to be plotted for a large number of samples of the chosen type of transistor. Measurements of this characteristic have been made on 100 samples of the power transistor type ADZ11 and the best and the worst characteristics so obtained are shown in Fig. 2. These characteristics may be closely represented by an equation of the form

$$I_c = k_1 (V_{be} - k_2)^x \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

where I_c = collector current

V_{be} = base to emitter voltage

and k_1, k_2 and x are all constants for individual transistors but will vary from sample to sample.

The equations for the characteristics of the best and the worst transistors found in the batch were:

$$\text{Best transistor } I_c = 46{\cdot}2\ (V_{be} - 0{\cdot}15)^{2{\cdot}2} \quad \ldots\ldots \quad (2)$$

$$\text{Worst transistor } I_c = 8{\cdot}55\ (V_{be} - 0{\cdot}1)^{1{\cdot}9} \quad \ldots\ldots \quad (3)$$

With the aid of these characteristics it is now possible to determine the value of emitter resistance which will result in current sharing to any required limits. Let I_{c1} and I_{c2} be the collector currents in transistors VT_1 and

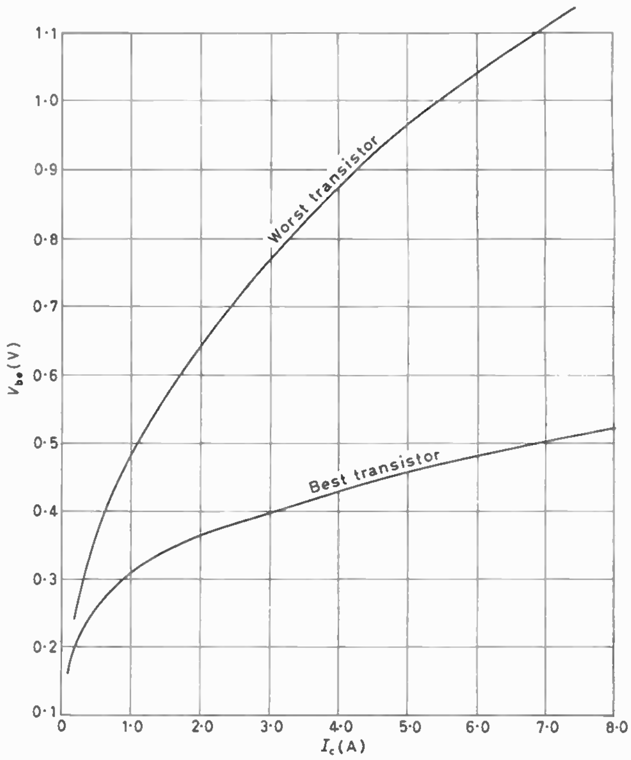

Fig. 2. $V_{be} - I_c$ characteristics for ADZ11 transistors (V_{ce} = 2V)

VT_2 respectively due to base voltages of V_{be1} and V_{be2}.

$$\text{Then } V_{be1} - V_{be2} \simeq (I_{c2} - I_{c1})\, R \quad \ldots\ldots\ldots \quad (4)$$

Assume for example that $I_{c2} = 1{\cdot}1\ I_{c1}$ (matching to 10 per cent and that the maximum current in I_{c1} is 5A. From the curves of Fig. 2

V_{be1} at I_{c1} = 5A is 0·955V while

V_{be2} at $I_{c2} = 1{\cdot}1\ I_{c1}$ = 5·5A is 0·465V.

Inserting these values in equation (4) gives

$0{\cdot}955 - 0{\cdot}465 = (5{\cdot}5 - 5)\, R$

$R = 0{\cdot}98\Omega$ or say $1{\cdot}0\Omega$.

It can be seen, therefore, that this value of resistor results in a large irreducible dissipation of power, the actual value being approximately 25W for every emitter resistor.

Moreover, with this arrangement, every paralleled transistor will be dissipating approximately the same amount of heat and consequently each transistor must be attached to a separate and probably bulky heat sink.

* *The General Electric Co. (Electronics) Ltd.*

A number of methods of improving on this situation are available and have for their objects the reduction in the size of transistor heat sinks and the production of more efficient regulator elements. In the circuit arrangements to be described these prime objectives have been achieved by ensuring that (a) the voltage drop across the regulator element can be reduced to a much lower value than with paralleled transistors and (b) where power must be dissipated it should, as far as possible, be dissipated in elements which are not as temperature sensitive as transistors.

Examination of the makers ratings of power transistors has shown that although the devices are limited both in current and in power, the maximum current ratings are usually so high that at these currents the maximum permissible dissipation will be reached at very low values of collector to emitter voltage. Hence any arrangement which results in the by-passing of current round the transistor when the voltage across the regulator is greater than that which would give maximum permissible dissipation at maximum current will in turn increase the voltage which can be tolerated by the element. Unfortunately, simple resistive by-passing is rarely satisfactory since this results in the possible voltage swing across the regulator element being dependent on the load current and at

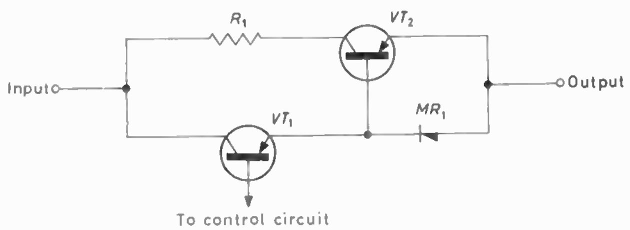

Fig. 3. Dual parallel section element

light loads the element will not be able to increase the effective resistance in the circuit beyond the value of the by-pass resistance. Control would therefore be lost.

One of the simplest circuit arrangements which makes use of the by-pass principle but which enables control to be maintained at low currents is shown in Fig. 3. In this arrangement* the by-pass resistor has in series with its main current path another transistor whose base drive is derived from current flowing in the main regulating transistor.

The operation of this type of circuit may be understood by considering first the condition when a large voltage is present across the element. In this case a very small current flowing in the emitter path of transistor VT_1 will be sufficient to swing the transistor VT_2 from the cut off condition to the fully bottomed condition. VT_2 will therefore act as a normal regulating transistor working with a collector load. If, however, the voltage across the element is required to be very small the branch containing VT_2 will be unable to pass the full load current. Transistor VT_1 then takes over the control while VT_2 remains in the bottomed, substantially non-dissipative, condition; VT_1 is therefore operating as a normal resistively by-passed regulating transistor. To prevent the full load current from being passed through the base emitter path of VT_2 a forward biased rectifier element is used, this prevents the base to emitter voltage from rising to a value much in excess of 1V. The most interesting feature of this type of circuit is that it is not possible for both transistors to dissipate appreciable amounts of power at the same time since when VT_1 approaches its peak power dissipation VT_2 will be bottomed and when VT_2 approaches its peak power dissipation the current in VT_1 will be very small.

Fig. 4 shows the constant power contours for each transistor plotted with relation to the voltage across and current through the whole element. It can be seen, therefore, that although two transistors are used only one heat sink is required and this would only have to be capable of dissipating one quarter of the total maximum power dissipated at any time in the regulator element. The collector resistor would have to be rated for the maximum regulator power since when maximum current through, and maximum voltage across, the element occur together, substantially all of the dissipation will take place in the resistor.

The electrical design of elements of this type is very simple. Let V_{max} be the maximum voltage which the element must support and I_{max} be the maximum current which may flow through the element. Then, to a very

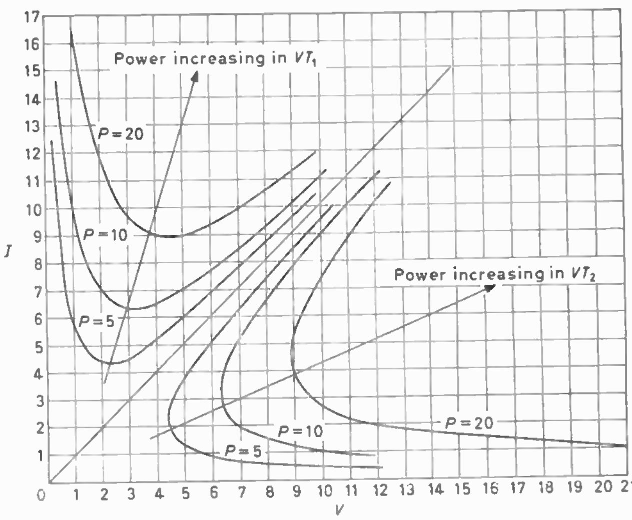

Fig. 4. Constant transistor power contours for circuit of Fig. 3 (R_1 = 1Ω)

good approximation, the value of the by-pass resistor is given by

$$R = V_{max}/I_{max}$$

The maximum power dissipated in either of the transistors will be given by

$$P_T = \frac{V_{max} I_{max}}{4} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

These formulae may be used freely provided that the transistors will bottom to a voltage which is insignificant compared with V_{max} and also provided that it is realized that, with germanium transistors, the voltage across the element cannot be reduced below about 1·3V, this voltage being the sum of the bottomed voltage of a transistor and the forward voltage drop of the rectifier. Unlike the case of the paralleled transistors with emitter resistors the minimum voltage across the element is substantially independent of the load current.

Referring back to the case of paralleled transistors it has been shown that for reasonable current sharing it would be necessary to drop approximately 5V across the emitter resistances if each transistor was passing approximately 5A. A two branch stabilizer of the type shown in Fig. 3 would, as compared with a paralleled transistor stabilizer, reduce the minimum voltage drop across the regulator element by a factor of nearly 4 while at the

* *U.K. Patent Application No. 29539/59.*

same time reducing the thermal rating of transistor heat sinks by a factor of 4 and making it possible to reduce the number of transistors by a factor of 2.

The limitation in bottomed voltage of this type of element can still be an embarrassment particularly in low voltage-high current supplies, where the product of load current and bottomed regulator voltage, i.e. the dissipation in the regulator element, may be an appreciable fraction of the power delivered to the load. A simple modification to the driving arrangements can however result in the elimination of the forward biased rectifier in the main current path. The basic circuit showing the modified system is shown in Fig. 5.

This type of circuit is based on the same basic principle as the dual parallel section element of Fig. 3. In this case, however, the current required to bottom VT_2 is not derived from VT_1 but is derived from the control circuit directly. The two points A and B are maintained at a substantially constant voltage difference of 1V due to the current flowing in the forward direction through MR_1. Since germanium transistors can, in general, be taken from the fully off to the fully on condition by a change of base to emitter voltage of 1V it follows that VT_2 must be fully bottomed before VT_1 begins to conduct.

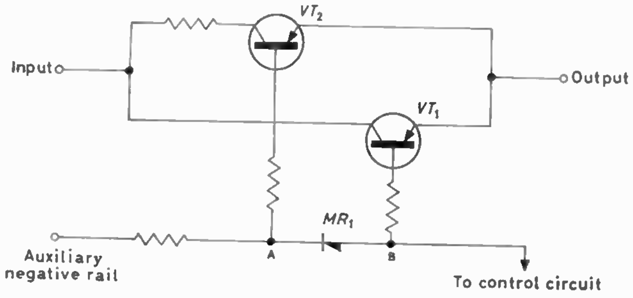

Fig. 5. Dual parallel section element modified to reduce minimum voltage

In practice the simple form of circuit shown in Fig. 5 would be impracticable since it would require a very large current to flow in the control circuit. By making VT_1 and VT_2 compound transistors the base currents at the points A and B may be made negligibly small and the circuit becomes practical.

The circuit* of Fig. 5 is the simplest form of a family of circuits which will be called sequential regulators since each transistor working from the top will become conductive in sequence as the current demand is increased. For any given regulator element power the power dissipated in transistors will fall as the number of branches is increased.

The basic form of a 4 branch element is shown in Fig. 6 but there is no theoretical limit to the number of branches which can be employed.

The method of design of a sequential element is best illustrated by examining the procedure necessary when it is known that the maximum voltage across the element is V_{max}, the maximum current through the element is I_{max} and the maximum permissible transistor dissipation is P. It is assumed that all transistors used are capable of carrying the current I_{max} or supporting the voltage V_{max} provided that the dissipation P is not exceeded.

The design sequence is then as follows:

(a) If there is a voltage drop V_{max} across the element the maximum power dissipated in the transistor in the first or uppermost branch will be obtained when the effective resistance of the collector emitter path of the transistor is equal to the resistance of the series resistor connected to the collector. The maximum transistor dissipation will therefore be $V_{max}^2/4R$. Since for the chosen transistor the maximum permissible dissipation P is known R may be determined from the equation

$$P = \frac{V_{max}^2}{4R} \qquad (6)$$

(b) Check whether

$$V_{max}/R \geqslant I_{max} \qquad (7)$$

(c) If condition (7) is met then n, the required number of branches is equal to two. In this case the first branch will include a resistor R while there will be no resistor in the second branch.

(d) If the condition (7) is not met a second branch identical with the first should be added.

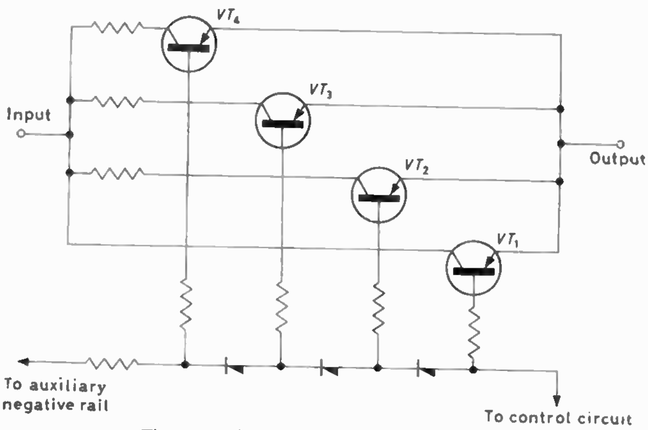

Fig. 6. A four branch sequential regulator

(e) Check whether

$$2V_{max}/R \geqslant I_{max} \qquad (8)$$

(f) If condition (8) is met only the first two branches will be identical.

(g) If condition (8) is not met it will be necessary to add further identical branches until

$$mV_{max}/R \geqslant I_{max} \qquad (9)$$

where m is the number of identical branches.

(h) So far m identical branches have been defined. If current is to flow in the $(m + 1)^{th}$ branch all the transistors in the first m branches must be bottomed. The effective resistance shunting the $(m + 1)^{th}$ path is therefore substantially equal to R/m.

(i) The maximum power conditions for the transistor in the $(m + 1)^{th}$ branch will be obtained when the effective collector emitter resistance of this transistor is

$$R/m + R_{(m+1)}$$

where $R_{(m+1)}$ is the value of the resistor in the $(m + 1)^{th}$ branch. The value of $R_{(m+1)}$ may now be defined in terms of other known quantities.

$$R_{(m+1)} = \frac{I_{max}^2(R_{Tm})^2}{4P} - R_{Tm} \qquad (10)$$

where R_{Tm} is the effective resistance of all previously considered branches in parallel assuming that the transistors in these branches are bottomed.

For subsequent branches the collector resistors can be defined by the general equation

* *U.K. Patent Application No. 43310/61.*

$$R_{(m+p)} = \frac{I_{max}^2 (R_{T(m+p-1)})^2}{4P} - R_{T(m+p-1)} \quad \ldots\ldots \quad (11)$$

where $p = 2, 3, 4$, etc.

(j) The final branch is then obtained when

$$R_{(m+p)} \leqslant 0$$

i.e. when $$\frac{I_{max}^2 (R_{T(m+p-1)})}{4P} \leqslant 1 \quad \ldots\ldots \quad \ldots \quad (12)$$

Applying this technique to the design of an element to handle voltages up to 10V, and currents up to 10A, using transistors which are only capable of dissipating 12·5W, step (a) gives a value of 2Ω for the resistor in the uppermost branch. Equation (7), step (b), is not then satisfied so a further branch using a 2Ω resistor is added. Equation (8), step (e), is now satisfied. Applying equation (10) gives a value of 1Ω for the resistor in the third path. Equation (12), step (j), is satisfied when $p = 2$. Thus, for this requirement a total of four branches will be needed.

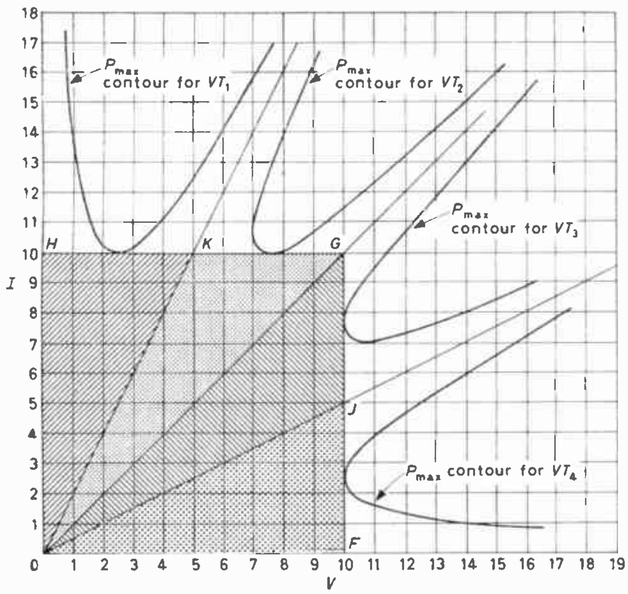

Fig. 7. Current-voltage load area for four branch regulator

For a rectangular voltage-current area characteristic the optimum arrangement will be obtained by dividing both the ordinate and the abscissa into an equal number of parts as shown in Fig. 7, each part corresponding to a branch of the element.

Any point within the area OFGH defines a working point for the regulator. If the point lies within the area OFJ then all transistors except the uppermost (branch 1) will be carrying a negligible current and consequently their dissipation will tend to zero. The transistor in branch 1 will dissipate some power, the actual amount being dependent on the working point. If the working point lies in area OJG the transistor in branch 1 will be bottomed, the transistors in branches 3 and 4 will be substantially cut off while the transistor in branch 2 will be dissipating an amount of power which is again dependent on the actual working point. Similar reasoning will apply to the remaining parts of the total load area. The maximum power contours for each transistor are superimposed on the diagram.

The slope of the line OJ gives the value of conductance which should be shunting branch 2 when the working point is in area OJG. The slope of the line OG gives the value of conductance which should be shunting branch 3 when the working point is in area OGK. This conductance will be formed by the resistors in branches 1 and 2 being in parallel. Similarly, the conductance represented by the slope of the line OK will be formed by the resistors in branches 1, 2 and 3 in parallel.

The advantages and disadvantages of sequential transistor regulators compared with paralleled transistor regulators are summarized below:

ADVANTAGES

(1) The serious voltage drop and power loss in the emitter feedback resistors can be eliminated.

(2) The number of power transistors required to handle a given power may be halved.

(3) The size of transistor heat sink may be greatly reduced, a reduction factor of 16 being quite feasible.

(4) Since most of the dissipation in the regulator element will take place in resistors it is possible to mount these in such a way that convection of cool air over the transistor heat sinks is increased thus reducing further the volume of heat sink required.

DISADVANTAGES

(1) Some additional components are required.

(2) At least some of the transistors must be capable of handling, individually, the whole load current.

So long as it is necessary to use relatively small power transistors to handle large powers it is believed that the type of circuit described will be most useful. Even though bigger transistors may become available it is likely that they will still be seriously temperature sensitive and the method described herein may still find application since it provides a means for transferring much of the dissipation from active semiconductor elements to passive, probably metallic, resistive elements which may be operated at much greater temperatures.

Acknowledgment

The author would like to acknowledge the assistance given by Mr. P. Davey during the early development of multi-branch sequential elements.

Two-Way Pocket Radio for Police

A contract to provide the constable on the beat with pocket transmitter-receivers has been awarded to G.E.C. (Electronics) Ltd of Wembley, Middlesex, by the Lancashire County Constabulary. Production is already in hand at the company's Radio Communications Division at Coventry.

The 'Lancon' is the smallest and lightest v.h.f. transmitter-receiver to receive Home Office and G.P.O. approval for police and commercial applications. It fits snugly and unobtrusively into an inside pocket. The set is fully transistorized and weighs only 1¼ lb. The combined transmitter-receiver unit is housed in a case measuring 8in × 4¼in × 1¾in.

The three-channel 'Lancon' set operates on f.m. The receiver is muted in the absence of signals. A 12V rechargeable battery housed inside the case powers the set.

Plug and socket connexions, which have proved unreliable in the past, have been avoided completely in this new equipment.

A feature of the set is its aerial system which clips conveniently inside the lapels, so overcoming the inconvenience and limitations of extending or trailing aerials. The 'Lancon' set is suitable for use under extreme conditions of service and is robustly constructed to minimize damage even during physical combat.

During extensive trials with the Lancashire Police, personal sets have made a significant contribution to effective crime prevention—many arrests are attributable to their use—and to the improved morale of the 'man on the beat'. For the first time, a constable is able to summon aid immediately, or seek advice, without moving from the scene of an incident. He is also able to give maximum co-operation to his fellow constables by knowing their activities at all times.

Semiconductor Time-Delay Circuits

By James J. Pinto*, M.Sc.

This article surveys the semiconductors available in this country with the particular requirements of process timers in view. The unijunction transistor is discussed in detail as the semiconductor best suited for use in time-delay circuits and its wider adoption and cheaper marketing are urged.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

SEMICONDUCTOR time-delay generators normally use the timing mechanism of most electronic timing circuits—i.e., the charging of a timing capacitor C_t, through a timing resistor R_t, from a fixed voltage V_i, to a voltage V_o which marks the end of the time interval. (Fig. 1). The voltage on the timing capacitor rises exponentially (see Appendix) unless constant current charging is used, when a linear rise is obtained.

Assuming accurate timing components and charging voltage, the basic aim underlying timing circuit design is the development of an accurate and stable voltage threshold detector to sense the voltage across the timing capacitor with a minimum loading effect.

Semiconductor timing circuits may be divided into the following **categories:**

(1) Zener diode voltage sensors.
(2) Transistor timers.
(3) Unijunction transistor timers.
(4) PNPN or Shockley diode timers.
(5) Other pnpn switching devices.

Of these semiconductors, probably the most suitable device for use in time-delay circuits is the unijunction transistor.

Zener Diode Timers

Zener diodes are semiconductor diodes with controlled reverse breakdown voltages. In the forward direction they have the characteristics of ordinary diodes, but in the reverse direction the diodes conduct no appreciable current until a specified and controlled voltage at which Zener or avalanche breakdown occurs. At this point the impedance becomes fairly low and the device therefore acts as a voltage regulator or detector. Below about 5½V the Zener effect occurs and the device has a negative temperature coefficient of a magnitude dependent on the voltage. Above 6V the breakdown is due to current avalanche and the voltage has a positive temperature coefficient of a magnitude dependent on the voltage. Zener diodes with breakdown voltages of approximately 5½V have very low temperature coefficients which can be either positive or negative and diodes are commercially available with temperature coefficients of less than one part in a thousand. Zener diodes are available with voltages ranging from 3 to 200V.

The simple Zener diode timer is shown in Fig. 2. The Zener is connected across the timing capacitor in series with the base of a transistor connected in the switching mode. The load in the collector circuit is therefore switched after a time delay depending on the Zener voltage and the base-emitter voltage of the transistor. The maximum value of the timing resistor is set by the value of the load resistance and the minimum gain of the transistor, assuming negligible leakage in the timing capacitor. The maximum time for which the circuit can be set is then limited by the largest capacitor value that can be used.

Voltage regulation of this circuit can be introduced by adding another Zener diode to regulate the charging voltage. The fundamental temperature errors are: The gain of the transistor varies by approximately ½ per cent/°C; the Zener diodes have temperature coefficients depending on voltage; the base-emitter voltage of the transistor varies by approximately $-2{\cdot}5$mV/°C. These temperature errors can be chosen to cancel out, but the practical production spread is appreciable.

The current range of the circuit may be increased by adding one or more stages of transistor amplification. To limit dissipation in the transistors, it is desirable that a degree of positive feedback be introduced, so that, when the threshold voltage is reached, sharp switching takes place. Loads of up to tens of watts may then be controlled using 100mW transistors.

For repetitive timing, some means of discharge of the timing capacitor must be introduced so that an accurate repeatability may be achieved in successive operations. Some pulsed timers do not need this facility, whereas others with relay loads may have spare sets of contacts to latch the relay on while simultaneously discharging the capacitor.

Transistor Timers

A rather versatile circuit that can be used as a positive feedback amplifier and threshold detector, is the Schmitt trigger, Fig. 3. When the circuit is switched on, the capacitor charges through the base of VT_1 which is bottomed, while VT_2 remains cut off. The circuit stays in this state for a time interval determined by the capacitor C_t, the timing resistor R_t and the input requirement of the trigger circuit, after which VT_1 starts to come out of bottoming and the circuit switches regeneratively to the second state when VT_2 conducts and supplies current to the load. For repetitive switching a quick-discharge, or reset circuit is connected as shown. When the supply is connected, the diode MR_1 is back biased, but when the supply is switched off the capacitor discharges through the diode and resistor r with a time-constant rC_t, which is limited since r imposes a bleed across the supply. The time delay obtained using this circuit is, to a first approximation, independent of the voltage supply. Temperature drift is determined by the drift of V_{be} and the drift of the current gain (β) of the first transistor, which may be virtually eliminated by careful design. The circuit is simple, reasonably accurate and it is commonly used for generating time delays from a few milliseconds up to a few seconds.

Another simple and commonly used circuit is the monostable multivibrator—Fig. 4—which generates a time delay after the application of a triggering pulse. This circuit has

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the disadvantage that the load cannot usually be connected in one of the collector circuits and further transistor stages have therefore to be used.

Semiconductors, being current operated devices, must draw some current for operation and hence impose limitations on the value of the charging resistance used. The input resistance of a transistor amplifier can be increased up to hundreds of megohms using expensive components. However, an attempt was made at producing a transistor time-delay unit for a period up to a minute, using low values of capacitance and cheap, readily available transistors and other components. The circuit that evolved is shown in Fig. 5.

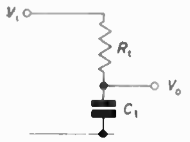


Fig. 1. Basic timing circuit

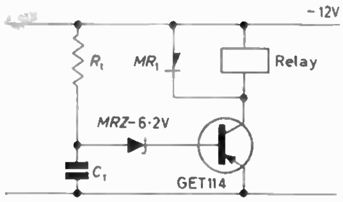


Fig. 2. Simple Zener diode timer

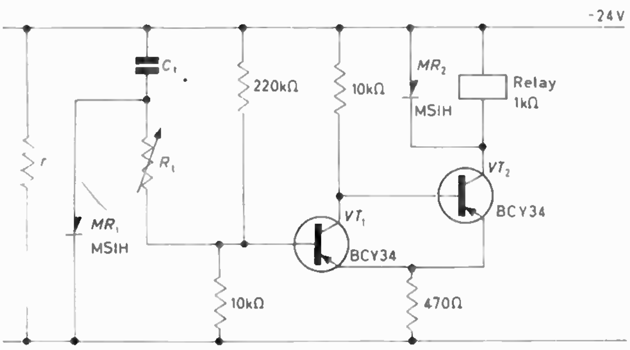


Fig. 3. Schmitt trigger circuit

The output transistor is fed from a bistable circuit which has set in the relay-off position during switch-on, due to the small 'memory' capacitor. The timing circuit is fed from a voltage that is as large as possible and connected to the input of the bistable by an isolating diode with a reverse resistance of many megohms. The trigger input requirement still sets a limit on the charging resistance and this obstacle is overcome by injecting pulses in series with the timing capacitor by means of a subsidiary oscillator or multivibrator. When the timing capacitor is sufficiently charged so as to almost forward bias the isolating diode, the pulses trigger the bistable into the relay-on state. By this means the timing resistor can be increased until its value becomes comparable with the resistance of the isolating diode. If the d.c. voltages are derived from a common supply, the voltage regulation is good since the two voltages vary in the same proportion. In a mains operated unit that was constructed, it was found sufficient to inject mains waveform as the triggering input. The circuit can be conveniently designed for time delays of one or two minutes using small paper capacitors.

Unijunction Transistor Timing

The unijunction transistor is a three terminal semiconductor device that exhibits a stable negative resistance under certain conditions, which makes possible the design of time-delay circuits using fewer components and achieving a better performance than comparable transistor circuits. It consists of an n-type silicon bar which has two ohmic base contacts and an emitter connexion made to a small section of p-type material between the two bases. The device operates by the variation of conductivity between the emitter and base 1. When a voltage is connected across the bases, the emitter would normally be at a voltage with a value dependent on its distance from the bases, the resistance between the bases acting as a voltage divider. This voltage is a fixed ratio—called the intrinsic stand-off ratio, n, of the interbase voltage. If the emitter is held below a voltage n times the interbase voltage, the device is in the cut-off condition. When the emitter voltage is increased sufficiently, holes (minority carriers) are injected into the

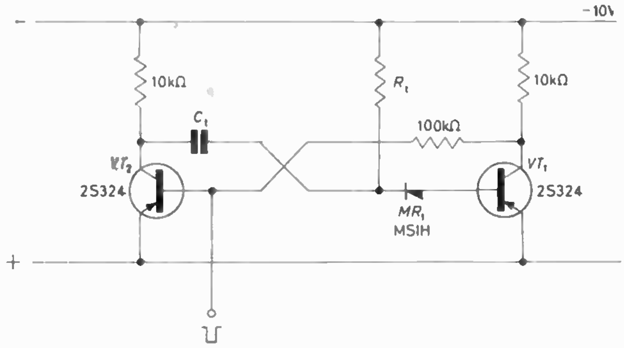


Fig. 4. Monostable multivibrator circuit

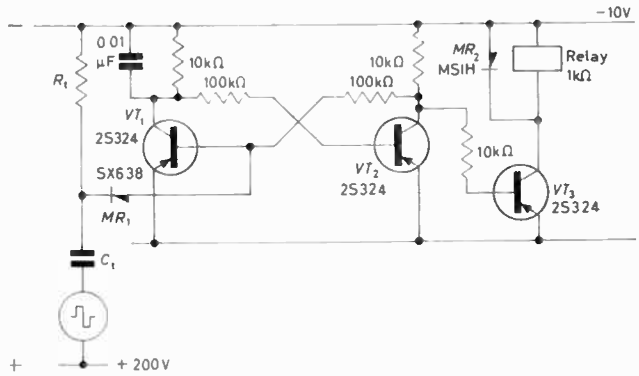


Fig. 5. Transistor circuit using low values of capacitors

silicon bar and carried towards base 1 by the internal field in the bar. This decreases the resistance of the emitter to base 1 and the emitter current increases regeneratively until it is limited by the emitter power supply.

The equivalent electrical circuit is shown in Fig. 6, in which R_{b1} and R_{b2} represent the base resistances and D_e the isolating diode of the pn junction with a forward voltage V_d. The voltage at which the emitter becomes forward biased is called the peak point voltage V_p and is given by:

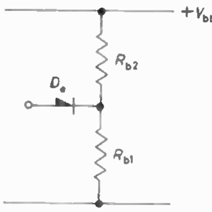
$$V_p = V_{bb}R_{b1}/(R_{b1} + R_{b2}) + V_d:$$
$$= nV_{bb} + V_d.$$

The interbase resistance, $R_{bb} = R_{b1} + R_{b2}$ varies by approximately 0·8 per cent/°C. Since changes in R_{b1} and R_{b2} are proportional, n is constant and independent of temperature—experimentally n varies by less than 0·01 per cent/°C. Therefore, the changes in the peak point voltage due to temperature are almost entirely due to the diode voltage variation which is approximately −2·5mV/°C. Stabilization of the peak point can be attained by a proper selection of a resistor connected in series with base 2, the value of which is given by the formula:

$$R = \frac{0{\cdot}3125\,R_{bb}}{nV_{bb}}$$

R_{bb} and n can easily be measured and therefore R, the optimum value of resistance stabilizing the triggering point, can be obtained. Since R_{bb} is a function of temperature, the optimum value of R will compensate over a limited range around the temperature at which it was calculated, which, however, is fairly large and sufficient for practical purposes. It is found that using the above method of calculation, the peak point voltage can be stabilized to within 50μV/°C over a range of 0 to 75°C, which by normal semiconductor standards, is extremely good.

The common-unijunction transistor time-delay circuit is shown in Fig. 7. When the supply is connected the timing circuit charges to the peak point voltage, at which point the unijunction transistor fires and the capacitor discharges through the relay, causing it to pulse. A change-over set of contacts is then made to hold the relay on and at the same time disconnect the rest of the circuit from the supply. The upper limit on R_t is set by the peak point emitter current (which can be as little as 6μA



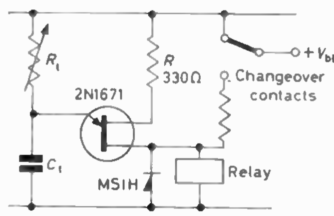


Fig. 6 (left). Unijunction transistor equivalent circuit
Fig. 7 (right). Unijunction transistor time delay circuit

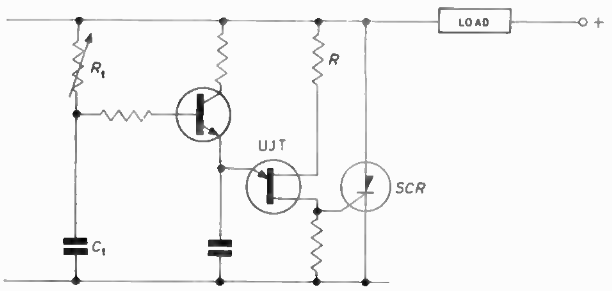


Fig. 8 Circuit to increase input impedance

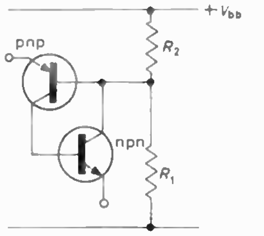
maximum) and the capacitor leakage current. The circuit has good voltage regulation since the peak point voltage varies in the same ratio as the supply. Further, the time delay can be made temperature stable by inserting R in series with base 2 and if accurate stability is required, R is calculated for individual units from the formula discussed above.

To increase the input impedance of the unijunction transistor timer, a transistor amplifier may be included as shown in Fig. 8. The transistor used must have appreciable gain at low collector currents. The output pulse may be used to fire a Thyristor.

The transistor equivalent of the unijunction circuit is shown in Fig. 9 and this is preferred by many circuit designers since two relatively inexpensive transistors may be used. It has the added advantage that the equivalent intrinsic stand-off ratio may be closely defined by choice of resistors and temperature compensation can be introduced, if required, by use of a temperature sensitive resistor in the divider chain. However, the unijunction transistor can give the same performance using fewer components.

Shockley or Trigger Diode Timing

The Shockley or trigger diode is a two terminal pnpn device with controlled breakover voltage. With reverse voltage it has the characteristic of a normal diode (though diodes are available with symmetrical forward and reverse characteristics) and in the forward voltage direction the diode remains non-conducting until a critical breakover voltage, V_s, when it switches through a negative resistance region to a conducting and low voltage state and has the forward characteristics of a normal diode. In the off state it has an equivalent resistance of larger than a megohm, while in the on state it has a resistance of a few ohms. Once the device has attained the low voltage condition it cannot revert to the high resistance state until the current through it has decreased, at least momentarily, to a low value called the holding current, I_h. Devices are available with switching voltages from 20 to 200V and holding currents from 1 to 50mA. The switching voltage has a small and non-linear temperature coefficient and the shift of this parameter up to about 60°C is sufficiently small to enable the device to be used in most industrial timing circuits. The holding current decreases considerably with temperature; this point is not usually important in



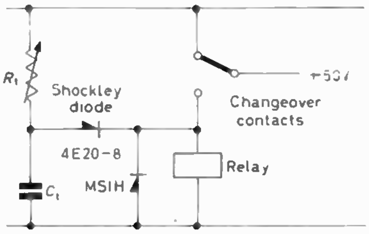


Fig. 9 (left). Transistor equivalent of unijunction circuit
Fig. 10 (right). Trigger diode timer

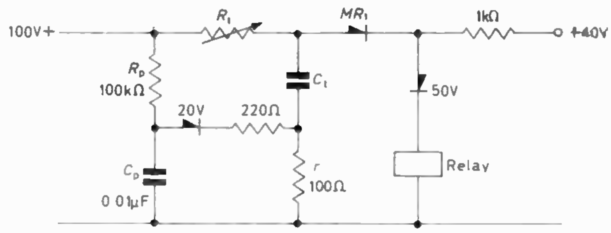


Fig. 11. Circuit for longer delays

process timers which are switched off by means of an on-off switch. The trigger diode combines unusual characteristics with fast switching, small size and power handling capacity. Its action is simple and a number of pulse and switching circuits can be designed around it, resulting in compact and economical circuits.

A simple trigger diode timer is shown in Fig. 10. When the voltage across the timing capacitor reaches the switching voltage of the trigger diode, it switches to the low voltage condition, discharging the capacitor into the relay, which is then latched on. The limit on R_t is determined by the current at the switching voltage which is usually about 100μA. The circuit has the inherent temperature coefficient of the trigger diode. Voltage regulation is introduced, if necessary, by stabilizing the charging voltage with a Zener diode.

For longer time delays, or for times using low values of capacitance, a circuit on the principle of the isolating diode discussed previously, may be used. The circuit is shown in Fig. 11, triggering pulses being generated by the circuit R_pC_p and the 20V diode and the timing circuit R_tC_t being isolated from the timing diode (50V) by the low leakage diode. When the timing capacitor has charged to approximately 50V, the triggering pulses cause the timing diode to switch to the low voltage condition and hold the relay on until the supply is interrupted. The maximum timing resistor used in this design can be of the order of 10 to 25MΩ and large time delays can therefore be generated.

Time Delay Circuits Using Silicon Controlled Rectifiers or Switches

The silicon controlled rectifier, or Thyristor, is a gate controlled pnpn switching device that is capable of controlling considerable currents by the application of relatively small signals to the gate. It remains in a non-conducting or off-state until turned on, or 'fired' by a low level control signal and it remains on without the need for a sustaining input, until it is turned off by reducing the current through it to a low level, called the holding current, or alternatively, by reversing the voltage across it.

The pnpn configuration has given rise to various similar devices which, due to lack of conformity between manufacturers, have been given different names. The silicon controlled rectifier, or Thyristor, the silicon controlled switch (s.c.s.), the Transwitch, the Dynaquad, the Trigistor and the Binistor all belong to this class and spring from the basic pnpn construction. The Thyristor and the s.c.r. belong to the first group of devices within this class and are essentially the same, with differences of gate sensitivity and current capacity. The Trigistor, the Transwitch, the Dynaquad (and from some manufacturers, the s.c.s.) belong to a second group, and have the added feature that turn-off is possible by means of a pulse of opposite polarity at the gate, the turn-off pulse required being usually much larger than that required for turn-on. The devices in this second group usually have lower maximum current ratings (of the order of 0·5A) but comparatively inexpensive devices are available, with trigger sensitivities of less than 1μA! Some devices are made with both gates being available for external connexion (i.e., an anode and a cathode gate) thus allowing greater circuit flexibility.

As a voltage threshold detector, the Thyristor or the s.c.s. may be used to turn on when a preset input has been exceeded. However, since the device is current operated and gate currents are not usually stable or well defined, timing circuits using Thyristors or controlled switches normally use auxiliary circuits as voltage detectors, the Thyristor being used as the output device when large powers have to be controlled. The Thyristor is best controlled by pulse firing and as such is best suited for use with trigger diodes or unijunction transistors. The latter in particular can supply the precision-timed pulses to fire the Thyristor, which can then directly control powers of up to the kilowatt range, since Thyristors are now available at voltages of up to 1 500V and at currents up to 500A (5 000A peak). One convenient fact that makes the Thyristor particularly useful for process timer applications is that no subsidiary turn-off circuit is required, this function being performed by the supply switch.

Conclusion

A large variety of semiconductor devices can be used to generate time delays and control directly by means of 'static' switching. The final choice of components and circuit to be used depends on various factors, including availability, accuracy, stability and repeatability required, reliability and perhaps most important, cost. Semiconductors have a number of advantages and their disadvantages are being steadily overcome. It is the present writer's firm belief that semiconductors will result, in most cases, in better, cheaper, smaller and more reliable instruments.

Acknowledgments

The author would like to thank the directors of Everett Edgcumbe & Co. Ltd for permission to publish results of work carried out in their laboratories.

Appendix

(1) Incremental Errors

The timing mechanism in most electronic timing devices is the charging of a capacitor C, through a resistance R, from a voltage V_i, to a voltage V_o, which marks the end of the time interval. Assuming the loading effect of the network that senses V_o to be negligible, the time t is given by:

$$t = RC \ln V_i/V_i - V_o$$

The accuracy of the time interval depends on the stability of R, C, V_i and V_o. The change in time produced by a change of R or C is linear, while that produced by a change of V_i or V_o is exponential. This fact governs the choice of a variable when a time scale is required. It should also be noted that the time interval does not vary when both V_i and V_o vary by the same fraction. This is useful when designing for voltage regulation of a timing unit.

The incremental errors due to changes of R, C, V_i and V_o are:

$$dt(RC) = d(RC) \ln V_i/(V_i - V_o) \quad ;$$
$$dt(V_i) = -dV_i V_o RC/V_i(V_i - V_o);$$
$$dt(V_o) = dV_o RC/(V_i - V_o) \quad ;$$

The incremental error resulting from an incremental change of V_o is a minimum when $V_o = (1 - 1/e) V_i$.

Electrolytic capacitors are obviously unsuitable for use in accurate timing circuits and non-electrolytic capacitors larger than about 10μF are often impractical. Precision resistors are commercially available up to values of about a few kilomegohms, but timing circuits rarely use values larger than 50 to 100MΩ. When R is required to be variable, reliable carbon potentiometers can be obtained up to values of about 10 to 25MΩ. However, when wire-wound potentiometers are essential, V_i or V_o are varied and the resultant logarithmic scale is linearized by some means of scale-shaping. Alternately, a circuit using constant-current charging may be used—e.g., the 'Bootstrap' circuit.

(2) Peak Point Voltage

The peak point voltage of a unijunction transistor is given by:

$$V_p = nV_{bb} + V_d$$

The change due to temperature is:

$$dV_p/dT = V_{bb}\, dn/dT + dV_d/dT.$$

The insertion of a resistor R in series with base 2 results in a change of V_p, which is now:

$$V_p' = V_{bb}R_{b1}/(R_{b1} + R_{b2} + R) + V_d;$$
$$= nR_{bb}V_{bb}/(R_{bb} + R) + V_d.$$

The change due to temperature is now:

$$dV_p'/dT = \frac{n\, dR_{bb}/dT\, V_{bb}R}{(R_{bb} + R)^2} + dV_d/dT:$$

Assuming, as is approximately true, that R is small compared to R_{bb}, then:

$$dV_p'/dT = \frac{dR_{bb}/dT R V_{bb} n}{R_{bb}^2} + dV_d/dT;$$

and for exact compensation, when $dV_p'/dT = 0$,

$$R = -\frac{R_{bb}^2\, dV_d/dT}{n\, V_{bb}\, dR_{bb}/dT}$$

Including the actual values of the variables:

$$dV_d/dT = -2{\cdot}5\text{mV}/°\text{C};\ dR_{bb}/dT = 8 \times 10^{-3} R_{bb}$$

$$R = \frac{0{\cdot}3125\, R_{bb}}{nV_{bb}}$$

Line Scanning Transistor — Dissipation during Switch-off

By F. D. Bate*, B.Sc., A.M.I.E.E.

An analysis is made of the power dissipated in a television line scanning transistor during the switch-off period T_{co} for different shapes of collector current fall. Fundamental frequency only and third harmonic tuning conditions are both considered and compared. It is found that, to a first approximation, the power dissipated always varies as the square of the cut-off time T_{co} and is 50 per cent greater when optimum third harmonic tuning is employed when compared with the case of fundamental frequency only being present.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

THE basic output circuit of a transistor line scanning stage is shown in Fig. 1. This shows a pnp transistor used as a switch.

At the end of the line scan a current I_o is established in the inductance L. The transistor is then switched off by applying a positive square wave between the base and emitter. After a certain storage time the collector current falls, roughly linearly, to zero in a finite time, which

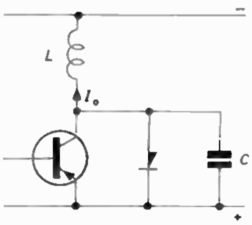


Fig. 1. Basic line scanning output stage

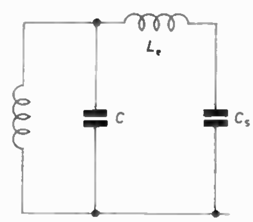


Fig. 2. Simple equivalent circuit to explain third harmonic tuning

results in power being dissipated in the collector region of the transistor. More generally, if the base voltage rises in a finite time then the collector current fall will be more likely to obey an equation given by:

$$i = I_o(1 - (t^n/T_{co}^n)) \quad \ldots\ldots\ldots\ldots (1)$$

where T_{co} is the time taken for the collector current to fall to zero, t is the time at any instant, and n is some positive number.

This is equivalent to a current impulse of duration T_{co} being given to the circuit, where:

$$i(t) = (t^n/T_{co}^n)\, I_o \quad \ldots\ldots\ldots\ldots (2)$$

using Laplace notation this becomes:

$$\mathcal{L}\; i(t) = (I_o/T_{co}^n)\,\frac{\Gamma(n+1)}{s^{n+1}} \quad \ldots\ldots\ldots\ldots (3)$$

The current $i(s)$ flowing in the LC circuit is then given by:

$$sL\left[i(s) - \frac{I_o\,\Gamma(n+1)}{T_{co}^n\, s^{n+1}}\right] + (i(s)/sC) = 0$$

hence:

$$i(s) = \frac{I_o\,\Gamma(n+1)}{T_{co}^n\, s^{n-1}(s^2+\alpha^2)} \quad \text{where } \alpha^2 = 1/LC \quad \ldots\ldots\ldots\ldots (4)$$

the voltage across C at any instant is given by:

$$V(s) = i(s)/sC$$

that is:

$$V(s) = \frac{I_o\,\Gamma(n+1)}{CT_{co}^n\, s^n\,(s^2+\alpha^2)} \quad \ldots\ldots\ldots\ldots (5)$$

expanding $1/(s^2+\alpha^2)$

$$V(s) = \frac{I_o\,\Gamma(n+1)}{CT_{co}^n}\{(1/s^{n+2}) - (\alpha^2/s^{n+4}) + (\alpha^4/s^{n+6})\} \quad \ldots\ldots\ldots\ldots (6)$$

and using the inverse Laplace transform this gives:

$$V(t) = \frac{I_o\,\Gamma(n+1)}{CT_{co}^n}\left[\frac{t^{n+1}}{\Gamma(n+2)} - \frac{\alpha^2\, t^{n+3}}{\Gamma(n+4)} \ldots\right] \quad \ldots\ldots\ldots\ldots (7)$$

now since $\Gamma(n+1) = n\Gamma(n)$

$$V(t) = \frac{I_o\, t^{n+1}}{CT_{co}^n(n+1)}\left[1 - \frac{\alpha^2 t^2}{(n+3)(n+2)} \ldots\right] \quad \ldots\ldots\ldots\ldots (8)$$

SYMBOLS

C	=	Capacitance across the inductance
I_o	=	Peak current in the inductance at the end of scan, fundamental frequency only
I_F	=	Fundamental component of current in the inductance at the end of scan, third harmonic tuning
I_T	=	Third harmonic component of current in the inductance at the end of scan, third harmonic tuning
$i_{(t)}$	=	Current impulse applied to the circuit
$i_{(s)}$	=	Laplace transform of the current
i	=	Instantaneous current
K	=	$\frac{t^{n+1}}{T_{co}^n\,(n+1)}$
L	=	Inductance
n	=	Some positive number
$\Gamma(n)$	=	Gamma function of n
T	=	Time of one complete cycle
T_{co}	=	Cut-off time of the transistor
T_f	=	Flyback time
s	=	Operator s in Laplace notation
t	=	Instantaneous time
V_o	=	Peak voltage during the flyback interval fundamental frequency only
V_o'	=	Peak voltage during the flyback interval third harmonic tuning
V_F	=	Peak value of the fundamental frequency voltage, third harmonic tuning
$V_{(t)}$	=	Instantaneous voltage
$V_{(s)}$	=	Laplace transform of the voltage
$iV_{(t)}$	=	Mean power dissipated in the collector
ω	=	Fundamental angular frequency of the flyback interval
α^2	=	$1/\surd(LC)$

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If the time of half an oscillation is given by $T_t = \pi \sqrt{(LC)}$ and the peak value of the voltage is:

$$V_o = I_o \sqrt{(LC)}$$

equation (8) becomes:

$$V(t) = \frac{V_o t^{n+1} \pi}{T_t T_{co}^n (n+1)} \left[1 - \frac{\pi^2 t^2}{(n+3)(n+2) T_t^2} + \ldots \right] \quad \ldots\ldots\ldots\ldots\ldots (9)$$

this equation being true for all values of $n > 0$.

Thus the power dissipated in the collector region during the time T_{co} is given by combining equation (1) and equation (9) and becomes:

$$iV_{(t)} = \frac{I_o V_o T_{co}^2 n \pi}{T T_t 2 (n+1)^2 (n+2)} \left[1 - \frac{(n+1)\pi^2 T_{co}^2}{(n+2)(n+3)(n+4) T_t^2} \ldots \right] \quad \ldots\ldots\ldots\ldots (10)$$

It is assumed that only the first term is important; then the power dissipated increases as the square of the cut-off time T_{co} and is dependent upon the shape of fall of the collector current. It may also be shown that the first term of equation (10) has a maximum value when $n^2 + n - 1 = 0$, or confining oneself to positive values only, $n = 0{\cdot}62$.

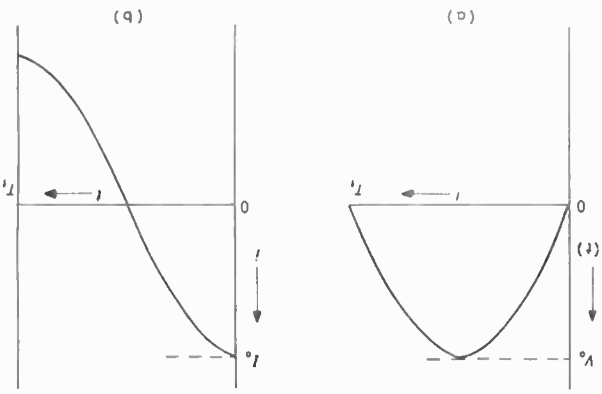

Fig. 3. Fundamental frequency only

The above results are true if only one frequency is present during the flyback interval and with the circuit of Fig. 1, this is in fact the case. In practice, however, a transformer is in parallel with the yoke to provide e.h.t. for the cathode-ray tube. A combination of leakage inductance and self-capacitance of the transformer results in an equivalent circuit given by Fig. 2 and this can oscillate at two frequencies.

When one frequency is three times the other frequency this is known as third harmonic tuning and if the values of components are chosen for optimum third harmonic tuning then the peak voltage during a fixed flyback interval will be a minimum. This occurs when the third harmonic voltage is $1/5^{th}$ of the fundamental voltage[1,2]. Theory shows that this minimum voltage is roughly 82 per cent of the voltage with no third harmonic tuning. (In practice the higher frequency is 2·8 times the fundamental frequency and the measured voltage about 85 per cent of the voltage with no third harmonic tuning, this difference, however, is not very significant).

Thus the current I_o is divided into two parts, one which oscillates at the fundamental frequency and the other which oscillates at the third harmonic frequency. The peak value of the fundamental frequency current is given by:

$$I_F = (V_F / \omega L)$$

where V_F is the peak value of the fundamental frequency voltage, and the peak value of the third harmonic frequency current is given by:

$$I_T = (V_F/5)/3\omega L = V_F / 15\omega L$$

and since $I_F + I_T = I_o$ it follows that $I_F = (15/16) I_o$ $I_T = (1/16) I_o$.

Now equation (8) neglecting all terms higher than the first becomes:

$$V(t) = (I_o / C) K \quad \ldots\ldots\ldots\ldots\ldots (11)$$

where $K = \dfrac{t^{n+1}}{T_{co}^n (n+1)}$

this being the case of the fundamental frequency only being present.

In the case of third harmonic tuning: :

$$V(t) = (I_F / C) K + (I_T / (C/9)) K \quad \ldots\ldots (12)$$

The second term of equation (12) has an effective capacitance of $(1/9) C$ because this is the third harmonic frequency component. Using the previous values for I_F and I_T

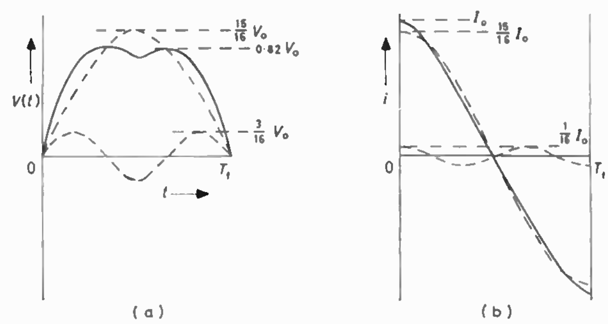

Fig. 4. Optimum third harmonic tuning

equation (12) becomes:

$$V(t) = \frac{(15/16) I_o K}{C} + \frac{(1/16) I_o K}{(1/9) C} = (3/2)(I_o / C) K \quad \ldots. (13)$$

These results are shown more clearly in Figs. 3 and 4 when a unit step of current is applied to the circuit.

Fig. 3 shows the waveforms of the collector voltage and current when a unit step is applied to the circuit of Fig. 1, that is, only the fundamental frequency is present.

Fig. 4 shows the comparable waveforms for a unit step applied to the circuit of Fig. 2 that is, a circuit third harmonically tuned.

Comparing equation (13) with equation (11) shows that, assuming only the first term is significant, then the initial part of the voltage during the flyback with third harmonic tuning is always 50 per cent greater than the case where the fundamental frequency only is present. This means that the power dissipated during the switch-off of the transistor is also increased by 50 per cent.

If V_o' is the peak voltage during the flyback with third harmonic tuning and V_o the peak voltage with the fundamental frequency only then in practice:

$$V_o' = 0{\cdot}85 V_o$$

Thus the equation for the collector voltage at any instant, neglecting terms greater than the first, is given by:

$$V(t) = (3/2)(V_o' / 0{\cdot}85) \frac{t^{n+1} \pi}{T_t T_{co}^n (n+1)}$$

or rewriting in a modified form:

$$0{\cdot}57 (V(t)/V_o')(T_t / T_{co}) = (t / T_{co})^{n+1} \frac{\pi}{(n+1)} \quad \ldots (14)$$

The first term of equation (10) for the mean power dissipated becomes:

$$\overline{iV(t)} = (3/2)\frac{I_oV_o'\,T_{co}^2 n\pi}{T\,T_t 2\,(n+1)^2\,(n+2)\,(0{\cdot}85)} \quad \ldots\ldots (15)$$

Graphs are plotted using equation (15) for the mean power dissipated for different values of n that is, equation

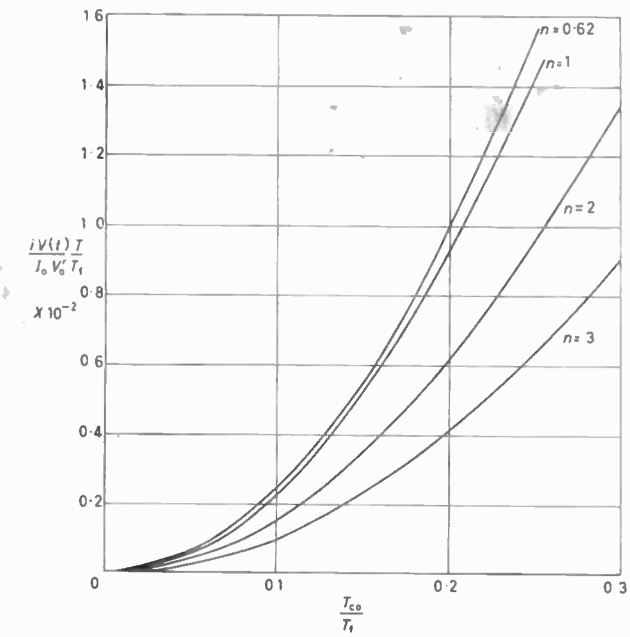

Fig. 5. Power dissipated in the collector for different current fall shapes third harmonic tuning

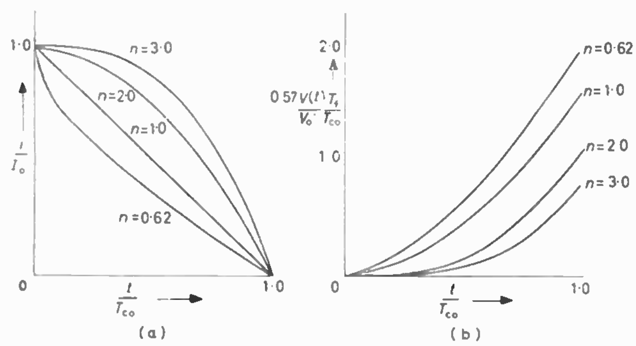

Fig. 6. Third harmonic tuning
(a) Collector current shapes for different values of n
(b) Collector voltage shapes for different values of n

(15) is re-written.

$$\frac{iV_{(t)}}{I_oV_o'}(T/T_t) = (3/2)\frac{n\pi}{2(n+1)^2\,(n+2)\,(0{\cdot}85)}\,(T_{co}/T_t)^2 \quad \ldots\ldots\ldots\ldots (16)$$

see Fig. 5.

In Fig. 6 the shape of the current fall and resulting voltage shapes are plotted for different values of n, equations (1) and (14).

If a perfect square wave is applied to the transistor the collector current falls linearly with respect to time, that is $n = 1$ and the collector voltage rises as the square of the time. In practice a perfect square wave is difficult to achieve, the actual base to emitter voltage rising in a finite time, and resulting in a collector current fall shape being given by the curves when $n = 2$ or 3, see Fig. 6.

Thus although the finite rise time of the base to emitter voltage increases T_{co}, the power dissipated will not increase as the square of T_{co} because the shape of fall of the collector current with time is no longer linear. The actual increase will depend upon how much the current fall departs from a linear fall and in practical cases the power dissipated will increase less than the square of T_{co}.

For instance, if a perfect square pulse was applied between the base and emitter and $T_{co}/T_t = 0{\cdot}1$ then for $n = 1$ (linear fall of current) the power dissipated would be $0{\cdot}23\ T_t/T\ I_oV_o' \times 10^{-2}$, see Fig. 5. Now suppose that the base to emitter voltage rose in a finite time so that $T_{co}/T_t = 0{\cdot}2$, that is, the cut-off time is doubled, and the collector current fell with a shape given when $n = 3$, then the power dissipated would be $0{\cdot}41\ T_t/T\ I_oV_o$, that is it would be less than doubled. Thus it is important, when comparing the power dissipated during different cut-off times, that the shape of the collector current fall is the same in each case, otherwise it will not increase as the square of the cut-off time.

Conclusion

It is found that, to a first approximation, the power dissipated always varies as the square of the cut-off time. The maximum power dissipated, for a fixed cut-off time occurs for a shape of a node current fall given by $i = I_o\,[1-(t/T_{co})^{0{\cdot}62}]$ this being 8 per cent greater than that obtained for a linear fall of current. The power dissipated, during the cut-off time, is increased by 50 per cent when optimum third harmonic tuning is employed when compared with the case of the fundamental frequency only being present.

Acknowledgment

The author wishes to thank the management of the Thorn-A.E.I. Applications Laboratory for permission to publish the article and also to certain members of the staff for their help and advice in its preparation.

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Ground Clutter and Obscuration in Ground Radar Simulators*

Ground clutter in radar simulators can be stored in the form of a transparency which is scanned by a flying spot scanner in sympathy with the simulated aerial rotation. In some cases it is desirable to simulate two effects connected with this: the variation of the clutter amplitudes as the elevation polar diagram alters, such as occurs in a height finding radar, and the obscuration of low flying aircraft by the ground as occurs with terrain following aircraft.

This can be accomplished by storing ground height information on the same transparency as the clutter amplitudes using two colours which can be separated after scanning by filters. The height information is stored as a density proportional to the elevation angle the ground at that point subtends at the radar set. Scanning must produce eventually a waveform with a voltage that does not decrease with range, as e.g. a hill must be considered as having a constant elevation angle beyond the peak as this area is obscured by the peak. It might be preferable to store this (or its differential with subsequent electronic integration) on the transparency rather than the actual ground elevation angle with circuits to ensure that it never has a decreasing waveform.

If the lower edge of the elevation polar diagram of the aerial is represented as a voltage, this is compared with the ground elevation voltage and the clutter allowed to pass to the display when the aerial voltage is less than the ground voltage. For more realism instead of a sharp cut-off, the actual shape of the elevation polar diagram could be simulated by storing its value at varying elevation angles, e.g. by a diode function generator and the aerial gain discovered by continuously applying the ground elevation signal to it and using the resultant voltage to multiply the instantaneous clutter signal.

* *A communication from EMI Electronics Ltd.*

A Bi-directional Decade Counter with Anti-coincidence Network and Digital Display

By A. F. Tassinari*, E.E., M.I.E.E.E.

In this article a reversible counter is described which consists, basically, of four self-gating, flip-flop binary divider stages in cascade, with the correct feedback to form a decade counter. An anti-coincidence network is included and semiconductor devices are used throughout.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

THE decade counter consists of four flip-flop self-gating binary divider stages in cascade, with the proper feedback and gating circuits, to form a bi-directional binary coded decimal device. The storage element used here is an Eccles-Jordan self-gating flip-flop. The basic flip-flop circuit and its logical functions are shown in Fig. 1.

The positive going pulse is fed, through an AND gate, to the 'on' transistor thus switching it 'off'; the gating is performed by R_1 MR_1 and R_2 MR_2. The capacitors gate, and assure reliable triggering, regardless of trigger pulse width. In order to have the same voltage levels to simplify the circuit design, the outputs of the NOR circuits, and of the flip-flops are clamped. A static voltage level at the bus of the steering diodes, controlled by a set-reset flip-flop, determines the sense of counting. The coding and feedback techniques used here, minimize the number of components needed when several decade stages are cascaded.

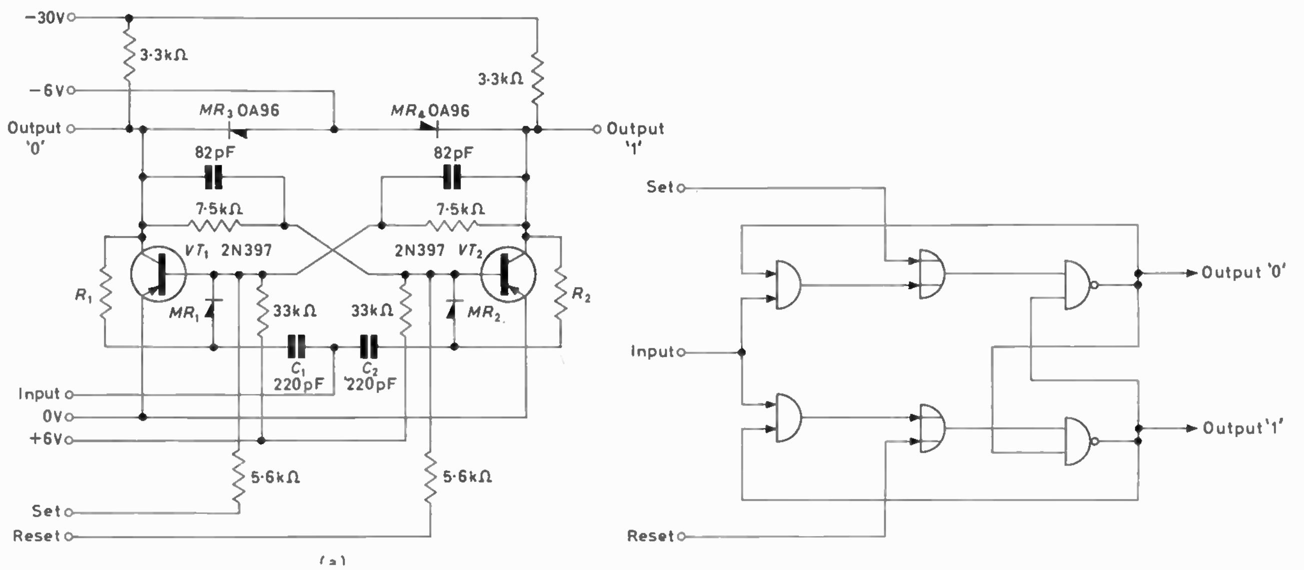


Fig. 1. Flip-flop self-gating binary divider schematic diagram and logical functions

C_1 and C_2 are part of the AND gate, in that they provide d.c. isolation for the diode-resistor junction from the trigger source. The AND gates operate as follows: when VT_1 is 'off', its collector is at V_{cc} volts, and the anode of MR_1 is at ground level, consequently the diode MR_1 is reverse biased. VT_2 is 'on', and its collector is practically at ground level, the anode of MR_2 is at the same level, and its cathode is at the 'on' base level, about −0·3V, consequently MR_2 is forward biased. The information can pass through it switching 'off' VT_2. Because the circuit is symmetrical, similar statements apply for VT_1, R_1 and MR_1 at the proper times during the cycle. The capacitors C_1 and C_2 delay the AND

Decade Logical Design (Fig. 2)

Four binary stages produce sixteen (2^4) and therefore the excess six state must be nullified. There are many arrangements in order to have a base-ten counter from a four bit binary device.

In this counter the 'excess three binary' code is used. This was chosen for its complementary characteristic; in fact it uses the nine-complements arithmetic system. The counting is performed between three and twelve inclusive; the binary two and thirteen, are used to activate the feedback line for the sensing network. Table 1 shows the relationship between the 1 2 4 8 binary code, and the 'excess three binary' code.

Since complementary bistable devices are used in counting, there are two outputs from each stage. As shown in

* *Paoletti S.p.A., Italy.*

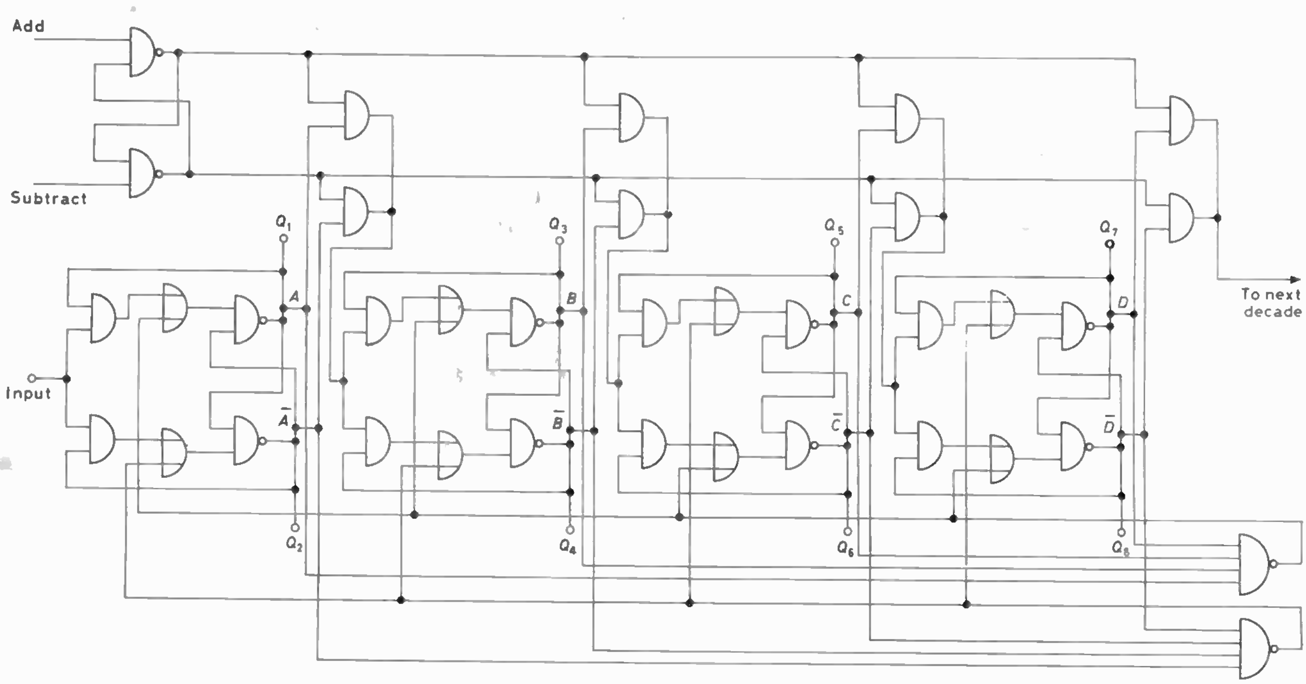


Fig. 2. Logical arrangement of the bi-directional decade counter

TABLE 1

Relation between 1248 Binary Code and Excess Three Binary Code

The binary combinations used in the excess three binary code are shown in the dotted box

DECIMAL	1	2	4	8	$\bar{1}$	$\bar{2}$	$\bar{4}$	$\bar{8}$	CODED DECIMAL DIGITS
0	0	0	0	0	1	1	1	1	
1	1	0	0	0	0	1	1	1	
2	0	1	0	0	1	0	1	1	
3	1	1	0	0	0	0	1	1	0
4	0	0	1	0	1	1	0	1	1
5	1	0	1	0	0	1	0	1	2
6	0	1	1	0	1	0	0	1	3
7	1	1	1	0	0	0	0	1	4
8	0	0	0	1	1	1	1	0	5
9	1	0	0	1	0	1	1	0	6
10	0	1	0	1	1	0	1	0	7
11	1	1	0	1	0	0	1	0	8
12	0	0	1	1	1	1	0	0	9
13	1	0	1	1	0	1	0	0	
14	0	1	1	1	1	0	0	0	
15	1	1	1	1	0	0	0	0	
16	0	0	0	0	1	1	1	1	

TABLE 2

Four Flip-Flop States during Counting and Logical Operations Required to Decode Excess Three Binary into Seven Segment Digit Code

FF_1 A	FF_2 B	FF_3 C	FF_4 D	$\overline{FF_1}$ $\bar{A}$	$\overline{FF_2}$ $\bar{B}$	$\overline{FF_3}$ $\bar{C}$	$\overline{FF_4}$ $\bar{D}$	DECIMAL	EXCESS THREE BINARY LOGIC	SEVEN SEGMENTS DIGIT LOGIC
1	1	0	0	0	0	1	1	0	$=\bar{A}.C.D$	$a+b+d+e+f+g$
0	0	1	0	1	1	0	1	1	$=A.B.D$	$d+g$
1	0	1	0	0	1	0	1	2	$=\bar{A}.B.D$	$a+c+d+e+f$
0	1	1	0	1	0	0	1	3	$=A.\bar{B}.\bar{C}$	$a+c+d+f+g$
1	1	1	0	0	0	0	1	4	$=\bar{A}.\bar{B}.\bar{C}$	$b+c+d+g$
0	0	0	1	1	1	1	0	5	$=A.B.C$	$a+b+c+f+g$
1	0	0	1	0	1	1	0	6	$=\bar{A}.B.C$	$a+b+c+e+f+g$
0	1	0	1	1	0	1	0	7	$=A.\bar{B}.\bar{D}$	$a+d+g$
1	1	0	1	0	0	1	0	8	$=\bar{A}.\bar{B}.\bar{D}$	$a+b+e+d+c+f+g$
0	0	1	1	1	1	0	0	9	$=A.\bar{C}.\bar{D}$	$a+b+e+d+f+g$

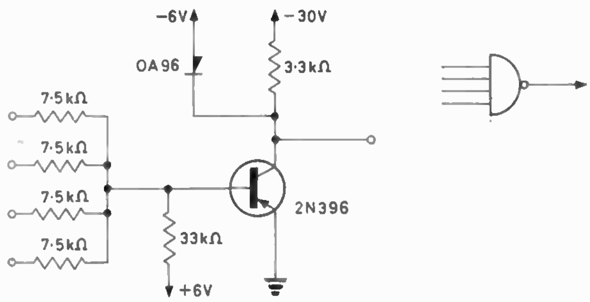


Fig. 3. Four inputs 'NOR' used in feedback coding circuits

Table 2, one output is referred to $A\ B\ C\ D$ and its complement as $\bar{A}\ \bar{B}\ \bar{C}\ \bar{D}$. The $A\ B\ C\ D$ outputs increase, as the $\bar{A}\ \bar{B}\ \bar{C}\ \bar{D}$ outputs decrease. The output of either set can be used to count up or down, by changing the interstage gating. Fig. 2 shows the logical arrangement for the bi-directional binary coded decimal counter. When the forward diode steering bus is activated the signal is derived from $A\ B\ C\ D$ collectors, the binary output increases in count, consequently the decimal digit is counted up for each input transition.

Conversely when the backward diode-steering bus is excited, the signal is derived from $\bar{A}\ \bar{B}\ \bar{C}\ \bar{D}$ collectors, the binary output decreases in count, and the decimal digit is counted down for each input incoming pulse.

When the device counts up, the process continues until decimal nine is reached, binary code 1100. After this point, the next binary state is 1101 which opens the forward feedback gate, which in turn resets the counter to the decimal zero, binary code 0011.

When counting down, the counting continues until the decimal zero is reached, binary 0011; the next combina-

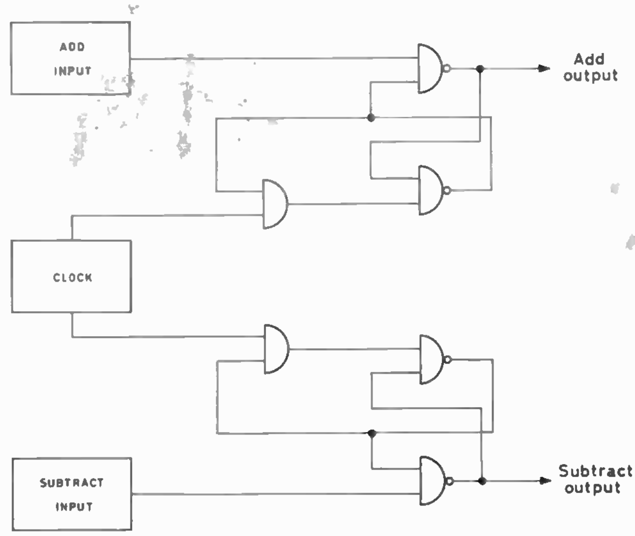


Fig. 5. Anti-coincidence device logic circuit

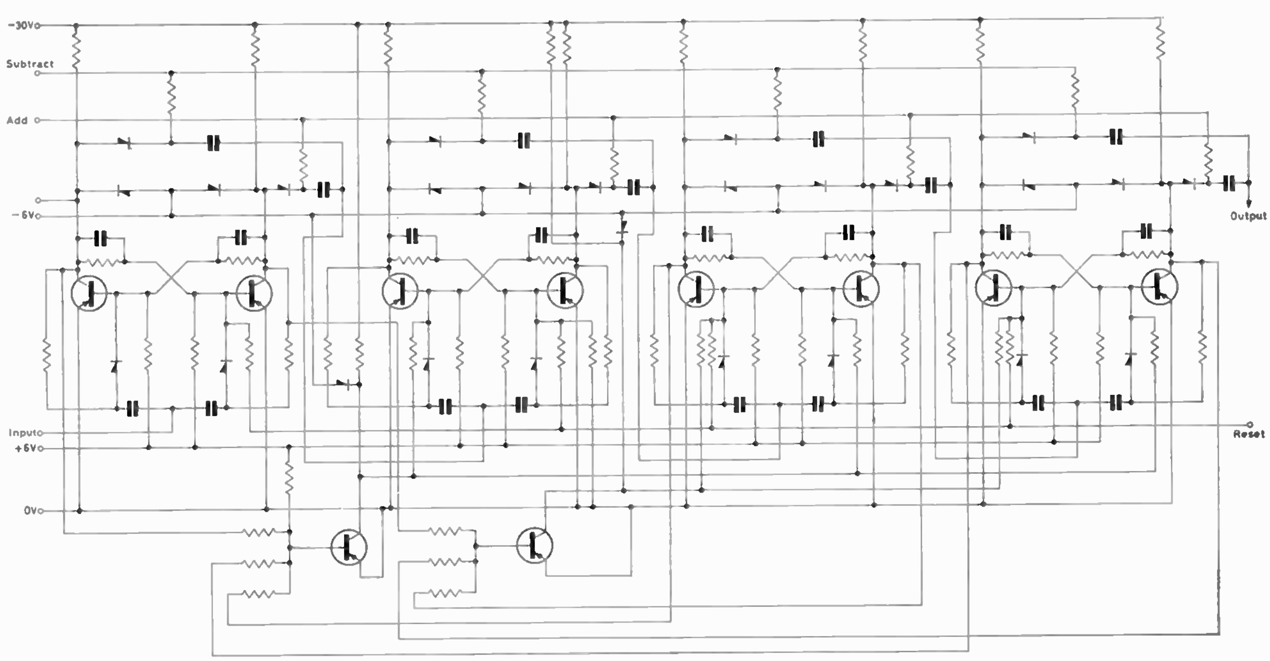


Fig. 4. Schematic diagram for logic of Fig. 2

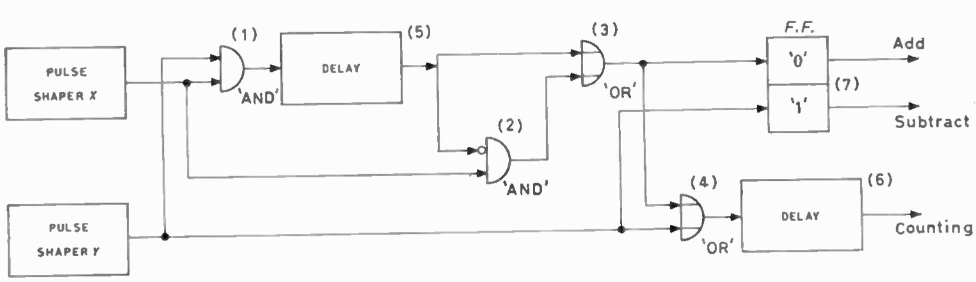


Fig. 6. More sophisticated anti-coincidence device—logic circuit

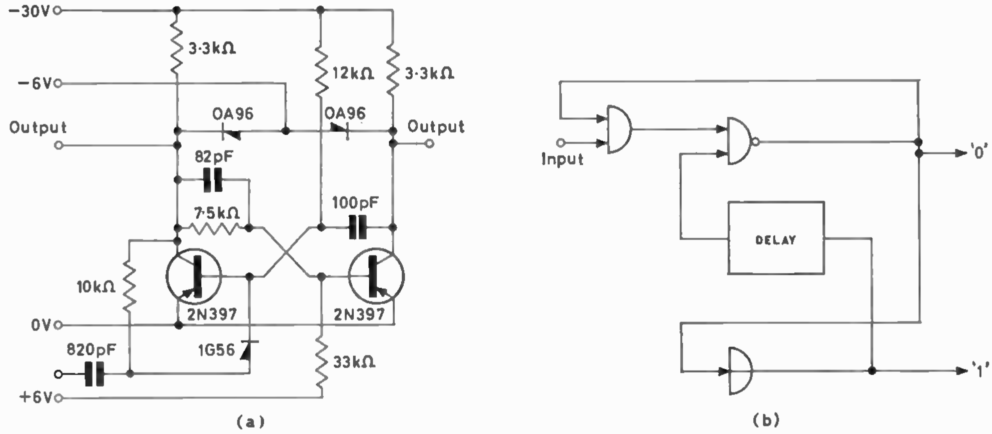


Fig. 8. One-shot multivibrator

tion is 1011, which opens the backward feedback gate, and resets the counter to the decimal nine, binary 1100. When the counter adds it is not necessary to gate the backward feedback line, since binary 0010 is never reached; similarly binary 1101 is never produced, when the counter subtracts, consequently it is not necessary to gate the forward reset line. Two four input NOR circuits, Fig. 3, are employed for feedback gating.

Anti-Coincidence Circuit

The anti-coincidence circuits are the basic building-blocks in a bi-directional counter. As the counter cannot add and subtract simultaneously, the sense of arrival of the pulses must be discriminated.

Several types of anti-coincidence circuits exist to direct the incoming information in the proper way. In Fig. 4 is shown a logical arrangement for a simple anti-coincidence device.

Two flip-flops, a clock, and two AND gates are used. The set input of one flip-flop, is driven by pulse arriving from the add source, and the other flip-flop input is driven from the subtract source. Pulses generated by the clock interrogate each AND gate, which in turn is connected to the reset input of its own flip-flop.

If the ADD flip-flop is flipped by an incoming pulse to the '1' state, the subsequent pulse from the clock, interrogates the AND gate flipping the flip-flop back to its '0' state; at the same time it produces an output pulse which drives the counter in a forward direction.

The subtract flip-flop works in the same way as the

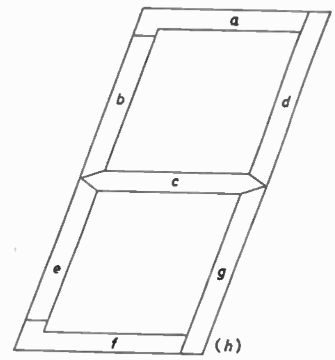


Fig. 9 (right). Seven segments in-line in-plane digital display

Fig. 10 (below). Diode matrix for excess three binary code, to seven segments digits code

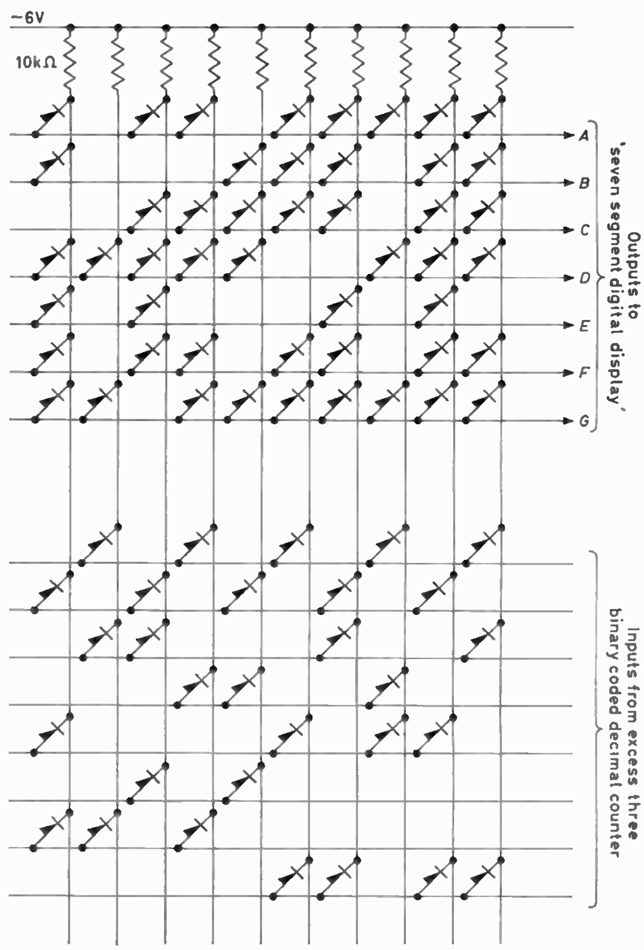
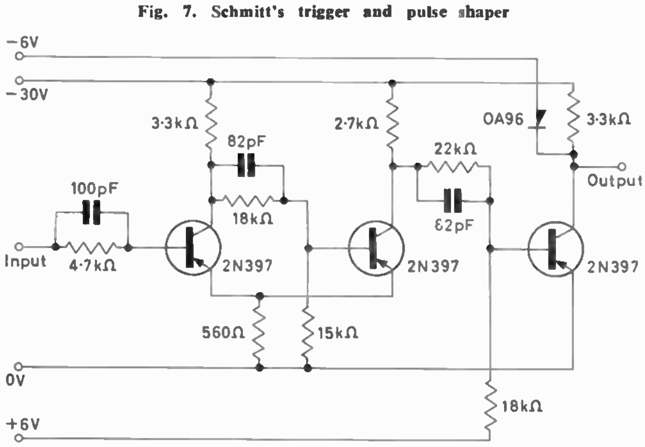


Fig. 7. Schmitt's trigger and pulse shaper



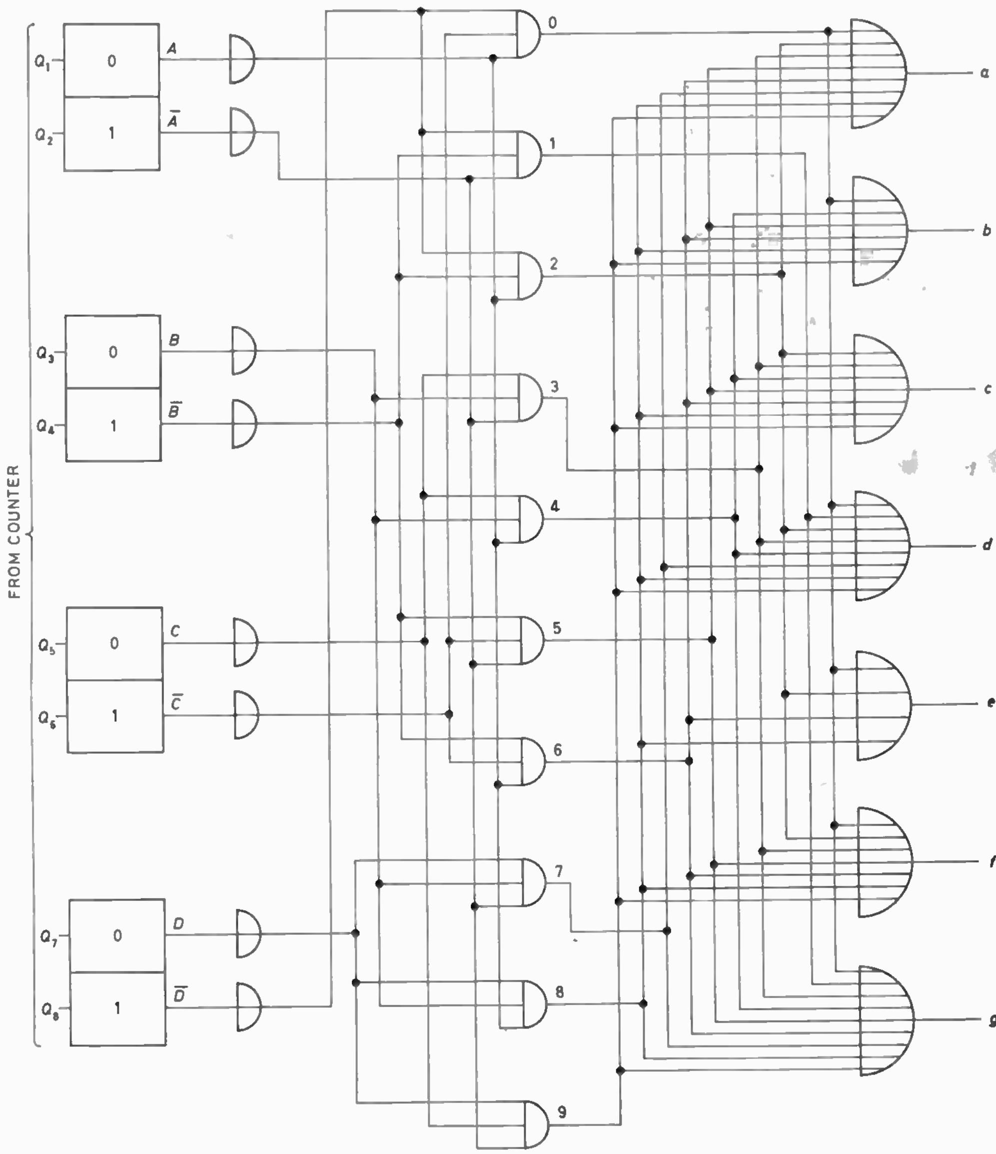


Fig. 11. Logical arrangements for digital read-out decoder

add one. To prevent loss of pulses, the clock interrogation frequency should be many times greater than the input rate. One of the disadvantages of this type of anti-coincidence network, is the high clock frequency required for a medium speed counter.

The logical arrangement for a more sophisticated anti-coincidence circuit is shown in Fig. 6. The input blocks x and y are two pulse shaper (Schmitt trigger) circuits, Fig. 7, followed by a one shot multivibrator, Fig. 8, they give a pulse of the same width, chosen to afford maximum separation between add and subtract pulses in the region of coincidence.

When information comes from the x add line, the pulse through the AND gate (2) opens the OR gate (3), flips the sense control in the forward direction and at the same time, through the OR gate (4), and the delay (6), is added When the information comes from the y subtract line, the sense control is flipped in the backward direction, at the same time through the OR gate (4) and the delay (6) is subtracted. If both add and subtract pulses arrive simultaneously, the AND gate (1) is open and the delay (5) is activated and so the AND gate (2) is inhibited and nothing can pass through it, consequently the sense control is not switched to forward counting; and only the subtract pulse is counted.

The trailing edge of the one-shot (5) passing through the OR gate (3) switches the sense control to forward counting, and through the OR gate (4) and delay (6) is counted. The delay of the one-shot (5) assures sufficient time separation between add and subtract pulses even at the worst coincidence. The delay (6) is used to allow the sense control to reach the proper counting state before any pulses are counted.

Seven Segment Digital Display and Decoder

The seven segment digital display, Fig. 9, is of the in-plane in-line type. Each segment is lit by two or more incandescent lamps, driven by a Darlington d.c. amplifier. Lighting two or more segments simultaneously forms the desired decimal digit between 0 and 9.

A diode matrix, Fig. 10, is employed to decode the excess three binary code to the seven segment digit code. The logical arrangement of the decoder is shown in Fig. 11.

A Simple Digital to Analogue Convertor

By K. H. Edwards*, B.Sc.

The article describes a simple digital to analogue convertor, designed to handle input data in serial form. It requires only four interconnexions with the source of information and has an overall accuracy better than ±1 per cent.

(Voir page 205 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 214)

WHEN a digital computer is used to control any physical process, the digital output from the computer must be converted into a proportional, analogue, voltage. The digital to analogue convertor described below has been found simple in construction and reliable in operation. It offers reasonable accuracy, ±1 per cent, and requires a minimum of modification to the computer.

Representation of Numbers in the Digital Computer

In most digital computers a number is represented by a series of binary digits whose repetition rate is the clock frequency of the computer. Normally the least significant digit occurs first. In the particular computer discussed[1], a 'zero' digit is represented by a negative voltage and a 'one' by a positive pulse about 9μsec long. The clock frequency is 57kc/s.

The digits representing a number form a word. For this computer the normal word length is 36 digit periods. The thirty-sixth or most significant digit (m.s.d.) of a word is a sign digit. A 'zero' in this position indicates a positive number, and a 'one' a negative number. The digit preceding the sign digit is therefore the most significant part of the number. It should be mentioned that a number may alternatively be contained in a double length word. When this facility is used, the m.s.d. of the first word loses its special significance and the sign digit is the m.s.d. of the second word. The convertor is designed, for convenience in gating, to decode only double length numbers. The computer is easily programmed to present its output in this form.

The Principle of the Decoder

Consider a number on the decade system but written backwards, that is, with its least significant digit first.

$$007 = 0 + 1.10 + 7.10^2 \text{ (i.e. 700 normally).}$$

Each digit has ten times the significance of its predecessor. In a similarly arranged binary system of numbers each successive digit doubles in value.

Now consider the decay of a network consisting of a resistor R and capacitor C in parallel.

Let it be charged initially to a voltage V_0.

Then at any subsequent time t the voltage V is:

$$V = V_0 e^{-t/RC}$$
$$= V_0 2^{-kt/RC} \quad \text{where } k = 1/\ln 2$$

Suppose that t is an integral number of digit periods n each of length τ secs.

Then:

$$V = V_0 2^{-kn\tau/RC}$$

so if:

$$k\tau = RC \quad V = V_0 2^{-n}.$$

This network, having a half life of one digit period, is the basis of the Shannon decoder[2].

In Fig. 1 an RC network is shown to be charged through a switch by a current generator. When triggered, the generator applies a fixed charge to the capacitor. A sample and hold circuit is shown as a means of recording the network output. Suppose the generator is triggered by the 'one' digits of a binary number of the type described above. In Fig. 2 is specified the contribution to the output at time T produced by digits at time 0, 1, 2, etc.

It can be seen in Fig. 2 that, at the time of sampling, the voltage may be changing rapidly. A. J. Rack has suggested a simple modification to prevent errors arising from this source. A parallel RLC circuit, resonant at digit frequency, and also having a half life of one digit period, is added in series with the Shannon circuit. Fig. 3 shows the response of the modified circuit to a digit at time 0. With correct design, the resultant output voltage is essen-

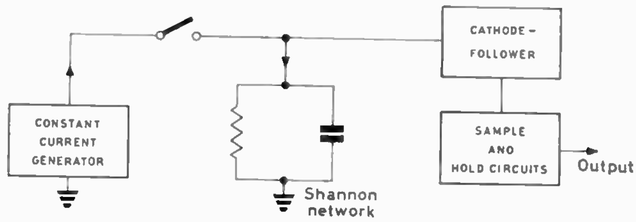
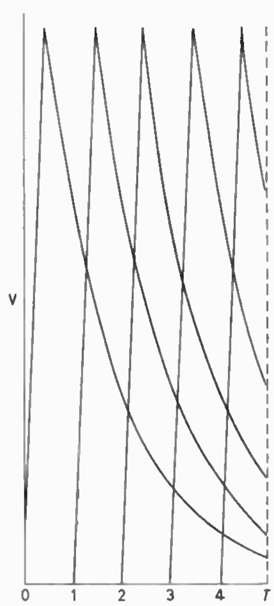
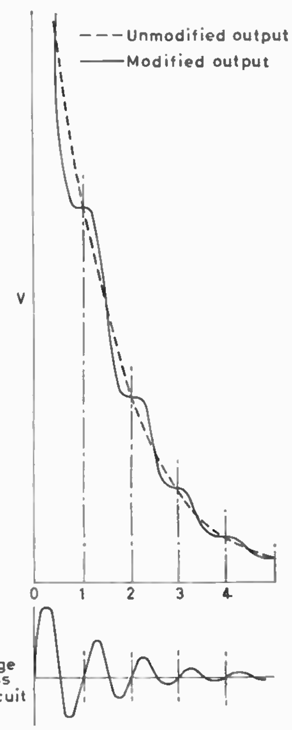


Fig. 1 (above). Arrangement of the Shannon decoder

Fig. 2 (below left). Output of decoder produced by binary digits at successive equal intervals. *T*—time of sampling

Fig. 3 (below right). Modified decoder output





* *The Queen's University of Belfast.*

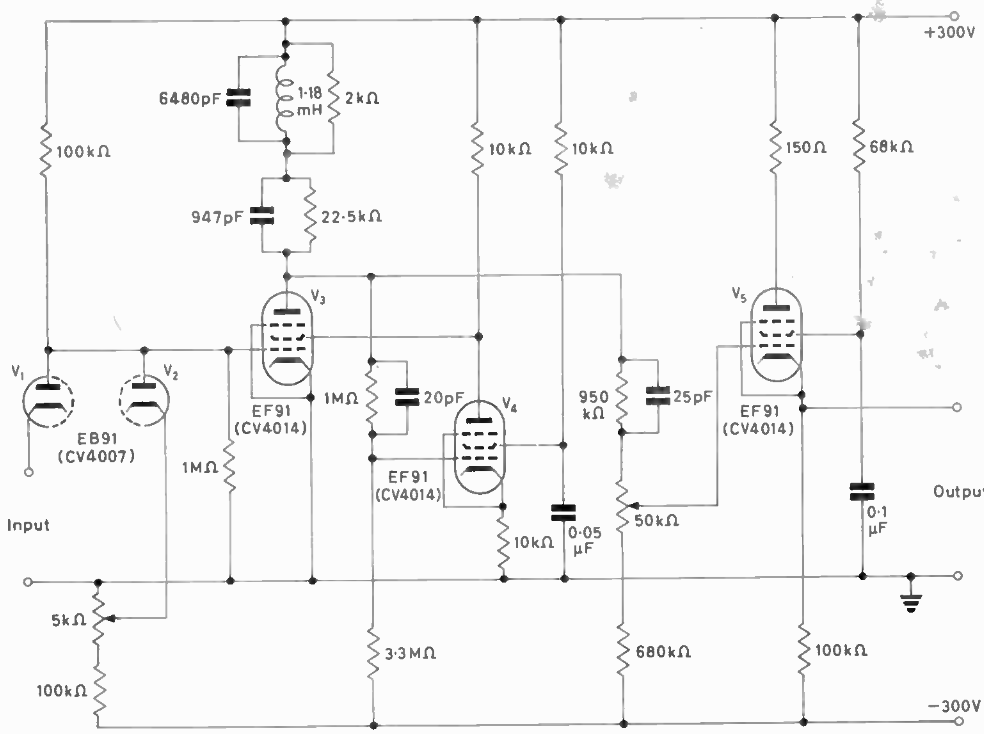


Fig. 4. Arrangement of the Shannon circuit

the effect of screen grid current in V_3 on screen potential.

The coil of the resonant circuit was wound on a former containing an adjustable slug so that all three components could be readily varied during alignment of the decoder. It was found to improve substantially the stability of the results over a long period of time. The accuracy was very sensitive to the tuning of both the Shannon circuit and the resonant circuit and to the time-constants of the coupling networks.

tially constant at multiples of digit periods. The instant of sampling is therefore no longer critical.

The Practical Circuit

The basis of the circuit is a pentode, V_3 of Fig. 4, normally biased well beyond cut-off, whose grid is raised to a defined level for a fixed period by each digit present in the input (binary) signal. The pentode operates under constant current conditions to charge the Shannon *RC* circuit, and the output is d.c. coupled to a cathode-follower output stage V_5. The output is then sampled and held to produce the decoded signal. The input signal is produced by a 5μsec multivibrator triggered by the train of pulses from the computer. The signal is applied through an AND gate, V_1 and V_2, to define the grid voltage at the Shannon valve.

Consider the action demanded of this valve. For simplicity ignore the resonant circuit. It is desired to produce a fixed change of voltage across the Shannon network independent of the voltage already existing across it. Even if the current in the capacitor is constant during charging, an increasing current is drawn from the valve to supply the discharge resistor. This bleed current depends on the initial voltage across the network as well as on the voltage change during charging. The normal discharge current of the capacitor from its initial voltage affects the shape of the voltage waveform but not the current drawn from the valve.

The current produced by the valve should be increased by successive digits. It is not, however, due to the discharge current mentioned, linearly related to the voltage across the circuit. A degree of compensation is provided by valve V_4, a pentode in a stable low gain configuration whose grid is d.c. coupled to the output of the Shannon circuit. The output of this valve is fed back to the screen grid of V_3. It can be seen in Fig. 5 that the anode current for a CV4014 (EF91) plotted against its screen voltage is linear over a wide range, and is of course independent of anode voltage. V_4 is run fairly hard in order to minimize

Decoding of Negative Numbers

It has been explained that the most significant digit of a word is the sign digit. This digit is normally scaled to represent $-(1/2)$. The values of the digits preceding it are then:

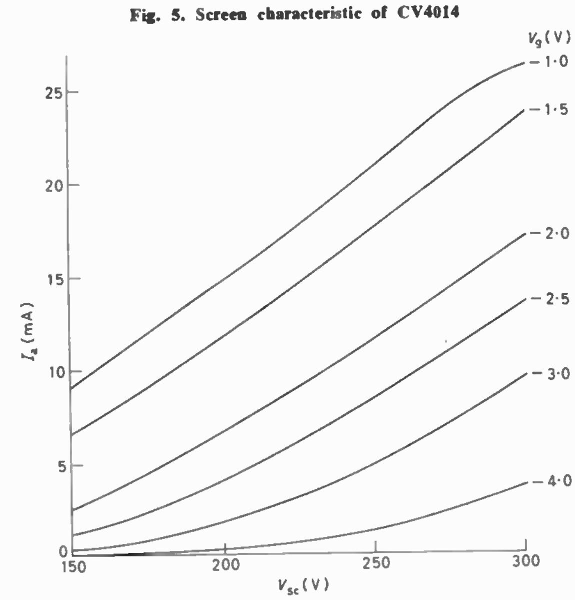
m.s.d. p_{36} $-(1/2)$
p_{35} $+(1/4)$
p_{34} $+(1/8)$
p_{33} $+(1/16)$ etc.

Therefore the largest possible negative number is represented by m.s.d. alone (and is $-(1/2)$). When all the digits are present the number represented is very nearly zero, since:

$$(1/4)+(1/8)+(1/16)+\ldots+(1/2^n) = (1/2)-(1/2^n)$$
(where $n = 31$).

When a negative number is indicated by the presence of m.s.d., a negative voltage, equal in magnitude to the

Fig. 5. Screen characteristic of CV4014



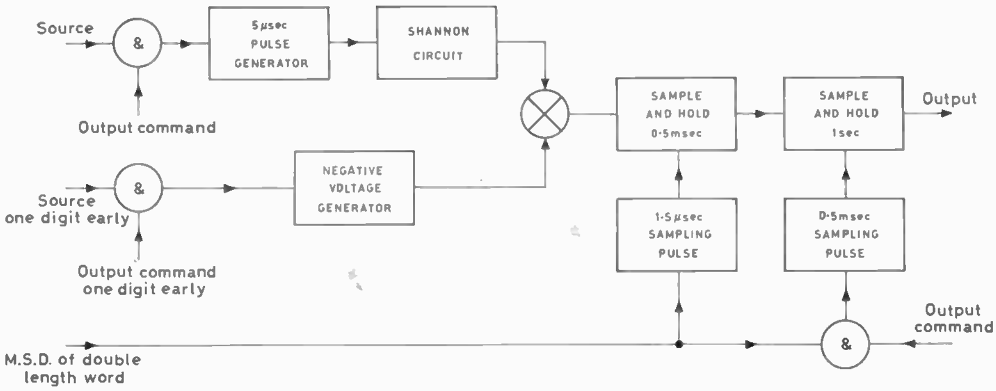


Fig. 6. Arrangement of the complete decoder

largest possible positive voltage, is subtracted from the output of the Shannon circuit. The negative voltage is obtained from a multivibrator, triggered by m.s.d., Fig. 6, whose output is of controlled amplitude. It is added to the signal from the Shannon circuit at the cathode-follower input to the first sampler. It is convenient to obtain the triggering pulse for the multivibrator one digit period early from the computer, relative to the train of pulses triggering the Shannon circuit. The sampler operates then at the same instant for both positive and negative numbers.

The Complete System

The various gates are arranged, Fig. 6, to give zero output continuously, unless the command signal is introduced to the computer programme. The first sampler is triggered once per word and normally therefore resets itself to zero. The second sampler has a very low rate of drift and is only triggered by the command signal. The gates themselves are built into a rack on the computer and four wires are used to carry signals to the decoder.

The command itself is a normal function of the computer. It can, if necessary, be used in the programme, but is avoided by the programmer so that spurious results are not obtained.

Setting-Up Procedure and Results

The critical circuit constants may be adjusted independently by applying three forms of binary number in turn.

The response to a single digit depends on the time-constants of the Shannon network and resonant compensating network, and on the time-constants of the d.c. coupling networks. These are adjusted so that the responses to single successive digits (excluding m.s.d.) are in the required ratio of 1:2.

If the number is made up of a series of digits the accuracy of the output depends upon the feedback to the current generator. The gain of the feedback valve must be adjusted until the currrent switched into the Shannon network produces a constant voltage change across the capacitor, independent of the initial voltage.

Finally, the correct response to a negative number is obtained by adjusting the amplitude of the negative signal applied to the sample and hold circuit. This is conveniently achieved by applying a number consisting of all digits (including m.s.d.) and adjusting for zero output.

Over short periods of time, the accuracy of decoding is better than $\pm\frac{1}{4}$ per cent and over long periods the errors are less than ± 1 per cent.

Acknowledgment

The author wishes to record his appreciation of the help given him by Dr. J. L. Douce at all stages of the work.

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A Solar Powered Warning System

A solar-powered v.h.f. radio alarm system designed to broadcast instant warnings of power network failures, high water levels or other danger conditions, has recently been developed. It is believed to be the first commercial application in this country to make use of the sun's energy.

Even on the dullest days, sufficient radiation penetrates the atmosphere to activate the solar cells which keep the nickel-cadmium battery, the only power supply needed, fully charged. If a normal mains supply is available a battery charger can replace the solar convertors.

The compact, fully-transistorized radio transmitter with its bank of solar convertors can be easily mounted on top of remote high voltage transmission line towers or in similar exposed locations where normal power supplies are not available.

When a pre-determined danger point is reached, an alarm contact brings the transmitter into operation and warning signals are transmitted to a central control point.

The equipment has been developed by British Telecommunications Research Ltd, a subsidiary of Automatic Telephone & Electric Co. Ltd, in collaboration with the Central Electricity Research Laboratories, Leatherhead. Production of the equipment has already begun at the Shropshire factory of A. T. & E. (Bridgnorth) Ltd, another Plessey Group company.

In addition to electricity, gas and water undertakings, the warning system has widespread applications for the police, ambulance and fire services. Street corner push-button installations would eliminate the need for extensive cable laying and could send radio alarm signals direct to control centres or patrolling vehicles. Other possible applications include the signalling of river water levels, tide levels, and flood conditions for river boards and harbour authorities. It could also provide alarms on aircraft collision warning lights on high buildings, radio masts and high voltage line towers.

Known as the type 68 system, the equipment has been designed to operate in conjuction with the v.h.f. radio control networks operated by many public utilities. Use is normally made of the frequency allocated to the mobile-to-base channel of these networks, so that alarm facilities can be provided without the need for additional radio channels.

Particular attention has been given to developing a self-contained weatherproof equipment for use in all situations, over a wide temperature range especially those where remote unattended operation is required, so that maintenance visits are virtually eliminated.

The fully transistorized crystal-controlled transmitter is G.P.O. approved and operates in the 68 to 88Mc/s band. It provides an output of approximately 200mW into a 75Ω load. It is expected that versions for high band (170Mc/s) operation will be available later. Power supplies are obtained from a battery of sealed nickel cadmium cells within the transmitter case. A regulator circuit limits the potential to which this battery can rise, and by this means loss of electrolyte due to gassing is minimized.

Closure of an external alarm contact or switch energizes the transmitter, which radiates a signal to the base station in the form of 'bursts' of audio tone modulated carrier. Alterations of the audio tone and the time interval between bursts allow for identification of one of a number of stations within a group, while the use of a modulated keyed carrier reduces interference with the normal speech from mobiles stations.

Short News Items

The Institute of Physics and The Physical Society propose to hold a second annual conference on solid state physics at the H. H. Wills Physics Laboratory, University of Bristol, from 5 to 8 January 1965.

This conference will follow the same general pattern as the meeting held there in January this year, it will provide an opportunity for workers in all branches of the solid state field to meet and discuss recent developments, and contributions on any topic of current interest in the field will be considered. To enable new work to be included, the deadline for offers of contributed papers has been set at 20 November 1964. Offers of contributions should be made to the conference Secretary, Dr. D. A. Greenwood, H. H. Wills Physics Laboratory, Royal Fort, Bristol 8.

Accommodation will be available at one of the University Halls of Residence. Enquiries regarding attendance should be made to the Administration Assistant, The Institute of Physics and The Physical Society, 47, Belgrave Square, London S.W.1.

At the Group Exhibition in Peking, organized by the Scientific Instrument Manufacturers' Association, equipment valued at nearly £½ million is being shown from 15 to 25 April. This will be the first major exhibition of British instruments ever to be held in China and 28 companies will occupy a space of 1 300 square metres at the Peking Exhibition Centre.

Submarine Cables Limited, owned jointly by AEI and BICC has received contracts valued at £2M for three wideband submarine telephone cable systems for North Sea routes as follows:—

UK-Norway, 385 nautical miles of cable and 52 repeaters to be ready for service by the autumn of 1966.

UK-Holland, 110 nautical miles of cable and 14 repeaters to be ready for service by mid 1966.

Norway-Denmark, 79 nautical miles of cable and 10 repeaters to be ready for service by the autumn of 1966.

The systems will employ fully-transistorized submersible repeaters providing 480 telephone circuits of full CCITT 4kc/s bandwidth—equivalent to 640 circuits of the narrower (3kc/s) bandwidth normally employed on transocean routes.

The submersible repeaters are to an entirely new design of Submarine Cables Ltd and will be manufactured at their Erith Works while the cable will be made at their Greenwich factory. The special submarine system terminal-station equipment will be manufactured by AEI to Submarine Cables Ltd's requirements.

Mullard Equipment Limited has developed a single-sideband version of the current British Army double-sideband field communication equipment type C.11. It has a daylight range of 90 miles —double that of the d.s.b. equipment— and a lower power consumption. Peak envelope power output under two-tone test conditions is 150W.

Most of the existing d.s.b. installation is retained and all the s.s.b. units are interchangeable with their d.s.b. counterparts. With the exception of the final power amplifier the equipment is transistorized throughout.

The equipment is intended for single-frequency simplex operation over a frequency range of 2 to 16Mc/s

A synthesizer has been designed which can be set-up manually by the trained personnel who would normally operate the equipment. It provides any specified channel frequency (in integral multiples of 1kc/s) in the range 2 to 16Mc/s, to an accuracy of one part in 10^6 of the nominal frequency and stable to within ± 10c/s at 16Mc/s over a temperature range of − 40°C to + 55°C.

The Third Canadian I.E.E.E. Symposium on Communications will be held at the Queen Elizabeth Hotel, Montreal, Quebec, on 25 to 26 September 1964.

Technical papers are solicited on subjects of interest to engineers and scientists working in the communications field, giving a broad interpretation to the term 'Communications'.

Persons wishing to present papers are requested to submit the title and a 350 word summary by 15 April 1964, for consideration and selection by the Technical Programme Committee. A short biographical note should be included also.

The 350 word summaries and biographical notes should be forwarded in triplicate before 15 April, 1964, to: Dr. F. G. R. Warren, Technical Program, Canadian IEEE Symposium on Communications, P.O. Box 802, Station B, Montreal, Quebec, Canada.

The second television service has now been brought into operation in Paris on Band IV.

The transmitting equipment has been designed and manufactured by the Compagnie Francaise Thomson Houston and is installed at the top of the Eiffel Tower. Operating at a frequency of 479Mc/s with a power output of 10kW, the equipment uses the new ceramic tetrode transmitting valves developed by the Company.

This is the first transmitter to be installed for the second channel, a similar transmitter is now being installed at Lyon, to be followed later this year by a 50kW transmitter at Lille-Bouvigny.

Three new trunk telephone switching centres are to be brought into operation by The General Post Office to deal with the large amount of trunk telephone traffic to and from the Home Counties, much of which now circulates via London.

The first of these centres is now in operation at Cambridge. The second centre at Tunbridge Wells will come into use in the spring and the third, at Reading, towards the end of the year.

The Production Engineering Research Association of Great Britain (PERA) has developed a new type of parametric amplifier for use on v.h.f. and u.h.f. bands, and which is, it is believed, suitable for mass production.

The parametric amplifier developed at PERA uses a computer diode for the parametric device and a new type of transistor for the pump source. Instead of the distributed circuit normally used, a lumped circuit has been developed.

Operating in the non-degenerative mode, excellent results have been obtained on the 145Mc/s communication band where measured performance has shown that the internal noise factor does not exceed 1dB over a 2Mc/s bandwidth with a gain factor of 17dB. Experiments have shown that a very low noise factor can be obtained on the band 4/5 television frequencies.

The Royal New Zealand Air Force has ordered the new AR-1 radar, Decca's multi-purpose air surveillance equipment, for installation at Whenuapai, near Auckland.

Whenuapai, where the AR-1 will come into service this year is some twelve miles north west of Auckland and is at present the major civil and military airfield on the North Island of New Zealand. In two years time all civil operations will move to a new £10M airport under construction to the south of Auckland, Whenuapai continuing as a military base.

The Decca AR-1 is a medium range surveillance radar specially designed to carry out all terminal air traffic control functions from very close range out to about 75 miles. It combines high definition and rapid renewal of information with greatly improved air surveillance radar characteristics. This leads to the radar's high versatility giving gap free cover to 75 miles at 50 000 feet, yet performing all close range functions to the full standards laid down by the International Civil Aviation Organization.

The BBC has placed a contract with the Marconi Company for the supply and installation of u.h.f. aerials at Sutton Coldfield, for coverage of the Birmingham area, and at Wenvoe, for coverage of the South Wales area.

These new aerials will be the first of their kind to be introduced in this country. They will consist of a number of fibreglass cylinders with the dipole aerials mounted on panels attached to the inside. In this way the cylinders not only provide excellent weather protection but will also act as the supporting structure. The whole assembly, measuring 5ft in diameter and having a length of 43ft (32ft for the Wenvoe installation), will be attached to the top of the existing 750ft masts.

Although, at the moment, only intended for radiation of BBC 2 programmes, an additional feature of these aerials is that they can radiate up to four programmes simultaneously. This will enable future additional programmes to be added without disturbance to the aerial system.

Enfield-Standard Power Cables Ltd is to build a new cable factory at Cambuslang, near Glasgow. It will provide over 350 new jobs and an investment of more than £2M in an area with a high unemployment level. Building work will start immediately, and the plant should be in operation within a year.

The Television Society announces that in future two Silver Medals will be presented annually for outstanding artistic achievement in television.

It is anticipated that one Medal will be awarded to an artist for outstanding artistic achievement in front of the camera and the second Medal will be presented for outstanding artistic achievement in television behind the camera.

The next presentation of these awards will be made at the Society's Annual Dinner and Dance on Friday 8 May, 1964, at the Dorchester Hotel in London and the names of the recipients for this year will be announced for release on that date.

The Ministry of Information and Broadcasting, Malaysia, has now awarded EMI Electronics Ltd a further contract to supp y equipment for the first phase of the Malaysian Television Service.

Included in the contract are two image orthicon cameras and associated equipment, picture monitors, vision and sound mixing consoles, for use in a second studio at Kuala Lumpur.

This order follows within three months the previous contract awarded to EMI to provide equipment for the Malaysian Television Service.

'Recent Advances in Semiconductor Applications' will form the subject of a two-day course to be held at Slough College on 18 and 19 March. The fee for the course is £3 10s—and applications should be made to the Head of the Science Department, Slough College, William Street, Slough, Buckinghamshire.

The British computer industry has benefited from five new contracts signed by D.S.I.R. for research and development into advanced computer techniques.

This project, designed to support the industry's already considerable research and development efforts, is to cover a four year period during which £1½M will be spent, of this half a million is being used to step up work in government laboratories and another million will be spent in industry, half of which will be contributed by D.S.I.R. and half by the firms.

The five contracts so far signed are worth more than £300 000. Two of the major contracts are with Plessey-UK Ltd. and Elliott Bros. (London) Ltd. Plessey are to do work on integrated transistor digital circuit development. Elliott Bros. will work on tunnel diode logic. They cover a period of two years.

Two contracts have been placed with Standard Telephones and Cables Ltd. The first is to investigate means of obtaining substantially increased reliability and possible automatic maintenance of computers with only a minor increase in costs. The other is for the development of a spark-machining process for the production of the accurate and complex masks required when using thin film techniques, for instance in the manufacture of cryotrons.

The first contract announced in September 1963 was with Mullard Ltd for the development of a cryogenic store.

The Radiochemical Centre of the U.K.A.E.A. has recently opened a showroom at Amersham to display the Centre's products, services and literature. In addition, arrangements have been made to feature displays of nucleonic instruments and other equipment through the co-operation of the Scientific Instrument Manufacturers' Association. These instrument displays will cover various aspects of radioisotope handling and applications, the subject of the exhibit changing quarterly. The first of the displays was installed at Amersham in January by seven S.I.M.A. member firms and shows a range of radiation dose-rate monitoring equipment.

A diagnostic system based on the Ural-2 electronic computer has been designed at the cybernetics laboratory of the Soviet Institute of Surgery headed by Alexander Vishnevsky. This system is now used for diagnosing two groups of diseases—congenital heart defects and diseases of the liver and bile tracts.

The machine has made several hundred diagnoses. The calculation data has helped the doctors to specify the nature of the disease.

The same laboratory has produced an automated medical archive, making for the fast and exact classing of medical data according to the symptoms of a disease. The classing can be done in any given direction and data can be obtained on cases of a rare disease, similar to the one observed by the doctor.

Surgeon Vishnevsky holds that logical and mathematical principles underlying these systems (diagnostic and information) are universal and can be used for different classes of diseases.

Hudson Electronic Devices Ltd has received a £19 000 order from the G.P.O. for 180 portable radio telephone sets for use by their external construction staff when engaged on the installation of underground telephone cables.

The sets are a modified version of the Hudson type FM 113 for short range use and operates in the v.h.f. band 71 to 175Mc/s with an output of 1W (de-rated in the U.K. to 0·5W to meet G.P.O. specifications.)

Weighing only 10 lb the FM 113 is compact and has low power consumption. Under average conditions it operates for 24 hours on 10 photoflash-type dry batteries contained within the set itself, which measures 10½in by 8in by 4in.

Meter-Flow Ltd, a subsidiary of S.E. Laboratories (Holdings) Ltd of North Feltham, Middlesex, has won a £20 000 contract for flow meters and associated electronic equipment from the Russian Organization for the Import and Export of Instrumentation. 'Mashpriborintorg'. It is intended for an oil refinery, and covers 56 complete systems, ranging from ¼in up to 6in.

Meter-Flow have now had contracts worth more than £80 000 from the Russians.

The electrical properties of polyphenyls is the subject of a report recently issued by the Electrical Research Association. The report contains measurements of the permittivity, conductivity and breakdown strength of two commercial materials referred to as polyphenyl A and polyphenyl B, in fresh and degraded state. The report also contains a partial interpretation of these measurements in terms of the conductivity as a function of temperature and chemical state. Polyphenyl A is a mixture of ortho, para and meta terphenyl. Polyphenyl B is a eutectic mixture of 26·5 per cent diphenyl for use as high temperature dielectrics.

The full report entitled "The Electrical

Properties of Polyphenyls" by V. Daniel, Ph.D., F.Inst.P., contains ten pages of text, two tables, five figures and one photograph.

Copies of the report priced at 10s. 6d. plus 6d. postage, are obtainable from the Electrical Research Association, Leatherhead, Surrey.

An 'Industrial Automation Group' has been set up by the fifty-two Industrial Research Associations in this country.

The first meeting of the I.A.G. was held in December 1963 and a start was made on formulating projects suitable for collaboration between Research Associations. Such projects will be based initially on current work in the Research Associations.

In addition a programme of new industrial automation projects is being prepared. Applications will be made to the Government for special financial support to assist Research Associations in undertaking operational surveys which will assist the promotion of automation in the industries they serve. These industries represent over 60 per cent of manufacturing industry in the United Kingdom.

The Independent Television Authority has placed a contract with EMI Electronics Ltd to supply and install an aerial, mast and feeder system at Rumster Forest, Caithness, to transmit the existing Independent Television programme on channel 8. The mast is also designed to take the extra load, on its top, of a u.h.f. cantilevered aerial capable of transmitting up to four u.h.f. programmes.

Present aerial will be vertically polarized and will operate in Band III. The 80ft directional aerial will consist of eight rings, each of three high-gain full-wave dipole panels, arranged as two independent 40ft arrays near the top of the mast. Each of these arrays will continue to operate if a fault develops in the other and each will be fed by a 3½in diameter semi-flexible transmission line. The maximum effective radiated power of the aerial will be 30kW.

Sub-contractor for the design, manufacture and erection of the 750ft high triangular lattice steel mast is British Insulated Callender's Construction Limited.

Scheduled date for completion of the contract, which is worth £120 000 is spring, 1965.

British Relay Ltd has acquired the whole of the issued share capital of Antiference Installations Ltd.

British Relay intend to continue the business of Antiference Installation Ltd as part of its Special Services Division—a Division which specializes in television and sound systems in hospitals, factories, school and public buildings and hotels.

British Relay's Services Division already has a very substantial business in providing master aerial systems for both television and v.h.f. radio in blocks of multi-storey flats throughout London and the provinces, and the merging of these two businesses will provide a strong organization for the extensive work of adapting master aerial systems to receive 625 line u.h.f. transmission and to meet the demand for new systems.

Subject to the necessary consents, it is intended to change the name of Antiference Installations Ltd to British Relay (Installations) Ltd.

'Medical Electronics and Biological Engineering' is the subject for a Special Course of six lectures to be held each Tuesday evening from 7 to 9 p.m., commencing on 7 April, 1964, at Norwood Technical College, Knight's Hall, S.E.27. The Fee for the Course is 15s—and the lecturer is W. J. Perkins, A.M.I.E.E., M.Brit. I.R.E.

Mr. Perkins is Head of the Instrument Laboratories at the National Institute for Medical Research and is Secretary of the Biological Engineering Society. He is also the President of the International Federation for Medical Electronics and Biological Engineering.

The object of the Course is to show to engineers and physicists the application of electronics in medicine and biology. At the same time we aim to interest students in the medical electronics field.

Cable and Wireless (WI) Ltd has announced a £3M (15 million W. Indies dollars) project in the Eastern Caribbean.

The Company proposes to establish a multi-channel tropospheric scatter and microwave system between Barbados and Antigua with connexions from Antigua to N. America by submarine coaxial telephone cable and out to the Commonwealth and rest of world.

The islands to which this scheme will bring greatly improved communications are Antigua, Barbados, Dominica, Grenada, Montserrat, St Kitts, St Lucia, St Thomas, St Vincent and Trinidad,

Rank Cintel, a division of The Rank Organization has received two export orders totalling almost £9 000 from Holland and Australia for projectile velocity measuring equipment.

The Dutch order is of particular interest because the system includes, for the first time, three of the new type 1032 Rank Cintel/Systron 2·5Mc/s counter timers. The 1032 is of solid state construction and includes large figure in-line read-out with automatic blanking and either twin or single channel plug-in modules. This order also comprises five 'Skyscreens' for use with horizontally fired projectiles together with ancillary equipment.

The Australian order is for eight 'Skyscreens' of the type designed for use with projectiles fired in elevation which include a specially constructed lens system.

The two types of 'Skyscreen', to be supplied under these orders, operate on the photoelectric principle and rely on the interruption of the light path to a photoelectric cell.

G.K.N. Screws & Fasteners Ltd has given its ICT 1201 computer to the Chance Technical College, Smethwick.

The 7 year old 1201 has been made of no commercial value to G.K.N. by the purchase of a new IBM 1410, nevertheless it is of great value for teaching purposes, and the College will use it for this purpose and for advanced mathematics, with the possibility of College administration applications following later. While no charge is being made for the computer, Chance Technical College will remove, install and maintain it at its own expense.

D.S.I.R. is providing substantial support for the UK contribution to the International Years of the Quiet Sun (IQSY). This is an enterprise in international scientific collaboration aimed at obtaining a better understanding of how the sun's behaviour influences the earth.

Nine universities and colleges are between them receiving £100 000 in the form of thirteen special research grants. Investigations by DSIR's Radio Research Station are being carried out at Halley Bay, Antarctica; Port Stanley, Falkland Islands; Singapore; Lerwick, Scotland; and Slough Buckinghamshire. The Radio Research Station is also responsible, on receiving notification from the USA, for transmitting to British observatories warnings of special geophysical conditions.

The IQSY(1 January, 1964 to 31 December, 1965) coincide with a period of minimum sunspot activity. The scientific programme carried out will complement observations made during the International Geophysical Year (1 July, 1957 to 31 December, 1958) when the sun was last at its most active. The preparation and co-ordination of the UK programme is in the hands of the Royal Society's British National Committee for Co-operation in Geophysics.

The university and college groups being assisted by DSIR are covering all of the IQSY programme subjects except meteorology. These are geomagnetism, aurora, airglow, ionosphere, solar activity, cosmic rays and aeronomy. Of concern to the Radio Research Station are geomagnetism and the ionosphere. Its ionosphere research includes the receiving and analysis of telemetered information from the top-side sounding satellites, and low and very low radio wave propagation studies.

Correction

The International Flight Test Instrumentation Symposium at the College of Aeronautics, Cranfield, will be held from 13 to 16 April and not 13 to 14 April as stated on page 114, February issue.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

Transistors as Rectifiers

DEAR SIR,—Mr. Hood's letter 'Transistors as Rectifiers' in your January issue prompts me to write of the experience of these laboratories where a very similar arrangement has been studied in connexion with the development of high efficiency high current rectifier systems.

Where the forward voltage drop of silicon rectifiers is an appreciable fraction of the output voltage it is natural to turn to germanium in order to take advantage of the lower forward voltage drop associated with junctions in this material. Unfortunately few germanium rectifiers are available commercially and for currents of the order of 20A we have made use of transistor junctions which have been designed for very high current working. In the literature the use of the collector-base diode is recommended but with this simple connexion the forward voltage drop is still significant. We therefore tried the combination of collector to

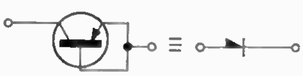


Fig. 1. Super diode using c-eb connexion

emitter and base (see Fig. 1) and found that the forward voltage drop was approximately halved. We have also experimented with the connexion suggested by Mr. Hood and have found that the performance obtained is very little different from our preferred arrangement of collector to emitter and base.

The reasons for our preference for this form of connexion are twofold. Firstly, it is the collector base diode which has to perform the blocking function and in many transistors the reverse voltage rating of the collector base diode is considerably greater than that of the emitter base diode which would be used as the blocking diode in Mr. Hood's arrangement. Secondly, in most power transistors the collector junction is usually larger than the emitter junction. The resistance associated with the bulk material of the collector electrode is therefore likely to be less than the equivalent resistance associated with the emitter electrode. By splitting the current flowing in one electrode of the super-diode between the emitter and base leads it was felt that a slightly lower forward voltage drop might be obtained. Experimental work has verified that this, in fact, is so, although the reduction obtained by using the c-eb connexion rather than cb-e connexion is only marginal in the types of transistor tested here.

Typical curves showing the forward characteristics of collector to base diodes and both forms of super-diode are shown in Fig. 2 for power transistors of the

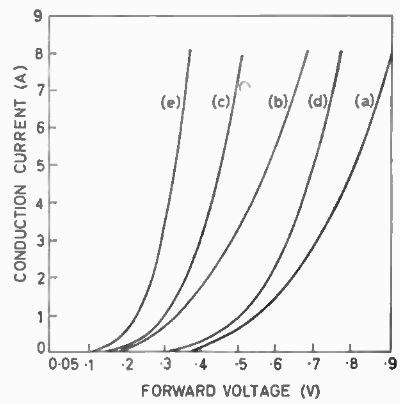


Fig. 2. Characteristics of power transistors used as rectifiers

(a) ADZ11 c-b
(b) ADZ11 cb-e
(c) ADZ11 c-eb
(d) 2N2728 c-b
(e) 2N2728 cb-e and c-eb

ADZ11 and 2N2728 types. The curves for the c-be and cb-e connexions for the 2N2728 differ only by about 15mV and in consequence only one characteristic is shown to cover both connexion arrangements.

The improved forward characteristics are apparently obtained at the expense of worsening the reverse characteristics of the blocking diode whether it be the collector-base or the base emitter diode depending upon the method of connexion. This state of affairs might be predicted in a rudimentary way from an examination of the diffusion equation for a diode

$$I = I_{sat}\,(e^{qV/kT} - 1)$$

where the symbols have their usual significance.

The factor $(e^{qV/kT} - 1)$ is obviously a constant for a given applied voltage and temperature. An increase in I_{sat}, the reverse current, by a factor, say b times, will therefore result in the forward current being increased by b times for the same applied voltage. Measurements of I_{sat} or reverse current for the various configurations confirm this quite closely.

In the cb-e configuration it was found that the reverse current for the 2N2728 was approximately ten times the reverse current for the emitter base diode alone. Similarly, the forward current for a fixed voltage is increased by the same order of magnitude.

Yours fathfully,

J. W. McPHERSON,

The General Electric Co. Ltd.
Stanmore, Middlesex.

The Correspondent replies:

DEAR SIR,—I have read with interest Mr. McPherson's letter on the use of 'cb-e' and 'c-eb' connected transistors as augmented or 'super' diodes, and I am in full agreement with his observations, both concerning the effect that this method of connexion will have upon the reverse leakage current of the system, and also upon the desirability of reversing the connexion of the transistor where the reverse voltage rating of the system is of importance.

However, our own experience had suggested that there was generally little operational difference between the two methods of connexion, and that, in fact, when one connects the transistor in the 'c-be' form, this merely has the effect of reversing the functions of the 'collector' and 'emitter', so that the region labelled 'collector' becomes the new emitter and the region labelled 'emitter' becomes the new collector. The transistor is therefore still 'cb-e' connected."

Yours faithfully,

J. L. LINSLEY HOOD,

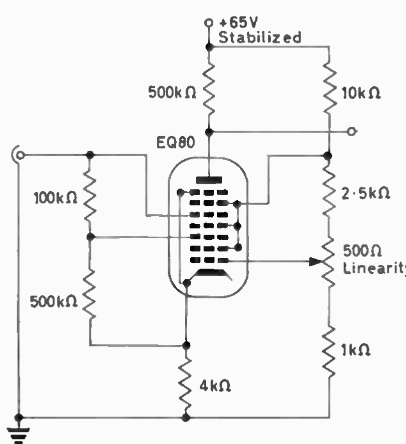
British Cellophane Limited,
Bridgwater, Somerset.

Multi-Electrode Valve Multipliers

DEAR SIR,—A recent article by Mr. Jirafe (November 1963 issue of *Electronic Engineering*) describes a multiplication circuit which is suitable as input for an electronic wattmeter. The article criticizes conventional multiplication circuits either as using non-linear characteristics of active components, or, in the case of multi-electrode valves, though the linear part of the characteristic can be used, as handling only a small range of signal voltages. Similarly, Hall effect multipliers, though remarkably linear, are of extremely low input impedance.

We have found that the enneode type EQ80 forms a simple multiplier when the inputs are applied to g_3 and g_5. This has been used as a squarer (Fig. 1) directly coupled to an *RC* integrator; the combination forms an electronic d.c. milliwattmeter[1] designed for continuous operation. In the circuit of Fig. 1, the voltage gain $e_o/e_{in}^2 = 6$, and the characteristics have remained stable over several thousands of hours operation. In parti-

Fig. 1. The squarer



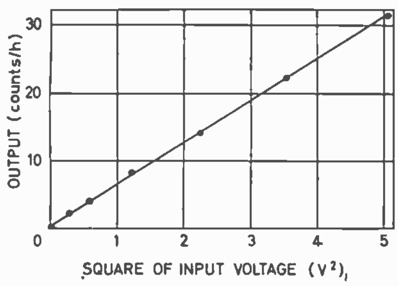


Fig. 2. Performance of wattmeter

cular, d.c. zero drift is very low, since g_1 is tied to a fixed point to cancel heater-voltage fluctuations, a source of error in Mr. Jirafe's circuit.

The performance of the wattmeter is shown in Fig. 2. Deviations from an exact square law are due to the slightly sigmoid nature of the 'linear' characteristic of the EQ80.

Yours faithfully,

V. A. STEPHEN,
W. W. FORREST,

C.S.I.R.O. Division of Biochemistry and General Nutrition, University of Adelaide, South Australia.

1. FORREST, W. W. Calorimeter for Continuous Study of Heat Production of Microbial Systems. *J. Sci. Instrum.* *38*, 143 (1961).

The Author replies:

DEAR SIR,—I have read Messrs. V. A. Stephen and W. W. Forrest's comments on my article with great interest and would agree that an enneode instead of a heptode as used by earlier workers, will improve the performance of multi-electrode valve multipliers particularly as regards the linear range of signal voltages. It could also facilitate to compensate for heater voltage fluctuation which is one of the sources of d.c. zero drift.

I would like to point out that my multiplier will be free from any zero drift since its output is in the form of an alternating voltage which can be fed to the next circuit in the chain if any, using *RC* coupling. Heater and other supply voltages might affect the calibration if they are not properly stabilized.

Yours faithfully,

W. J. JIRAFE,

Indian Institute of Technology, Bombay, India.

A Short Term Analogue Data Storage Circuit

DEAR SIR,—I am referring to Mr. Griffiths' letter (October 63) commenting on an article 'A short term analogue data storage circuit', by Mr. Wager. It happens that I read Mr. Griffiths' letter first.

I designed a storage circuit which employed current feedback with the same aim as Mr. Griffiths, namely to balance the leakage currents. The 'battery' was a Zener diode fed from a current source. In order to stabilize the working conditions of the buffer transistor its emitter return was also held at a Zener voltage below the emitter. This makes it, I think, a Chinstrap/Bootstrap circuit. The detailed design figures were given in 'Electronics' January 1962 pages 79 and 80. Since that time the buffer transistor was changed to silicon and so I_{CBO} became negligible.

I would like to question Mr. Wager on his article. Why does he not mention the leakage characteristics of VT_8, the discharge transistor, and what are the magnitudes of the currents into VT_3 and VT_4. In the case of VT_3 it would appear that it would be $\beta \times I_{CBO} + I_b$ or something approaching this there are high impedance conditions in that transistors base.

Yours faithfully,

J. BAULDREAY,

I.C.T. (Engineering) Ltd., Whyteleafe, Surrey.

The Author replies:

DEAR SIR,—I refer to Mr. Bauldreay's query arising from my article in the April, 1963, issue of your journal.

I did not refer specifically to the leakage current of the discharge transistor VT_8 since in this case the base supply is of low impedance and I_{cbo} for this transistor can be neglected, bearing in mind the fact that the storage capacitor is of large value. Speculation as to the magnitudes of the currents in VT_3 and VT_4 individually is not really necessary, since the only factor determining overall store performance with regard to droop of the output during the storage period is that the algebraic sum of the currents at the junction of VT_3 collector, VT_4 base and the store capacitor shall be small.

The circuit Mr. Bauldreay describes in 'Electronics' January, 1962, was only operated over a small range of ambient temperature and in the environment for which my store was designed the balancing of leakage currents to zero could prove difficult, hence my use of a large store capacitor to mask the effects of unwanted currents.

Yours faithfully,

J. H. WAGER,

The University of Birmingham, Birmingham, 15.

The Correspondent replies:

DEAR SIR,—With regard to Mr. Bauldreay's letter, possibly owing to the wrong diagram having been printed with my letter, he misunderstood the current feedback arrangement I had.

The one he describes in his letter feeds back a constant current to the storage capacitor, a more or less constant current being taken from it during its storing mode of operation.

The storage capacitor of my circuit has a leakage which varies with voltage in an approximately linear manner with a zero offset. Consequently a current feedback amplifier which supplies current at a rate proportional to voltage and has a zero offset will approximately neutralize the leakage. The approximation was good enough for my requirements. If it had not been, it would have been possible to make the current feedback amplifier non-linear and shaped to the leakage characteristics of the storage capacitor. Secondly it may be possible to go to greater lengths than I did to minimize the order of leakage current concerned.

Yours faithfully,

D. T. GRIFFITHS,

Mullard Equipment Ltd, Crawley, Sussex.

Number of Sections for a Delay Line

DEAR SIR,—For an *LC* delay line of *N* identical symmetrical *T*- or π-sections and nominal time delay *D*, the cut-off frequency is

$$f_c = N/\pi D \quad \text{........... (1)}$$

As this cut-off frequency is approached, however, the errors in both matching and time delay increase until, at the cut-off, the reflection becomes total and the delay rises 57 per cent above nominal (the phase delay becoming π radians instead of 2 radians per section).

I have worked out direct formulas (2) and (3) for the number of sections *N* necessary in order to keep these errors within required limits.

For matching accuracy

$$N \geqslant (\pi/2) fD (1/r)^{1/2} (1+r) \quad \text{...... (2)}$$

where *D* is the nominal delay, and $r(>0)$ is the absolute value of permissible reflection coefficient at frequency *f*. (Note: voltage reflects without change of sign for *T*-sections, and with change of sign for π-sections.) It is assumed, of course, that the line is terminated in its nominal characteristic impedance, i.e. $(L/C)^{1/2}$.

For delay accuracy

$$N \geqslant \pi (60^\circ/\delta)^{1/2} (fD + (\delta/360^\circ))^{3/2} \quad \text{... (3)}$$

where $\delta\ (>0)$ is the permissible phase delay error at the end of the line at frequency *f*.

Formula (2) is exact, while formula (3) is slightly pessimistic, as it is based on the approximation

$$\delta/N \simeq (1/24)\phi^3 \quad \text{........... (4)}$$

(in which both the error per section δ/N and the actual phase delay per section ϕ are in radians), while in fact

$$\delta/N = \phi - 2\sin(\phi/2) < (1/24)\phi^3 \quad \text{... (5)}$$

Number *N* given by formula (3) is in the worst instance too high by 6½ per cent, and this occurs only at cut-off frequency, for which the correct *N* is given by equation (1). For frequencies well below cut-off, i.e. permissible delay errors well below 57 per cent, the over-estimate of *N* by formula (3) is negligible.

Yours faithfully,

A. LEWKOWICZ,

Northampton College, E.C.1.

BOOK REVIEWS

Semiconductor Fundamentals: Devices and Circuits

By A. H. Seidman and S. L. Marshall. 278 pp. Med. 8vo. J. Wiley & Son Ltd. 1963. Price 50s.

THE book is intended as a first introduction to the physics, technology and circuit applications of diodes and transistors. It begins with a discussion of semiconductor physics, the pn junction diode and its applications to rectifiers, modulators and gating circuits. The next three chapters deal with the transistor action; types of transistors, their technology and circuit properties; *T*- and *h*-parameter equivalent circuits. Next graphical analysis; bias stabilization; power, feedback, tuned amplifiers types and oscillators are considered. The remaining part of the book deals with digital computer circuits, the tunnel diode and its circuit applications, and measurement of diode and transistor *h*-parameters. Each chapter ends with a selection of problems with answers at the end of the book.

In their preface the authors state that the book will provide a firm background of transistor fundamentals for students and electronic engineers. The book suffers from quite a number of serious shortcomings. For example, the dynamic current transfer characteristic of Figs. 8.12 and 8.13 give the impression that the collector current increases with increasing base current; this of course is erroneous. On page 129 a numerical example is worked giving a voltage gain of 2·26, a current gain of 100 for a load resistor of 3kΩ; this corresponds to an input resistance of over 100kΩ for a common emitter stage which hardly seems factual. On page 174 when calculating the influence of a by-pass capacitor on the gain of a stage the authors ignore the fact that the effects of resistance and capacitance do not add up arithmetically. The symbolism is inconsistent in that in chapters 8 and 9 different symbols are used to signify the d.c. values of collector current and collector voltage.

In spite of the above criticism the newcomer to the field of transistor circuits can find the book to be a useful one.

S. S. HAKIM

Electric Filter Circuits

By Emrys Williams. 163 pp. Demy 8vo. Sir Isaac Pitman. 1963. Price 25s.

THE majority of the 163 pages of this book is devoted to a study of loss-free Zobel filters. Only in the final chapter are hyperbolic functions used and the general treatment requires little more mathematics than the ability to manipulate complex numbers. There are many examples, some of which extend the matter in the text, and answers are given to all of them. The author has not been concerned with rigour in his approach and some theorems are used which are either proved in part only or not proved at all. The style is friendly but not colloquial and the book is well illustrated.

Although the work is well done, it is doubtful whether, in 1964, it is fair to the reader to limit a book of this length to the narrow and impracticable aspect of filter theory outlined above or to assume that there is a large number of readers unable to handle hyperbolic functions but able to understand the theory of electrical networks.

J. T. ALLANSON

Introduction to Lasers and Masers

By Allan Lytel. 95 pp. Demy 8vo. Foulsham-Sams. 1963. Price 16s.

THIS is an American book which apparently sets out to provide the intelligent layman having some electronics background with a readily comprehensible introduction to masers and lasers and to provide some indication of the range of applications, both actual and projected, of these devices.

The first thing one would look for in such a book would be some discussion of the origin and nature of the energy states of ions in a crystalline or gaseous environment. Agreed this is difficult but not impossible to present at an elementary level and one feels that Mr. Lytel's discussion which goes no further than the Bohr model of the hydrogen atom is just not good enough. The discussion of the principles of the operation of masers and lasers which follows is vague in the extreme and no real idea is given as to how it is that the same material can function both as an amplifier of microwaves and as a coherent light source.

Proceeding from principles to devices, Mr. Lytel discusses the solid state maser and illustrates his discussion not with reference to any of the known maser devices but with an imaginary device (figs. 2.7 and 2.8) which is misleading.

In a chapter on Modulation and Detection, Mr. Lytel embarks on a detailed discussion of the travelling wave tube (which is barely relevant) and in fact devotes considerably more space to this device than to the maser; even this discussion, however, is not free from error. A fourth chapter discusses flash tubes and power supplies again in disproportionate detail and following a chapter on Laser Communications (based on the erroneous information that a laser has a 10% bandwidth) the book concludes with a discussion of Laser Applications which dwells largely on the rather sensational possible military aspects.

In terms of the accuracy of its material and balance of its presentation the standard of this book is deplorably low and one cannot agree with the author of the preamble to the English edition that it "really does explain the basic principles of Masers and Lasers". Far from it, this book can only confuse the uninitiated and amuse the initiated and one cannot recommend it to any class of reader.

J. C. WALLING

Automatic Data Processing

By F. P. Brooks and K. E. Iverson. 494 pp. Med. 8vo. J. Wiley & Son Ltd. 1963. Price 80s.

WRITTEN by two senior IBM engineers, this volume is paradoxically both up-to-date and out-of-date. Apart from an introductory first chapter on fundamentals and a second on manual data processing equipment, it treats data processing entirely in terms of the IBM 650 computer and its associated peripheral equipment. The result is that although many of the techniques described are relevant to modern machines they are presented in the context of an obsolescent computer.

The authors, in their preface, justify this approach by pointing out that the IBM 650 is not untypical of modern computers and that the use of a specific machine to illustrate general principles offers a number of advantages over the hypothetical machines favoured by some writers in this field. In the reviewer's opinion the results have largely justified the method; the field of coverage is sufficiently restricted to permit detailed explanations of most topics and yet is wide enough to give the newcomer to data processing a good overall picture of the problems he may encounter and the available means of solution.

Chapter 1 is an introduction to the fundamentals of numbering systems, codes and logical design. The treatment is brief but adequate for the purpose of the book. A second chapter deals with manual processing equipment and briefly describes various document copying, filing, and indexing systems and the operation of desk calculators.

Chapter 3 commences the main treatment and deals in great detail with punched card handling equipment and the operations it can perform. There is no comparable section on other input-output media. Three chapters follow on the coding, internal organization and programming of the IBM 650. One facet of these sections illustrative of the general tone of the book is the discussion on optimum programming, rendered unnecessary in latter-day machines by fast access computing stores. The final three chapters discuss searching and sorting techniques, metaprograms and data processing system design.

Each chapter is provided with numerous exercises, a small proportion of which are selected for solution at the end of the book. One criticism of the exercises is that the solutions to many are not to be found explicitly in the text and the student would need access to an experienced instructor if he were to benefit fully from them.

The index is excellent and printing and production are of a very high standard.

G. H. STEARMAN

Digital Computer Technology and Design. Volume II

By Willis H. Ware. 548 pp. Med. 8vo. J. Wiley & Sons Ltd. 1963. Price 90s.

THE volume starts with part II of Chapter 7 and is a continuation of the final chapter of Volume 1 which dealt with reliability. Thus the emphasis is again on the essential intrinsic property of all digital computers. Chapters eight, nine and ten deal respectively with toggle circuits, gates and miscellaneous circuits in a most thorough manner starting from the basic elements, both active and passive, and building up to complete configurations. The theme of reliability is carried throughout by emphasis on the need for the allowable spread of design parameters and the cause and effect of marginal operation.

Chapters 11 to 14 inclusive consider the larger components of a digital computer dealing respectively with the arithmetic unit, store, control and input-output. Throughout these chapters the role of the programmer is mentioned where appropriate drawing attention to the fact that it is the programmer who makes a computer perform its task. Each chapter has a section of examples, problems and collateral reading.

The final chapter starts by putting the contents of both volumes into context by means of the detailed information flow diagram of a typical computer, HYPAC 1, designed by the author. After further generalities the book ends on a philosophical note. In essence Dr. Ware makes the point that advances in the technology of digital computing can be taken only so far in the field of theoretical studies. For significant advances to be made computers must actually exist and be made available for use in all branches of science and technology. His concluding sentence ". . . . it is to adventuresome workers in programming, machine organisation and circuit technology that we look for new insights and flashes of wisdom," is singularly apt.

T. R. H. SIZER

Digital Computer Design

By E. L. Braun. 606 pp. Med. 8vo. Academic Press Inc. 1963. Price 118s.

THIS is an extremely good book. It is long and expensive, but in spite of going at times into considerable detail the author has contrived to keep it readable. Of course, with respect to the dust jacket, which states that it will enable the reader to produce designs ... ... of stored programme machines, one cannot really learn to design computers from a book. The author explains how to synthesize various systems on a functional basis. Such circuitry as is given does not include component values. This approach is justified on the grounds that technical developments are at present so rapid that any detailed study is out of date before such a book can be written, let alone published. Although the reviewer is in general agreement with this approach, he would like to have seen at least a section dealing with problems of circuit design itself. Even if out of date, the approach and methods of attack for this problem would have been of value to students who study the subject to this level.

The author takes a little while to get into his stride and the introduction is rather elaborate. For the main content, it is difficult to have anything but praise. After a chapter on Boolean algebra, an account is given of the various electronic devices used in the construction of building blocks. Another chapter gives a review of current storage systems, and perhaps the best chapter in the book deals with the means by which arithmetical operations may be carried out. The problem of designing a complete system is examined, as it were, from a distance and worked out in a specific case. There are further chapters on digital differential analysers and on the correction of errors. The number of references is enormous and no less than 650 separate authors are named. Most of the references are from U.S. sources, which is natural. It is, however, surprising to find that on the subject of thin film research there is no reference whatever to the pioneering work done in England, much of which has been published in the United States. This is a book which should be in the library of every electronic research establishment.

F. L. WESTWATER.

RCA Phototube and Photocell Manual

192 pp. Demy 8vo. Radio Corpn of America. Price $1.50

The manual provides the circuit designer with information on phototubes and photocells from photoelectric theory to measurement techniques to technical data for each photosensitive device in the RCA line.

The technical data section gives extensive coverage of ratings, characteristics, spectral response curves, outline and terminal-connexion diagrams, socket and shield information, and contains more than 150 design curves for 19 gas types, 14 vacuum types, and 34 multiplier photo-tubes, as well as 23 photocells.

'The Engineer' Index 1856-1959

244 pp. Med 4to. Morgan Brothers (Publishers) Ltd. 1964. Price £8.

The Index is in two parts, 'Names' and 'Subjects'. Included in the 'Names' section are company names, personal names, pseudonyms, place names and names of ships, bridges, etc. The 'Subjects' section contains entries referring to constructions, instruments, machinery, plant, processes, etc. Both sections contain many cross-references.

The Index lists 77 of the many libraries in the world that hold complete sets of 'The Engineer'. In addition, the publishers offer a photo-copy service for which order cards are provided inside the back cover of the volume.

Electronic Equipment at

THE PHYSICAL SOCIETY EXHIBITION

A description compiled from information supplied by the manufacturers, of a small selection of the electronic equipment, exhibited at the 48th Physical Society Exhibition, held in London from 6 to 9 January.

(Voir page 197 pour la traduction en français; Deutsche Übersetzung Seite 206)

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A beat detector enables a.f. beats to be obtained from a built-in loudspeaker for unknown inputs in the frequency

range 10kc/s to 30Mc/s; sub-audio beats may be displayed on an edge-scale meter and a filtered output of beat frequency is available at a front-panel socket for use with an external frequency meter. Unknown inputs may also be compared with the standard frequency on a built-in c.r.t. which can be switched to give either a Lissajous or a Z-modulated circular trace display.

Both the c.r.t. and the meter may be switched for internal circuit checks; divider operation down to 100c/s is checked on the c.r.t. and below 100c/s on the meter, which can also be switched to monitor internal voltages.

Operation is from a.c. mains or 12V accumulator (which may be floated on the mains) with automatic changeover in the event of mains failure.

EE 67 751 *for further details*

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c.w. power, sideband power, and modulation depth in the frequency range 1 to 1 000Mc/s.

Carrier and sideband powers are indicated directly on a 3½in scale meter in one of two ranges 0 to 100mW and 0 to 300mW, selected by a front panel switch. For modulation measurement the carrier power is first noted, the selector switch turned to 'modulation', and the meter needle brought back to its original reading by rotating a calibrated potentiometer; percentage modulation depth is then indicated directly on the potentiometer scale.

For carrier measurement no additional power source is necessary; internal dry batteries provide power for sideband and modulation measurement, and have a life in use of several hundred hours.

The r.f. input is taken to a standard Airmec connector type 341 mounted on the front panel and there is also a co-axial output socket for the modulation waveform, enabling it to be observed on an oscilloscope.

EE 67 752 *for further details*

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This instrument (type EM6B) is a high resolution electron microscope based on the design of the EM6, but extensively modified to make it particularly suitable for biological work. The object has been to combine high performance on transmission specimens with extreme simplicity of operation.

The electron optical system is based on a new objective lens, designed for optimum performance, and projector lenses which provide a continuous range of magnification from × 1 000 to ×

250 000. Particular attention has been given to ease of operation and the number of controls has been reduced to less than half those on any other high performance electron microscope. The specimen holder can accommodate three samples at one loading to speed the rate of examination. The accelerating voltage can be selected from the range of 30, 40, 50, 60 or 80kV as desired by a single switch.

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Features of the tube are:

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(c) Sensitivity: threshold of detectability 50 photo-electrons per image point;

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i_a (pk) (A)	1.0	200	700	1000	2000	10000
I_a (av) (A)	0.3	0.35	1.25	1.0	3	15
Pb factor	1000	2200	10000	10000	20000	80000

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Ranges are provided having full-scale deflexions of 100mV to 1 000V for a.c./d.c. voltage measurements and 30μA to 3A for current measurements (a.c. or d.c.) with an accuracy to ±3 per cent of f.s.d. The nominal potential drop is 30mV on all current ranges. Resistance may be measured between 0·5Ω and 20MΩ (mid-scale values 20Ω, 2 000Ω and 200,000Ω).

Two panel mounted switches 'function' and 'range' select all available facilities. The meter is fully protected against accidental over-load and provision is made for centre zero operation.

The instrument is battery operated and two 9V batteries with a life of approximately 500 hours provide the supply lines for the amplifiers and resistance measurements.

EE 67 755 *for further details*

IN-SITU TRANSISTOR TESTER

This is a new portable, battery operated transistor tester for the 'in-situ' testing of signal or medium power pnp or npn transistors.

Carefully designed circuits balance out the shunting effect of components external to the transistor under test. A d.c. bridge circuit balances the in-circuit components connected to the transistor collector and enables the collector current and voltage to be set to the required value. An a.c. bridge circuit balances out the in-circuit components connected to the base of the transistor under test and enables β to be measured at the a.c. bridge frequency of approximately 1 000c/s.

The collector current is continuously variable up to a maximum of 10mA. Current gain (β) within the range 0 to 150 and 0 to 300 may be measured either 'in-situ' or out of circuit and leakage current I_{co}' is indicated directly on the meter with the transistor out of circuit.

The instrument will be supplied complete with two probes, one specially designed for in-situ testing to enable contact to be made with the copper side of a printed circuit board, the other for out-of-circuit testing or for use when sufficient length of wire connexion is available.

A battery check facility ensures that the supply voltages do not fall below the limit required for satisfactory operation. Overload protection is provided by an internal circuit limitation.

EE 67 756 *for further details*

BELL & HOWELL LTD

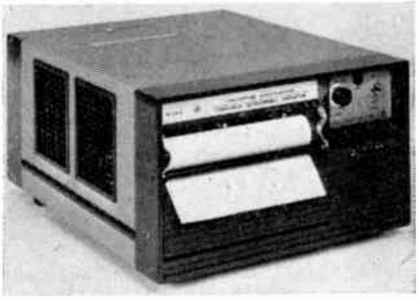
Consolidated Electrodynamics Division, 14 Commercial Road, Woking, Surrey

ULTRA-VIOLET RECORDING OSCILLOGRAPH

(Illustrated below)

This portable recording oscillograph is very easy to load and to operate and, for its size it is versatile and accurate.

The recorder produces 7in wide records by the print-out process, requiring no chemical processing. Data from d.c. to 10kc/s can be recorded on eighteen separate channels using Consolidated Electrodynamics 7-300 series galvanometers in onjunction with recently developed high speed print-out papers.



In addition to timing lines and grid lines positive trace identification is accomplished by a sequential interruption gap appearing in each trace every 12in. Opposite each interruption a trace number corresponding to the galvanometer position is printed along the edge of the oscillogram.

Trace widths are 0·1in or less. Recording speeds are selected by push-button and any of the five speeds can be selected before or during recording.

The instrument measures 7¾in × 13in × 15½in and weighs 40 lb.

EE 67 757 *for further details*

CAMBRIDGE INSTRUMENT CO. LTD

13 Grosvenor Place, London, S.W.1

DISPLACEMENT TRANSDUCER

This prototype transducer measures displacement over a wide range, for example, from 0 to 4μm up to 0 to 4mm.

It comprises four dust cores with similar windings arranged in pairs and in opposition, one pair acting as a transformer primary with its coils connected in 'series aiding', the other acting as a secondary with its coils connected in 'series opposition'. The moving member consists of a conducting vane located between the opposing pairs of coils.

An a.c. signal is applied to the primary windings, the output from the secondary being amplified and then detected by a phase sensitive rectifier whose reference voltage is derived from a transistor oscillator supplying the primary. There is no net output when the vane is positioned symmetrically with respect to the two halves of the secondary windings, but if it is moved so that it covers more of one secondary than of the other, then there will be a net output, the amplitude of which is proportional to the movement of the vane. This relationship is linear up to about ±2mm, the output phase changing through 180° at the point of symmetry.

EE 67 758 *for further details*

COSSOR INSTRUMENTS LTD

The Pinnacles, Elizabeth Way, Harlow, Essex

WIDE BAND OSCILLOSCOPE

The model CT476 is a wide band oscilloscope featuring a 5in diameter cathode-ray tube operating at 10kV providing a window display area 6cm × 10cm.

The instrument is designed for inter-service use, and has a bandwidth from d.c. to not less than 56Mc/s (−3dB) at sensitivities from 50mV/cm to 20V/cm, and from 3c/s to 40Mc/s at, from 5mV/cm to 2V/cm.

Signal delay of 150nsec is incorporated to permit observation of the leading edge of the triggering waveform. The main time-base has 24 calibrated ranges from 5sec/cm to 0·1μsec/m and any range can be expanded × 5; it can be triggered from sine waves 5Mc/s to 25Mc/s on the internal trigger mode, and from 5Mc/s to 50Mc/s externally.

An automatic mode facilitates locking on recurrent signals with repetition rates from 30c/s to 2Mc/s without control adjustments. Calibration accuracy is within ±3 per cent of full scale on basic ranges, ±5 per cent with × 5 expansion.

The main 'A' sweep can be delayed by a second time-base 'B' which is calibrated from 2μsec/cm to 1sec/cm in a 1, 2, 5 series, providing a sweep delay up to 10sec.

Z axis modulation is provided by 500Mc/s ±2 per cent and 50Mc/s ±2 per cent markers, triggered from the 'A' sweep which provide an accurate measuring system for pulse rise times.

The *X* amplifier has a bandwidth of d.c. to 2Mc/s at sensitivity range 1V/cm to 100V/cm. An additional plug-in unit, model 1 085S, converts the instrument to a dual-channel oscilloscope, with bandwidth d.c. to 40Mc/s at sensitivity range 50mV/cm to 20V/cm. A further plug-in unit, model 1 080S, has a bandwidth d.c. to 1Mc/s providing sensitivity range 1mV/cm to 50V/cm.

Cossor standard camera fixing is provided.

EE 67 759 *for further details*

DAWE INSTRUMENTS LTD

Western Avenue, Acton, London, W.3

PRECISION SOUND LEVEL METER

(Illustrated on page 190)

This instrument is designed as a portable precision sound analyser weighing approximately 12lb with batteries. It is fitted with a capacitor microphone and measures sound level from 20dB to 140dB with reference to a standard level. The microphone is mounted on a probe containing the cathode-follower unit and may be used with a 25ft extension cable between the probe and the instrument.

Standard 'A', 'B' and 'C' weighting networks are included which meet B.S., I.E.C. and A.S.A. Specifications. A linear response from 15c/s to 50kc/s is also provided from the amplifier.

Frequency analysis is performed by the detachable 600Ω octave band filter which has a range from 31·5c/s to 31·5kc/s in accordance with the proposed I.E.C. specification for octave filters.

The attenuation of each filter band is independently adjustable down to the minimum noise level of the amplifier.

An output is available to feed a tape recorder or other instruments such as a high speed level recorder or statistical analyser.

EE 67 760 *for further details*

DECCA RADAR LTD

Albert Embankment, London, S.E.1

ELECTRON SPIN RESONANCE EQUIPMENT

This exhibit consisted of a complete 100kc/s modulation e.s.r. spectrometer. A low noise klystron is phase-locked to a harmonic of a quartz crystal, thus ensuring excellent frequency stability. Facilities are provided for varying the incident power, selecting the pure absorption mode and observing the spectrum on an oscilloscope or pen recorder. Extra units can be added to convert to superhet detection and 33c/s modulation is also available for special applications.

The sensitivity of the system exhibited is $1{\cdot}5 \times 10^{12}\Delta H$ spins for 1mW cavity power with a 1sec time-constant.

EE 67 761 *for further details*

DEVICES LTD

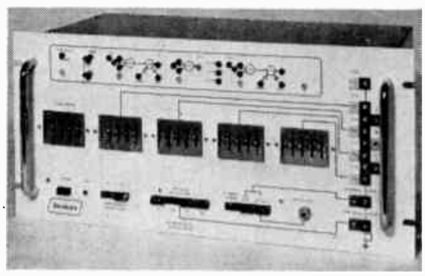
13-15 Broadwater Road, Welwyn Garden City, Hertfordshire

DIGITAL TIME INTERVAL MARKER

(Illustrated below)

This instrument is designed to deliver preset patterns of timed impulses to initiate events required in many electro-physiological or psychological experiments. These impulses could trigger stimulus generators, to evoke a response from the physiological mechanism being studied, and time-base generators to allow observtion and timing of the electrical concomitant of the response on a cathode-ray tube.

The use of digital techniques gives high precision to the setting (and re-setting) of the timed pulses while a quartz crystal clock pulse generator ensures high accuracy of timing. From this clock pulse generator a time scale is formed to calibrate the time-base



velocity. Marks forming the time scale may be selected from the range 0·1msec to 1sec to be appropriate to the time-base velocity. Additional marks denoting the release of the various events appear on the time scale if desired. The Digitimer may be set to run continuously, the programme of events repeating at regular but adjustable intervals in the range 0·1msec to 10sec, or triggered by an external mechanical or electrical signal. A diagrammatic connexion board on the front panel of the instrument allows internal circuits to be connected to produce square wave and/or pulse trains of variable duration.

EE 67 762 *for further details*

EKCO ELECTRONICS LTD

Southend-on-Sea, Essex

TRANSISTORIZED PULSE COUNTING SYSTEM

Ekco Electronics are introducing a new range of transistorized counting equipment of higher specification and complementary to the existing Thermonic range. A comprehensive autoscaler-ratemeter system, applied to general pulse counting or spectrometry, illustrated the use of some of the basic units of this new range. The functional units used to build this particular system are: high voltage unit, amplifier—pulse height analyser, scaler, timer and ratemeter, together with new transistorized versions of the N676 high resolution, or N691 general purpose, scintillation counter probes.

Some of the features of this system as applied to gamma spectrometry are: stability not worse than 0·1 per cent throughout, bandwidth 10Mc/s, dynamic range 50:1 with overload capability of 100:1 for recovery time not exceeding 1μsec. The resolution of this system is basically 0·1μsec, but the scaler unit is standard at 1μsec, optionally 0·1μsec. With the N676 probe a graded resolution is obtainable up to a peak-to-valley ratio in excess of 6·0:1 on Cobalt-60 and digital display of all appropriate operational settings is provided.

EE 67 763 *for further details*

EMI ELECTRONICS LTD

Hayes, Middlesex

OSCILLOSCOPE

(Illustrated below)

The WM41 is a general purpose transistor oscilloscope with bandwidth of d.c. to 10Mc/s (−3dB) and sensitivities from 50mV/cm to 20V/cm in 9 switched ranges. Input impedance is 1MΩ in parallel with 30pF on all ranges.

The following facilities are provided:

Trigger

Selection: internal, external and external attenuated 20:1 (all of either polarity).
Mode: a.c. and automatic.

Time-base ranges

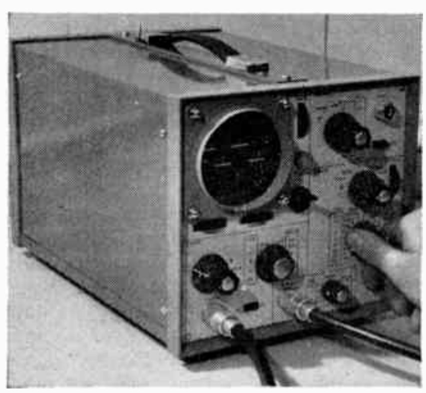
Unexpanded 200nsec/cm to 100msec/cm in 18 switched ranges. Continuous expansion × 1 to × 5 calibrated both ends.

Voltage calibrator

This produces a 7kc/s square wave with a rise time of better than 1μsec. The amplitude can be varied in 8 steps from 200mV to 40V.

Mains supply and battery facilities

Normally main supply operated over the range 200 to 265V or 100 to 132V, 50 to 60c/s. Alternatively an external 12V battery can be used. The approximate power required is 18W.



The WM41 will work over an ambient temperature range of −5 to +40°C.

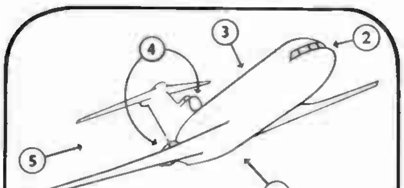
EE 67 764 *for further details*

'ELECTRON STICK'

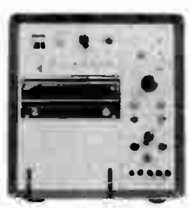
This is a new aid to technical educa-

S.E.L. and aviation

S.E.L. instrumentation is in use on the Hawker Siddeley Trident, 600 mph short- and medium-range jet airliner. S.E.L. equipment was used both for research testing on the ground and in the air, as well as for production tests, to examine and record pressures, rotational speeds, mass flows and a number of other parameters. S.E.L. equipment is selected not only for measurement and recording in the aviation industry but is in use in practically all other branches of engineering where it provides complete and practical instrumentation systems, second to none in reliability and accuracy, at a reasonable cost.



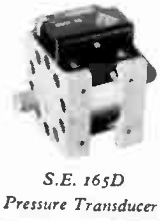
1. Pressure transducers in undercarriage hydraulically actuated control surfaces general system pressures
2. Solenoid Valve control on "stick pusher"
3. Mass air flowmeters in pressurised cabin
4. Pressure transducers for engine pressures
5. Accelerometers to measure "G" and vibration levels



SE. 2000 Recorder

E.S. 105 Valve

S.E. 75 Pressure Transducer



S.E. 165D Pressure Transducer

S.E. 910 Mass Flow Computer System

The S.E.L. equipment in use on the Hawker Siddeley Trident includes mass air flowmeters, pressure and displacement transducers, and accelerometers. Associated electronics and amplifiers are of rack mounting design as well as encapsulated units and ground flutter recordings have been carried out on various models of S.E.L. U.V. direct - read - out multi - channel recorders.

S. E. LABORATORIES (ENGINEERING) LTD

606 North Feltham Trading Estate, Feltham, Middlesex. Telephone: Feltham 5876

a subsidiary of S. E. LABORATORIES (HOLDINGS) LTD.

tion which enables the chief characteristics of a wide variety of microwave tubes to be shown to students at 1/20th of the cost of using the individual tubes.

The electron stick is in essence an isolated electron beam which may be inserted into various external circuits. By this means certain microwave tubes, such as the travelling-wave tube, two-cavity klystron amplifier, Adler tube and backward-wave amplifier, may be constructed in order to demonstrate the principles of operation in a versatile and inexpensive manner.

EE 67 765 *for further details*

ELECTRONIC APPLICATIONS (COMMERCIAL) LTD

Endeavour House, North Circular Road, London, N.W.2

ULTRASONIC LEVEL GAUGE

This instrument employs a narrow beam ultrasonic echo sounding technique to measure distance from its transducer to a liquid or solid surface. The time that elapses between transmission pulse and echo is measured and displayed digitally giving a reading proportional to distance.

A 150kc/s oscillator is pulsed approximately twice per second. The oscillator output is used to drive a lead zirconate piezoelectric transducer which is resonant at this frequency. The resulting ultrasonic pulse is propagated in air in a 3° cone and reflects from any surface normal to its path. The same transducer receives the echo and the corresponding voltage signal is amplified.

Coincident with the transmission pulse, an electronic gate is opened, permitting pulses from a stable oscillator to pass to a three-decade transistor counter, with in-line read-out. Reception of the echo signal closes this gate. The next transmission pulse cancels the count stored in the counter and the sequence is repeated.

The number registered by the counter at each sounding is a measure of the time taken for the sounding and is thus proportional to the distance between the transducer and surface. The present equipment reads in units of 0·in, has a maximum range of 10ft and an accuracy to 0·2 per cent ±1 digit over this range.

A limit facility is incorporated so that a relay may be set to operate over a range of any ten digits characterized by the two most significant figures of the reading.

The instrument's main use is in the gauging of the liquid contents of tanks. In this application a calibration graph of volumetric content against instrument reading is first prepared and this is used subsequently for content measurement. The system has the outstanding merit that no contact whatever with the liquid is required. This is most important in applications requiring a very high degree of hygiene and also where problems of corrosion are present.

EE 67 766 *for further details*

ELLIOTT-AUTOMATION LTD

34 Portland Place, London, W.1

SLOW SPEED INDUCTION MOTOR

(Illustrated below)

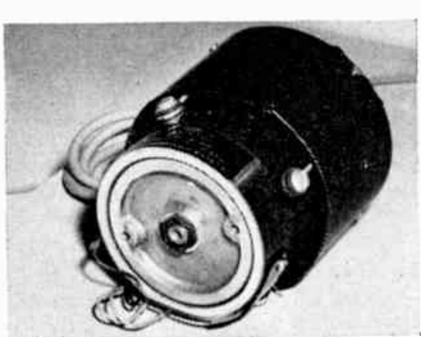
A new type of slow-speed, high-torque induction motor known as the Steromotor is now being manufactured by the Servo Components Division of Elliott Brothers (London) Ltd a member of the Elliott-Automation Group. This unit is of a fundamentally new basic conception in that it gives a high-torque output at a low shaft speed without the need for reduction gearing. Furthermore it has the property of providing extremely rapid starting and stopping, and is thus particularly suitable for automatic and servo control duties.

The motor comprises a wound stator excited with alternating current which produces a double rotating magnetic field, and a permanent magnet 'rotor' which does not rotate in the normal sense but gyrates about a very small radius. The gyratory motion of the rotor is converted to rotary motion by means of hypocycloidal gearing. In practice, the rotor has end-disks of slightly smaller diameter than their enclosing roll-ways. The disks roll over the inside of the roll-ways and this causes a slow-speed revolution of the rotor with a corresponding high-torque output.

Owing to the small radius of gyration of the rotor its inertia is negligible and the time required for the motor to start or stop is less than 10msec. As the rotor does not strictly revolve, it has no bearings but instead roll-ways coupled with a flexible output shaft, while the stator has a flexible mounting. No brushes or sliprings are used and the stator windings are encapsulated in order to ensure reliability under the most severe environmental conditions.

A particular feature of the motor is that it can be repeatedly started, stopped, reversed or stalled under load without any adverse effects. Apart from its use as a continuously revolving induction motor it can also be operated as a stepping motor if the stator is excited from a direct current supply via an appropriate control circuit.

The motor is particularly suitable for servo control purposes or applications requiring very rapid and critical response to input signals. In high-speed servo systems no feedback tachometer is required since the motion is essentially 'deadbeat'.



Motors are available in torques from 9lb-in down to zero and in higher torques up to 900lb-in. They are at present suitable for normal voltage, single or polyphase, 50 or 60c/s power supplies, or for d.c. power supplies if step-by-step operation is required.

EE 67 767 *for further details*

FEEDBACK LTD

Crowborough, Sussex

INSTRUCTIONAL SERVO SYSTEM

(Illustrated below)

This servo system is intended for use by students and embodies many features to enable introductory control theory to be investigated both in principle and in details.

The system is in two units, a control unit which contains the necessary amplifiers, power supplies, etc., and a mechanical assembly which contains the motor, reduction gears, and error channel potentiometers. Both units are mounted in a single case.

Basically the system has a velocity lag characteristic with a single defined time-constant associated with the motor. The error signal is supplied to an operational amplifier in the control unit which can be used to add error and velocity feedback signals. This amplifier can also be used to introduce an additional integration or time-constant into the forward path so that the system can be made unstable and compensation techniques investigated. The front panel carries a diagrammatic representation of the internal circuit connexions. The mechanical assembly is arranged to slide out for easy access. The motor and gear train are mounted directly on a single plate enabling the gear ratio to be changed easily.

The system contains a number of useful features such as provision to reverse the sense of the error or velocity feedback, also the necessary components to introduce integration or a time-constant in the forward path. In addition the power supplies in the control unit are suitable to operate standard feedback analogue computer units to be used in conjunction with the system for relay control investigations, etc. The system can be supplied in a taller case with provision for mounting analogue units between the mechanical assembly and the control unit.

EE 67 768 *for further details*

FERRANTI LTD

Ferry Road, Edinburgh, 5

MOIRE FRINGE MEASURING EQUIPMENT

The equipment exhibited comprised a single axis prototype model of a new range of Moire fringe measuring equipment which will be in production during 1964. Compared with previous Ferranti equipment in this field the new range has several interesting features:

The four count per grating pitch arrangement has been extended to give ten to twenty counts per pitch.

The four photocell waveforms from the reading head are applied to a feedback pre-amplifier and amplifier using silicon transistors, with the addition of a common mode feedback. This arrangement produces a pair of stable symmetrical waveforms in quadrature which can be applied directly to the pulse generating and direction sensing circuits.

Now with a maximum counting rate of 100 000 digits per second as standard, the bi-directional ring counter has a higher maximum counting rate than before. A first stage with a counting rate of 1 000 000 digits per second may be substituted for applications involving high peak velocities.

Important optional equipment includes an input stage check circuit, a complete counter check using the ternary system and an electronic changeover switch giving non-complementary operation. In addition, a c.r.t. monitor unit is available for setting up and checking input waveforms.

Modular construction with easily accessible printed circuit cards and numerical display indicator that can be with or remote from their associated circuits, are main design features. Print-out facilities will be available in compatible construction using magnetic core buffer storage. Associated circuits will be solid state, permitting the use of high-speed tape, punch and data link equipment.

The prototype shown on the stand was operating at twenty counts per grating pitch from a 250 line/mm grating giving a digit size of 0·2 microns. This would be applicable to extremely high precision measurements. However, a system giving a digit size of one micron using 100 line/mm gratings would normally be suitable for most scientific requirements involving the reduction of photographic data.

EE 67 769 *for further details*

THE GENERAL ELECTRIC CO. LTD

Hirst Research Centre, East Lane, Wembley, Middlesex

MAGNETIC FILM LOGIC

Magnetic films providing inexpensive computer memories and capable of fast operation have been developed in cooperation with Salford Electrical Instruments Ltd and the laboratories of International Computers and Tabulators (Engineering) Ltd. Such films have a preferred axis of magnetization in the plane of the film. Each memory element in the film can be magnetized in one direction or the other along the axis (the direction representing 0 or 1) and the magnetization remains in this direction in the absence of a magnetic field. These magnetic films can be used for manipulating information in the logical section of a computer as well as for memory purposes.

The demonstration given showed the operation of a device which forms part of a proposed magnetic film logic system in which the output signals from several storage cells are suitably combined and used to operate subsequent storage cells, all the cells being linked by conducting loops above the film. In the arrangement shown two conducting loops overlap in such a way that the coupling between them is positive, zero or negative depending on the relative permeabilities of the areas of film beneath the overlapping sections: these permeabilities can be changed by the hard direction fields produced by the current flowing in a control conductor lying across the overlapping sections of the conducting loops. A signal representing a binary digit can thus be modified by the coupling arrangement before being used to set a magnetic film storage cell. The cell will store a binary digit of the same sense as the original signal, the inverse of this, or nothing, depending on the value of the control current at the time the cell is set.

EE 67 770 *for further details*

GULTON INDUSTRIES (BRITAIN) LTD

Regent Street, Brighton, 1

CERAMIC TRANSDUCERS

The development of the technology of producing ceramic materials in wafer form with a thickness down to ·003in has led to the manufacture of a range of electromechanical transducers with enhanced properties.

(a) Gramophone Pick-up Elements

In recent years piezo-electric ceramics have started to replace rochelle salt as the sensitive element in pick-ups. A new technique in which the element is constructed of three plates of thin ceramic, a high permittivity material formed into a sandwich between two wafers of piezo-electric ceramic, has led to the production of a range of extremely high capacitance bimorph elements. The capacitance is more than twenty times greater than that of conventional elements so that low impedance transistor circuits can now be fed directly.

(b) Electrostatic Relays

Sheets of oppositely poled piezo-electric ceramic can be bonded together to form a bimorph bending system. Pairs of these benders, clamped at one end and with a contact on the free end, can be used to form relays. Such relays are capable of several million operations and can be extremely small in size.

(c) Piezo-electric Loudspeakers

Bimorph benders, mounted as cantilevers or simple beams, can be used as the driving element of a loudspeaker. Dynamic properties can be controlled by altering the physical dimensions of the ceramic sandwich.

(d) Microphones

The extreme sensitivity and high capacitance of ceramic elements can be used in the construction of high quality microphones.

EE 67 771 *for further details*

J. & P. ENGINEERING (READING) LTD

Portman House, Cardiff Road, Reading, Berkshire

E.H.T. POWER SUPPLY

(Illustrated below)

This instrument provides up to 4kV at 3mA with a stability of 1 part in 10^4. It has been designed and developed for A.E.R.E., Harwell as one of the 2 000 series of unitized nucleonic equipment. The use of semiconductor devices throughout has resulted in a unit approximately one third of the volume of currently available instruments of comparable performance.

The basic design incorporates a silicon controlled rectifier circuit in conjunction with a transistor d.c. to d.c. convertor, enabling the output voltage to be continuously adjustable from zero to 4kV. Decade switching is used with a setting accuracy of ± 0·2V. The output voltage polarity is reversible by means of a switch. The instrument is protected against internal short-circuits by a fast acting trip circuit which also makes it impossible to receive a dangerous electric shock.

The stability of the unit was demonstrated by feeding the output to a voltage drift monitor, which has been developed for this purpose. It contains a precision

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For reliability and efficiency, railway signalling and control systems depend on Wandleside Cables.

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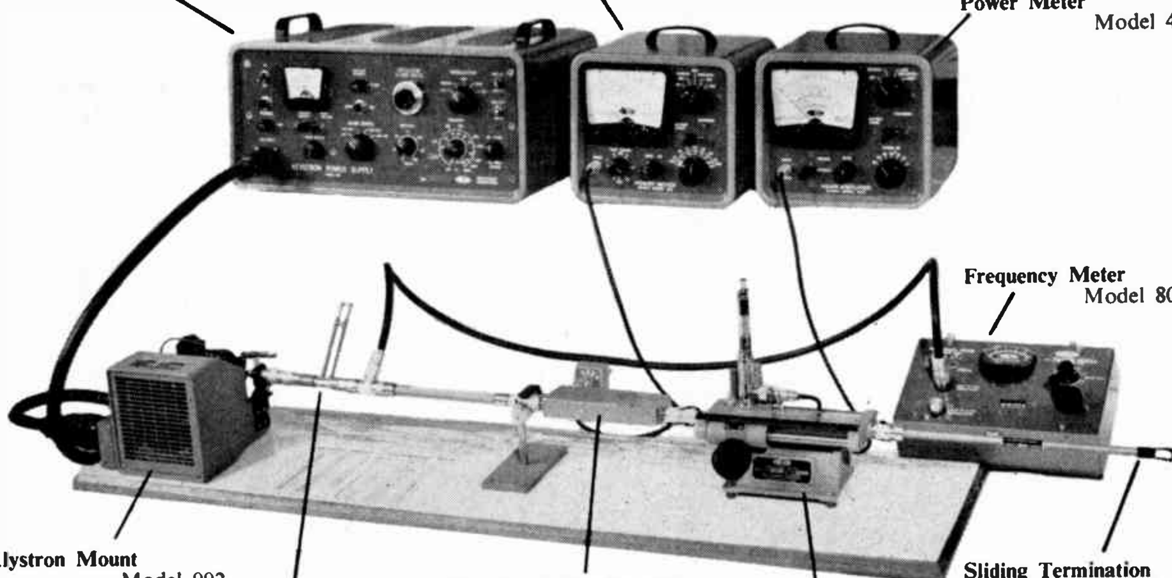
AVEL INSTRUMENTATION

MICROWAVE INSTRUMENTS & COMPONENTS

from

the narda microwave corporation



This illustration shows a typical co-axial setup that may be made for the measurement of impedance, attenuation, and other quantities of co-axial systems. For convenient and accurate measurements, it is very important to use precision made components. NARDA's complete range of co-axial and waveguide equipment is designed to provide flexibility and versatility for all aspects of microwave measurement. Co-axial equipment is available for frequencies from D.C. - 1200 Mc/s., waveguide equipment available for frequencies up to 90 Gc/s.

Details of these and other microwave instruments & components from:—

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voltage divider, highly stable reference voltage and differential amplifier and has an inherent stability of better than one part in 10^5 per week. The output was shown driving a recorder which indicated changes of a few parts per million.

EE 67 772 *for further details*

GEORGE KENT LTD

Luton, Bedfordshire

DISPLACEMENT TRANSDUCER

(Illustrated below)

This device employs a differential transformer and associated solid-state circuits to provide an isolated output current suitable for long-distance transmission of a process variable. The output current, in the range 0 to 10mA, is accurately proportional to the input displacement and an applied control voltage in the range 2 to 5V. The equipment operates from an unstabilized supply of 24V d.c.

Displacement is applied to the core of a differential transformer fed by a square-wave oscillator whose output amplitude is proportional to an applied d.c. control voltage. The transformer output is demodulated and used to control the transmitted current. A variable feedback resistance is used to set the transmitted current and obtain full-scale indications corresponding to displacements from 0 to 0·05in to 0 to 0·25in.

The demonstration showed an application with three variable inputs in which:

$$\text{Output current} \propto \frac{\text{mechanical displacement} \times \text{control voltage}}{\text{feedback resistance}}$$

When required, the control voltage may be replaced by a reference diode and the feedback resistance fixed to obtain the relationship:

Output current $\propto$ mechanical displacement.

EE 67 773 *for further details*

MUIRHEAD & CO. LTD

Beckenham, Kent

DIGITAL READ-OUT SYSTEM

This new instrument, the K-162-A, is of especial interest to research workers engaged in the solution of noise and vibration problems, as it eliminates the tedious work involved in converting data from analogue to digital form. The digital output is intended to operate a tape-punch, but can be used to operate any form of numerical printer, e.g. teleprinter, electric typewriter, in-line printer. Designed to work with Muirhead automatic recording wave analysers, the complete system is fully automatic in operation.

The information appearing on the punched tape is the frequency to which the analyser is tuned, together with the amplitude of signal in that band. The signal to be analysed is recorded on a loop of magnetic tape, and a 'window' is made near the tape-joint by removing a small section of the emulsion. When this 'window' passes a photo-electric device that is situated near the tape, a pulse is produced that initiates a timing sequence.

During analysis, the frequency and amplitude information is presented in analogue form by the analyser and level recorder respectively. At the correct time, both signals are fed to an analogue to digital convertor, which then feeds the tape-punch via an encoder.

Since only one analogue to digital convertor is used, the amplitude and frequency information must be presented to it sequentially: this function is carried out by a synchronous timing device. The timing device also ensures that all the other necessary switching functions are carried out in the correct order, and at the correct time. The timing sequence is initiated by the pulse obtained from the tape loop.

EE 67 774 *for further details*

MULLARD LTD

Mullard House, Torrington Place, London, W.C.1

LIGHT OPERATED SOLID STATE DEVICE

A Transluxor is a light-operated solid state device with a power gain, and properties similar to those of a transistor. It offers the prospect of an attractive alternative to the conventional transistor since it may give a superior performance at u.h.f. and microwave frequencies.

The Transluxor depends for its operation on the highly efficient emission and collection of light in order to obtain a current gain approaching unity, as in the transistor.

Highly efficient emission of light from gallium arsenide junctions was discovered in the latter part of 1962 in the U.S.A. The light is emitted at 8 400Å at a temperature of 77°K, or with considerably less efficiency at 9 100Å at room temperature.

In order to achieve highly efficient collection a hetero-junction is used. In this case it consists of a junction between an n-type region of gallium arsenide and a p-type region of another semiconductor with a smaller energy gap.

The speed of a Transluxor is not limited by the transit time of the signal across the base since the signal is carried by light. However there are effective time spans for the emission and collection of the light and these produce the basic frequency limitations of the device. It is expected that operation at frequencies above 1Gc/s will be possible.

A further advantage of the Transluxor is the possibility of making a four-terminal version in which the input and output are electrically isolated; this version may be particularly useful in computer circuits and is analogous to a relay but of course the speed of operation is much higher.

The exhibits comprised a separated emitter and hetero-junction transmitting an audio modulated high-frequency signal (1Mc/s) which can be interrupted by a shutter.

EE 67 775 *for further details*

G. V. PLANER LTD

Windmill Road, Sunbury-on-Thames, Middlesex

THERMOELECTRIC GENERATOR MATERIALS AND TEST EQUIPMENT

(Illustrated below)

Apparatus was shown for the evaluation of the figure of merit of thermoelectric materials for use at temperatures of up to 600°C, in power generating devices. A steady state, absolute method is employed, the thermal conductivity, Seebeck coefficient and electrical conductivity measurements being carried out on the same test specimen without withdrawal from the apparatus.

A number of experimental samples of high temperature thermoelectric alloys, produced by chill-casting, as well as hot and cold pressing, were shown, including doped lead telluride and germanium telluride compositions and silver antimony telluride. The metal powder mixes in the preparation of the alloys are produced by chemical precipitation methods or by chill casting. The materials are for use in high temperature generators, one such application being in direct conversion generators incorporating a nuclear heat source, for satellites; another use is in high temperature heat flow measurements.

EE 67 776 *for further details*

THE PLESSEY CO. (U.K.) LTD

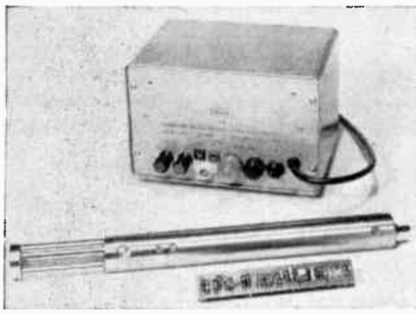
Ilford, Essex

UNDERWATER SOUND VELOCITY METER

(Illustrated below)

This sound velocity meter has been developed for use in oceanography and bathythermograph applications and has the advantage of almost instantaneous velocity measurement—the only practical limit in resolution of the ocean structure lies in the speed of the associated recorder. Accuracy of the meter is ± 1·0ft/sec and maximum depth greater than 2 000ft.; the instrument eliminates errors due to temperatures in the range −5 to +45°C and salinities up to 40 parts per thousand. An f.m. output, easily adaptable to standard recorders, is provided via an armoured single-core cable.

The photograph shows the measuring head (centre) with its internal circuit.



At the rear is a laboratory model of the associated convertor which feeds a direct-reading meter or recorder; final design of the convertor could be considerably reduced in size.

EE 67 777 *for further details*

RESEARCH ELECTRONICS LTD

Bradford Road, Cleckheaton, Yorkshire

EDUCATIONAL NUCLEONIC INSTRUMENTS

(Illustrated below)

This new range comprises simplified and very inexpensive transistorized nucleonic instruments (scaler, ratemeter, castle, etc.) of small size, light weight and robust construction specially designed for the teaching of the revised G.C.E. syllabus in Modern Physics, and incorporating the recommendations of the Modern Physical Science Committee

of the Association for Science Education in conjunction with the Nuffield Foundation. It is anticipated that in addition to schools use, the instruments will be of particular value for certain teaching purposes in Technical Colleges and Universities where the elaboration and expense of more complicated instruments may not be required.

The instruments demonstrated were the simplified scaler and the simplified ratemeter, both with built-in e.h.t. supply for the operation of halogen quenched Geiger Muller tubes. Accessories include a simplified castle for both end-window (solid sample) and liquid sample counting, and a horizontal G.M. tube holder for inverse square law measurements.

EE 67 778 *for further details*

SPERRY GYROSCOPE CO. LTD

Great West Road, Brentford, Middlesex

FIBRE OPTIC FILTERS

The Sceptron is a novel pattern, or signal, recognition device based on the use of optical fibres as resonant mechanical structures. The signal may be of any sort that can be transformed into a pattern of mechanical vibrations, e.g., sound or, by scanning, a topological (visual) pattern.

The basic unit is an array of fibres (typically 1 000 or so) emerging from a common base as cantilever beams. The base is profiled so that the free length of the fibres give a range of natural frequencies in the audio band, say from 200c/s to 5kc/s.

The fibre array is mounted on an electromechanical transducer (e.g. a loudspeaker driver) driven by the signal it is desired to monitor. Fibres are excited into resonance according to the frequencies present in the vibration pattern, and the tips of excited fibres will vibrate about their rest position. Light is passed down the fibres, and thus the signal is transformed into a characteristic pattern of light dots, some stationary and some vibrating, in the plane of the fibre tips. The pattern corresponding to the original signal is stored by means of a mask in front of the fibre tips, which only allows light through when frequencies present in the original signal are excited; thus the amount of light passed through the mask will depend on the degree of resemblance of the monitored signal to the original signal. The light passing through the mask falls on a photocell, and when the output of the cell exceeds a predetermined, arbitrary, level a threshold device operates. This constitutes recognition of the signal. The mask is an exposed photographic plate, and is made by exposing the plate to the vibrating dot pattern of the original signal. (In fact, the masking arrangements are a little more complicated than as described.)

It is evident that the Sceptron is self-programming in a very simple way and no knowledge of the make-up of the signal is necessary. Another important feature is that a very large amount of information can be stored in a very small space. It is now possible to manufacture arrays containing 2 000 fibres with a volume of $\frac{1}{4}$in² ($\frac{1}{2} \times \frac{1}{2} \times$ 1in), each of which can store a large amount of information for a single signal. Arrays considerably smaller than this are under development. Thus a Sceptron signal classifier is likely to be very much smaller than, e.g., an all electronic version.

The Sceptron is as yet in an early stage of development. Present experiments are mostly concerned with the classification of sounds and systems can successfully recognize monosyllabic words spoken by a given speaker. Many other applications are envisaged: character recognition, aids to medical diagnosis, machinery fault diagnosis, etc.

EE 67 779 *for further details*

TELEQUIPMENT LTD

Chase Road, Southgate, London, N.14

EDUCATIONAL OSCILLOSCOPE

(Illustrated below)

This instrument has been designed specifically for educational use.

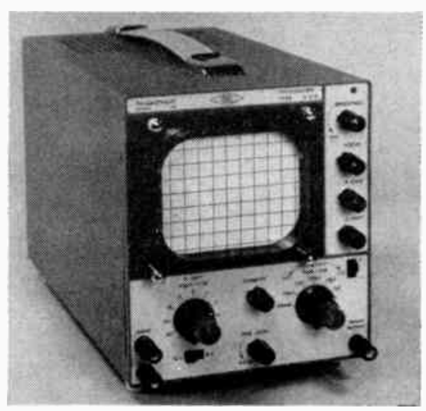
Known as the 'Serviscope' S51E, it fully meets the recent recommendations of the Nuffield Interim Report on the Teaching of Modern Physics, which stressed the need for an instrument combining simplicity, accuracy and versatility.

The S51E, developed from Type S51, incorporates a 5in flat faced p.d.a. tube operated at 3kV, weighs only 16 lb and measures 7in × 15in × 8in.

The time-base of the S51E provides six pre-set calibrated sweep speeds from 100msec/cm to 1μsec/cm. Frequency response of the Y amplifier is d.c. to 3Mc/s at maximum sensitivity of 100mV/cm, while the nine-position frequency-compensated input attenuator gives direct reading from 100mV/cm—50V/cm. Input impedance is 1MΩ+30pF (approx.).

For simplicity of operation by students, the television field facility and internal/external trigger switches are omitted.

The S51E is available with either P1 (short persistence) or P7 (long persis-



tence) tube at no additional cost. A mains on/off warning light is also provided.

EE 67 780 *for further details*

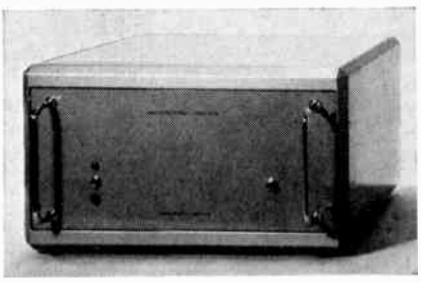
J. LANGHAM THOMPSON LTD

Park Avenue, Bushey, Hertfordshire

ANALOGUE TO DIGITAL CONVERTOR

(Illustrated below)

This convertor changes analogue input voltages of between 0 and −10V to an equivalent binary digital output suitable for feeding to a paper-tape punch-machine or directly to a computer. It is triggered by a 10V positive going step or pulse so that the input voltage can be converted to a digital output at any given instant. Thus, by using a suitable trigger pulse generator, the convertor can be used to produce digital outputs corresponding to the input voltage at regular time intervals.



The convertor uses the straddle balance system to change the analogue input to an eight binary digit output. The full scale input of −10V produces an output of $2^8 = 256$ digit. Each binary digit therefore represents an input of approximately 39mV. The digital outputs are in the form of 0/+12V. Internal boards can be supplied to enable Addo X or Creed punches to be operated.

The unit can be supplied for mounting on a 19in rack or as a bench unit. It is 8¾in high and 11½in deep.

An amplifier which will enable the convertor to function with smaller inputs will shortly be available.

EE 67 781 *for further details*

H. TINSLEY & CO. LTD

Werndee Hall, South Norwood, London, S.E.25

WHEATSTONE BRIDGE

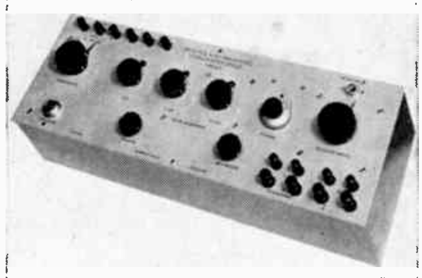
(Illustrated above right)

The main feature of this six-dial Wheatstone bridge is that conductance dials are used in place of series resistance dials. All the switch contacts are in parallel and the coil resistance values are high, hence switch residual resistance is comparatively so low as to be negligible even in the most precise measurements. There are seven ranges. The highest range is up to 100MΩ maximum and lowest range is up to 100Ω maximum.

The lowest stud reading is 0·0001Ω.

The accuracy at 20°C is 1 part in 100 000 of the maximum reading.

EE 67 782 *for further details*



INDUCTIVE RATIOMETER

This instrument is intended to replace the resistance bridges normally used in resistance thermometry. It has seven dials and measures resistance from 1 to 1 000Ω in three ranges, viz. 1 to 10, 10 to 100 and 100 and 1 000Ω. It is therefore suitable for platinum resistance thermometry.

Discrimination is to 1 part in 10^7 and this value is preserved even when the current through the thermometer has the maximum value of 2mA.

Normal operation is on 1kc/s but the instrument can be manufactured to work on other frequencies, if required.

EE 67 783 *for further details*

20TH CENTURY ELECTRONICS LTD

King Henry's Drive, New Addington, Croydon, Surrey

AUTOMATIC LEAK DETECTOR

(Illustrated above right)

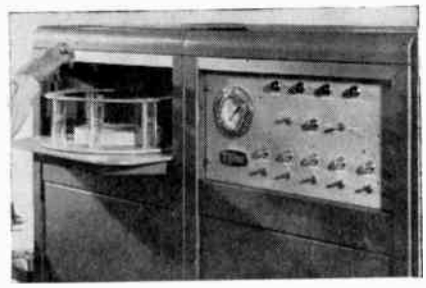
A completely new automated leak detector was demonstrated. This equipment will high vacuum test individually up to 1 000 devices per hour. Any devices which leak are automatically rejected.

Leak testing small sealed components (e.g. transistors, capacitors, etc) to a high standard and in relatively large quantities is a frequent requirement and the equipment exhibited will handle a wide range of such components without skilled attention. The only manual operation necessary is to load the devices into the feed turret at the front of the machine. The control circuits are designed to enable the machine to cope with any abnormal vacuum conditions created by a 'rogue' device.

To facilitate leak testing, a snift of helium is introduced into sealed components during manufacture. Helium leaking out of the device under test is detected with a high sensitivity mass spectrometer leak detector.

The equipment can test transistors or any devices having maximum dimensions −½in diameter × 2½in long, but the principle can be readily applied to the testing of appreciably larger devices. At throughputs of up to 1 000 per hour, the leak rejection threshold may be set to less than 10^{-5} l/μsec.

The automated leak detector employs a standard 20th Century Electronics' Centronic mass spectrometer leak de-



tector, to which only very minor modifications have been made. The Centronic leak detector which has an ultimate sensitivity of 10^{-14} l/sec can be used at any time to carry out individual leak testing on other components, merely by switching off the automatic tester.

The device under test is passed through a sequence of evacuating stages until the space surrounding the sample is at a sufficiently reduced pressure for the device to be introduced into a chamber which is permanently connected to the Centronic mass spectrometer leak detector. The stages are separated by specially designed pneumatically actuated high vacuum valves which isolate each stage from the next and at the same time act as mechanical transfer gates. The arrangement is such that each vacuum stage acts as a guard to the preceding or succeeding stage.

EE 67 784 *for further details*

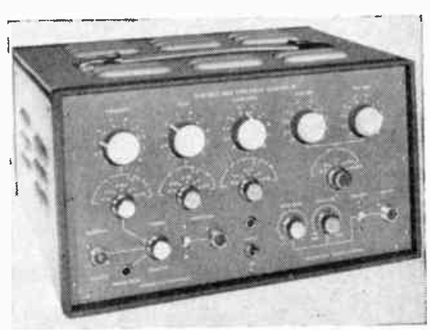
VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

PULSE GENERATOR

(Illustrated below)

The main feature of this instrument (type TSA 648) is that every parameter of the pulse can be altered. Not only are the usual controls of frequency and pulse width and amplitude provided but also controls permitting adjustment of the rise and fall time and the d.c. level. The generator provides a frequency range of from 10c/s to 1Mc/s and will operate down to pulse widths of 0·5μsec the fastest rise time being 10nsec/V. A pre-pulse is available together with a calibrated delay time control. Both output pulses have provision for the selection of polarity, the main output being a 10V amplitude pulse at an output impedance of 50Ω. Transistors are used throughout.



EE 67 785 *for further details*

MEETINGS THIS MONTH

BRITISH INSTITUTION OF RADIO ENGINEERS

All London meetings will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, unless otherwise stated.

Electro-Acoustics Group

Date: 4 March. Time: 6 p.m.
Lecture: Recent Trends in Transistor Audio Amplifier Design.
By: P. Tharma.
Date: 10 March. Time: 6 p.m.
Lecture: Parametric Up-conversion by the Use of Non-Linear Resistance and Capacitance.
By: A. Szerlip and D. P. Howson.
Lecture: Double-sideband Parametric Conversion Using Non-Linear Resistance and Capacitance:
By: K. L. Hughes and D. P. Howson.
Lecture: Parametric Amplifiers and Convertors with Pumped Inductance and Capacitance.
By: D. G. Tucker and K. L. Hughes.
Lecture: Highly-Efficient Generation of a Specified Harmonic or Sub-Harmonic by means of Switches.
By: D. G. Tucker.
Date: 11 March. Time: 6 p.m.
Lecture: Stereophonic Broadcasting and Receivers.
By: G. J. Phillips and J. G. Spencer.

Southern Section

Date: 4 March. Time: 6.30 p.m.
Held at: Brighton College of Technology.
Lecture: Solid State Control Systems.
By: G. B. Kent.
Date: 10 March. Time: 6.30 p.m.
Held at: The Lanchester Theatre, University of Southampton.
Lecture: Present Day Trends in Microwave Techniques.
By: G. D. Sims.

South Western Section

Date: 18 March. Time: 6.30 p.m.
Held at: Bristol University, Engineering Lecture Rooms, Bristol.
Lecture: The Development of the Atlas Computer System.
By: D. B. G. Edwards.

South Wales Section

Date: 4 March. Time: 6.30 p.m.
Held at: The Welsh College of Advanced Technology, Cardiff.
Lecture: Latest Developments in Electronic Weighing.
By: L. F. Cohen.

West Midlands Section

Date: 16 March. Time: 7.15 p.m.
Held at: The Herbert Art Gallery, Coventry.
Lecture: Machine Tool Control.
By: C. J. Charnley.
Date: 11 March. Time: 7.15 p.m.
Held at: Wolverhampton College of Technology.
Lecture: Applications of Industrial Television.
By: P. Wontner.

Scottish Section

Date: 11 March. Time: 7 p.m.
Held at: The University, Department of Natural Philosophy, Drummond Street, Edinburgh.
Lecture: Counting Techniques.
By: W. R. Diggle.
Date: 12 March. Time: 7 p.m.
Held at: The Institution of Engineers and Shipbuilders, 39 Elmband Crescent, Glasgow.
Lecture: Counting Techniques.
By: W. R. Diggle.

Merseyside Section

Date: 18 March. Time: 7.30 p.m.
Held at: The Walker Art Gallery, Liverpool.
Lecture: Parametric Amplifiers.
By: T. Buckley.

North Western Section

Date: 5 March. Time: 7 p.m.
Held at: Manchester College of Science and Technology, Reynolds Hall, Manchester.
Lecture: Recent Advances in H.F. Transmission Equipment.
By: V. O. Stokes.

North Eastern Section

Date: 11 March. Time: 6 p.m.
Held at: The Institute of Mining and Mechanical Engineers, Westgate Road, Newcastle upon Tyne.
Lecture: The Application of Numerical Control to Machine Tools.
By: J. M. Hutchison.

THE INSTITUTE OF NAVIGATION

Date: 13 March. Time: 5.30 p.m.
Held at: The Royal Geographical Society, 1 Kensington Gore, London, S.W.7.
Lecture: Meteorology and Supersonic Transport.
By: S. Serebreny.

INSTITUTION OF ELECTRICAL ENGINEERS

All meetings will be held at Savoy Place, commencing at 5.30 p.m., unless otherwise stated.

Ordinary Meetings

Date: 5 March.
Discussion: Industrial Design Applied to Engineering Products.
By: J. Howe.
Date: 24 March.
Lecture: The Science of Near Space.
By: E. Appleton.

Informal Meetings

Date: 16 March. Time: 6 p.m.
Discussion: An Engineer is as good as his Mathematics.
Opened by: R. C. Foss.

IEE/RAeS London Group on the Applications on of Electricity in Aircraft

Date: 17 March.
Discussion: Electrical Aspects in the Integration of Systems in Aircraft.
Opened by: C. S. Hudson.

Electronics Division

Date: 2 March.
Discussion: Merits and Demerits of Equivalent Circuits.
Opened by: A. R. Boothroyd, F. J. Hyde, A. R. Owens and J. J. Sparkes.
Date: 6 March.
Discussion: Encapsulation of Electronic Circuits Implantation.
Opened by: S. A. Braley, A. Evans, P. Lord, and J. Scales.
Date: 11 March.
Lecture: The Planning of Communications Satellite Systems.
By: F. J. D. Taylor.
Date: 18 March.
Discussion: The Measurement of the Amplitude and Peak Power of Pulse r.f. Systems.
Opened by: I. A. Harris.
Date: 23 March.
Lecture: Practical Aspects of Microwave Radio-Relay Systems.
By: B. Wilson, H. D. Hyamson and W. Grossett.

Power Division

Date: 2 March.
Lecture: Voltage Effects of Capacitive Load on the Synchronous Generator.
By: J. L. Dineley and K. J. Glover.
Date: 3-4 March.
Symposium on: Electricity and Space Heating. (All wishing to attend must register: forms available on application.)
Date: 9 March.
Discussion: Transient Analysers and their Applications.
Opened by: B. G. Kendall.
Date: 18 March.
Lecture: Influence of Soil-moisture Migration on Power Rating of Cables in High-Voltage Transmission Systems.
By: A. N. Arman, D. M. Cherry, L. Gosland and P. M. Hollingsworth.
Lecture: Characteristics of Soil Affecting Cable Ratings.
By: A. G. Milne and K. Mocklinski.
Date: 24 March.
Lecture: Excitation of Large Turbogenerator.
By: V. Easton.

Science and General Division

Date: 10 March.
Lecture: Principles Governing the Design of Systems for Continuous Numerical Control of Machine Tools.
By: D. J. Mynall.
Date: 11 March.
Discussion: Application of Analogue Techniques to Control-System Studies.
Date: 17 March. Time: 2.30 p.m. and 5.30 p.m.
Discussion: Computation for Engineers.
Date: 19 March:
Lecture: Gaseous Lasers.
By: H. A. H. Boot.
Date: 20 March.
Discussion: The Present Position of m.h.d. Generation.
Opened by: F. J. P. Crampton, P. D. Dunn, B. C. Lindley, J. C. Ralph and D. T. Swift-Hook.
Date: 24 March.
Discussion: Carbon Brushes.
Opened by: Haydn Ward.

THE RADAR AND ELECTRONICS ASSOCIATION

Date: 12 March. Time. 7 p.m.
Held at: Royal Society of Arts, John Adam Stree, Adelphi, London, W.1.
Lecture: Observation of Radio Galaxies.
By: J. S. Hey.

SOCIETY OF ENVIRONMENTAL ENGINEERS

Date: 18 March. Time: 6 p.m.
Held at: Imperial College, Mechanical Engineering Department, Exhibition Road, London, S.W.7.
Lecture: Explosives and Environments.
By: J. Rome.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

Date: 11 March. Time: 5 p.m.
Held at: The Battersea College of Technology.
Lecture: New Analogue Techniques for Control Studies.
Date: 24 March. Time: 7 p.m.
Held at: Mansion House, 26 Portland Place, London, W.1.
Lecture: A Data Handling System for a Radar Installation.
By: J. E. A. Harrison and R. J. Chase.

THE TELEVISION SOCIETY

All meetings will be held at the Conference Hall, I.T.A., 70 Brompton Road, London, S.W.3.
Date: 5 March. Time 7 p.m.
Discussion: Factors Affecting the Choice of a Colour Television System for the U.K.
Date: 20 March. Time: 7 p.m.
Lecture: The Propagation of Colour Television Signals at U.H.F.
By: K. Bernath.

PUBLICATIONS RECEIVED

PRODUCTS OF THE RECTIFIER DIVISION OF WESTINGHOUSE BRAKE AND SIGNAL CO. LTD is the title of a new publication which gives a brief survey of semiconductor components and equipments and is a guide to the rectifier services provided by the Company. Copies are available on request to the Publicity Manager (Rectifiers), Westinghouse Brake and Signal Co. Ltd, 82 York Way, King's Cross, London, N.1.

P.M.D. SERVICE TO THE ELECTRONIC INDUSTRIES is a brochure in four languages, which sets out the P.M.D. Service to the electronic industries in French and also in German, Italian and English. The P.M.D. Service covers the machining and plating of contacts for plugs and sockets; plating of semiconductors and printed circuits etc.; supply of chemicals for the Shipley through hole plating process, and the supply of precious metal plating chemicals and plant. Copies are available on request to Precious Metal Depositors Ltd, Broad Lane, Coventry.

MULLARD SEMICONDUCTOR DESIGNERS GUIDE provides a quick reference to Mullard semiconductor devices for industrial and communication equipment and the 1964 edition is now available from the company. Three new Quick Find Charts for transistors have been introduced which list the devices under the main headings of collector voltage, total dissipation and cut-off frequency. This basic information is augmented in subsequent pages under device headings which also include the full range, of diodes, rectifier diodes and thyristors. Requests for copies should be made on company headed notepaper to the following address: Technical Office, Industrial Semiconductor Division, Mullard Limited, Mullard House, Torrington Place, London, W.C.1.

BICELFLUX (SELF-FLUXING) ENAMELLED WINDING WIRES, publication No. 474 has recently been published by British Insulated Callender's Cables Ltd, P.O. Box 5, 21, Bloomsbury Street, London, W.C.1. This publication gives particulars of Polyurethane based enamel insulated self-fluxing winding wires for high-speed winding of coils of every type and shape, particularly where large numbers of soldered joints are required. Copies of this publication are available from the Company on request.

EE 67 145 *for further details*

- D.C. to 2,000 Mc/s
- 2% Accuracy
- Sensitivity 10MΩ/V
- All Solid-state
- Drift-free
- Warm up time eliminated
- Battery Driven
- Robust-sealed

BRADLEY ELECTRONIC MULTIMETER CT471B

Nato Type No. NSN6625-99-580-6048

This instrument combines the ruggedness of a conventional multimeter with the sensitivity formerly achieved only with specialised vacuum tube instruments. The fully insulated case allows floating high voltage measurements to be made in safety.

The instrument has 54 ranges giving full scale deflections up to 1,200 volts, 1·2 amp and 1,000 megohms. The 50Ω, 75Ω and High Impedance probes are housed in the cover compartment.

Write or phone for full technical data.

G. & E. BRADLEY LIMITED

Electral House, Neasden Lane, London, N.W.10. Tel. Dollis Hill 7811. Telegrams Bradelec London, N.W.10. Telex 25583

Le Matériel Électronique au Salon de la PHYSICAL SOCIETY

Une description, basée sur des renseignements fournis par les fabricants, d'un choix de matériels électroniques exposés au 48ème Salon de la Physical Society, tenu à Londres du 6 au 9 janvier 1964.

(Traduction des pages 188 à 195)

AIRMEC LTD

High Wycombe, Buckinghamshire

Etalon de fréquence

(Illustration à la page 188)

Cet appareil compact et entièrement transistorisé est piloté par quartz et sa stabilité de fréquence est de 5 parties dans 10^9 à court terme et de 1 partie dans 10^8 par jour à long terme.

Des sorties d'ondes sinusoïdales à 1 MHz en décades jusqu'à 1 Hz sont fournies simultanément à partir de douze douilles séparées, du panneau frontal. Une minuterie numérique à 12 heures, actionnée intérieurement par la sortie de 1 Hz, est montée sur le panneau frontal pour les mesures à long terme.

Un détecteur de battement permet d'obtenir des battements BF d'un haut-parleur incorporé pour des entrées inconnues dans la gamme de fréquence de 10 kHz à 30 MHz; des battements à fréquence infra-acoustique peuvent être affichés sur un appareil de mesure à échelle sur la tranche et une sortie filtrée de fréquence de battements est prévue sur une prise du panneau frontal pour l'emploi avec un fréquencemètre extérieur. Des entrées inconnues peuvent également être vérifiées en fonction de la fréquence étalon sur un tube cathodique incorporé qui peut être branché pour donner soit une image à trace circulaire modulée en Z soit une image Lissajous.

Tant le tube cathodique que l'instrument de mesure peuvent être branchés pour des vérifications de circuit intérieures: le fonctionnement de division jusqu'à 100 Hz est contrôlé sur le tube cathodique et, au dessous de 100 Hz, sur l'instrument de mesure, qui peut être utilisé également pour le contrôle des tensions intérieures.

L'étalon fonctionne soit sur secteur alternatif soit sur accumulateur de 12 V (pouvant être relié au secteur) avec commutation automatique en cas de panne de secteur.

EE 67 751 *pour plus amples renseignements*

Wattmètre UHF

(Illustration à la page 188)

Le Wattmètre UHF type 319 est un instrument léger et compact pour mesurer la puissance de la porteuse, la puissance de la bande latérale et la profondeur de modulation dans la gamme de fréquence de 1 à 1 000 MHz.

La puissance de la porteuse et la puissance latérale sont mesurées directement sur un instrument de mesure à échelle de 9 cm sur l'une des deux gammes de 0 à 100 mW et de 0 à 300 mW, choisies à l'aide d'un commutateur sur le panneau frontal.

Pour la mesure de modulation, on note d'abord la puissance de la porteuse, puis on tourne le bouton sélecteur vers la "modulation", l'aiguille de l'instrument de mesure étant ramenée à sa lecture originale en tournant un potentiomètre étalonné; la profondeur du taux de modulation est alors indiquée clairement sur l'échelle du potentiomètre.

Aucune source de puissance supplémentaire est nécessaire à la mesure de la porteuse; les batteries sèches intérieures fournissent la puissance voulue pour la mesure de la bande latérale et de la modulation, leur durée de vie étant de plusieurs centaines d'heures.

L'entrée HF est transmise à un connecteur standard Airmec, type 341, monté sur le panneau frontal et l'appareil est également muni d'une douille de sortie coaxiale pour la forme d'onde de modulation, qui peut ainsi être observée sur un oscilloscope.

EE 67 752 *pour plus amples renseignements*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

33 Grosvenor Place, London, S.W.1

Microscope électronique

(Illustration à la page 188)

Cet instrument (type EM6B) est un microscope électronique à haute résolution basé sur le modèle type EM6, mais considérablement modifié afin de le rendre particulièrement propre aux travaux biologiques, le but étant de combiner une performance élevée sur les spécimens de transmission avec une très grande simplicité de fonctionnement.

Le système optique électronique est basé sur une nouvelle lentille à objectif, conçue pour le fonctionnement optimum, et des lentilles de projection qui fournissent une gamme continue d'agrandissement de × 1 000 à × 250 000. Un soin particulier a été apporté à la facilité du fonctionnement et le nombre de commandes a été réduit de moitié par rapport à tout autre microscope électronique à grande performance. Le porte-échantillon peut recevoir trois échantillons à la fois afin d'accélérer la vitesse de contrôle. La tension d'accélération voulue s'obtient sur la gamme de 30, 40, 50, 60 ou 80 kV par un commutateur à une seule direction.

Malgré sa simplicité de commande inégalée, cet instrument a toujours réussi à obtenir une résolution de 5 Å.

EE 67 753 *pour plus amples renseignements*

Tube de caméra photoélectrique à action rapide

Ce tube a été conçu en vue de l'enregistrement de phénomènes exigeant des résolutions de temps supérieures à 10^{-1} sec pour pouvoir être enregistrés. Le mode de fonctionnement consiste à former une image du phénomène devant être enregistré sur une cathode photoélectrique semi-tranparente.

Les électrons sont émis à partir de divers points de la cathode dans des quantités proportionnelles au niveau de lumière tombant sur ces points. Les électrons sont accélérés par une anode et concentrés au moyen d'une électrode conique sur un écran fluorescent. On obtient une pose en faisant dévier l'électron à travers une ouverture dans une plaque d'obturation se trouvant entre l'anode et l'écran.

Le tube a les caractéristiques suivantes:

(a) Résolution de temps. Une seule pose —1 nsec: résolution chronographique —10^{-2} nsec:

(b) Résolution d'espace: 250 paires de lignes dans chaque direction à travers un format carré:

(c) Sensibilité: seuil de détectabilité—50 photoélectrons par point d'image:

(d) Caractéristique spectrale: visible, mais pouvant être étendue à l'ultra-violet à l'aide d'une fenêtre d'extrémité à quartz.

EE 67 754 *pour plus amples renseignements*

AVO LTD

Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1

Appareil de mesure à induction électronique

Cet appareil a été conçu pour servir d'instrument de mesure universel à l'ingénieur électronique. La sensibilité aux gammes inférieures est de 1 MΩ/V s'élevant à une résistance d'entrée maxima de 30 MΩ dans les gammes de 30, 100, 300 et 1 000 V. Deux amplificateurs entièrement transistorisés, l'un à courant alternatif et l'autre à courant continu, forment la base du multimètre. Une sonde est prévue pour les mesures HF.

Les déviations sur la totalité de l'échelle des gammes de l'appareil vont de 100 mV à 1 000 V pour les mesures de tension c.a./c.c., et de 30 μA à 3A pour les mesures de courant c.a./c.c., avec une précision de ±3% de déviation totale. La chute de potentiel nominal est de 30 mV sur toutes les gammes de courant c.a./c.c. La résistance peut être mesurée entre 0.5 Ω et 20 MΩ (valeurs moyennes d'échelle: 20 Ω, 2 000 Ω et 200 000 Ω).

Deux commutateurs de "fonction" et "gamme," montés sur panneau, choisissent toutes les possibilités d'utilisation prévues. L'appareil est entièrement protégé contre toute surcharge accidentelle et il peut fonctionner sur zéro central.

L'instrument de mesure fonctionne sur batterie, ses deux batteries de 9 V, dont la durée de vie est d'environ 500 heures, fournissant les lignes d'alimentation pour les amplificateurs et pour les mesures de résistance.

EE 67 755 *pour plus amples renseignements*

Contrôleur de transistors sur place

Il s'agit ici d'un nouveau contrôleur de transistors, portatif et fonctionnant sur batterie, pour le contrôle sur place des transistors p.n.p. ou n.p.n. à signaux ou à puissance moyenne.

Les circuits conçus avec soin équilibrent l'effet de shunt de composants extérieurs au transistor soumis à l'essai. Le circuit en pont à c.c. équilibre les composants en circuit reliés au collecteur à transistors et permet de régler le courant et la tension au collecteur à la valeur voulue. Le circuit en pont c.a. équilibre les composants en circuit reliés à la base du transistor soumis à l'essai et permet de mesurer béta à la fréquence d'environ 1 000 Hz du pont c.a.

Le courant au collecteur est à variation continue jusqu'à un maximum de 10 mA. Le gain de courant (béta) dans la gamme de 0 à 150 et de 0 à 300 peut être mesuré soit sur place soit hors de circuit, le courant de fuite I'co étant indiqué directement sur l'instrument de mesure lorsque le transistor est hors de circuit.

L'appareil sera fourni avec deux sondes, dont l'une est spécialement étudiée pour le contrôle sur place, afin de pouvoir établir le contact avec le côté en cuivre d'une plaquette de circuit imprimé, et l'autre est pour le contrôle hors de circuit ou pour l'emploi lorsqu'on dispose d'une longueur sufisante de connexion de fil métallique.

Un dispositif de contrôle de la batterie permet de s'assurer que les tensions ne tombent pas au-dessous de la limite nécessaire au fonctionnement satisfaisant. La protection contre les surcharges est assurée par un disjoncteur de circuit intérieur.

EE 67 756 *pour plus amples renseignements*

BELL & HOWELL LTD

Consolidated Electrodynamics Division, 14 Commercial Road, Woking, Surrey

Oscillographe enregistreur à rayons ultra-violets

(*Illustration à la page 189*)

Cet oscillographe enregistreur portatif est très simple à charger et à utiliser et, considérant son encombrement réduit, il est d'une précision et d'une souplesse d'emploi remarquables.

L'enregistreur produit des enregistrements de 17,78 cm de largeur par un procédé d'impression qui n'exige aucun traitement chimique. Des données du courant continu à 10 kHz peuvent être enregistrées sur 18 canaux séparés en utilisant les galvanomètres Consolidated Electrodynamics de la série 7-300, conjointement avec des papiers d'impression à action rapide, récemment mis au point.

En plus des lignes temporisées et des lignes de réseau, l'identification de trace positive est réalisée par l'apparition dans chaque trace, à tous les 31 cm, d'un espace d'interruption en séquence. Un numéro de trace, correspondant à la position du galvanomètre, est imprimé, en face de chaque interruption, le long du bord de l'oscillogramme.

Les largeurs de trace sont d'environ 3 mm et des vitesses d'enregistrement dépassant nettement 50 000 pouces/seconde peuvent être réalisées. Les vitesses d'enregistrement sont choisies par bouton-poussoir et n'importe laquelle des 5 vitesses peut être choisie avant ou pendant l'enregistrement.

L'instrument mesure 19,3 cm × 33 cm × 38,1 cm et son poids est de 18 kg.

EE 67 757 *pour plus amples renseignements*

CAMBRIDGE INSTRUMENT CO. LTD

13 Grosvenor Place, London, S.W.1

Transducteur de déplacement

Ce transducteur prototype mesure le déplacement dans une gamme étendue allant, par exemple, de 0 à 4 μm jusqu'à 0 à 4 mm.

Il comprend quatre noyaux à fer divisé avec des bobinages similaires, disposés en paires et en opposition, une des paires servant de primaire de transformation, ses bobines étant reliées en série d'accord, l'autre paire servant de secondaire avec ses bobines reliées en série d'opposition. Le membre mobile consiste en une ailette conductrice logée entre les paires de bobines en opposition.

Un signal de courant alternatif est appliqué aux bobinages primaires, la sortie du secondaire étant amplifiée puis détectée par un redresseur sensible aux phases dont la tension de référence provient d'un oscillateur à transistors alimentant le primaire. Il n'y a pas de sortie nette lorsque l'ailette est placée de manière symétrique par rapport aux deux moitiées des bobinages secondaires, mais si elle est déplacée de manière à couvrir une plus grande partie de l'un des secondaires que de l'autre, il y aura alors une sortie nette, dont l'amplitude est proportionnelle au déplacement de l'ailette. Ce rapport est linéaire jusqu'à environ ±2 mm, la phase de sortie variant à travers 100° au point de symétrie.

EE 67 758 *pour plus amples renseignements*

COSSOR INSTRUMENTS LTD

The Pinnacles, Elizabeth Way, Harlow, Essex

Oscilloscope à large bande

Le modèle CT476 est un oscilloscope à large bande comprenant un tube cathodique de 12,7 cm fonctionnant à 10 kV et fournissant une surface d'image de 6 cm × 10 cm.

L'instrument a été réalisé pour l'emploi interarmes; sa largeur de bande s'étend du courant continu à un maximum de 56 MHz (−3 dB) à des sensibilités de 50 mV/cm à 20 V/cm, et de 3 Hz à 40 MHz à des sensibilités de 5 mV/cm à 2 V/cm.

Un dispositif à retard de signal de 150 nsec est incorporé à l'oscilloscope pour permettre l'observation de la tranche principale de la forme d'onde de déclenchement. La base de temps principale comporte 24 gammes étalonnées de 5 sec/cm à 0,1 µsec/cm et n'importe laquelle des gammes peut être élargie jusqu'à 5 fois; elle peut être déclenchée à partir d'ondes sinusoïdales de 5 MHz à 25 MHz sur le mode de déclenchement interieur, et de 5 MHz à 50 MHz sur le mode extérieur.

Le mode automatique facilite le verrouillage sur les signaux périodiques avec des taux de répétition de 30 Hz à 2 MHz sans réglages de commande. La précision de l'étalonnage est de ±3 % de l'échelle totale sur les gammes de base et de ±5 % avec une expansion de × 5.

Le balayage principal 'A' peut être différé à l'aide d'une deuxième base de temps 'B,' étalonnée de 2 µsec/cm à 1 sec/cm en 1, 2, 5 séries et assurant un retard de balayage pouvant aller jusqu'à 10 sec.

La modulation d'axe Z est assurée par des marqueurs de 500 MHz ±2 % et de 50 MHz ±2 % déclenchés par le balayage 'A', qui constitue un système de mesure précis pour les temps de montée d'impulsions.

L'amplificateur X a une largeur de bande allant du courant continu à 2 MHz dans une gamme de sensibilité de 1 V/cm à 100 V/cm. Un élément supplémentaire à fiches, le modèle 185S, transforme l'appareil en un oscilloscope à deux canaux dont la largeur de bande s'étend du courant continu à 40 MHz dans une gamme de sensibilité de 50 mV/cm à 20 V/cm. Un autre élement à fiches, le modèle 1080S dont la largeur de bande va du courant continu à 1 MHz comporte une gamme de sensibilité de 1 mV/cm à 50 V/cm.

Le montage de caméra standard Cossor est prévu.

EE 67 759 *pour plus amples renseignements*

DAWE INSTRUMENTS LTD

Western Avenue, Acton, London, W.3

SONOMÈTRE DE PRÉCISION

(Illustration à la page 190)

Cet instrument est un analyseur de son portatif de précision, pesant environ 5,4 kg avec ses batteries. Il est muni d'un microphone à condensateur et mesure le niveau du son entre 20 et 140 dB en fonction d'un niveau de référence standard. Le microphone est monté sur un palpeur cathodique et il peut être utilisé avec un câble de rallonge de 7,62 m entre le palpeur et l'instrument.

Le sonomètre comprend des réseaux à atténuation prédéterminée de type standard 'A,' 'B' et 'C,' répondant aux spécifications B.S., I.E.C. et A.S.A. Une réponse linéaire de 15 Hz à 50 kHz est également assurée à partir de l'amplificateur.

L'analyse de fréquence est effectuée par le filtre de bande d'octaves dont la gamme s'étend de 31,5 Hz à 31,5 kHz conformément à la spécification I.E.C. projetée pour les monteurs d'octaves.

L'atténuation de chaque bande de filtre est règlable indépendamment jusqu'au niveau de bruit minimum de l'amplificateur.

Une sortie est prévue pour le branchement de magnétophones ou d'autres instruments tels que les enregistreurs de niveau à action rapide ou les analyseurs statistiques.

EE 67 760 *pour plus amples renseignements*

DECCA RADAR LTD

Albert Embankment, London, S.E.1

EQUIPEMENT DE RÉSONANCE ROTATIONNELLE ÉLECTRONIQUE

Cet appareil constitue un spectromètre de modulation complet de 100 kHz. Un klystron à faible bruit est asservi en phase à l'harmonique d'un cristal de quartz, guarantissant ainsi, une excellente stabilité de fréquence. L'appareil est muni de dispositifs pour varier la puissance incidente, choisir le mode d'absorption pur et observer le spectre sur un oscilloscope ou un enregistreur à plume. Des éléments supplémentaires peuvent être ajoutés pour convertir l'appareil à la détection superhétérodyne, et la modulation de 33 Hz peut également être obtenue pour les applications spéciales.

La sensibilité de l'appareil exposé est de $1{,}5 \times 10^{-12} {}_{\Delta} H$ rotations pour une puissance de cavité de 1 mW avec une constante de temps de 1 sec.

EE 67 761 *pour plus amples renseignements*

DEVICES LTD

13-15 Broadwater Road, Welwyn Garden City, Hertfordshire

MARQUEUR NUMÉRIQUE D'INTERVALLES DE TEMPS

(Illustration à la page 190)

Cet instrument a été réalisé pour fournir des diagrammes préréglés d'impulsions temporisées pour le déclenchement de phénomènes requis dans de nombreuses expériences électro-physiologiques ou psychologiques. Ces impulsions peuvent déclencher des générateurs de stimulations, afin de provoquer une réponse du mécanisme physiologique étudié, ainsi que des générateurs de base de temps pour permettre l'observation et le minutage du concomitant électrique de la réponse sur un tube cathodique.

L'emploi des méthodes numériques donne une grande précision au réglage (ainsi qu'au réenclenchement) des impulsions temporisées, cependant qu'un générateur d'impulsions horaires à quartz assure un minutage de grande précision. Une échelle de temps est formée par ce générateur d'impulsions horaires afin d'étalonner la vitesse de la base de temps. Des repères formant l'échelle horaire peuvent être pris de la gamme de 0,1 msec à 1 sec, ces repères étant appropriés à la vitesse de la base de temps. Des repères supplémentaires indiquant le déclenchement des divers phénomènes peuvent apparaître sur l'échelle horaire si on le désire. Le 'Digitimer' peut être réglé pour le fonctionnement continu, le programme des événements se répétant à intervalles réglables mais réguliers dans la gamme de 0,1 msec à 10 sec, ou pouvant être déclenché par un signal électrique ou mécanique extérieur. Une plaquette portant un diagramme des connexions, fixé sur le panneau frontal de l'instrument permet de brancher des circuits intérieurs afin de produire des trains d'ondes carrées ou d'impulsions de durée variable.

EE 67 762 *pour plus amples renseignements*

EKCO ELECTRONICS LTD

Southend-on-Sea, Essex

SYSTÈME DE COMPTAGE D'IMPULSIONS TRANSISTORISÉ

La société Ekco Electronics a présenté une nouvelle gamme d'appareils de comptage transistorisés d'une spécification plus élevée et complémentaire à la gamme Thermonic actuelle. L'emploi de certains des éléments de base de cette nouvelle gamme a été illustré par le système complet d'échelles de comptage automatique et d'intensimètres, appliqués au comptage d'impulsions général ou à la spectrométrie. Les élément fonctionnels utilisés pour ce système particulier comprennent: un élément à tension élevée, un amplificateur/analyseur de hauteur d'impulsion, une échelle de comptage, une minuterie et un intensimètre ainsi que des versions nouvelles transistorisées des sondes de comptage de scintillations du modèle N676 à résolution élevée ou du modèle universel N691.

Certaines des caractéristiques de ce système, tel qu'il est appliqué à la spectrométrie gamma sont: stabilité totale non inférieure à 0,1 %, largeur de bande de 10 MHz, gamme dynamique de 50:1 avec capacité de surcharge de 100:1 pour une durée de rétablissement ne dépassant pas 1 µsec. La résolution du système est fondamentalement de 0,1 µsec, mais l'échelle de comptage est standard à 1 µsec, facultativement 0,1 µsec. Avec la sonde N676, on obtient une résolution par degrés allant jusqu'à un rapport de taux d'amplitude dépassant 6,0:1 sur Cobalt-60, et l'affichage numérique est prévu pour tous les réglages opérationnels appropriés.

EE 67 763 *pour plus amples renseignements*

EMI ELECTRONICS LTD

Hayes, Middlesex

OSCILLOSCOPE

(Illustration à la page 190)

Le modèle WM41 est un oscilloscope universel à transistors avec une largeur de bande du courant continu à 10 MHz (−3dB) et des sensibilités de 50 mV/cm à 20 V/cm dans 9 gammes commutées. L'impédance d'entrée est de 1 MΩ en parallèle avec 30 pF sur toutes les gammes.

Ses caractéristiques sont comme suit:
Déclenchement:

Sélection: intérieure ±, extérieure ±, et extérieure atténuée 20:1 ±.

Gamme de base de temps:

Non déployée 200 nsec/cm à 100 msec/cm en 18 gammes commutées. Déploiement continu × 1 à × 5 étalonné aux deux extrémités.

Étalonneur de tension

Ce dispositif produit une onde carrée de 7 kHz avec un temps de montée supérieur à 1 μsec. Cette amplitude peut être variée en 8 plots de 200 mV à 40 V.

Alimentation secteur ou par batterie.

L'alimentation se fait normalement sur secteur dans la gamme de 200 à 265 V ou de 100 à 132 V, 50 à 60 Hz. En variante, on peut utiliser une batterie extérieure de 12 V. La puissance requise est d'environ 18 W.

Le WM41 peut être utilisé dans une gamme de températures ambiantes de −5 à +40° C.

EE 67 764 *pour plus amples renseignements*

' BAGUETTE ÉLECTRONIQUE '

Il s'agit ici d'un nouvel auxiliaire à l'enseignement technique qui permet de montrer aux étudiants les principales caractéristiques d'une variété étendue de tubes microondes à 1/20ème du coût de l'emploi de tubes individuels.

La baguette électronique est en substance un faisceau électronique isolé pouvant être inséré dans divers circuits extérieurs. Par ce moyen, on peut construire certains tubes microondes, tels que les tubes à ondes progressives, les amplificateurs à klystron à deux cavités, les tubes Adler et les amplificateurs à ondes rétrogrades, afin de pouvoir montrer les principes de leur fonctionnement de plusieurs façons et à peu de frais.

EE 67 765 *pour plus amples renseignements*

ELECTRONIC APPLICATIONS (COMMERCIAL) LTD

Endeavour House, North Circular Road, London, N.W.2

DÉCIBELMÈTRE À ULTRA-SONS (VERSION ACOUSTIQUE)

Cet instrument utilise une technique de sondage à ultra-sons et à faisceau étroit pour mesurer la distance qui sépare son transducteur d'une surface liquide ou solide. Le temps qui s'écoule entre l'émission de l'impulsion et l'écho est mesuré et affiché numériquement, donnant ainsi une indication proportionnelle à la distance.

Un oscillateur de 150 kHz émet des impulsions au rythme d'environ 2 impulsions par seconde. La sortie de l'oscillateur est utilisée pour actionner un transducteur piézoélectrique au zirconate de plomb qui résonne à cette fréquence. L'impulsion ultra-sonore qui en résulte est propagée dans l'air dans un cône de 3 % et elle est réfléchie par n'importe quelle surface normale à sa trajectoire. Le même transducteur reçoit l'écho et le signal de tension correspondant est amplifié.

Un dispositif de déclenchement périodique électronique est ouvert en coincidence avec l'impulsion d'émission, et permet de faire passer des impulsions d'un oscillateur stable à un compteur à transistors à trois décades, avec lecture en ligne. La réception du signal d'écho ferme ce dispositif de déclenchement périodique. L'impulsion d'émission suivante annule le résultat du comptage emmagasiné dans le compteur et la séquence est alors répétée.

Le nombre enregistré par le compteur à chaque sondage est fonction du temps pris par le sondage et il est donc proportionnel à la distance entre le transducteur et la surface. L'équipement actuel peut lire en unités de 0,1 pouce, il a une gamme maxima de 3 mètres et une précision de 0.2 % ±1 chiffre dans cette gamme.

Un dispositif de limitation est incorporé à l'appareil de manière à ce qu'un relais puisse être fixé pour fonctionner dans une gamme de n'importe quels dix chiffres caractérisés par les deux chiffres les plus significatifs de la lecture.

L'usage principal de l'instrument est la mesure du contenu liquide de réservoirs. Dans cette application, un graphique d'étalonnage du contenu volumétrique en fonction de la lecture de l'instrument est d'abord établi. Il est utilisé par la suite pour la mesure du contenu. Le système a ce mérite exceptionnel qu'aucun contact, quel qu'il soit, avec le liquide n'est nécessaire. Cet avantage est d'une importance particulière dans les applications exigeant un degré très élevé d'hygiène, ainsi que pour les applications se rapportant aux problèmes de corrosion.

EE 67 766 *pour plus amples renseignements*

ELLIOTT-AUTOMATION LTD

34 Portland Place, London, W.1

MOTEUR À INDUCTION À VITESSE RÉDUITE

(Illustration à la page 191)

Un nouveau type de moteur à induction à couple élevé et à vitesse réduite, appelé Steromotor est maintenant réalisé par la Division des Composants asservis de la société Elliott Brothers (London) Ltd., qui est un membre du Groupe Elliott-Automation. Ce moteur est d'une conception de base entièrement nouvelle car il donne une sortie à couple élevé à une vitesse d'arbre réduite, sans qu'il y ait lieu d'employer un démultiplicateur. Il a en outre la faculté d'assurer une mise ne marche ou un arrêt extrêmement rapides, et il est donc particulièrement indiqué pour les fonctions automatiques et de servo-commande.

Le moteur comprend un stator bobiné amorcé par courant alternatif, produisant un double champ magnétique rotatif, et un rotor à aimant permanent qui ne tourne pas dans le sens normal mais autour d'un très petit rayon. Le mouvement giratoire du rotor est converti en un mouvement rotatif au moyen d'un engrenage hypocycloïdal. En pratique, le rotor a des disques d'extrémité d'un diamètre légèrement plus réduit que les chemins de roulement dans lesquels ils se trouvent. Les disques roulent à l'intérieur des chemins de roulement, ce qui provoque la rotation a vitesse réduite du rotor avec une sortie à couple élevée correspondante.

En raison du faible rayon de rotation du rotor, son inertie est négligeable et le temps nécessaire à la mise en marche ou à l'arrêt du moteur est inférieur à un 100ème de seconde. Etant donné que le rotor ne tourne pas à proprement parler, il n'a pas de roulements mais plutôt des chemins de roulement accouplés à un arbre de sortie souple, tandis que le stator a un montage souple. Le moteur ne comporte ni balais ni collecteurs et les bobinages du stator sont encapsulés de maniere à assurer sa fiabilité dans les conditions environnantes les plus défavorables.

Le moteur se caractérise en particulier par le fait qu'il peut être mis en marche, arrêté, inversé ou câlé, de manière répétée et sans effet défavorable. En dehors de son emploi comme moteur à induction à rotation continue, on peut également l'employer comme moteur d'avancement si le stator est excité par une alimentation en courant continu au moyen d'un circuit de commande approprié.

Le moteur convient particulièrement pour la commande asservie ou les applications exigeant une réponse très rapide et critique aux signaux d'entrée. Dans les systèmes asservis à action rapide nul tachymètre à réaction n'est nécessaire étant donné que le mouvement est essentiellement apériodique.

Les moteurs sont prévus à couples de 4 kg/2.5 cm jusqu'à zéro et à couples plus élevés jusqu'à 408 kg/2.5 cm. Il conviennent pour les alimentations de tension normale, simple ou polyphasée de 50 ou 60 Hz, ou pour les alimentations en courant continu si le fonctionnement par degrés est nécessaire.

EE 67 767 *pour plus amples renseignements*

FEEDBACK LTD

Crowborough, Sussex

APPAREILLAGE D'ASSERVISSEMENT POUR L'INSTRUCTION TECHNIQUE

(Illustration à la page 191)

Cet appareillage d'asservissement est destiné à l'usage des étudiants et comprend de nombreuses caractéristiques permettant d'étudier la théorie de commande d'introduction, tant dans son principe que dans ses détails.

L'appareillage comprend deux éléments soit un élément de commande qui comprend les amplificateurs et alimentations nécessaires et un assemblage mécanique qui comprend le moteur, les démultiplicateurs et les potentiomètres de canaux d'erreurs. Les deux éléments sont montés dans un seul coffret.

Fondamentalement, l'appareillage a une caractéristique de décalage de vitesse avec une seule constante de temps définie se rapportant au moteur. Le signal d'erreur est fourni à un amplificateur opérationnel dans l'élément de commande qui peut être utilisé pour additionner les signaux de réaction de vitesse et d'erreur. Cet amplificateur peut être utilisé également pour introduire une intégration supplémentaire ou une constante de temps dans le chemin avant, de manière à ce que le système puisse être rendu instable et les méthodes de compensation étudiées. Le panneau frontal porte un diagramme des connexions de circuit intérieures. L'assemblage mécanique est disposé de façon à pouvoir le faire glisser à l'extérieur pour en faciliter l'accès. Le moteur et le train d'engrenages sont montés directement sur une seule plaque permettant de changer rapidement la démultiplication.

Le système comprend un nombre de dispositifs utiles, donnant notamment la possibilité d'inverser le sens de l'erreur ou de la réaction de vitesse, ainsi que les composants nécessaires pour introduire l'intégration ou une constante de temps dans la course avant. De plus, les alimentations dans le bloc de commande permettent d'utiliser des calculatrices analogiques à réaction standard en liaison avec le système, pour les études de commande de relais etc. Le système peut être fourni en un boîtier plus haut pour le montage de blocs analogiques entre l'assemblage mécanique et l'élément de commande.

EE 67 768 *pour plus amples renseignements*

FERRANTI LTD

Ferry Road, Edinburgh, 5

ÉQUIPEMENT DE MESURE DE FRANGE MOIRE

L'équipement exposé comprenait un modèle prototype à un seul axe d'une nouvelle gamme d'appareils de mesure de frange Moire qui seront produits en série en 1964. Par rapport aux appareils Ferranti précédents du même type, la nouvelle gamme comporte plusieurs caractéristiques intéressantes:

Le dispositif à quatre comptages par espacement de réseau a été agrandi pour donner 10 ou 20 comptages par espacement.

Les quatre formes d'onde de cellules photoélectriques de la tête de lecture sont appliquées à un préamplificateur à réaction et à un amplificateur à transistors au silicium auxquels on ajoute une réaction de mode commun. Ce dispositif produit une paire de formes d'ondes symétriques stables en quadrature pouvant être appliquées directement aux circuits générateurs d'impulsions et sensibles à la direction.

Avec un taux de comptage actuel maximum de 100 000 chiffres par seconde, normalement comptés, le compteur annulaire bidirectionnel a un taux de comptage maximum plus élevé qu'auparavant. Un premier développement avec un taux de comptage de 1 000 000 de chiffres par seconde peut être substitué au précédent pour les applications comportant des vitesses de pointe élevées.

Des accessoires facultatifs importants comprennent un circuit de contrôle d'étage d'entrée, un contrôleur de comptage complet utilisant le système ternaire et un commutateur électronique assurant le fonctionnement non complémentaire. De plus un contrôleur cathodique est prévu pour le réglage et la vérification des formes d'ondes d'entrée. Les caractéristiques de réalisation principales sont la construction modulaire avec des cartes de circuits imprimés d'un accès facile et un indicateur d'affichage numérique pouvant être reliés à leur circuits associés ou éloignés de ces derniers. Un appareil d'impression de construction appropriée est prévu pour l'emmagasinage de noyaux magnétiques. Les circuits connexes seront constitués de corps solides, permettant l'emploi de bandes magnétiques rapides et d'accessoires de perforation et de jonction de données.

Le prototype qu'on a pu voir au stand fonctionne à la vitesse de 20 comptages par espacement à partir d'un réseau de 250 lignes/mm donnant une grandeur de chiffre de 0,2 micron. Il pourrait donc être utilisé pour des mesures de très grande précision. Toutefois, un système à grandeur de chiffre de 1 micron utilisant des réseaux de 100 lignes/mm conviendrait normalement pour la plupart des travaux scientifiques comportant la réduction de données photographiques.

EE 67 769 *pour plus amples renseignements*

THE GENERAL ELECTRIC CO. LTD

Hirst Research Centre, East Lane, Wembley, Middlesex

LOGIQUE DE FILMS MAGNÉTIQUES

Des films magnétiques constituant des mémoires de calculatrices peu coûteuses et pouvant fonctionner rapidement ont été mis au point en collaboration avec la Salford Electrical Instruments Ltd. et les laboratoires de la International Computers and Tabulators (Engineering) Ltd. Ces films ont un axe de magnétisation préféré dans le plan du film. Chacun des éléments à mémoire du film peut être aimanté dans l'une ou l'autre direction le long de l'axe (la direction représentant 0 ou 1) et la magnétisation reste dans cette direction en l'absence de film magnétique. Ces films magnétiques peuvent être utilisés pour traiter des informations dans la section logique d'une calculatrice ainsi que pour les besoins de la mémoire.

La démonstration donnée montra le fonctionnement d'un dispositif faisant partie d'un système logique projeté de films magnétiques dont les signaux de sortie de plusieurs cellules d'emmagasinage sont combinés de façon appropriée et utilisées pour actionner d'autres cellules d'emmagasinage, toutes les cellules étant reliées par des boucles conductrices au-dessus du fil. Dans le dispositif exposé, deux boucles conductrices se chevauchent de manière à ce que le couplage entre elles soit positif, zéro ou négatif, selon les perméabilités relatives des parties du film au-dessous des sections se recouvrant. Ces perméabilités peuvent être changées par les champs durs de direction produits par le courant passant dans un conducteur de commande placé entre les sections se recouvrant des boucles conductrices. Un signal représentant un chiffre binaire peut ainsi être modifié par le dispositif de couplage avant d'être utilisé pour régler une cellule d'emmagasinage à film magnétique. La cellule peut emmagasiner un chiffre binaire du même sens que le signal original, l'inverse de ce dernier, ou rien, selon la valeur du courant de contrôle au moment du réglage de la cellule.

EE 67 770 *pour plus amples renseignements*

GULTON INDUSTRIES (BRITAIN) LTD

Regent Street, Brighton, 1

TRANSDUCTEURS CÉRAMIQUE

Le développement de la technologie de la production de matériaux en céramique sous forme de galette d'une épaisseur minima de 0,003" a permis de fabriquer toute une gamme de transducteurs électromécaniques dont les propriétés ont été considérablement améliorées.

(a) *Eléments de pick-up de gramophone*

Au cours de ces dernières années, la céramique a graduellement remplacé le sel Rochelle pour les éléments sensibles de pick-ups. Une nouvelle méthode permettant de construire l'élément en trois plaques de céramique mince, ainsi qu'un matériau d'une permettivité élevée formée en sandwich entre deux galettes de céramique piézoélectrique, ont donné lieu à la production d'une gamme d'éléments bimorphes à capacité extrêmement élevée. Cette capacité est plus de vingt fois supérieure à celle des éléments classiques de sorte que les circuits transistorisés à faible impédance peuvent maintenant être alimentés directement.

(b) *Relais électrostatiques*

Des feuilles de céramique piézoélectrique à pôles opposés peuvent être jointes pour former un système à flexion bimorphe. Des paires de ces ressorts, serrés à l'une des extrémités et munis d'un contact à extrémité libre, peuvent être utilisées pour former des relais. Ces relais peuvent effectuer plusieurs millions d'opérations et peuvent être de dimensions extrêmement réduites.

(c) *Haut-parleurs piézoélectriques*

Des ressorts bimorphes, montés en porte à faux ou comme simples supports, peuvent être utilisés comme éléments d'entraînement de haut-parleur. Les propriétés dynamiques peuvent être contrôlées en modifiant les dimensions physiques du "sandwich" de céramique.

(d) *Microphones*

La sensibilité extrême et la capacité élevée des éléments en céramique peuvent être mises à profit dans la construction de microphones de haute qualité.

EE 67 771 *pour plus amples renseignements*

J. & P. ENGINEERING (READING) LTD

Portman House, Cardiff Road, Reading, Berkshire

BLOC D'ALIMENTATION T.H.T.

(Illustration à la page 192)

Cet instrument fournit jusqu'à 4 kV à 3 mA avec une stabilité de 1 partie dans 10^4. Il a été étudié et mis au point pour A.E.R.E., Harwell, et fait partie des 2000 séries d'appareils nucléoniques. L'emploi exclusif de dispositifs semi-conducteurs a résulté en un élément dont le volume est d'un tiers de celui des instruments actuellement disponibles et d'une performance comparable.

Le dessin de base comporte un circuit redresseur au silicium et utilisé en liaison avec un convertisseur à transistors de courant continu en courant alternatif, ce qui permet de régler de façon continue la tension de sortie de zéro à 4 kV. La commutation à décades est utilisée avec une précision de réglage de $\pm 0,2$ V. La polarité de la tension de sortie peut être inversée au moyen d'un commutateur. L'instrument est protégé contre les courts-circuits par un circuit de coupure à action rapide qui empêche également tout choc électrique dangereux.

La stabilité de l'instrument a été démontrée en injectant la sortie à un contrôleur de dérive de tension, spécialement réalisé à cette fin. Ce dernier contient un diviseur de tension de précision, un amplificateur de différentiel et de tension de référence d'une grande stabilité. Sa stabilité propre est supérieure à 1 partie dans 10^6 par semaine. La sortie a pu entraîner, au cours d'une démonstration, un enregistreur indiquant des changements de quelques parties par million.

EE 67 772 *pour plus amples renseignements*

GEORGE KENT LTD

Luton, Bedfordshire

TRANSDUCTEUR DE DÉPLACEMENT

(Illustration à la page 193)

Cet appareil emploie un transformateur différentiel ainsi que les circuits connexes constitués de corps solides et donne ainsi un courant de sortie isolé pour l'émission à grande distance d'une variable de processus. Le courant de sortie, dans la gamme de 0 à 10 mA, est rigoureusement proportionnel au déplacement d'entrée et à la tension de commande appliquée dans la gamme de 2 à 5 V. L'équipement fonctionne sur alimentation non stabilisée de 24 V. c.c.

Le déplacement est appliqué au noyau d'un transformateur différentiel alimenté par un oscillateur à ondes carrées dont l'amplitude de sortie est proportionnelle à la tension de commande c.c. appliquée. La sortie du transformateur est démodulée et utilisée pour commander le courant émis. Une résistance à réaction variable est employée pour régler le courant émis et obtenir des indications sur la totalité de l'échelle correspondant à des déplacements de 0 à 0,05" et de 0 à 0,25".

La démonstration a permis de voir une application avec trois entrées variables où le courant de sortie $\propto$

$$\frac{\text{déplacement mécanique} \times \text{tension de commande}}{\text{résistance de réaction}}$$

Si nécessaire, la tension de commande peut être remplacée par une diode de référence et la résistance de réaction peut être fixée pour obtenir le rapport: courant de sortie $\propto$ déplacement mécanique.

EE 67 773 *pour plus amples renseignements*

MUIRHEAD & CO. LTD

Beckenham, Kent

SYSTÈME DE LECTURE NUMÉRIQUE

Ce nouvel instrument, type K-162-A, réalisé par Muirhead & Co. Ltd, présente un intérêt particulier pour les chercheurs attachés à la solution des problèmes de bruit et de vibrations car il élimine le travail fastidieux de conversion de données analogiques en données numériques. La sortie numérique est destinée à actionner une perforatrice de bande, mais elle peut être utilisée pour actionner n'importe quel type d'imprimeur numérique tel que: téléimprimeur, machine à écrire électrique, imprimeur en ligne. Conçu pour l'emploi avec les analyseurs d'ondes Muirhead à enregistrement automatique, le système complet est entièrement automatique en cours de fonctionnement.

L'information paraissant sur la bande perforée représente la fréquence à laquelle l'analyseur est accordé, ainsi qui l'amplitude du signal dans cette bande. Le signal devant être analysé est enregistré sur une boucle de bande magnétique, une "fenêtre" étant pratiquée près de la jointure de la bande en enlevant une petite partie de l'émulsion. Lorsque cette "fenêtre" passe par un dispositif photoélectrique situé près de la bande, cela produit une impulsion qui déclenche une séquence de minutage.

Durant l'analyse, les données de fréquence et d'amplitude sont présentées sous forme analogique par l'analyseur et l'enregistreur de niveau respectivement. Au moment voulu, les deux signaux sont injectés à un convertisseur analogique/numérique, qui alimente ensuite la perforatrice de bande au moyen d'un encodeur.

Etant donné qu'on n'emploie qu'un seul convertisseur analogique/numérique, les données d'amplitude et de fréquence doivent lui être présentées en séquence. Cette fonction est remplie par un dispositif de minutage synchrone. Ce dernier veille également à ce que toutes les autres fonctions voulues de minutage soient exécutées dans l'ordre correct et au moment voulu. La séquence de minutage est déclenchée par l'impulsion obtenue de la boucle de bande.

EE 67 774 *pour plus amples renseignements*

MULLARD LTD

Mullard House, Torrington Place, London, W.C.1

DISPOSITIF CONSTITUÉ DE CORPS SOLIDES ET ACTIONNÉ PAR LA LUMIÈRE

Le Transluxor est un dispositif constitué de corps solides et fonctionnant au moyen de la lumière. Son gain de puissance et ses propriétés sont semblables à ceux d'un transistor. Il offre la perspective d'une variante séduisante du transistor classique car ses performances sont supérieures aux ultra-hautes fréquences et aux fréquences microondes.

Le fonctionnement du Transluxor dépend de l'émission hautement efficace et du captage de la lumière, pour produire un gain de courant presque unitaire, comme dans le cas des transistors.

L'émission hautement efficace de la lumière à partir de jonctions d'arseniure de gallium a été découverte vers la fin de l'année 1962 aux Etats-Unis. La lumière est émise à 8 400Å à une température de 77°K ou, avec beaucoup moins d'efficacité, à 100Å à la température de salle.

Une hétéro-jonction est utilisée afin d'obtenir un captage de grande efficacité, consistant en une jonction entre la zone type-n de l'arseniure de gallium et la zone type-p d'un autre semi-conducteur avec un entrefer d'énergie plus réduit.

La vitesse du Transluxor n'est pas limitée par la durée de transit du signal à travers la base car le signal est porté par la lumière. Il y a, cependant, des intervalles de temps effectifs pour l'émission et le captage de la lumière et ces intervalles produisent les limitations de fréquence de base du dispositif. On pense que le fonctionnement pourra être mis au point pour des fréquences au-dessus de 1 GHz.

Un avantage supplémentaire du Transluxor réside dans la possibilité qu'il offre de réaliser une version à quatre bornes dont l'entrée et la sortie sont électriquement isolées. Cette version peut être particulièrement utile dans les circuits de calculatrices et elle est semblable à un relais, mais sa vitesse de fonctionnement est, évidemment, beaucoup plus élevée.

Les modèles exposés comprenaient un émetteur et une hétérojonction transmettant un signal de haute fréquence à modulation acoustique qui peut être interrompue par un obturateur.

EE 67 775 *pour plus amples renseignements*

G. V. PLANER LTD

Windmill Road, Sunbury-on-Thames, Middlesex

MATÉRIAUX THERMOÉLECTRIQUES POUR GÉNÉRATEURS ET APPAREILLAGE DE CONTRÔLE

(*Illustration à la page 193*)

On a pu voir au Salon des appareils pour l'évaluation de l'indice de qualité de matériaux thermoélectriques pouvant être utilisés à des températures atteignant 600°C. dans des dispositifs générateurs de puissance. On emploie à cet effet une méthode stable et absolue, les mesures de conductivité thermique, du coefficient Seebeck et de conductivité électrique étant effectuées sur le même matériau soumis à l'essai sans qu'il y ait lieu de le retirer de l'appareil.

On a pu voir un certain nombre d'échantillons expérimentaux en alliages thermoélectriques à température elevée, produits par fonte en coquille, ainsi que par matriçage à chaud et à froid, et comprenant des compositions de tellurure de plomb enduit, de tellurure de germanium et de tellurure d'antimoine d'argent. Les mélanges de poudre de métal utilisés dans la préparation des alliages sont produits par des méthodes de précipitation chimique ou par la fonte en coquille. Les matériaux sont destinés à l'emploi dans des générateurs à haute température dont, entre autres, les générateurs de transformation directe comprenant une source de chaleur nucléaire pour satellites; ils sont également employés pour la mesure de flux thermique à haute température.

EE 67 776 *pour plus amples renseignements*

THE PLESSEY CO. (U.K.) LTD

Ilford, Essex

INSTRUMENT DE MESURE DE LA VITESSE DE PROPAGATION DU SON DANS L'EAU

(*Illustration à la page 194*)

Cet appareil de mesure de la vitesse du son a été réalisé pour les applications océanographiques et bathythermographiques et a l'avantage de permettre la mesure de vitesse quasi instantanée. La seule limite virtuelle de résolution de la structure de l'océan réside dans la vitesse de l'enregistrement associé. La précision de l'instrument est de ±30cm/sec et la profondeur maxima est de 609 m. Il élimine les erreurs dues à la température dans une gamme de −5 à +45°C et des salinités atteignant 40 parties par mille. Une sortie à modulation de fréquence, facilement adaptable aux enregistreurs standard, est assurée au moyen d'un câble blindé à un seul conducteur.

La photographie montre la tête de mesure (au centre) avec son circuit intérieur. A l'arrière, on voit un modèle de laboratoire du convertisseur connexe qui alimente un enregistreur à lecture directe. La version finale du convertisseur pourrait être de dimensions beaucoup plus réduites.

EE 67 777 *pour plus amples renseignements*

RESEARCH ELECTRONICS LTD

Bradford Road, Cleckheaton, Yorkshire

INSTRUMENTS NUCLÉAIRES D'ENSEIGNEMENT

(*Illustration à la page 194*)

Cette nouvelle gamme comprend des instruments nucléaires transistorisés de conception simple (échelle de comptage, intensimètre, château, etc.), de ormat réduit, de poids léger et de construction robuste, spécialement conçus pour l'enseignement du programme d'études secondaires de physique moderne et tenant compte des recommandations du Comité des Sciences Physiques Modernes de l'Association pour l'Enseignement Scientifique en liaison avec la Fondation Nuffield. On prévoit qu'en plus de leur emploi dans les écoles, ces instruments seront d'une valeur particulière pour l'enseignement de certaines matières dans les collèges techniques et les universités où des appareils plus compliqués et plus coûteux ne sont pas exigés.

Les instruments exposés comprenaient l'échelle de comptage simplifiée et l'intensimètre simplifié, tous deux comportant l'alimentation T.H.T. incorporée, pour l'utilisation de tubes Geiger-Müller d'extinction au halogène. Les accessoires comprennant un château simplifié, tant pour la vision par fenêtre d'extremité (échantillon solide) que pour le comptage d'échantillons liquides, ainsi qu'un porte-tube G.M. horizontal pour les mesures d'inversion de loi quadratique.

EE 67 778 *pour plus amples renseignements*

SPERRY GYROSCOPE CO. LTD

Great West Road, Brentford, Middlesex

TRANSDUCTEURS OPTIQUES À FIBRES

Le Sceptron est un nouveau dispositif servant à reconnaître des dessins ou des signaux. Il est basé sur l'emploi de fibres optiques comme structure métallique résonnante. Le signal peut être de n'importe quelle sorte pouvant être transformée en un réseau de vibrations métalliques, c'est à dire un réseau sonore ou, par balayage, un réseau topologique (visuel).

L'élément de base est un réseau de fibres (un millier de fibres environ) émergeant d'une base commune sous forme de faisceaux portant à faux. La base est profilée de manière à ce que la longueur libre des fibres puisse donner une gamme de fréquences dans la bande acoustique, soit de 200 Hz à 5 kHz.

Le réseau de fibres est monté sur un transducteur électromécanique (par exemple un élément de commande de haut-parleur) entraîné par le signal que l'on veut contrôler. Les fibres sont excitées de manière à les faire résonner suivant les fréquences du réseau de vibrations, les extrémités des fibres excitées vibrant autour de leur position de repos. On fait passer la lumière le long des fibres, et le signal est ainsi transformé en un réseau caractéristique de points lumineux, certains stationnaires et certains vibrants, sur le plan des extrémités des fibres. Le réseau correspondant au signal original est emmagasiné au moyen d'un masque se trouvant devant les extrémités des fibres. Ce masque ne permet le passage de la lumière que lorsque les fréquences dans le signal original sont excitées; ainsi la quantité de lumière passant à travers le masque dépend du degré de ressemblance du signal contrôlé au signal original. La lumière passant à travers le masque tombe sur une cellule photoélectrique et un dispositif de seuil entre en action lorsque la sortie de la cellule dépasse un niveau arbitraire prédeterminé. Ce passage constitue la reconnaissance du signal. Le masque est une plaque photographique exposée et il est réalisé en exposant la plaque au réseau de points vibrants du signal original. (En fait, le masquage est légèrement plus compliqué que ne l'indique notre description.)

Il est évident que le Sceptron est à auto-programmation très simple et ne nécessite aucune connaissance de la constitution du signal. Une autre caractéristique importante réside dans le fait qu'un très grand nombre de données peut être emmagasiné dans un très petit espace. On peut actuellement fabriquer des dispositifs contenant 2000 fibres d'un volume de 1,6 cm² (1,27 cm × 1,27 cm × 2,54 cm), dont chacune peut emmagasiner un grand nombre de données pour un seul signal. Des réseaux considérablement plus petits sont en cours de mise au point. Ainsi le classificateur de signaux Sceptron sera vraisemblablement beaucoup plus petit que, par exemple, une version entièrement électronique.

Le Sceptron est encore au premier stade de développement. Les expériences actuelles portent principalement sur la classification des sons. Les systèmes actuels peuvent reconnaître avec succès des mots d'une syllabe prononcés par un orateur donné. De nombreuses autres applications sont envisagées: reconnaissance des caractères, aides aux diagnostics médicaux, diagnostics de pannes etc.

EE 67 779 *pour plus amples renseignements*

TELEQUIPMENT LTD

Chase Road, Southgate, London, N.14

OSCILLOSCOPE D'ENSEIGNEMENT

(*Illustration à la page 194*)

Cet instrument est destiné spécifiquement à l'enseignement. Désigné sous le nom de 'Serviscope' S51E, il répond pleinement aux récentes recommandations du Rapport intérimaire Nuffield sur l'enseignement de la physique moderne, qui souligne la nécessité de pouvoir disposer d'un instrument simple, précis et d'une grande souplesse d'emploi.

Le 'Serviscope' S51E, réalisé suivant le modèle du type S51, dont il constitue une version perfectionnée, comprend un tube de post-accélération à face plate de 12,7 cm et fonctionnant à 3 kV; il ne pèse que 7,2 kg et mesure 17,78 cm × 38,1 cm × 20,3 cm.

La base de temps du S51E fournit 6 vitesses de balayage étalonnées et préréglées de 100 msec/cm à 1 μsec/cm. La réponse de fréquence de l'amplificateur Y va du courant continu à 3 MHz à une sensibilité maxima de 100 mV/cm, cependant que l'atténuateur d'entrée à compensation de fréquence et à 9 positions donne une lecture directe de 100 mV/cm à 50 V/cm. L'impédance d'entrée est de 1 M + 30 pf (approx.).

Afin de faciliter l'utilisation de l'oscilloscope par les étudiants, les commutateurs de télévision et de déclenchement intérieur/extérieur on été omis.

Le S51E peut être fourni soit avec tube P1 à courte persistance soit avec tube P7 à longue persistance, sans supplément de prix. Une lumière d'alarme secteur arrêt/marche est également prévue.

EE 67 780 *pour plus amples renseignements*

J. LANGHAM THOMPSON LTD

Park Avenue, Bushey, Hertfordshire

Convertisseur analogique/numérique

(Illustration à la page 195)

Ce convertisseur change les tensions d'entrée analogiques de 0 à −10 V en une sortie numérique binaire équivalente, pouvant être injectée dans une perforatrice de bande magnétique ou directement dans une calculatrice. Il est déclenché par une impulsion positive de 10 V de sorte que la tension d'entrée peut être convertie en une sortie numérique à n'importe quel moment. Ainsi, on peut, à l'aide d'un générateur d'impulsions de déclenchement approprié, utiliser le convertisseur pour produire des sorties numériques correspondant à la tension d'entrée à des intervalles de temps réguliers.

Le convertisseur utilise le système d'équilibrage chevauchant pour changer l'entrée analogique en une sortie de 8 chiffres binaires. L'entrée sur la totalité de l'échelle de −10 V produit une sortie de 2^8 = 256 chiffres. Chaque chiffre binaire représente donc une entrée d'environ 39 mV. Les sorties numériques sont sous forme de 0/ +12 V. Des plaquettes intérieures peuvent être fournies pour permettre d'actionner des perforateurs Addo X ou Creed.

L'appareil peut être fourni pour montage sur rack de 48 cm ou comme élément de banc d'essai. Il mesure 22.2 cm de haut et 29,2 cm de profondeur.

Un amplificateur qui permettra d'utiliser le convertisseur avec de plus faibles entrées sera prochainement offert avec cet appareil.

EE 67 781 *pour plus amples renseignements*

H. TINSLEY & CO. LTD

Werndee Hall, South Norwood, London, S.E.25

Pont de Wheatstone

(Illustration à la page 195)

La principale caractéristique de ce pont de Wheatstone à six échelles réside dans le fait que des échelles de conductance sont utilisées à la place d'échelles de résistance en série. Tous les contacts de commutation sont en parallèle et les valeurs de résistance de bobine sont élevées. Par conséquent, la résistance résiduelle de commutation est négligeable même pour les mesures les plus précises. L'appareil comporte sept gammes. La gamme la plus élevée s'élève jusqu'à un maximum de 100 MΩ et la gamme la plus réduite va jusqu'à un maximum de 100Ω.

La lecture de contact la plus réduite est de 0·0001Ω.

La précision à 20° C est de 1 partie dans 100 000 de la lecture maxima.

EE 67 782 *pour plus amples renseignements*

Indicateur inductif de rapport

Cet instrument est destiné à remplacer les ponts de résistance normalement employés dans la thermométrie de résistance. Il comprend sept échelles et il mesure la résistance de 1 à 1000Ω en trois gammes, à savoir de 1 à 10, de 10 à 100 et de 100 à 1000Ω. Il convient donc pour la thermométrie de résistance au platine.

La discrimination est de 1 partie dans 10^7 et cette valeur est maintenue même lorsque le courant à travers le thermomètre a la valeur maximum de 2 mA.

Le fonctionnement normal s'effectue sur 1 kHz mais l'instrument peut être prévu pour l'utilisation sur d'autres fréquences, si nécessaire.

EE 67 783 *pour plus amples renseignements*

20TH CENTURY ELECTRONICS LTD

King Henry's Drive, New Addington, Croydoo, Surrey

Détecteur de fuite automatique

(Illustration à la page 195)

On a pu voir au Salon un nouveau détecteur de fuite entièrement automatique, pouvant contrôler individuellement sous vide poussé jusqu'à 1000 dispositifs par heure. Tous les dispositifs accusant une fuite sont automatiquement rejetés.

Le contrôle de fuite de petits composants scellés (tels que transistors, condensateurs, etc.) en fonction d'une norme élevée et en quantités relativement élevées constituent une nécessité assez fréquente et l'appareil exposé peut contrôler une gamme étendue de ces composants sans l'aide d'opérateurs spécialisés. La seule opération manuelle nécessaire est de charger les dispositifs dans un barillet d'alimentation à l'avant de la machine. Les circuits de commande sont prévus pour permettre à la machine de faire face à n'importe quelles conditions de vide anormales créées par un dispositif de simulation.

Pour faciliter le contrôle de fuite, on introduit une bouffée de hélium dans les composants scellés au cours de la fabrication. L'hélium fuyant du dispositif soumis au contrôle est détecté au moyen d'un détecteur de fuite de spectromètre de masse à sensibilité élevée.

L'appareil peut contrôler des transistors ou n'importe quel dispositif ayant des dimensions maxima, soit 12 mm de diamètre × 62 mm de longueur, mais le principe peut être aisément appliqué au contrôle de dispositifs beaucoup plus grands. Au rythme de 1000 par heure, le seuil de rejet de fuite peut être fixé à moins de 10^{-5} 1 μsec.

Le détecteur de fuite automatique utilise un détecteur de fuite de spectromètre de masse standard Cintronic de la 20th Century Electronic, auquel de très légères modifications ont été apportées. Le détecteur de fuite Cintronic dont la sensibilité maxima est de 10^{-14} l/sec peut être utilisé à n'importe quel moment pour exécuter le contrôle de fuite individuel d'autres composants, en débranchant simplement le contrôleur automatique.

On fait passer le dispositif soumis à l'essai par une séquence de stade d'évacuation jusqu'à ce que l'espace entourant l'échantillon soit à une pression suffisamment réduite pour pouvoir introduire le dispositif dans une chambre reliée en permanence au détecteur de fuite de spectromètre de masse Cintronic. Les etages sont séparés par des tubes à vide poussé, actionnés pneumatiquement et de conception spéciale, qui isolent chacun des étages et servent en même temps de déclencheurs de transfert mécanique. Cette disposition permet à chaque étage de vide de "protéger" l'étage précédent ou suivant.

EE 67 784 *pour plus amples renseignements*

VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

Générateur d'impulsions

(Illustration à la page 195)

La caractéristique principale de cet instrument (type TSA648) réside dans le fait que chaque paramètre de l'impulsion peut être modifié. Il est non seulement pourvu des commandes habituelles de fréquence et de largeur d'impulsion et d'amplitude, mais il est également muni de commandes permettant de régler le temps de montée et de chute ainsi que le niveau de courant continu. Le générateur fournit une gamme de fréquence allant de 10 Hz à 1 MHz et fonctionne jusqu'à des largeurs d'impulsions de 0.5 μsec, le temps de montée le plus rapide étant de 10 nsec/V. Une préimpulsion est prévue ainsi qu'une commande de temps différé étalonnée. Les deux impulsions de sortie permettent la sélection de polarité, la sortie principale étant une impulsion d'amplitude maxima de 10 V à une impédance de sortie de 50Ω. Le générateur est entièrement transistorisé.

EE 67 785 *pour plus amples renseignements*

Résumés des Principaux Articles

Dispositifs d'accumulation à tube cathodique: télévision par ligne téléphonique par A. E. Cawkell

Résumé de l'article aux pages 142 à 149

L'auteur décrit les principes de fonctionnement fondamentaux des tubes d'accumulation à charge cathodique. Il décrit en particulier, le fonctionnement des tubes de vision directe bistables et en simili. Les tubes bistables et en simili sont comparés.

Il examine ensuite des instruments d'accumulation d'images et de formes d'ondes incorporant des tubes en simili et décrit quelques applications.

L'article continue par une étude du fonctionnement des tubes électriques et d'un instrument comprenant un tel tube pour l'accumulation d'images de grand écran. La transmission des images de télévision le long de lignes téléphoniques par le balayage ralenti d'une image accumulée est enfin analysée.

Les amplificateurs passe-bande à gain commandé et l'emploi d'amplificateurs vidéo à circuit intégré par M. D. Wood

Résumé de l'article aux pages 150 à 153

La première partie de cet article traite des difficultés que présentent les amplificateurs à transistors accordés à haute fréquence et à commande de gain. Les problèmes particuliers que créent les circuits à Q élevé et la neutralisation sont examinés dans ce contexte, ainsi que les méthodes classiques utilisées pour les résoudre. Diverses méthodes de commande de gain sont ensuite indiquées et discutées, notamment en ce qui concerne leurs répercussions sur l'accord des amplificateurs.

La seconde partie introduit et définit le concept de l'utilisation d'un amplificateur vidéo avec étages accordés d'entrée et de sortie servant à préciser la forme de bande. On y montre que l'amplificateur vidéo à circuit intégré dont il est question également, réussit non seulement à surmonter ces difficultés mais offre aussi des avantages supplémentaires.

Un modulateur d'impulsions de fréquence acoustique à gamme étendue par M. E. Bryan et W. Tempest

Résumé de l'article aux pages 154 à 158

Un modulateur d'impulsions BF à deux voies est décrit en détail. Chacune des voies peut moduler un signal BF afin de fournir une impulsion de 0,5mS à 5S de longueur dans l'une des deux formes d'enveloppe. Les temps de montée et de chute de l'impulsion sont à variation indépendante dans la gamme de 0,3mS à 100mS. Le niveau de bourdonnement, de bruit et de distorsion harmonique dans l'impulsion et dans l'intervalle entre les impulsions est inférieur de plus de 50dB au niveau des impulsions. Les deux voies peuvent être utilisées pour fournir une séquence A-B-A-B d'impulsions dans lesquelles les caractéristiques des impulsions A et B sont à variation indépendante.

Un détecteur universel sensible aux phases par E. A. Faulkner et R. H. O. Stannett

Résumé de l'article aux pages 159 à 161

Ce détecteur sensible aux phases a été réalisé sous forme d'instrument universel de laboratoire, particulièrement destiné à la réduction de la largeur de bande dans les mesures comportant l'emploi des méthodes de modulation. La réponse est linéaire de 10Hz à 100kHz sans réglage, la dérive de courant continu a été réduite à un niveau très bas et le comportement est suffisament bon pour permettre d'utiliser l'instrument en liaison avec un amplificateur non accordé dans des applications caractéristiques.

Eléments régulateurs à transistors par J. W. McPherson

Résumé de l'article aux pages 162 à 165

Cet article traite de certaines des imperfections de la méthode de réalisation d'éléments régulateurs de grande puissance à transistors en parallèle et indique quelques nouveaux circuits pouvant résulter dans l'emploi d'un nombre plus réduit de transistors de puissance, de plus petites sources froides et n'entraîne que des pertes permanentes réduites.

Circuits retardateurs à semiconducteurs par J. J. Pinto

Résumé de l'article aux pages 166 à 169

Cet article étudie les divers semiconducteurs pouvant être obtenus en Grande Bretagne, compte tenu des besoins particuliers des minuteries de processus. Le transistor à unijonction est examiné en détail, étant considéré comme le type de semiconducteur le plus approprié aux circuits retardateurs. L'auteur recommande son emploi dans une mesure plus étendue et sa vente à meilleur marché.

La dissipation de courant d'un transistor d'exploration de lignes durant la mise hors circuit par F. D. Bate

Résumé de l'article aux pages 170 à 172

Il s'agit d'une analyse de la puissance dissipée par un transistor d'exploration de lignes de télévision durant la période de mise hors circuit T_{co} pour différentes formes de chute de courant au collecteur. L'auteur examine et compare tant la fréquence fondamentale que les conditions d'accord de la troisième harmonique. Il constate, d'après une première estimation, que la puissance dissipée varie toujours au carré du temps de coupure T_{co} et qu'elle est de 50% supérieure lorsque l'accord optimum de troisième harmonique est utilisé, par rapport au cas où seule la fréquence fondamentale est présente.

Un compteur de décades bi-directionnel avec réseau anti-coincidence et affichage numérique par A. F. Tassinari

Résumé de l'article aux pages 173 à 177

Cet article traite d'un compteur réversible qui se compose fondamentalement de quatre étages diviseurs binaires flip-flop en cascade et à auto-déclenchement périodique, avec la réaction voulue pour former un compteur de décades. Un réseau anti-coïncidence est inclus dans l'appareil qui est entièrement muni de dispositifs semi-conducteurs.

Un convertisseur simple d'éléments analogiques en éléments arithmétiques par K. H. Edwards

Résumé de l'article aux pages 178 à 180

Cet article décrit un convertisseur simple d'éléments analogiques en éléments arithmétiques, conçu pour le traitement en série de données d'entrée. Il n'exige que quatre inter-connexions avec la source d'information et sa précision totale est supérieure à $\pm 1\%$.

Elektronische Geräte auf der Ausstellung der PHYSICAL SOCIETY

Beschreibung einer kleinen Auswahl der auf der 48. Ausstellung der Physical Society vom 6. bis 9. Januar in London gezeigten elektronischen Geräte nach Angaben der Hersteller

Übersetzung der Seiten 188 bis 195

AIRMEC LTD

High Wycombe, Buckinghamshire

Frequenznormal

(Abbildung Seite 188)

Ein kompaktes, volltransistorisiertes, quarzgesteuertes Frequenznormal, das eine kurzzeitige Frequenzkonstanz von 5×10^{-9} und eine Langzeitkonstanz von 1×10^{-8} pro Tag hat.

Zwölf getrennten Buchsen auf der Frontplatte können gleichzeitig Sinuswellen bei 1 MHz in Dekaden bis zu 100 Hz und Impulse bei 1 MHz in Dekaden bis zu 1 Hz entnommen werden. Für Langzeitmessungen ist auf der Frontplatte eine intern vom 1-Hz-Ausgang getriebene 12-Stunden-Digitaluhr vorgesehen.

Mit einem Schwebungsdetektor können im eingebauten Lautsprecher Schwebungstöne unbekannter Eingänge im Frequenzbereich 10 kHz...30 MHz hörbar gemacht werden; Tiefstfrequenzen können auf einem Profilmessgerät angezeigt und ein gesiebter Ausgang der Schwebungsfrequenz einer Frontplattenbuchse für einen externen Frequenzmesser entnommen werden. Unbekannte Eingänge kann man auf dem Schirm der eingebauten Oszillographenröhre, die auf Lissajoussche oder Z-modulierte kreisrunde Darstellung umschaltbar ist, vergleichen.

Sowohl die Oszillographenröhre, als auch das Messinstrument können zur Prüfung interner Schaltungen benutzt werden; die Arbeitsweise der Teiler wird bis zu 100 Hz mit der Oszillographenröhre und unter 100 Hz mit dem Messinstrument, das auch auf Überwachung interner Spannungen geschaltet werden kann, geprüft.

Das Gerät wird entweder aus dem Wechselstromnetz oder einem 12-V-Akkumulator als Notstrom-Batterie mit automatischer Umschaltung bei Ausfall des Netzes gespeist.

EE 67 751 *für weitere Einzelheiten*

UHF-Wattmesser

Der UHF-Wattmesser 319 ist ein leichtes und kompaktes Instrument zum Messen der Dauerstrichleistung, Seitenbandleistung und Modulationstiefe im Frequenzbereich 1 MHz...1 GHz.

Träger- und Seitenbandleistung werden in einem der beiden auf der Frontplatte einstellbaren Bereiche von 0...100 mW und 0...300 mW direkt auf einem Messgerät mit 89 mm langer Skala angezeigt. Zum Messen der Modulation wird erst die Trägerleistung notiert, dann der Drehschalter auf Modulation umgestellt und der Messgerätzeiger durch Drehen eines geeichten Potentiometerknopfes auf die ursprüngliche Anzeige zurückgebracht; die Modulationstiefe ist dann direkt in Prozent auf der Potentiometerskala ablesbar.

Für Trägermessungen sind keine zusätzlichen Stromquellen erforderlich; interne Trockenbatterien mit einer Lebensdauer von mehreren hundert Stunden dienen als Stromquellen für Seitenband- und Modulationsmessungen.

Die HF wird dem Gerät über eine Airmec-Standardsteckverbindung 341 auf der Frontplatte zugeführt, auf der auch eine Koaxialbuchse zur Entnahme der Modulationswellenform für Darstellung auf einem Oszillographen vorhanden ist.

EE 67 752 *für weitere Einzelheiten*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

33 Grosvenor Place, London, S.W.1

Elektronenmikroskop

(Abbildung Seite 188)

Modell EM6B ist ein Elektronenmikroskop mit grossem Auflösungsvermögen, das auf der Konstruktion des EM6 beruht, aber weitgehend abgewandelt wurde, um es besonders für biologische Untersuchungen geeignet zu machen. Dabei wurde darauf abgezielt, die grosse Leistungsfähigkeit bei durchlässigen Proben mit einfachster Bedienung zu verbinden.

Das elektronenoptische System beruht auf einer neuen, für optimale Eigenschaften konstruierten Objektivlinse und Projektorlinsen, die einen kontinuierlichen Vergrösserungsbereich von ×100...×250 000 ergeben. Besondere Aufmerksamkeit wurde einfacher Bedienung gewidmet, und es sind weniger als die Hälfte der an anderen Hochleistungs - Elektronenmikroskopen üblichen Bedienelemente erforderlich. Der Probenhalter kann jeweils drei Proben aufnehmen, was die Untersuchungen beschleunigt. Die Beschleunigungsspannung kann je nach Wunsch mit einem Schalter auf 30, 40, 50, 60 oder 80 kV eingestellt werden.

Trotz seiner vereinfachten Arbeitsweise kann dieses Gerät laufend eine Auflösung von 5 Å erzielen.

EE 67 753 *für weitere Einzelheiten*

Hochempfindliche fotoelektrische Bildfängerröhre

Diese Röhre wurde für das Registrieren von Vorgängen, die Zeitauflösungen unter 10^{-1} ns zur Auswertung benötigen, entwickelt. Zu diesem Zweck wird auf einer halbdurchsichtigen Fotokathode ein Bild des zu registrierenden Vorgangs gebildet. Von verschiedenen Punkten dieser Kathode werden Elektronen emittiert, deren Anzahl der auf diese Punkte fallenden Beleuchtung proportional ist. Diese Elektronen werden durch eine Anode beschleunigt und mittels einer Konusanode auf einen Fluoreszenzschirm fokussiert. Eine Aufnahme erfolgt durch Ablenkung des Elektrons durch eine Öffnung in einer Verschlussplatte, die zwischen Anode und Schirm liegt.

Eigenschaften der Röhre sind:

(a) Zeitauflösungsvermögen: Einzelaufnahme 1 ns, Strich- und Chronographauflösung 10^{-2} ns

(b) Raumauflösungsvermögen: 250 Zeilenpaare in jeder Richtung über ein rechteckiges Format

(c) Empfindlichkeit: untere Empfindlichkeitsschwelle 50 Fotoelektronen pro Bildpunkt

(d) Spektrale Verteilungscharakteristik: sichtbar, kann jedoch mit einem

Quarzstirnfenster bis in den ultravioletten Bereich erweitert werden.

EE 67 754 *für weitere Einzelheiten*

AVO LTD

Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1

ELEKTRONISCHES TESTMESSGERÄT

Das Gerät wurde als Universal-Instrument für den Elektroniker entwickelt. Die Empfindlichkeit ist in den niedrigeren Bereichen 1 MΩ/V und steigt bis zu einem Höchsteingangswiderstand von 30 MΩ für die 30-, 100-, 300- und 1 000-V-Bereiche. Die Basis des Vielfachinstrumentes bilden zwei volltransistorisierte Verstärker, je einer für Gleichstrom und für Wechselstrom.

Für Gleich- oder Wechselspannungsmessungen sind Teilbereiche mit Skalenendwerten von 100 mV bis zu 1 000 V und für Gleich- oder Wechselstrommessungen solche von 30 μA bis zu 3 A vorhanden; die Messunsicherheit ist ±3 % des Vollausschlags. Der Nennspannungsabfall ist für alle Strombereiche 30 mV. Widerstand kann zwischen 0.5 Ω und 20 MΩ (Skalenmittenwerte 20 Ω, 2 000 Ω und 200 000 Ω) gemessen werden.

Alle Bereiche können mittels zweier Schalter "Funktion" und "Bereich" im Bedienfeld eingestellt werden. Das Messgerät ist gegen zufällige Überlastung voll geschützt und kann auf Betrieb mit Nullpunkt in der Mitte umgestellt werden.

Das Gerät ist batteriegespeist; zwei 9-V-Batterien mit rund 500 Stunden Lebensdauer bilden die Stromversorgung für die Verstärker und Widerstandsmessungen.

EE 67 755 *für weitere Einzelheiten*

IN-SITU-TRANSISTOR-TESTER

Ein neuer tragbarer, batteriegespeister Transistor-Tester zum Prüfen eingebauter pnp- oder npn-Signal- oder Mittelleistungstransistoren.

Sorgfältig entworfene Schaltungen gleichen die Nebenschlusswirkung von Bauelementen, die in Bezug auf den zu prüfenden Transistor extern sind, aus. Eine Gleichstrombrückenschaltung kompensiert für die am Transistorkollektor und im Kreis liegenden Bauelemente, so dass Kollektorstrom und -spannung auf den erforderlichen Wert eingestellt werden können. Eine Wechselstrombrückenschaltung kompensiert für die an der Transistorbasis und im Kreis liegenden Bauelemente, so dass β bei der Wechselstrombrückenfrequenz von rund 1 000 Hz gemessen werden kann.

Der Kollektorstrom ist bis zu höchstens 10 mA kontinuierlich regelbar. Die Stromverstärkung kann innerhalb der Bereiche 0...150 und 0...300 entweder in situ oder ausgebaut gemessen werden; der Sperrstrom I'_{co} kann bei ausgebautem Transistor direkt am Messgerät angezeigt werden.

Das Gerät wird komplett mit zwei Messköpfen geliefert, von denen einer besonders für In-situ-Tests ausgelegt ist und mit der Kupferseite einer Leiterplatte Kontakt macht, während der andere für Tests ausserhalb der Schaltung oder mit ausreichend langen Anschlussdrähten geeignet ist.

Eine Batterieprüfungseinrichtung sorgt dafür, dass die Spannung nicht unter den für einwandfreies Arbeiten erforderlichen Wert fällt.

EE 67 756 *für weitere Einzelheiten*

BELL & HOWELL LTD

Consolidated Electrodynamics Division, 14 Commercial Road, Woking, Surrey

ULTRAVIOLETTER DIREKTSCHREIBER

(Abbildung Seite 188)

Streifeneinlegen und Bedienung dieses tragbaren Direktschreibers ist sehr einfach, und er ist für seine Grösse sehr vielseitig und genau.

Das Registriergerät erzeugt 178 mm breite Aufzeichnungen im Direktschreibverfahren ohne chemische Behandlung. In achtzehn getrennten Kanälen können mit Galvanometern Serie 7-300 der Consolidated Electrodynamics auf einem erst kürzlich entwickelten Schnellschreibpapier Daten von 0...10 kHz registriert werden.

Ausser Zeit- und Rasterlinien wird eine positive Kennzeichnung der Spuren durch aufeinanderfolgende Unterbrechungslücken erzielt, die ungefähr alle 305 mm in jeder Spur auftreten. Entlang der Streifenkante wird gegenüber jeder Unterbrechung eine Spurnummer ausgedruckt, die mit der Galvanometerposition übereinstimmt.

Die Spur ist 0,25 mm breit oder weniger. Papiervorschub wird durch Drucktasten gewählt, wobei jede der fünf Geschwindigkeiten vor oder während des Registrierens eingestellt werden kann.

Die Abmessungen des Gerätes, das 18.2 kg wiegt, sind 194 × 330 × 387 mm.

EE 67 757 *für weitere Einzelheiten*

CAMBRIDGE INSTRUMENT CO. LTD

13 Grosvenor Place, London, S.W.1

WEGGEBER

Der Prototyp dieses Wandlers hat einen grossen Messumfang, z.B. von 0...4 μm bis zu 0...4 mm.

Er besteht aus vier in Paaren und in Gegenphase angeordneten Massekernen mit gleichartigen Wicklungen, wobei ein Paar mit seinen Wicklungen gleichsinnig in Reihe geschaltet als Primärspule eines Übertragers, das andere mit seinen Wicklungen gegensinnig in Reihe geschaltet als Sekundärspule wirkt. Das bewegliche Element besteht aus einer leitenden Fahne zwischen den gegenphasigen Paaren.

Ein Wechselstromsignal wird an die Primärwicklungen gelegt, der Ausgang von der Sekundärspule verstärkt und dann mittels eines phasenempfindlichen Gleichrichters, dessen Bezugsspannung einem die Primärspule speisenden Transistor-Oszillator entnommen wird, gleichgerichtet. Wenn die Fahne in Bezug auf die Hälften der Sekundärspule symmetrisch steht, ist der Ausgang null; wenn die Fahne jedoch so bewegt wird, dass sie eine Hälfte der Sekundärspule mehr überdeckt als die andere, tritt ein Ausgang auf, dessen Amplitude der Fahnenverschiebung proportional ist. Das Verhältnis ist bis zu rund ±2 mm linear, und die Ausgangsphase wird bei Bewegung durch den Symmetriepunkt um 180° verschoben.

EE 67 758 *für weitere Einzelheiten*

COSSOR INSTRUMENTS LTD

The Pinnacles, Elizabeth Way, Harlow, Essex

BREITBANDOSZILLOGRAPH

Das Modell CT476 ist ein Breitbandoszillograph, der eine 127-mm-Elektronenstrahlröhre mit 10 kV Anodenspannung benutzt und für die Anzeige eine Fensterfläche von 6 × 10 cm hat.

Das Gerät ist für Einsatz mit den Streitkräften konstruiert und hat eine Bandbreite von 0 bis nicht weniger als 56 MHz (−3 dB) bei Ablenkfaktoren von 50 mV/cm bis zu 20 V/cm, und von 3 Hz bis zu 40 MHz bei 5 mV/cm bis zu 2 V/cm.

Eine eingebaute Signalverzögerung erlaubt Beobachtung der Vorderflanke der Triggerwellenform. Die Hauptzeitablenkung hat 24 von 5 s/cm bis zu 0,1 μs geeichte Bereiche, und jeder Bereich kann 5x gedehnt werden. Die Ablenkung kann mit Sinuswellen intern bei 5...25 MHz und extern bei 5...50 MHz getriggert werden.

Bei automatischem Betrieb kann die Ablenkung mit sich wiederholenden Signalen bei Folgefrequenzen von 30 Hz...2 MHz ohne Nachregelung synchronisieren. Die Eichunsicherheit ist für die Grundbereiche innerhalb ±3 % des Skalenendwertes und bei fünffacher Dehnung innerhalb ±5 %.

Der Haupthinlauf 'A' kann durch eine zweite Zeitablenkung 'B,' die von 2 μs/cm bis zu 1 s/cm in 1-2-5-Folge geeicht ist, verzögert werden, was Einstellung von Hinlaufverzögerungen bis zu 10 s erlaubt.

Z-Achsenmodulation ist durch Marken bei 500 MHz ±2 % und 50 MHz ±2 % vorgesehen, die durch die A-Ablenkung getriggert werden und für Impulsanstiegszeiten ein genaues Messsystem darstellen.

Der X-Verstärker hat bei Ablenkfaktoren von 1 V/cm bis zu 100 V/cm eine Bandbreite von 0...2 MHz. Ein Einschubzusatz 1085S wandelt das Gerät in einen Zweikanal-Oszillographen mit 0...40 MHz Bandbreite und Ablenkfaktoren von 50 mV/cm bis zu 20 V/cm um. Ein weiterer Einschub 1080S hat bei

Ablenkfaktoren von 1 mV/cm bis zu 50 V/cm eine Bandbreite von 0...1 MHz.

Die Cossor-Standardkamera kann mit vorhandenen Befestigungsmitteln angebaut werden.

EE 67 759 *für weitere Einzelheiten*

DAWE INSTRUMENTS LTD

Western Avenue, Acton, London, W.3

PRÄZISIONS-SCHALLPEGELMESSER

(Abbildung Seite 190)

Dieses Instrument ist ein tragbarer Präzisions-Schallanalysator, der mit Batterien rund 5,5 kg wiegt. Er ist mit einem Kondensatormikrofon ausgerüstet und misst Schallpegel von 20 ... 140 dB auf einen Normalpegel bezogen. Das Mikrofon ist mit einem Kathodenfolger in einen Messkopf zusammengebaut und kann mit bis zu 7,60 m langem Verlängerungskabel zwischen Messkopf und Gerät benutzt werden.

Standard-Bewertungsfilter A, B und C sind nach britischen, internationalen und amerikanischen Normen vorhanden. Der Verstärker hat zwischen 15 Hz und 50 kHz einen linearen Frequenzgang.

Die Frequenzanalyse wird mit einem abnehmbaren 600-Ω-Oktav-Bandfilter mit einem Bereich von 31,5 Hz bis zu 31,5 kHz nach dem IEC-Normvorschlag für Oktav-Filter vorgenommen.

Die Abschwächung ist für jedes Filterband unabhängig und bis zum Mindest-Rauschpegel des Verstärkers herunter regelbar.

Für Anschluss eines Magnetbandgerätes oder anderer Instrumente, z.B. eines Pegelschnellschreibers oder statistischen Analysators, sind Ausgangsbuchsen vorgesehen.

EE 67 760 *für weitere Einzelheiten*

DECCA RADAR LTD

Albert Embankment, London, S.E.1

ELEKTRONENRESONANZ-AUSRÜSTUNG

Gezeigt wurde ein komplettes Elektronenresonanz-Spektrometer mit 100-kHz-Modulation. Ein geräuscharmes Klystron wird phasenstarr mit einer Harmonischen eines Quarzkristalls betrieben, was ausgezeichnete Frequenzkonstanz gewährleistet. Vorhandene Einrichtungen erlauben Regelung der vorlaufenden Leistung, Einstellen der reinen Absorptionsarbeitsweise und Beobachtung des Spektrums mit einem Oszillographen oder Schreiber. Für Sonderzwecke sind Zusätze für Umstellung auf Überlagerungsdemodulation und 33-Hz-Modulation lieferbar.

Die Empfindlichkeit des ausgestellten Systems ist $1{,}5 \times 10^{12}\,\Delta H$ Spins für 1 mW Hohlraumleistung mit einer Zeitkonstanten von 1 Sekunde.

EE 67 761 *für weitere Einzelheiten*

DEVICES LTD

13-15 Broadwater Road, Welwyn Garden City, Hertfordshire

DIGITAL-ZEITABSTANDMARKIERER

(Abbildung Seite 190)

Das Gerät wurde für die Abgabe taktmässiger Impulse zur Einleitung von Vorgängen in einem vorgewählten Muster, wie sie für viele elektrophysiologische und psychologische Experimente notwendig sind, entwickelt. Diese Impulse können Reizgeber triggern, um in dem zu untersuchenden physiologischen Mechanismus Wirkungen hervorzurufen, oder Zeitablenkgeräte steuern, um Beobachtung und Zeitmessung elektrischer Begleiterscheinungen der Wirkung auf Oszillographen zu ermöglichen.

Die Digitaltechnik erlaubt Einstellen und Wiedereinstellen der taktmässigen Impulse mit grosser Präzision, während der Quarzkristall-Taktimpulsgeber hohe Genauigkeit der Zeitsteuerung gewährleistet. Mit Hilfe dieses Taktimpulsgebers wird eine Zeitskala zur Eichung der Zeitablenkgeschwindigkeit gebildet. Auf der Zeitskala können auf Wunsch zusätzliche Marken erscheinen, die die Auslösung verschiedener Vorgänge anzeigen. Man kann den 'Digitimer' entweder kontinuierlich laufen lassen—wenn sich das Programm der Vorgänge regelmässig in zwischen 0,1 ms und 10 s einstellbaren Zeitabständen wiederholt—oder durch ein externes, mechanisches oder elektrisches Signal triggern. Ein Bildschaltfeld auf der Frontplatte des Gerätes ermöglicht Schalten interner Kreise, so dass Rechteckwellen und/oder Impulsreihen regelbarer Dauer erzeugt werden.

EE 67 762 *für weitere Einzelheiten*

EKCO ELECTRONICS LTD

Southend-on-Sea, Essex

TRANSISTORISIERTES IMPULSZÄHLSYSTEM

Ekco Electronics hat ein neues Programm transistorisierter Zählgeräte mit strengerem Pflichtenblatt angekündigt, das die bestehenden Röhrengeräte ergänzt. Ein für allgemeines Impulszählen oder Spektrometrie eingesetztes komplettes, selbstuntersetzendes Ratemeter illustriert den Einsatz der Grundgeräte dieses neuen Programmes. Zur Konstruktion dieses Systems wurden folgende Funktionseinheiten benutzt: Hochspannungsgerät, Verstärker-Impulshöhenanalysator, Untersetzer, Zeitgeber und Ratemeter, zusammen mit der neuen transistorisierten Ausführung der Szintillationszähler-Messköpfe N676 (hohes Auflösungsvermögen) oder N691 (Mehrzweck).

Einige auf die Gamma-Spektrometrie bezogene Merkmale dieses Systems sind: Konstanz durchweg nicht schlechter als 0,1%; Bandbreite 10 MHz; dynamischer Bereich 50 : 1 mit Überlastbarkeit von 100 : 1 für eine Erholungszeit, die 1 µs nicht überschreitet. Das Grundauflösungsvermögen des Systems ist 0,1 µs, für den Unterteiler in Standardausführung jedoch 1 µs, gegen Sonderauftrag 0,1 µs. Mit dem Messkopf N676 ist eine abgestimmte Auflösung mit einer Einsattlung über 6,0 : 1 an Kobalt 60 erreichbar; Digitalanzeige erfolgt für alle geeigneten Betriebseinstellungen.

EE 67 763 *für weitere Einzelheiten*

EMI ELECTRONICS LTD

Hayes, Middlesex

OSZILLOGRAPH

(Abbildung Seite 190)

Modell WM41 ist ein Mehrzweck-Transistor-Oszillograph mit 0 ... 10 MHz (−3 dB) Bandbreite und Ablenkfaktoren von 50 mV/cm bis zu 20 V/cm in neun umschaltbaren Bereichen. Der Eingangswiderstand ist in allen Bereichen 1 MΩ, 30 pF.

Technische Daten sind:

Trigger

Selektion: intern ±, extern ± und extern mit 20 : 1 Abschwächung ±.

Arbeitsweise: Wechselstrom oder automatisch.

Zeitablenkung

Ungedehnt 200 ns/cm bis zu 100 ms/cm in 18 Stufen.

Kontinuierliche Dehnung von ×1 bis zu ×5 mit Eichung an beiden Enden.

Eichspannung

7 kHz Rechteckwelle mit einer Anstiegszeit von besser als 1 µs.

Die Amplitude ist in acht Stufen von 200 mV bis zu 40 V veränderlich.

Netzanschluss und Batterien

Normalerweise mit Netzanschluss 200 ... 265 V oder 100 ... 132 V, 50 ... 60 Hz betrieben. Wahlweise kann eine externe 12-V-Batterie verwendet werden. Die Leistungsaufnahme ist 18 W.

Das Modell WM41 kann in einem Umgebungstemperaturbereich von −5° ... +40° C arbeiten.

EE 67 764 *für weitere Einzelheiten*

'ELEKTRONENSTAB'

Hier handelt es sich um ein neues Hilfsmittel der technischen Schulung, mit dem man Studenten die Haupteigenschaften einer weiten Auswahl von Mikrowellenröhren für ein Zwanzigstel der Kosten, die bei Verwendung der einzelnen Röhren entstehen würden, demonstrieren kann.

Der 'Elektronenstab' ist im wesentlichen ein isolierter Elektronenstrahl, der in die verschiedenen externen Schaltungen eingefügt wird. Auf diese Weise können gewisse Mikrowellenröhren, wie z.B. die Wanderfeldröhre, der Zwei-Kammer-Klystronverstärker, die Adler-Röhre und der Rückwärtswellenverstärker konstruiert werden, um ihre Betriebsprinzipien in vielseitiger und viel sparsamerer Weise vorzuführen.

EE 67 765 *für weitere Einzelheiten*

ELECTRONIC APPLICATIONS (COMMERCIAL) LTD

Endeavour House, North Circular Road, London, N.W.2

ULTRASCHALL-FÜLLSTANDMESSER

Diese Ausrüstung benutzt die Ultraschall-Echolottechnik mit feingebündeltem Strahl zum Messen der Entfernung vom Geber zu einer Flüssigkeit oder festen Oberfläche. Die zwischen der Ausstrahlung des Impulses und dem Echo verflossene Zeit wird gemessen, digital dargestellt und gibt damit eine der Entfernung proportionale Anzeige.

Ein 150-kHz-Oszillator gibt ungefähr zwei Impulse pro Sekunde ab. Der Oszillatorausgang treibt einen piezoelektrischen Bleizirkonat-Wandler, der bei dieser Frequenz schwingt. Der entstehende Ultraschallimpuls wird in Luft in einem 3°-Konus fortgepflanzt und von jeder rechtwinklig zu diesem Weg liegenden Oberfläche reflektiert. Derselbe Wandler empfängt das Echo, und das entsprechende Spannungssignal wird verstärkt.

Gleichzeitig mit der Ausstrahlung des Impulses wird ein elektronisches Tor geöffnet, das Impulse von einem frequenzkonstanten Oszillator zu einem Dreidekaden-Transistor-Zähler mit Einzeilenanzeige durchlässt. Empfang des Echosignals schliesst das Tor. Der nächste ausgestrahlte Impuls stellt den Zähler zurück und die Reihenfolge wird wiederholt.

Die vom Zähler für jede Lotung registrierte Zahl ist ein Massstab der für die Lotung erforderlichen Zeit und daher dem Abstand zwischen Wandler und Oberfläche proportional. Die vorliegende Ausrüstung zeigt in Einheiten von 0,1″ (2,54 mm) an, hat eine Höchstmessstrecke von 3,05 m und über diese Entfernung eine Messunsicherheit von 0,2 % ±1 Ziffer.

Eine Grenzwerteinrichtung ist vorhanden, so dass ein Relais für Betätigung innerhalb jeder beliebigen Gruppe von 10 Ziffern, die durch die beiden kennzeichnenden Ziffern der Anzeige bestimmt wird, eingestellt werden kann.

Das Instrument findet hauptsächlich für die Bestimmung des Flüssigkeitsstandes in Tanks Verwendung. Für diesen Zweck wird erst eine Eichkurve erstellt, die den volumetrischen Inhalt für die Instrumentanzeige gibt. Das System hat den hervorstechenden Vorteil, dass überhaupt kein Kontakt mit der Flüssigkeit erforderlich ist, was besonders bei sehr hohen hygienischen Anforderungen oder wo Korrosionsprobleme auftreten sehr wichtig ist.

EE 67 766 *für weitere Einzelheiten*

ELLIOTT-AUTOMATION LTD

34 Portland Place, London, W.1

LANGSAMLAUFENDER ASYNCHRONMOTOR

(*Abbildung Seite 191*)

Die Servo Components Division der Elliott Brothers (London) Ltd, einer Firma der Elliott-Automation-Gruppe, stellt unter dem Namen Steromotor einen neuen langsamlaufenden Asynchronmotor mit hohem Drehmoment her. Es handelt sich um ein grundsätzlich neues Konzept, da der Motor bei niedrigen Wellenumdrehungen ohne Untersetzungsgetriebe ein hohes Drehmoment abgibt. Kennzeichnende Eigenschaften sind ferner schnelles Anlaufen und Stoppen, die den Motor besonders für Einsatz in der Automatik und Servosteuerung geeignet machen.

Der Motor besteht aus einem mit Wechselstrom erregten gewickelten Stator, der ein doppeltes magnetisches Drehfeld erzeugt, und einem Dauermagnet-"Rotor", der nicht in der normalen Weise rotiert, sondern um einen sehr kleinen Radius kreist. Die kreisrunde Bewegung des Rotors wird mittels eines Hypozykloidgetriebes in eine Drehbewegung umgewandelt. In der Praxis hat der Rotor Endscheiben, deren Durchmesser etwas kleiner ist als der der sie umschliessenden Rollbahnen. Die Scheiben rollen über die Innenseite dieser Rollbahnen, wodurch langsame Umdrehungsgeschwindigkeiten des Rotors mit entsprechend hoher Drehleistungsabgabe entstehen.

Da der Rotor um einen kleinen Radius kreist, ist sein Trägheitsmoment vernachlässigbar klein, und die zum Anlaufen und Stoppen des Motors erforderliche Zeit liegt unter 0,01 Sekunden. Genau genommen rotiert der Rotor nicht, hat auch keine Lager, statt dessen aber Rollbahnen, die mit einer biegsamen Ausgangswelle gekuppelt sind, während der Stator elastisch montiert ist. Weder Bürsten noch Schleifringe werden benutzt, und die Statorwicklungen sind gekapselt, um selbst bei schwierigsten Umgebungsbedingungen Betriebssicherheit zu gewährleisten.

Charakteristisch für diesen Motor ist, dass er wiederholt belastet angelassen, gestoppt, umgekehrt oder abgewürgt werden kann, ohne dass Schäden auftreten. Ausser als kontinuierlich umlaufender Asynchronmotor kann er auch als Fortschaltmotor benutzt werden, wenn der Stator von einer Gleichstromquelle über eine geeignete Steuerschaltung erregt wird.

Der Motor ist besonders für die Servosteuerung oder für Verwendungszwecke, die sehr schnelles und kritisches Ansprechen auf Eingangssignale erfordern, geeignet. Schnelle Servosysteme brauchen kein Rückführungstachometer, da die Bewegung im wesentlichen "aperiodisch" ist.

Motoren sind für Drehmomente von 10,35 kg cm bis zu Null und in den höheren Drehleistungen bis zu 10,35 kg m lieferbar. Sie sind zur Zeit für ein- oder mehrphasige Standardspannungen, 50 oder 60 Hz erhältlich, oder für Gleichstromanschluss, wenn schrittweiser Betrieb erwünscht ist.

EE 67 767 *für weitere Einzelheiten*

FEEDBACK LTD

Crowborough, Sussex

UNTERRICHTS-SERVOSYSTEM

(*Abbildung Seite 191*)

Dieses Servosystem ist für Studenten bestimmt und hat viele Eigenschaften, die mit der Einführung in die Steuerungs- und Regelungstheorie zusammenhängende Untersuchungen sowohl im Prinzip, als auch in Einzelheiten ermöglichen.

Das System besteht aus zwei Einheiten, und zwar einem Kontrollgerät, das die notwendigen Verstärker, Stromversorgungen usw. enthält, und einer mechanischen Baugruppe, die Motor, Untersetzungsgetriebe und Fehlerkanalpotentiometer umfasst. Beide Einheiten sind in einem Gehäuse untergebracht.

An und für sich hat das System eine Geschwindigkeitsverzögerungscharakteristik mit einer definierten Zeitkonstanten, die dem Motor zugeordnet ist. Das Fehlersignal wird einem Funktionsverstärker im Kontrollgerät zugeführt, mit Hilfe dessen Fehlersignale und Geschwindigkeitsrückführung hinzugefügt werden können. Auch lässt sich mit diesem Verstärker eine zusätzliche Integration oder Zeitkonstante in die Vorwärtsstrecke einführen, wodurch das System labil wird und sich zur Untersuchung der Kompensationstechnik einsetzen lässt. Auf der Frontplatte werden die internen Schaltungsverbindungen graphisch dargestellt. Die mechanische Baugruppe ist so ausgelegt, dass sie herausgleitet und leicht zugänglich ist. Motor und Getriebe sind so auf eine Platte montiert, dass die Untersetzung leicht geändert werden kann.

Das System hat eine Anzahl zweckdienlicher Eigenschaften wie z.B. Umkehr der Fehlerrichtung oder Geschwindigkeitsrückführung, sowie die zur Einführung von Integration oder einer Zeitkonstanten in die Vorwärtsstrecke erforderlichen Bauelemente. Ferner lassen sich die Stromversorgungen im Kontrollgerät in Verbindung mit dem System als Standard-Rückführungseinheiten für Analogrechner zur Untersuchung von Relaissteuerungen verwenden, usw. Das System kann in einem höheren Gerät geliefert werden, in dem zwischen dem Kontrollgerät und der mechanischen Baugruppe Platz für den Einbau analoger Bausteine ist.

EE 67 768 *für weitere Einzelheiten*

FERRANTI LTD

Ferry Road, Edinburgh, 5

INTERFERENZSTREIFENMESSER

Das ausgestellte Gerät war der Einachsen-Prototyp einer neuen Serie von Interferenzmessern, deren Herstellung in diesem Jahr anlaufen wird. Im Vergleich mit älteren Ferranti-Ausrüstungen auf diesem Gebiet hat die neue Serie mehrere interessante Konstruktionsmerkmale.

Die Anordnung, nach der pro Gittergrundmass vier Zählungen stattfanden, wurde auf zehn oder zwanzig Zählungen pro Grundmass erweitert.

Die vom Abtastkopf abgegebenen vier Fotozellenwellenformen werden bei zusätzlicher Mitkopplung in einen Gegenkopplungsvorverstärker und Verstärker mit Silizium-Transistoren gespeist. Diese Anordnung erzeugt ein Paar um 90° verschobene konstante symmetrische Wellenformen, die direkt an impulserzeugende und richtungwahrnehmende Schaltungen gelegt werden können.

Mit einer Höchstzählrate von 100 000 Ziffern pro Sekunde als Standard hat der Vor- und Rückwärtsringzähler jetzt eine höhere Höchstzählrate als vorher. Für Verwendungszwecke, in denen Spitzengeschwindigkeiten vorkommen, kann die erste Stufe mit einer Zählrate von 1 000 000 Ziffern pro Sekunde geliefert werden.

Zur optischen Ausrüstung gehört eine erste Stufe mit Kontrollschaltung, eine komplette Zählerprüfung mit Ternärsystem und einem elektronischen Umschalter für nichtkomplementären Betrieb. Ausserdem steht für das Einstellen und die Kontrolle der Eingangsformen ein Oszillograph als Monitor zur Verfügung.

Baukastenprinzip mit leicht zugänglichen Leiterkarten und Nummernanzeige in unmittelbarer Nähe oder entfernt von den zugehörigen Schaltungen sind Hauptkonstruktionsmerkmale. Ausdruckeinrichtungen mit Magnetkernpufferspeicherung sind in vereinbarter Ausführung lieferbar. Da die zugehörigen Schaltungen in Festkörpertechnik gebaut sind, können schnelle Magnetband-, Locher- und Datenübertragungsausrüstungen benutzt werden.

Der auf dem Stand vorgeführte Prototyp arbeitet mit zwanzig Zählungen pro Gittergrundmass von einem Gitter mit 250 Strichen/mm und ergibt eine Zifferngrösse von 0.2 Mikron; das wäre für äusserst genaue Präzisionsmessungen ausreichend. Ein System mit einer Zifferngrösse von 1 Mikron mit einem Gitter von 100 Strichen/mm würde jedoch den meisten wissenschaftlichen Anforderungen, die Reduktion fotografischer Daten erfordern, genügen.

EE 67 769 *für weitere Einzelheiten*

THE GENERAL ELECTRIC CO. LTD

Hirst Research Centre, East Lane, Wembley, Middlesex

MAGNETFILM-LOGIK

In Zusammenarbeit der Salford Electrical Instruments Ltd und den Labors der International Computers and Tabulators (Engineering) Ltd wurden Magnetfilme entwickelt, die preisgünstige Rechnerspeicher ergeben und schnell schalten können. Solche Filme haben eine bevorzugte Magnetisierungsache in der Filmebene. Jedes Speicherelement im Film kann längs der Achse in der einen oder anderen Richtung magnetisiert werden, wobei die Richtung 0 oder 1 darstellt; in Abwesenheit eines magnetischen Feldes bleibt die Magnetisierung in dieser Richtung bestehen. Diese Magnetfilme können sowohl für die Bearbeitung der Information im Logik-Teil eines Rechners wie auch für Speicherzwecke verwendet werden.

Die Demonstration zeigte die Arbeitsweise eines solchen Bausteins, der einen Teil eines vorgeschlagenen Magnetfilm-Logiksystems bildet, in dem die Ausgangssignale verschiedener Speicherzellen in geeigneter Weise kombiniert und zur Betätigung nachfolgender Speicherzellen benutzt werden, wobei alle Zellen durch leitende Schleifen über dem Film miteinander verbunden sind. In der gezeigten Anordnung überlappen sich zwei Schleifen in solcher Weise, dass die Kopplung in Abhängigkeit von der relativen Permeabilität der Filmflächen unter den überlappenden Abschnitten entweder positiv, null oder negativ ist; diese Permeabilitäten können durch die harten Richtungsfelder geändert werden, die ein durch einen Steuerleiter, der über den überlappenden Abschnitten der leitenden Schleifen liegt, fliessender Strom erzeugt. Ein eine Binärziffer darstellendes Signal kann daher die Kopplung ändern, bevor es zur Einstellung einer Speicherwelle benutzt wird. Die Zelle wird daher eine Binärziffer entweder in derselben Richtung wie das Originalsignal, in umgekehrter Richtung davon, oder überhaupt nicht speichern, je nach der Grösse des Steuerstroms zur Zeit der Einstellung der Zelle.

EE 67 770 *für weitere Einzelheiten*

GULTON INDUSTRIES (BRITAIN) LTD

Regent Street, Brighton, 1

KERAMISCHE WANDLER

Entwicklungen in der Technologie der Fertigung keramischer Werkstoffe in Form von Scheibchen, die unter 0,076 mm dick sind, haben zur Herstellung einer Reihe elektromechanischer Wandler mit verbesserten Eigenschaften geführt.

(a) *Tonabnehmerelemente*

In den letzten Jahren hat piezoelektrische Keramik allmählich Rochellesalz als empfindliches Element in Tonabnehmern verdrängt. Nach einer neuen Technik wird das Element aus drei dünnen Keramikplättchen aufgebaut: ein Material mit hoher Dielektrizitätskonstante wird zwischen zwei Scheibchen aus piezoelektrischem Material gelegt und hat zur Fertigung einer Serie von Doppelplattenelementen äusserst hoher Kapazität geführt. Diese Kapazität ist über zwanzig mal so gross wie die herkömmlicher Elemente, so dass Transistorschaltungen mit niedriger Impedanz nunmehr direkt gespeist werden können.

(b) *Elektrostatische Relais*

Platten ungleichnamig gepolter piezoelektrischer Keramik werden so zusammengekittet, dass sie ein Zweiplatten-Biegesystem bilden. Paare dieser Biegeelemente werden an einem Ende zusammengeklemmt und können —mit einem Kontakt am freien Ende —Relais bilden. Solche Relais vertragen mehrere Millionen Betätigungen und haben äusserst kleine Abmessungen.

(c) *Piezoelektrische Lautsprecher*

Zweiplatten-Biegeelemente als Ausleger oder einfache Träger montiert können als Treiber eines Lautsprechers dienen. Änderung der Abmessungen des Schichtkörpers erlaubt Regelung der dynamischen Eigenschaften.

(d) *Mikrofone*

Die sehr grosse Empfindlichkeit und hohe Kapazität der keramischen Elemente kann in der Konstruktion von Mikrofonen der Spitzenklasse ausgenutzt werden.

EE 67 771 *für weitere Einzelheiten*

J. & P. ENGINEERING (READING) LTD

Portman House, Cardiff Road, Reading, Berkshire

HOCHSPANNUNG-STROMVERSORGUNG

(*Abbildung Seite 192*)

Dieses Gerät gibt 4 kV 3 mA mit einer Konstanz von 1×10^{-4} ab. Es wurde für das britische Atomenergie-Forschungsinstitut in Harwell für dessen kerntechnische Anbaugeräte der Serie 2000 entwickelt. Durch Ausführung in Festkörpertechnik nimmt die Einheit nur ein Drittel des Raumes der zur Zeit lieferbaren Geräte vergleichbarer Leistung ein.

Grundsätzlich besteht das Gerät aus einer Schaltung mit steuerbarem Silizium-Gleichrichter in Verbindung mit einem transistorisierten Gleichstrom - Gleichstromwandler, wodurch kontinuierliche Regelung der Ausgangsspannung von 0 ... 4 kV möglich wird. Dekadenschalten gibt ±0,2 V Einstellgenauigkeit. Die Ausgangsspannung kann mittels eines Schalters umgepolt werden. Eine schnellwirkende Auslöseschaltung schützt das Gerät gegen interne Kurzschlüsse und verhindert, dass man gefährliche elektrische Schläge erhält.

Die Konstanz des Gerätes wurde durch Speisung der Ausgangsspannung in einen für diesen Zweck entwickelten Spannungsdriftmonitor vorgeführt. Der letztere enthält einen Präzisions-Spannungsteiler, hochkonstante Bezugsspannungs- und Differentialverstärker und hat eine Eigenkonstanz von besser als 1×10^{-5} je Woche. In der Vorführung wurde der Ausgang zum Treiben eines Schreibers benutzt, der Änderungen von einigen Millionsteln anzeigt.

EE 67 772 *für weitere Einzelheiten*

GEORGE KENT LTD

Luton, Bedfordshire

WEGGEBER

(*Abbildung Seite 193*)

Der gezeigte Wandler hat einen

Differentialübertrager und zugehörige Festkörperschaltungen, die einen getrennten Ausgangsstrom erzeugen, der für die Übertragung einer Verfahrensvariablen über grosse Entfernungen geeignet ist. Der Ausgangsstrom ist im Bereich 0 ... 10 mA der Eingangsverschiebung genau proportional; die angelegte Steuerspannung liegt im Bereich 2 ... 5 V. Das Gerät wird von einer nichtstabilisierten 24-V-Gleichstromquelle gespeist.

Der Verschiebungsweg wirkt auf den Kern eines Differentialübertragers, der von einem Rechteckwellenoszillator gespeist wird, dessen Ausgangsamplitude der angelegten Steuergleichspannung proportional ist. Der Übertragerausgang wird demoduliert und steuert dann den übertragenen Strom. Dieser wird mittels eines veränderlichen Rückführungswiderstandes so geregelt, dass Vollausschlag des Instrumentes Verschiebungswege von 0 ... 1,27 mm bis zu 0 ... 6,35 mm überstreicht.

Die Demonstration zeigte ein Anwendungsbeispiel mit drei veränderlichen Eingängen:

$$\text{Ausgangsstrom} \propto \frac{\text{mech. Verschieb.} \times \text{Steuerspannung}}{\text{Rückführungswiderstand}}$$

Auf Wunsch kann die Steuerspannung durch eine Bezugsdiode ersetzt und der Rückführungswiderstand unveränderlich gemacht werden, wodurch die Beziehung

$$\text{Ausgangsstrom} \propto \text{mechanischem Verschiebungsweg}$$

wird.

EE 67 773 *für weitere Einzelheiten*

MUIRHEAD & CO. LTD

Beckenham, Kent

DIGITALDARSTELLUNGSSYSTEM

Das neue Gerät K-162-A ist von besonderem Interesse für Forscher, die sich mit der Lösung von Geräusch- und Schwingungsproblemen befassen, da es die mit der Umwandlung von analogen Daten in die Digitalform verbundenen mühsamen Arbeiten beseitigt. Der Digitalausgang ist für die Steuerung eines Streifenlochers gedacht, kann jedoch auch für die Steuerung numerischer Drucker jeder Art, z.B. Fernschreiber, elektrische Schreibmaschinen oder direktangeschlossene Druckwerke, eingesetzt werden. Das Gerät wurde für Zusammenarbeit mit dem automatischen, registrierenden Wellenformanalysator von Muirhead entwickelt; der Betrieb des kompletten Systems ist vollautomatisch.

Die in den Lochstreifen gestanzte Information besteht aus der Frequenz, auf die der Analysator abgestimmt ist, zusammen mit der Amplitude des Signals in diesem Band. Das zu analysierende Signal wird auf einem endlosen Magnetband aufgenommen und in der Nähe der Klebstelle durch Entfernung der Beschichtung ein kleines "Fenster" geschaffen. Wenn dieses Fenster durch eine am Magnetband liegende fotoelektrische Einrichtung läuft, wird ein Impuls erzeugt, der eine Zeitfolge einleitet.

Während der Analyse werden Frequenz- und Amplitudeninformation durch den Analysator und Pegelschreiber in analoger Form dargestellt. Zur gegebenen Zeit werden beide Signale in einen Analog-Digitalwandler gespeist, der über einen Verschlüssler den Streifenlocher steuert.

Da nur ein Analog-Digitalwandler benutzt wird, muss die Amplituden- und Frequenzinformation nacheinander eingegeben werden, und diese Aufgabe wird durch einen synchronen Zeitgeber gelöst. Dieser Zeitgeber gewährleistet auch, dass alle anderen erfordlichen Schaltvorgänge in der richtigen Reihenfolge und zur richtigen Zeit erfolgen. Die Zeitfolge wird durch einen durch das Fenster des endlosen Magnetbandes erhaltenen Impuls eingeleitet.

EE 67 774 *für weitere Einzelheiten*

MULLARD LTD

Mullard House, Torrington Place, London, W.C.1

LICHTBETÄTIGTES FESTKÖRPERELEMENT

Ein 'Transluxor' ist ein lichtbetätigtes Festkörperelement mit Leistungsverstärkung und Eigenschaften, die denen eines Transistors ähnlich sind. Er bietet Aussicht auf eine verlockende Alternative zum herkömmlichen Transistor, da er bei UHF- und Mikrowellenfrequenzen überlegene Eigenschaften haben mag.

Die Arbeitsweise des Transluxors hängt von der hochleistungsfähigen Emission und Sammlung von Licht ab, um die Stromverstärkung—wie beim Transistor—auf annähernd 1 : 1 zu bringen.

In der zweiten Hälfte von 1962 wurde in U.S.A. bekannt, dass Galliumarsenid-Grenzflächen sehr wirksames Licht emittieren. Bei 77°K wurde Licht mit 8400 Å, bei Raumtemperatur viel weniger leistungsfähig mit 9100 Å emittiert.

Durch Wahl von Hetero-Übergangszonen wurde die Sammlung hochleistungsfähig gemacht. In diesem Fall ist es die Übergangszone zwischen einem n-Gebiet aus Galliumarsenid und einem p-Gebiet aus einem anderen Halbleiter mit kleinerem Bandabstand.

Die Geschwindigkeit des Transluxors wird nicht durch die Laufzeit des Signals durch die Basis begrenzt, da das Signal von Licht übertragen wird. Es bestehen jedoch effektive Zeitspannen für Emission und Sammlung des Lichtes, die die Grundfrequenzbegrenzung des Elementes bestimmen. Man nimmt an, dass Betrieb bei Frequenzen über 1 GHz möglich sein wird.

Ein weiterer Vorteil des Transluxors ist die Möglichkeit, Vierpolelemente herzustellen, in denen Eingang und Ausgang elektrisch isoliert sind; diese Ausführung wird voraussichtlich besonders in Rechnerschaltungen sehr zweckdienlich sein und ist einem Relais analog, hat aber viel höhere Arbeitsgeschwindigkeiten.

Die Demonstration zeigte die Übertragung eines tonmodulierten HF-Signals (1 MHz) mittels eines getrennten Emitters und einer Hetero-Übergangszone und konnte durch eine Blende unterbrochen werden.

EE 67 775 *für weitere Einzelheiten*

G. V. PLANER LTD

Windmill Road, Sunbury-on-Thames, Middlesex

TESTAUSRÜSTUNGEN UND MATERIALIEN FÜR THERMOELEKTRISCHE GENERATOREN

(*Abbildung Seite 193*)

Apparaturen zur Bestimmung der Güteziffer thermoelektrischer Materialien für Verwendung in energieerzeugenden Einrichtungen bei Temperaturen bis zu 600°C wurden gezeigt. Ein absolutes Festzustandverfahren wird benutzt, und thermische Leitfähigkeit, Seebeck-Koeffizient und elektrische Leitfähigkeit werden an demselben Prüfling und ohne Entfernung aus den Apparaten gemessen.

Eine Anzahl von Versuchsproben im Hartguss hergestellter warmfester thermoelektrischer Legierungen sowie Kalt- und Warmpresslinge wurden gezeigt, darunter dotierte Bleitellurid- und Germaniumtelluridverbindungen und Silberantimontellurid. Die Metallpulvermischungen in der Aufbereitung der Legierungen werden im chemischen Niederschlagverfahren oder als Hartguss hergestellt. Die Materialien werden in Hochtemperatur-Generatoren benutzt; eine Anwendungsmöglichkeit dafür ist in Direktumsetzungsgeneratoren mit Kernwärmequellen für Satelliten, eine andere für Wärmeflussmessungen bei hohen Temperaturen.

EE 67 776 *für weitere Einzelheiten*

THE PLESSEY CO. (U.K.) LTD

Ilford, Essex

UNTERWASSERSCHALL-GESCHWINDIGKEITSMESSER

(*Abbildung Seite 194*)

Dieser Schallgeschwindigkeitsmesser wurde für meereskundliche und Bathythermografen-Zwecke entwickelt und hat den Vorteil fast augenblicklicher Geschwindigkeitsangabe—die einzige praktische Begrenzung der Auflösung der Meeresstruktur liegt in der Geschwindigkeit des zugehörigen Schreibers. Die Messunsicherheit des Instrumentes ist ± 30 cm/s, die maximale Tiefe grösser als 610 m; das Gerät eliminiert auf Temperaturen im Bereich $-5° \ldots +45°$C und Salzhaltigkeit bis zu 40×10^{-3} zurückzuführende Fehler. Ein über ein einadriges Panzerkabel entnommenes FM-Ausgangssignal kann ohne Schwierigkeiten einem Standardschreiber angepasst werden.

Das Foto zeigt den Messkopf (Mitte) mit einer internen Schaltung. Im Hintergrund ist ein Labormodell des zugehörigen Wandlers, der ein direktanzeigendes Messgerät oder einen Schreiber speist. Die Abmessungen der endgültigen Wandlerkonstruktion dürften wesentlich kleiner sein.

EE 67 777 *für weitere Einzelheiten*

RESEARCH ELECTRONICS LTD

Bradford Road, Cleckheaton, Yorkshire

KERNTECHNISCHE UNTERRICHTSGERÄTE

(Abbildung Seite 194)

Diese neue Serie umfasst vereinfachte und sehr preiswerte transistorisierte kerntechnische Geräte (Untersetzer, Ratemeter, Kammer, usw.), die trotz robuster Konstruktion klein und leicht sind. Sie werden besonders für den Unterricht nach dem revidierten Lehrplan des General Certificate of Education für Moderne Physik entwickelt; die Empfehlungen des Ausschusses für moderne physikalische Wissenschaft des Verbandes für wissenschaftliche Schulung und der Nuffield-Stiftung wurden dabei berücksichtigt. Es wird erwartet, dass die Geräte ausser in Schulen auch für bestimmte Unterrichtszwecke in technischen Lehranstalten und Hochschulen besonderen Wert haben, wo man auf die Verfeinerungen teurerer komplexer Geräte verzichten kann.

Ausgestellt waren der vereinfachte Untersetzer und das vereinfachte Ratemeter, beide mit eingebauter Hochspannungsquelle für den Betrieb von Geiger-Müller-Halogenzählrohren. Unter dem Zubehör befanden sich Kammern mit Stirnfenstern (Festproben) und solche für Flüssigkeitsprobenzählung, sowie eine horizontale GM-Zählrohrhalterung für Messungen nach dem umgekehrt-quadratischen Gesetz.

EE 67 778 *für weitere Einzelheiten*

SPERRY GYROSCOPE CO. LTD

Great West Road, Brentford, Middlesex

FASEROPTISCHE FILTER

Das 'Sceptron' ist ein neuartiges Muster- und Signalerkennungsgerät, das auf der Anwendung optischer Fasern als mitschwingende mechanische Strukturen beruht. Das Signal kann jeder Art sein, solange es sich in ein Muster mechanischer Schwingungen umsetzen lässt, z.B. Schall oder—durch Abtasten—ein topologisches (visuelles) Bild.

Die Grundeinheit ist eine Fasergruppe (aus beispielsweise ungefähr 1000 Fasern), die aus einem Tragfuss einseitig eingespannt hervortreten. Der Tragfuss ist geformt, so dass die freie Länge der Fasern Eigenfrequenzen im Tonfrequenzbereich haben, z.B. in einem Band von 200 Hz ... 5 kHz.

Die Fasergruppe wird auf einen elektromechanischen Wandler, z.B. das Treibsystem eines Lautsprechers, montiert, an den das zu überwachende Signal gelegt wird. Fasern werden entsprechend den im Schwingungsbild vorhandenen Frequenzen zum Mitschwingen erregt, und die Spitzen der erregten Fasern vibrieren um ihre Ruhestellung. Licht wird entlang den Fasern weitergeleitet und das Signal dadurch in ein kennzeichnendes Lichtpunktmuster in der Faserspitzenebene umgesetzt, in dem einige Punkte feststehen, andere vibrieren. Das dem Originalsignal entsprechende Muster ist auf einer Abdeckplatte vor den Fasern gespeichert, die nur dann Licht durchlässt, wenn die im Originalsignal vorhandenen Frequenzen erregt werden; das durch die Abdeckplatte erlaubte Licht hängt davon ab, in welchem Grad das überwachte Signal dem Originalsignal ähnlich ist. Das durch die Abdeckung gelassene Licht fällt auf eine Fotozelle, und sobald der Ausgang der Fotozelle einen willkürlich vorbestimmten Pegel überschreitet, wird eine Empfindlichkeitsschwelleneinrichtung betätigt. Damit ist das Signal erkannt. Die Abdeckung ist eine belichtete fotografische Platte, die durch Belichtung mit dem vibrierenden Punktmuster des Originalsignals hergestellt wird. (In der Praxis ist das Abdeckverfahren etwas komplizierter als hier beschrieben).

Es ist klar, dass sich das Sceptron auf sehr einfache Weise selbstprogrammiert und dass die Signalzusammensetzung nicht bekannt zu sein braucht. Das Sceptron hat die weitere wichtige Eigenschaft, sehr viel Information in einem sehr kleinen Raum speichern zu können. Es ist nunmehr möglich, eine Gruppe mit 2 000 Fasern herzustellen, die ein Volumen von unter 16,5 cm^3 hat und eine grosse Informationsmenge für ein Einzelsignal speichern kann. Gruppen mit wesentlich kleineren Abmessungen werden zur Zeit entwickelt. Ein Sceptron-Signalklassiergerät wird daher wahrscheinlich viel kleiner sein als z.B. eine allelektronische Ausführung.

Das Sceptron ist noch in den Anfangsstufen der Entwicklung. Laufende Versuche befassen sich hauptsächlich mit der Klassierung von Schall und Systemen, die erfolgreich von einer bestimmten Person gesprochene einsilbige Worte erkennen können. Viele andere Anwendungsmöglichkeiten werden erwogen, u.a. das Erkennen von Schriftzeichen, Hilfsmittel für medizinische Diagnosen, die Diagnose von Störungen in Maschinen, usw.

EE 67 779 *für weitere Einzelheiten*

TELEQUIPMENT LTD

Chase Road, Southgate, London, N.14

UNTERRICHTS-OSZILLOGRAPH

(Abbildung Seite 194)

Dieses Gerät wurde besonders für Einsatz im Unterricht entwickelt.

Es wird als 'Serviscope' S51E bezeichnet und entspricht in jeder Beziehung den Empfehlungen der Nuffield-Stiftung in ihrem Zwischenbericht über Unterricht in Moderner Physik, in dem der Bedarf an einfachen, genauen und vielseitigen Geräten betont wurde.

Das aus der Type S51 entwickelte Gerät S51E hat eine Oszillographenröhre mit 127-mm-Planschirm und Nachbeschleunigung, die mit 3 kV betrieben wird, wiegt nur 7,25 kg und hat Abmessungen von 178 × 381 × 203 mm.

Die Zeitablenkung des S51E hat sechs voreingestellte, geeichte Stufen für Geschwindigkeiten von 100 ms/cm bis zu 1 μs/cm. Der Frequenzgang des Y-Verstärkers ist 0...3 MHz bei 100 mV/cm Höchstempfindlichkeit; ein neunstufiger, entzerrter Eingangsabschwächer gibt Direktanzeige von 100 mV bis zu 50 V/cm. Die Eingangsimpedanz ist 1 MHz + 30 pF (ungefähr).

Um Studenten die Bedienung zu erleichtern, wurden die Einrichtungen für das Fernsehgebiet sowie die Schalter für internes/externes Triggern weggelassen.

Modell S51E ist ohne Zuschlag entweder mit P1-Schirm (kurzes Nachleuchten) oder P7-Schirm (langes Nachleuchten) lieferbar. Der Netzschalter betätigt eine Kontrollampe.

EE 67 780 *für weitere Einzelheiten*

J. LANGHAM THOMPSON LTD

Park Avenue, Bushey, Hertfordshire

ANALOG-DIGITALWANDLER

(Abbildung Seite 195)

Dieses Gerät wandelt analoge Eingangsspannungen von 0 ... −10 V in entsprechende binäre Digitalinformation, die entweder in einen Streifenlocher oder direkt in einen Rechner gespeist werden kann. Es wird durch einen positiv verlaufenden Sprung oder Impuls getriggert, so dass sich die Eingangsspannung jederzeit in eine Digitalausgabe umwandeln lässt. Bei Einsatz eines geeigneten Triggerimpulsgebers kann daher der Wandler dazu benutzt werden, in regelmässigen Zeitabständen Digitalinformation von der entsprechenden Eingangsspannung zu erzeugen.

In dem Gerät wird ein Spezial-Abgleichsystem für die Umwandlung der analogen Eingangsspannung in eine 8ziffrige Binärausgabe angewendet. Die volle Eingangsspannung von −10 V erzeugt einen Digitalausgang von 2^8 = 256. Jede Binärziffer stellt daher einen Eingang von rund 39 mV dar. Der Digitalausgang hat die Form 0 oder + 12 V. Leiterplatten für Anschluss der Addo X oder Creed-Locher sind lieferbar.

Das Gerät kann für 19"-Gestelleinbau oder als Tischmodell geliefert werden; es ist 222 mm hoch und 292 mm tief.

Ein Verstärkervorsatz für kleinere Eingangsspannung wird in Kürze erhältlich sein.

EE 67 781 *für weitere Einzelheiten*

H. TINSLEY & CO. LTD

Werndee Hall, South Norwood, London, S.E.25

WHEATSTONESCHE BRÜCKE

(Abbildung Seite 195)

Das Hauptmerkmal dieser Wheatstoneschen Brücke mit sechs Skalen sind Leitwertskalen anstelle von Serienwiderstandsskalen. Alle Schaltkontakte liegen parallel, und die Widerstandswerte der Spulen sind hoch, wodurch der Restschaltwiderstand im Vergleich so niedrig wird, dass er selbst für genauste Messungen vernachlässigt werden kann. Die Skalenendwerte der sieben Bereiche liegen zwischen 100 Ω und 100 MΩ.

Die Anzeige für die niedrigste Kontaktstellung ist 0.0001 Ω.

Die Messunsicherheit ist bei 20° C 1×10^{-5} des Skalenendwertes.

EE 67 782 *für weitere Einzelheiten*

INDUKTIVER QUOTIENTENMESSER

Das Gerät ist für Einsatz mit Widerstandsthermometern anstelle der üblichen Widerstandsbrücken gedacht. Es hat sieben Skalen und misst Widerstand von 1...1 000 Ω in drei Bereichen, und zwar 1...10, 10...100 und 100...1 000 Ω, ist also für Platinwiderstandsthermometer geeignet.

Das Unterscheidungsvermögen ist 1×10^{-7}, und dieser Wert ist selbst dann bewahrt, wenn der Strom durch das Thermometer den Höchstwert von 2 mA hat.

Das Gerät arbeitet normalerweise mit 1 kHz, kann aber auf Wunsch auch für andere Frequenzen geliefert werden.

EE 67 783 *für weitere Einzelheiten*

20TH CENTURY ELECTRONICS LTD

King Henry's Drive, New Addington, Croydon, Surrey

AUTOMATISCHER LECKSUCHER

(Abbildung Seite 195)

Ein völlig neuer automatischer Lecksucher, der bis zu 1 000 Elemente pro Stunde einzeln im Hochvakuum prüfen kann, wurde vorgeführt. Jedes Element, das leckt, wird automatisch ausgeworfen.

Es besteht ein Bedarf, kleine dichte Bauelemente wie z.B. Transistoren, Kondensatoren usw. in grossen Mengen und nach strengen Anforderungen auf Lecks zu prüfen. Die ausgestellte Ausrüstung kann solche Bauelemente in breiter Auswahl ohne fachkundige Wartung prüfen. Der einzige manuelle Arbeitsgang ist das Auffüllen des Zuführungskopfes vorn an der Maschine mit Bauelementen. Die Steuerschaltungen sind so ausgelegt, dass sie jedem durch ein minderwertiges Element verursachten abnormalen Vakuumzustand gewachsen sind.

Um das Lecksuchen zu erleichtern, wird während der Fertigung eine Spur Helium in die dichten Bauelemente eingeführt. Helium, das aus dem zu prüfenden Element leckt, wird mit einem hochempfindlichen Massspektrometer-Lecksucher nachgewiesen.

Die Ausrüstung kann Transistoren und beliebige Bauelemente mit Höchstabmessungen von 12 mm Durchmesser und 62 mm Länge prüfen; das Prinzip lässt sich jedoch ohne Schwierigkeiten auf wesentlich grössere Artikel ausdehnen. Bei einem Durchsatz von bis zu 1 000 pro Stunde kann die Leckauswerfungsschwelle auf weniger als 10^{-5} l/µs eingestellt werden.

Im automatisierten Lecksucher wird ein Standard-Centronic-Massspektrometer-Lecksucher der 20th Century Electronics Ltd mit nur sehr unwesentlichen Änderungen eingesetzt. Durch Abschalten des automatischen Testers kann der Centronic-Lecksucher mit seiner absoluten Empfindlichkeit von 10^{-14} l/s jederzeit für Einzellecktests an anderen Bauelementen benutzt werden.

Das zu prüfende Bauelement wird durch verschiedene Evakuierstufen gefördert, bis der Druck in dem das Muster umgebenden Raum niedrig genug für Einführung in die dauernd an den Centronic - Massspektrometer - Lecksucher angeschlossene Kammer ist. Die Stufen sind durch besonders entwickelte, pneumatisch betätigte Hochvakuumventile, die gleichzeitig als mechanische Überführungstore dienen, voneinander getrennt. Durch ihre Anordnung wirkt jede der Vakuumstufen als Schutz für die vorhergehende und nachfolgende Stufe.

EE 67 784 *für weitere Einzelheiten*

VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

IMPULSGEBER

(Abbildung Seite 195)

Das Hauptmerkmal dieses Gerätes (Typ TSA 648) ist, dass jeder Parameter des Pulses geändert werden kann. Es sind nicht nur die üblichen Bedienelemente für Frequenz, Impulsdauer und -amplitude vorhanden, sondern auch Regler für die Anstieg- und Abfallzeit sowie den Gleichspannungspegel. Der Generator hat einen Frequenzbereich von 10 Hz... 1 MHz und kann Impulse bis zu 0,5 µs Dauer herunter abgeben; die schnellste Anstiegszeit ist 10 ns/V. Ein Vorimpuls steht mit einem geeichten Verzögerungsregler zusammen zur Verfügung. Die Polarität beider Ausgangsimpulse kann eingestellt werden. Der Hauptimpuls hat eine Höchstamplitude von 10 V bei 50 Ω Ausgangsimpedanz. Es werden durchweg Transistoren benutzt.

EE 67 785 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Elektronenstrahl-Speichervorrichtungen: Fernsehen über Fernsprechleitungen von A. E. Cawkell

Zusammenfassung des Beitrages auf Seite 142-149

Einer Beschreibung der grundsätzlichen Arbeitsweise der Elektronenstrahl-Speicherröhre folgt eine, die sich besonders mit dem Arbeiten von bistabilen und Halbton-Bildröhren befasst. Bistabile und Halbtonröhren werden verglichen.

Mit Halbtonröhren bestückte Wellenform- und Bildspeichergeräte werden besprochen und einige Anwendungsmöglichkeiten beschrieben.

Weiterhin wird in dem Beitrag die Arbeitsweise der elektrisch-elektrischen Röhren gegeben und ein Gerät mit einer Röhre dieser Art für Grossschirm-Bildspeicherung besprochen. Die Übertragung von Fernsehbildern über Fernsprechleitungen durch langsame Abtastung gespeicherter Bilder wird diskutiert.

Verstärkungsgeregelte Bandpassverstärker: Eine neue Methode mit Video-Verstärkern in integrierter Schaltungstechnik von M. D. Wood

Zusammenfassung des Beitrages auf Seite 150-153

Teil I dieses Beitrags gibt einen Überblick über die Schwierigkeiten bei der Regelung abgestimmter HF-Transistor-Verstärker mittels Verstärkung. Die mit Schaltungen hoher Güte und Neutralisation zusammenhängenden Sonderprobleme werden in diesem Zusammenhang zusammen mit den herkömmlichen Hilfsmitteln für ihre Überwindung besprochen. Verschiedene Verfahren der Verstärkungsregelung werden umrissen und unter besonderer Berücksichtigung ihrer Wirkung auf die Abstimmung der Verstärker diskutiert.

Im zweiten Teil wird der Gedanke, einen Video-Verkstärker mit abgestimmten Eingangs-und Endstufen für die Bestimmung der Bandform zu benutzen, eingeführt und entwickelt. Es wird gezeigt, dass beschriebene Video-Verstärker in integrierter Schaltungstechnik nicht nur diese Schwierigkeiten überwinden, sondern noch weitere Vorteile bieten.

Ein Grossbereich-Impulsmodulator für Tonfrequenzen von M. E. Bryan und W. Tempest

Zusammenfassung des Beitrages auf Seite 154-158

Ein Zweikanal-Impulsmodulator für Tonfrequenzen wird eingehend beschrieben. Jeder der beiden Kanäle kann ein Tonfrequenzsignal so modulieren, dass ein Impuls von 0,5 ms . . . 5 s Dauer in einer von zwei Umhüllungsformen entsteht ; die Anstiegs- und Abfallzeiten des Impulses sind unabhängig voneinander im Bereich 0,3 . . . 100 ms veränderlich. Im Impuls und im Intervall zwischen Impulsen liegen Brumm- und Rauschpegel sowie der Klirrfaktor mehr als 50 dB unter dem Impulspegel. Die beiden Kanäle können dazu benutzt werden, eine A-B-A-B . . . -Folge abzugeben, in der die Kenndaten der Impulse A und B unabhängig voneinander einstellbar sind.

Ein phasenempfindlicher Mehrzweck-Detektor von E. R. Faulkner und R. H. O. Stannett

Zusammenfassung des Beitrages auf Seite 159-161

Dieser phasenempfindliche Detektor wurde in Form eines Mehrzweck-Laborinstrumentes entwickelt und ist besonders für Anwendung in der Herabsetzung der Bandbreite in Messungen, die Modulationsverfahren mit sich bringen, bestimmt. Der Frequenzgang ist von 10 Hz . . . 100 kHz ohne Nachregelung linear, die Gleichstromdrift wurde auf einen sehr niedrigen Wert reduziert, und die Leistung ist gut genug, um das Instrument in Verbindung mit einem nichtabgestimmten Verstärker in typischen Anwendungsmöglichkeiten einzusetzen.

Konstantreglerelemente mit Transistoren von J. W. McPherson

Zusammenfassung des Beitrages auf Seite 162-165

Dieser Beitrag bespricht einige der Nachteile der Verwendung parallel geschalteter Transistoren in der Konstruktion von Konstantreglerelementen für hohe Leistung und gibt einige neue Schaltungsanordnungen bekannt, die zu weniger Leistungstransistoren, kleineren Kühlflächen und verringerten Fixverlusten führen können.

Halbleiter-Verzögerungsschaltungen von J. J. Pinto

Zusammenfassung des Beitrages auf Seite 166-169

Dieser Beitrag gibt eine Übersicht der in England greifbaren Halbleiter unter besonderer Berücksichtigung der Verfahrens-Zeitsteuergeräte. Der Unijunctiontransistor wird als der am besten für Zeitverzögerungsschaltungen geeignete Halbleiter eingehend besprochen und auf seine weitgehendere Einführung sowie preisgünstigeren Vertrieb gedrängt.

Verlustleistung des Zeilentransistors während des Sperrens von F. D. Bate

Zusammenfassung des Beitrages auf Seite 170-172

Die Verlustleistung in einem Fernsehzeilentransistor während der Sperrzeit T_{co} wird für die verschiedenen Abfallkurven des Kollektorstroms analysiert. Die Zustände bei Abstimmung auf die Grundfrequenz allein sowie auf die dritte Harmonische werden untersucht und verglichen. Es zeigt sich, dass die Verlustleistung in der ersten Annäherung immer mit dem Quadrat der Sperrzeit T_{co} schwankt und bei optimaler Abstimmung auf die dritte Harmonische 50% grösser ist, als wenn nur die Grundfrequenz vorhanden ist.

Ein Vor- und Rückwärtsdekadenzähler mit Antikoinzidenz-Netzwerk und Digitaldarstellung von A. F. Tassinari

Zusammenfassung des Beitrages auf Seite 173-177

In diesem Beitrag wird ein umkehrbarer Zähler beschrieben, der im Grunde genommen aus vier selbststeuernden Flip-flop-Binärteilerstufen in Kaskadenschaltung mit korrekter Gegenkopplung zur Bildung eines Dekadenzählers besteht. Ein Antikoinzidenz-Netzwerk ist einbegriffen, und es werden durchweg Halbleiter benutzt.

Ein einfacher Digital-Analogwandler von K. H. Edwards

Zusammenfassung des Beitrages auf Seite 178-180

Der Beitrag beschreibt einen einfachen Digital-Analogwandler, der Eingangsdaten in Serienform verarbeiten kann. Es sind nur vier Verbindungen mit der Informationsquelle erforderlich, und die Gesamtgenauigkeit des Gerätes ist besser als ±1%.