ELECTRONIC ENGINEERING

VOL. 32 No. 394

DECEMBER 1960

Commentary

THE year which is just ending has been a notable one as far as the electronic industry is concerned, if only for the number of exhibitions and conferences which have taken place during the year and which have been looked upon as 'musts' for exhibitor and visitor alike.

There is no point in giving a complete list of all the exhibitions and conferences held on electronic and related subjects throughout the world in 1960 as so many have been of limited appeal, but as far as this country is concerned the season may be considered to have opened with the Physical Society's Exhibition in January which was followed by the Instruments, Electronics and Automation Exhibition, the Medical Electronics Exhibition, the Radio Show and Farnborough.

The continued drive for exports and the advent of the European Free Trade Area have together made it more essential than ever for industry to exhibit abroad and take its goods to the customer's doorstep and so to the list of home exhibitions must be added exhibitions abroad such as the French Component Show in Paris, the Hanover Fair where a group of British component manufacturers had a joint stand, and Interkama at Dusseldorf. Mention should also be made of the highly successful S.I.M.A. Exhibition in Moscow where all the goods on display were sold on the spot.

At the Dusseldorf Exhibition which was held at the end of October some 470 firms were represented. The majority were, of course, from West Germany, but there were 188 exhibitors from abroad and it is gratifying to record that of these, British firms formed the largest contingent.

Some British firms exhibited independently or through their German agents, but twenty-five members of the Scientific Instrument Manufacturers' Association formed a joint exhibit on a stand designed and provided by the British Central Office of Information for the Board of Trade.

So all in all it has been a full year and the 1961 diary shows that conditions for next year are no different and they may in fact be more strenuous, and the question must inevitably arise if the time is not ripe for the whole business of exhibitions to be given much more serious thought.

The purpose of an exhibition is not denied but it does seem that they are being organized on a more haphazard basis than ever and that their very number is tending to defeat their primary object.

Apart from the hardy annuals such as the "Phys Soc", the Radio Show and Farnborough there will be next year the Component Exhibition organized by the Radio and Electronic Component Manufacturers' Federation in June and for good measure a Computer Exhibition in October.

Until last year the R.E.C.M.F. Exhibition was held at Grosvenor House with an overspill at Park Lane House—an arrangement which was inevitable owing to the size of the Exhibition, but which was regarded as unsatisfactory by all concerned. Now, after a lapse of two years, the Component Exhibition will be held at a new venue and the likely plan is that it will alternate on a yearly basis with the I.E.A. Exhibition.

This would appear to be an ideal arrangement as far as this country is concerned, but a two-year cycle for the I.E.A. Exhibition does not fit in too well as far as corresponding exhibitions in Europe are concerned and agreement between the appropriate authorities must be reached as soon as possible if a serious clash of dates is to be avoided.

Interkama, which is largely the shop window of the West German instrument industry is the second to be held since the war. The first was held in 1957 and the pattern seems to be set for it to be held every three years in future.

But the United Kingdom and West Germany are not the only electronic industrial centres in Europe. France has a large and expanding electronic industry and next year is proposing to hold an Exhibition of its products in May at a new site in Paris.

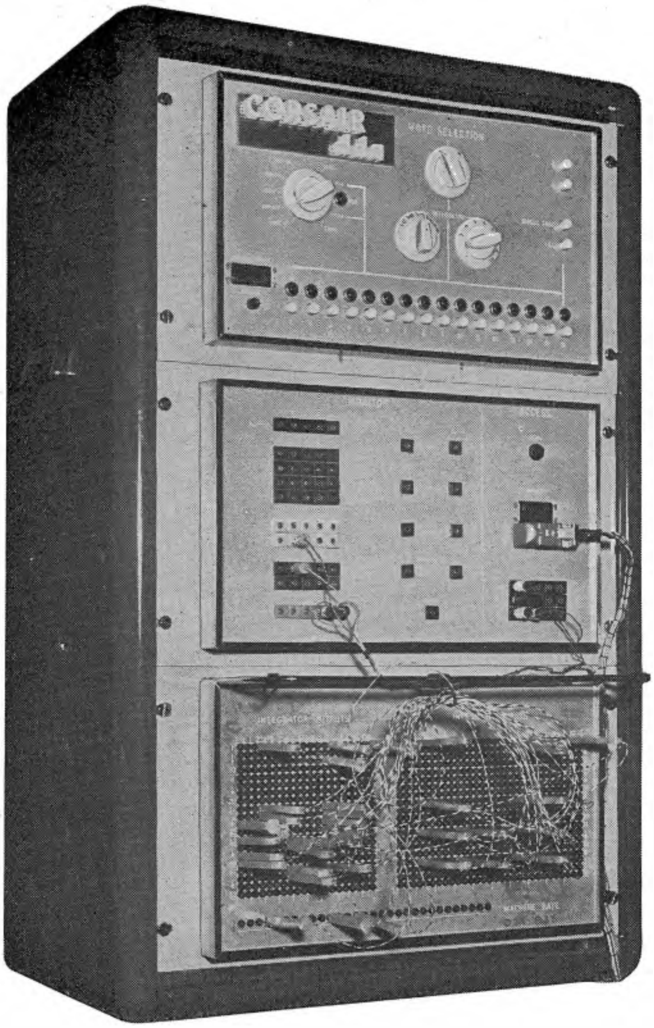
To be known as MESUCORA, it is the first of its kind to be held in France, but nothing is planned at the moment for similar exhibitions in the future.

However, should it become a regular event in France it is all too easy to suggest as a first step in the integration of the electronic industries of the European Countries and having an eye on the ultimate formation of the European Free Trade Area, that the ideal arrangement would be a three-year cycle for I.E.A., MESUCORA and INTERKAMA, each being on an international basis at which countries other than the United Kingdom, France and Germany could exhibit.

It sounds, of course, very neat and tidy, but it would not be an easy matter to bring into being. There are in fact as many arguments for its rejection as for its acceptance.

It would, of course, exclude countries other than the three already mentioned from holding exhibitions of their own and this may be important from the point of view of national prestige.

But whatever the future pattern may be, one thing stands out above all else as far as this country is concerned and that is the need for an exhibition site in or near London on a scale comparable with Dusseldorf or the new centre in Paris and with adequate and up to date facilities.



CORSAIR
A Digital Differential Analyser

By P. L. Owen*, B.A., M. F. Partridge*, M.A.
and T. R. H. Sizer*, A.M.I.E.E.

Differential analysers operate by reducing all computation to the single operation of integration: variables may be integrated with respect to quantities other than time and it is this facility which enables the computer to deal with non-linear problems. Digital integration is performed by the summation of rectangles in a step by step process; electronic speeds of operation enable continuous quantities to be represented with great accuracy. Integrators are interconnected by transmitting pulses which represent increments of the computed quantity. In CORSAIR the state of each integrator is described by means of two numbers or words in binary code which are stored in a ferrite core matrix. These number pairs are read out sequentially and integration process takes place in a central time-sharing arithmetic unit.

(Voir page 796 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 801)

THE incremental method of computation has been described fairly extensively[1,2]. Machines for performing incremental computation called digital differential analysers (d.d.a.) have been constructed both in the U.K. and the U.S.A. In this article one such machine, CORSAIR†, is described which has been designed and constructed at the Royal Aircraft Establishment, Farnborough, as part of a research project.

Basic Design Considerations

The various ways in which a d.d.a. may be constructed have been described previously[1], and CORSAIR is of the 'serial sequential' type. That is, the Y and R numbers describing the states of the integrators are read out of a store in sequence and processed serially in a time-shared arithmetic unit.

In order that CORSAIR should represent an advance on earlier d.d.a's both in design and performance certain new features have been introduced, notably in the storage and integrator interconnexion units. Previous machines, for example[2], have been designed round the magnetic drum as the central storage unit and because of this have suffered from certain limitations. The main one is the integration rate which is fixed by the frequency of rotation of the drum, as mechanical considerations dictate a maximum rotation rate of 100 to 150rev/sec. The type of integrator interconnexion system imposed a limitation on the number of integrators in relation to the number of digits in the basic word. In fact, if the word length is, say, twenty digits the maximum possible capacity of the machine is twenty integrators. Additionally increase in the capacity of a drum d.d.a. would be very difficult to achieve and would involve changing the drum.

In order to obtain a higher frequency of integration a ferrite core store is used in CORSAIR. The use of this core store has the further advantage that it allows the capacity of the machine to be increased if this should be required. While a completely serial organization of the store leads to the most elegant design of d.d.a., the high digit rate required in the arithmetic unit (500kc/s) made this impossible with the cores that were currently available. In CORSAIR a compromise is achieved between the digit rate and the read-write cycle time of the core store by reading out the Y and R words in parallel form and serializing them in two shift registers for transmission to the arithmetic unit. The read-write cycle time then becomes equal to the word time of the machine, a speed requirement which is well within the capability of the core store.

The interconnexion or address unit is completely novel[3] and the restriction on the number of integrators mentioned

* *Royal Aircraft Establishment, Farnborough*
† *Patent applied for.*

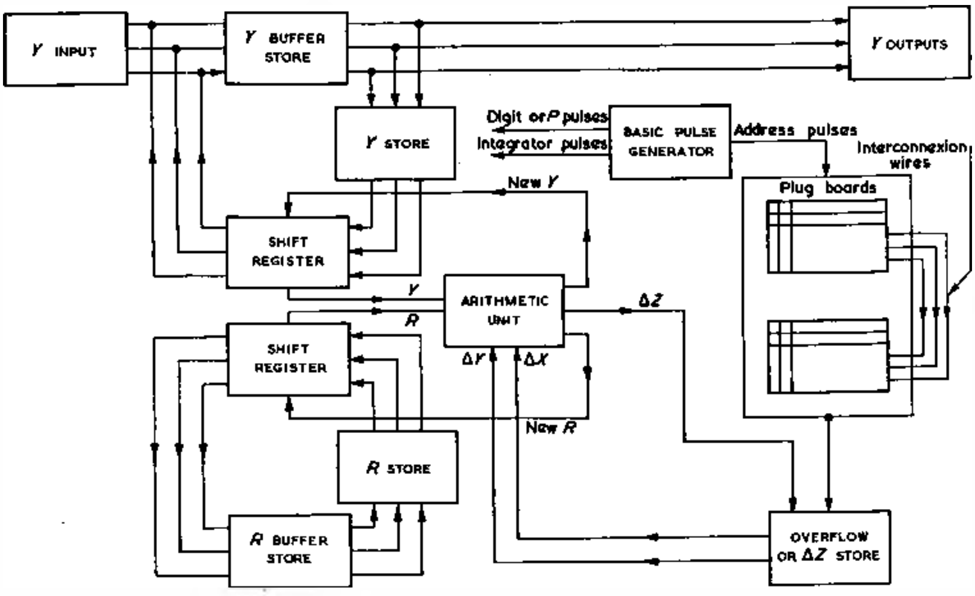


Fig. 1. Information flow

For a sequentially operated d.d.a. the iteration period of the machine is divided into integrator periods which may conveniently be labelled $I_1, I_2 \ldots I_n$, where n is the number of integrators (50 in the case of CORSAIR). During an integration period a Y/R number pair passes through the arithmetic unit and undergoes the integration process. The Y/R number pair associated with I_n is labelled Y_n/R_n before the relevant integration process and Y_n^*/R_n^* for the current integration period. The integration process has been described in detail previously[1]. In order to realize the process in practical terms it is convenient to break it down into the following elementary operations.

above has been avoided. In addition, the actual interconnexion of integrators is performed by means of connecting plugs between two patch panels thus enabling analogue computer operators to change over to the d.d.a. with the minimum reorientation.

General Description of CORSAIR

The principal units are shown in Fig. 1 and consist of the following items:

(1) The main core store for the Y/R numbers; for convenience of illustration this store is assumed to be in two physical parts.

(2) Two serializing shift registers.

(3) One arithmetic unit.

(4) The overflow or ΔZ stores.

(5) The plug board for integrator interconnexion.

(6) The basic control pulse generator.

(7) Input and output devices.

A specification is given in Table 1.

TABLE 1

Specification of CORSAIR

Type of Machine	Sequential Operation with Serial Arithmetic
Integration Rate	500 Steps per Second
Number of Integrators	50
Maximum Accuracy	1 Part in 2^{15}
Digit Rate	500kc/s.
Integrator Interconnexion System	Plug Board
Inputs and Outputs	Whole Number or Incremental
Storage System	Ferrite Cores
Power Consumption	50W.

(1) Accumulate the appropriate ΔY's and ΔX from the overflow store to form the Y increment and ΔX input respectively.

(2) Read a Y/R number pair from the store in parallel form into the shift registers.

(3) Transmit the Y/R pair in serial form through the arithmetic unit to undergo the integration process, back to the shift registers.

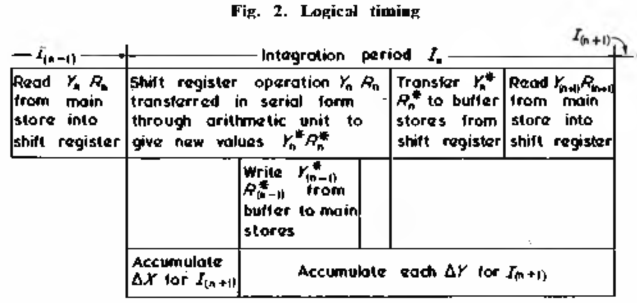
(4) Pick out the ΔZ pulse and send it to the appropriate position of the overflow store.

(5) Read the new Y/R number pair back into the store.

Fig. 1 shows the general flow of information in the computer when integration takes place and Fig. 2 shows the relative timing of the various operations in a typical integrator period. It may be noted on examination of Fig. 2 that the process is speeded up by the over-lapping of certain operations. For instance the accumulation of ΔX and the ΔY's for a given integrator period takes place in the preceding integrator period. Also, the use of buffer stores in the main loops allow Y_{n-1}^*/R_{n-1}^* to be written into the main store while the arithmetic is being performed on Y_n/R_n.

The selection of the appropriate ΔY's and ΔX to be accumulated for a particular integrator is performed by means of pulses which are directed by the interconnexion plugs. The detailed logical description of this unit is given later.

Fig. 2. Logical timing



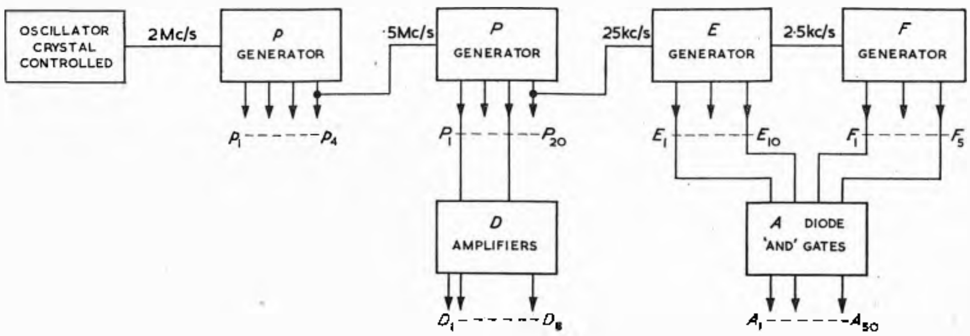


Fig. 3. The pulse generators

into R. If ΔX is $+1$ then Y^* is added to R, if ΔX is -1 then Y^* is subtracted, if ΔX is zero Y^* is not transferred and R remains unchanged. The resulting number in the R register is R^* for the current integration period. Such a system of transfer is known as ternary; a more accurate form of machine results from its use.

The Pulse Generators

In the serially operated d.d.a. numbers and digits are usually identified by means of related, basic waveforms. There are four generators in CORSAIR shown schematically in Fig. 3. The definition of the fifty Y and R numbers requires a waveform generator with fifty output lines, a pulse appearing at a particular output during the period in time when the associated number occurs. These number pulses are designated $A_1, A_2 \ldots . A_{50}$ and are formed by combining pairs of outputs from the E and F pulse generators in AND gates. The P pulse generator has twenty outputs and defines the digit periods of the number while the p pulses, of which there are four, define the four phases of each digit period. These are used for controlling the logical operations in the arithmetic and for restandardization where necessary. The relationship between the pulses is shown in Fig. 4.

Surface barrier transistors and point contact diodes are used in the p and P pulse generators in direct coupled circuits. In the remaining pulse generator point contact diodes and alloy junction transistors are used in conventional circuits.

The Arithmetic Unit

As CORSAIR is a serially operated machine there is only one arithmetic unit, used on a time-sharing basis by all the integrators in a fixed sequence. The unit, in effect, mechanizes the process implied by the integrator schematic shown in Fig. 5 which consists of the two registers Y and R and a ΔX gate. The integrand is the binary number held in Y and its value is varied incrementally by ΔY, the result of the operation for the current integration period being Y^*.

An independent variable ΔX forms the second input to the integrator and controls the transfer of the Y^* number

TABLE 2

Specification of the ΔZ discriminator

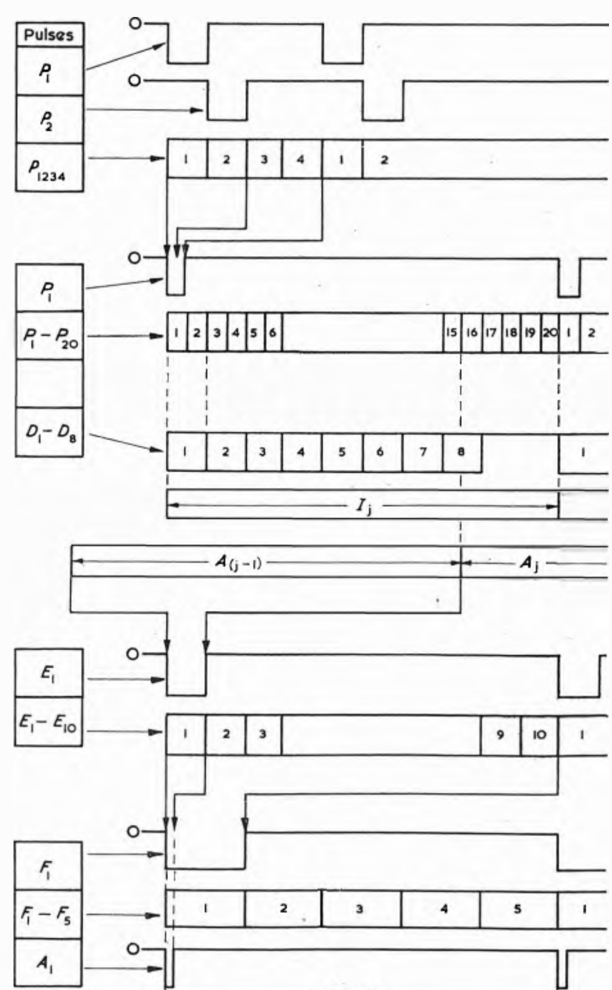
FUNCTION	$\Delta Z+$	$\Delta Z-$
(1.) No Overflow	0	0
(2.) Y^* sign, ΔX sign: Both '0' or Both '1' Overflow	1	0
(3.) Y^* sign, ΔX sign: $Y^*=0$ $\Delta X=1$, $Y^*=1$ $\Delta X=0$ Overflow	0	1
(4.) Overflow Program Sign Change=1	Conditions 2 & 3 are Reversed	

As the R register is of limited length the maximum content will eventually be exceeded; the resulting overflow is ΔZ, the increment to the integral. Fig. 6 shows the schematic form of an integrator and it will be seen that the equation implemented is:

$$\Delta Z = Y \,.\, \Delta X$$

A block schematic of the arithmetic unit is shown in Fig. 7. The ΔY increments are in two-wire form, $+\Delta Y$ and $-\Delta Y$, and arrive at the backward-forward counter. A total of seven increments is possible, which means that the ΔZ's of up to seven integrators may be summed at

Fig. 4. Control pulse waveforms



this point. The count is in binary during the previous integration period and P_{20} of this period transfers the number in parallel to a serializing shift register, unique to the arithmetic unit. Here the output of the counter is serialized to form the four least significant digits of a sixteen digit number, the shift register also making up the number to the full length of sixteen digits; if the most

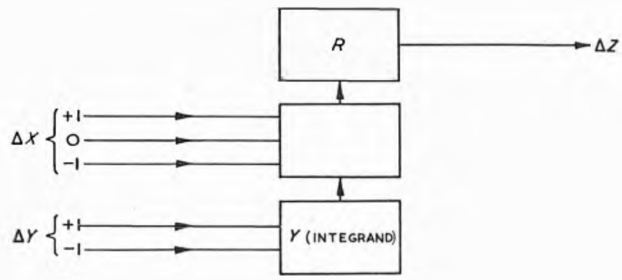


Fig. 5. An integrator consisting of two registers and a gate

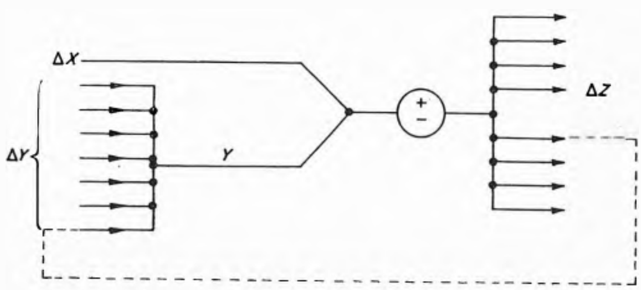


Fig. 6. An integrator unit

significant digit of the four is a 1 then twelve ones are added, if a 0 then twelve noughts are added.

The resulting number, $\Sigma\Delta Y$ is passed to the Y adder where it is added to the previous Y to form Y^*. This value of Y^* is also transferred to the R adder, but the transfer gate has the property of being able to complement the number on receipt of a $\Delta X = -1$ signal in which case Y^* is subtracted from R; $\Delta X = 0$ inhibits the gate. Table 2 shows the specification of the ΔZ discriminator. A total number of 420 surface barrier transistors in direct coupled circuits, is used throughout in the arithmetic unit.

The Main Store

The fifty pairs of Y and R numbers are stored between arithmetic operations on a 50×32 ferrite core matrix. Since the numbers are required to be read and processed in a fixed sequence, there is no necessity for random access to the storage locations and the address selection system is relatively simple.

It is further simplified by the fact that the Y and R numbers are read in parallel as a single 32 bit word by passing down the column of 32 cores a controlled current pulse, sufficient to switch completely every core (Fig. 8).

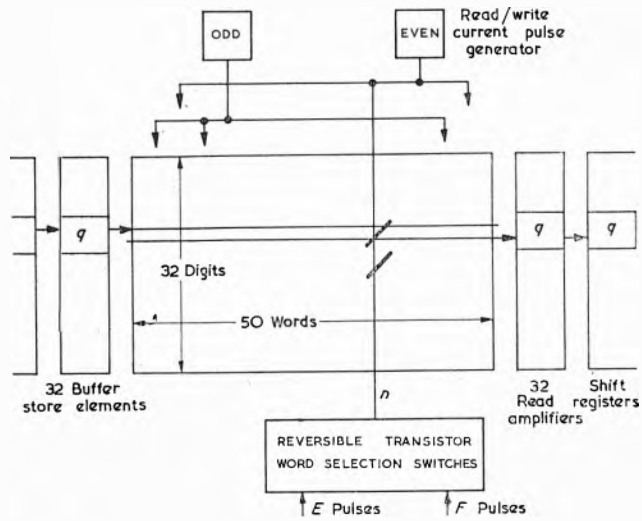


Fig. 8. The core store

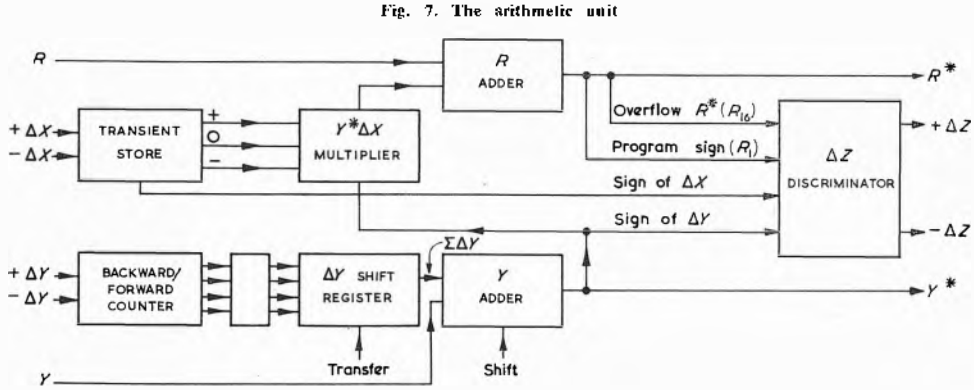
The output signal on the wire threading each row of cores is detected by one of 32 read amplifiers and the original state of the core represented by 1 or 0 is set up on the appropriate element of the main shift register. The numbers are then shifted serially at high speed through the arithmetic unit and at the end of the integration period, the shift registers contain the new values Y^* and R^*. These are returned to the main store via the buffer store, a set of bistable circuits, each controlling a current switch in series with a second wire threading the row of cores.

To write the new word into the column of cores, a half current 'write' pulse is sent up the column and at the same time half-current pulses are sent along the row wires wherever a '1' is to be stored. The term 'half current' implies a pulse which is insufficient by itself to switch a core due to the square hysteresis loop of the core.

The word selection circuits comprise a single reversible transistor in each word wire which is controlled by a suitable signal applied to its base. Each transistor will, in the 'on' state, conduct either 'read' or 'write' current pulses which flow in opposite directions. The control signals are derived from the outputs of the main pulse generators, which furnish the two sets of ten E pulses and five F pulses. Their relationship is indicated in Fig. 4.

It will be evident from Fig. 2 that the period during which a particular word, i.e. a column of 32 cores, is involved in tranfer operations spans a time equivalent

Fig. 7. The arithmetic unit



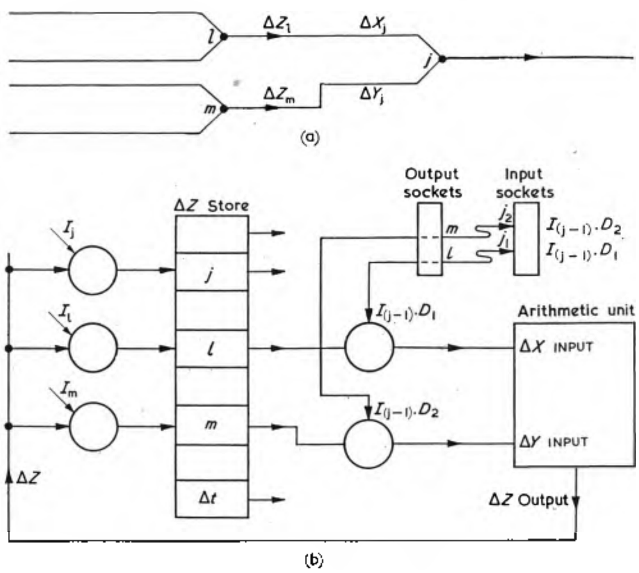


Fig. 9. Logical design of the address system

to two adjacent integrator periods. Thus the pair Y_n/R_n are read from the store at the end of period I_{n-1}; Y_n^*/R^* become available towards the end of I_n when they are transferred to the buffer store. They are finally written back into the main store during the early part of I_{n+1}. This operation overlaps part of the corresponding operation on the number pair Y_{n+1}/R_{n+1}, so to achieve the optimum simplicity in the drive circuits the store is divided into two effectively separate parts, denoted 'odd' and 'even', and comprising the contents of the odd and even-numbered integrators. In each half there is now no overlapping, the sequence being as follows:

$$\text{Read } Y_n/R_n\text{; Write } Y_n^*/R_n^*\text{; Read } Y_{n+2}/R_{n+2}\text{;}$$
$$\text{Write } Y_{n+2}^*/R_{n+2}^*$$

The control signals are therefore arranged to close switch n over the later part of I_{n-1}, throughout I_n and during the first part of I_{n+1}. The read pulse applied during I_{n-1} finds only switch n closed and therefore reads the n^{th} column. Likewise the write pulse during I_{n+1} can flow only in column n.

The Address System

The function of the address system is to connect the overflow, or ΔZ, outputs of selected integrators to the inputs ΔX and ΔY of other integrators in accordance with the particular programme which has been set up. In a simultaneous machine this can be performed by direct wired connexions, each integrator having its own input and output channels.

A similar method is used in CORSAIR; however, as this is a sequential machine, the mechanism of the address system is related to that of the time-shared arithmetic unit, where the ΔX, ΔY and ΔZ channels are common to all integrators. Within this unit, the period I_j is allotted to the processing of the words Y_j and R_j and in a like manner, the preceding period I_{j-1} is devoted to the accumulation of ΔX and ΔY increments ΔX_j and ΔY_j. Therefore, if a series of signals are applied to the ΔX and ΔY inputs of the arithmetic unit, those occurring during the period I_{j-1} will be the increments appropriate to integrator j.

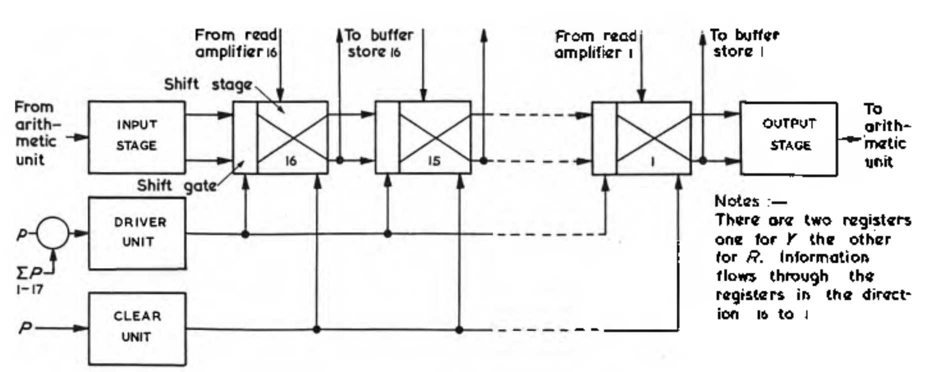
Say, for instance, that integrator j was to take its ΔX and ΔY inputs from the outputs of integrators l and m respectively (Fig. 9(a)). Then during I_{j-1} the signal ΔZ_l must appear at the ΔX input of the arithmetic unit and ΔZ_m at the ΔY input of the arithmetic unit. Since each ΔZ must be available as an input to any integrator it is necessary to provide a store in which the ΔZ output of each integrator is held continuously. The ΔZ output of integrator m appears during I_m, so it must be gated into location m by the pulse I_m bringing the stored ΔZ_m up to date once per iteration cycle. Information from this store is then gated into the inputs by the signal, I_{j-1}, as indicated in Fig. 9(b).

The same figure shows how further time-sharing is used to achieve the facility of connecting more than one output to a ΔY input. The I_{j-1} pulse is divided into eight sub-periods by gating it with a set of eight D pulses which are in fact amplified alternate P pulses. The input channel is time-shared between the ΔX signal, which is that occurring during D_1, and the seven possible ΔY signals, occupying $D_2, D_3 \ldots D_8$. Fig. 9(b) also indicates the functions in the system of the patch panel.

Each socket of the 'input' panel carries a pulse, repeated once per iteration cycle, which may be said to represent one of the eight inputs to a particular integrator. These sockets are naturally labelled to accord with the integrator number. The sockets of the output panel are connected to the gates between the ΔZ store and the $\Delta X/\Delta Y$ input channel and are likewise numbered to correspond with the ΔZ storage elements. In addition, there are a set of ΔT or 'machine rate' sockets connected directly to the $\Delta X/\Delta Y$ input; these allow the injection of a permanent 1 input signal, i.e. the maximum increment rate, to any integrator. As far as the programmer is concerned, the 'output' sockets may be treated as sources of ΔZ signals, which are externally connected to the integrator 'input' sockets in accordance with the programme or flow diagram.

Since a ternary transfer system is used in CORSAIR the ΔZ store must hold three values, $+1$, 0, or -1 for each location, and the ΔX and ΔY input channels are duplicated, together with the interrogation gates. The ΔZ storage elements are in fact active tristable devices and a significant feature of the programme is that some of the

Fig. 10. The serializing shift register



gating necessary to produce the pulses "$I_{j-1}.D_q$" from the basic D, E and F pulses is performed by diodes and resistors moulded into the polythene plugs.

The Serializing Shift Register

The shift register comprises two separate registers, one for the Y numbers and one for the R numbers. As the two are identical in operation they can be considered as one unit for the purposes of description. Thus where the term number is used, this applies equally to both Y and R.

As has already been stated, the number is read out of the store in parallel into the shift register, the timing of the process is shown in Fig. 2. Referring to the block diagram of Fig. 10, digit 16 is read via read amplifier 16 into shift stage 16; digit 15 via read amplifier 15 into shift stage 15 and so on. This operation on digits 1 to 16 takes place in period P_{20} of I_{n-1}.

During period I_n the number is transferred out of the shift register in serial form and into the arithmetic unit. This operation is controlled by the driver unit where signal '$P_1 \cdot\cdot P_{17}$' opens a control gate allowing a sequence of 500kc/s p pulses to shift the number out and the new number in after processing in the arithmetic unit.

Thus it can be seen that the action in the shift register is a continuous process where the new digit 1, i.e. 1*, of the number follows the old digit 16 of the same number. There is a blank digit period between 1* and 16. The timing is arranged so that when the new digit 16, (16*), reaches the old digit 16 position, shifting action ceases and the new word is transferred in parallel to a row of buffer stores on P_{19} of I_n.

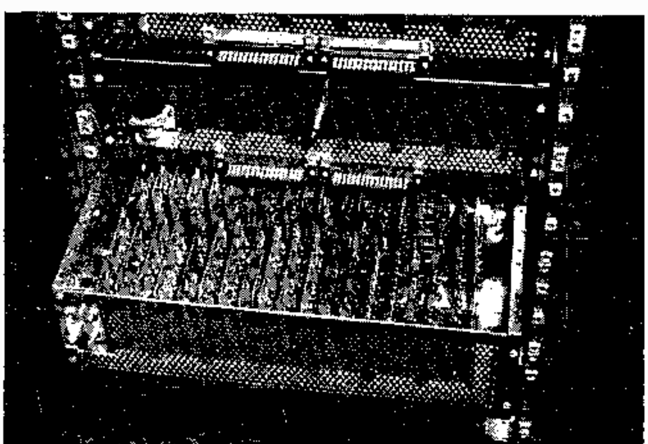
During the period P_{20} of I_n, the number for I_{n+1} is read into the shift register and at P_1 of I_{n+1} the whole process is repeated. Also during I_{n+1} the new number of I_n which had been held in the buffer store is returned to the main store.

The elements of the shifting stages were developed to the authors' requirements by Messrs. Cintel Ltd and are now fully described in advertising literature. The input and output stages together with the driver and clear units were designed at R.A.E.

The Mechanical Form

The core-store and associated circuits, serializing shift register, pulse generators, arithmetic unit and address unit are all contained in one cabinet 36in by 19in wide by 12in deep. Power supplies of which there are six voltage levels, are contained in a second cabinet 26in by 19in by 12in, both cabinets are transportable.

Fig. 11. A rear view of the analyser with one unit withdrawn



Circuit elements are formed on printed wiring boards 4¼in by 4¼in with rhodium flashed edge connexions. The boards are mounted into 22-way sockets and grouped into units as detailed above. There are six such units in the form of self-contained trays which slide into the cabinet from the rear, plugging into 32-way sockets secured to vertical channels immediately behind the front panels (see Fig. 11).

The computer is brought into operation firstly by switching on the individual power supplies in a fixed sequence; all currents and voltages can be monitored on two meters and one selector switch. These controls are mounted on the power unit console.

On the computer console are three panels; the top one being the main control panel, the middle one the monitor and information access panel and the lower one the programme panel. The main control switch rests in an "off" position, a clockwise rotation brings the pulse generators into operation in a fixed sequence, the store is energized, then an 'idle' position is reached, during which the programme is set up and finally a 'run' position when computation is taking place.

The remaining controls are a Y and R selector switch, two switches for selecting the integrators, a row of sixteen push-buttons for manual filling of numbers, a fill button, a single-shot button for stepped operation, and a further button for clearing the ΔZ store.

On the 'monitor' side of the middle panel all the important waveforms are brought out to sockets together with computer earth. Facilities on the 'access' side are described in the next section.

Input/Output Systems

The computer accepts the input of initial conditions in binary form by means of push-buttons on the control panel, or from a punched card reader. Selection of integrator register for manual input is achieved by three rotary switches, labelled Y/R; 1, 2, ... 10; and 1-10, 11-20 .... 41-50. Pressing the button labelled 'fill' transfers the information set up on the row of 16 buttons into the buffer store so that it is written into the appropriate store location. The card reader operates in a similar manner, except that both integrator selection and the Y number are punched on the card (there is no card input for R numbers). The contents, in binary, of any integrator register are available for display on a set of 16 lights corresponding to the setting up buttons, and use of the same selector switches.

On the access side of the middle panel all the Y numbers are brought out in parallel form as electrical signals. From these the contents of appropriate integrators are selected and converted to analogue voltages (output $\pm$100V, accuracy 10 bits) which drive the two axes of a plotting table giving a continuous record of the function computed. In addition, an incremental output is available from two fixed locations in the ΔZ store.

Acknowledgment

Acknowledgment is made to the Directors and Mr. L. Wratten of Microcell Electronics Ltd, for their work on the printed circuits; to the Directors and Mr. H. H. Galpin of Rank Cintel Ltd, for their work on the shift register elements and to Mr. E. J. Perry, late of the R.A.E., now at Kings College London University, who did much of the detailed mechanical design.

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A REVERSIBLE DEKATRON CIRCUIT

By A. J. Oxley*, M.A., Ph.D.

This article describes a reversible counter built with the slower type of Dekatron tubes (GS10C, GC10B, etc.). The speed is therefore limited to about 4kc/s, but the same principles could be applied in a counter using the faster (GS10D) tubes. An explanation of the operation of the circuit is given, and an outline of its original application. The possible errors which might arise from counts of opposite sign following each other too closely are considered in some detail, and the conclusion drawn that, up to a specified limit, the circuit can be made free from logical errors for such inputs.

(Voir page 796 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 801)

DOUBLE pulse Dekatron tubes manufactured by Ericsson Telephones Ltd have been described several times[1,2,3] and only a brief résumé will be given here. The tubes consist essentially of thirty parallel wires arranged uniformly in a circle around an anode disk, all contained in a sealed glass envelope containing gas at low pressure. If all thirty wires are earthed and the anode connected via a resistor to a rising potential, a discharge occurs in the gas between the anode and one wire when the potential reaches about 300V, and a visible glow invests the wire. The current flowing in the resistor causes the potential across the electrodes to fall to about 190V, which is insufficient to initiate a discharge to another wire: so only one wire cathode conducts at a time.

The thirty wires, although identical, serve different purposes: following the common nomenclature, numbers 0,3,6,... 27 are called cathodes, 1,4,7 ... 28 are connected internally and called first guides (g_1), and 2,5,8,... 29 are also connected internally and called second guides (g_2). Connexions to g_1, g_2, anode, and cathode number 0 (C_0) are always made available externally, and some other cathodes are brought out: e.g. in the Dekatron selector GS10C tube all ten are available externally, while in the GC10B numbers 1 to 9 are connected internally and brought out to one pin.

In use, the cathodes will usually be connected via resistors to earth and the guides held at a positive bias of about 40V. Suppose the glow is on cathode number 6 (C_6) and that overlapping negative pulses of about 100V are applied to g_1 and then g_2 (as in Fig. 1(a)). The glow always tends to move to the closest most negative wire, so it will rotate clockwise (i.e. towards a higher-numbered cathode), falling on C_7 as the pulses die away. If the overlapping pulses were applied in the reverse order (Fig. 1(b)) the glow would move anticlockwise, finishing on C_5. Depending on the order of arrival of the guide pulses the Dekatron will therefore add or subtract. To be useful, more than one decade will invariably be required, so it is necessary to ensure that the tens decade adds one count as the glow in the units decade moves from 9 to 0, and that one tens count is subtracted if the reverse occurs.

One such coupling circuit for reversible counters will be described, and the logical principles of design considered. An outline description of the machine incorporating this circuit is also given, to show its special requirements of the design.

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A Reversible Coupling Circuit

Two complete decades of a reversible counter are shown in Fig. 2, and waveforms at point *A* (add channel input to Dekatron 1), *S* (subtract input), and C_0 (zero cathode) are shown in Fig. 3, for the case of steady addition in (a), and for steady subtraction in (b), at 4kc/s. With the component values shown the Dekatron cathodes rise to about 35V when glowing, and it will be seen that C_0 is coupled to the grid of a triode V_1. The grid circuit constitutes the only loading on the Dekatron itself, which

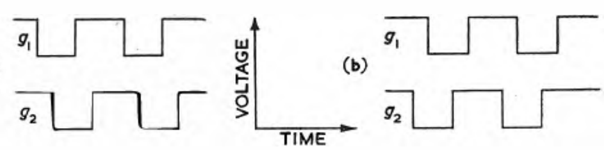

Fig. 1. Idealized guide waveforms

may be of any type, even the simplest GC10B, although component values may need changing to suit different tube types.

The waveforms provided at the Dekatron guide electrodes by this circuit are shown in Fig. 4. Although different from the idealized shape of Fig. 1, there is no uncertainty in the Dekatron's performance. Frequently an integrating circuit is used for the second guide[1,3] but it is important here to ensure a sharp trailing edge to the g_2 pulse, with corresponding rapid transfer of the glow to a cathode. The component values in the guide feed part of the circuit do not appear critical and 20 per cent tolerance components were used. The maximum counting speed during testing was 3·5 to 4kc/s.

When the glow invests C_0 current flows through V_1, causing the cathode and anode levels to change by about 40V: opposite changes occur as the glow leaves C_0. Double triodes $V_{2,3}$ and $V_{4,5}$ are univibrators designed to supply carry pulses to the higher decade when appropriate. $V_{2,3}$ is energized by positive pulses from V_1 cathode (i.e. by the glow moving on to C_0) and $V_{4,5}$ by positive pulses from V_1 anode (glow moving off C_0). Both are gated by the d.c. levels of the add or subtract inputs, and are unaffected by negative pulses from V_1. The C_0 pulse has a fairly sharp trailing edge but a longer rise-time, which depends on the rate at which the Dekatron is being driven. This accounts for the asymmetry in the methods for feeding pulses from V_1 to the two univibrators.

To facilitate understanding of the circuit the d.c. levels at some interesting points are shown in Fig. 2, for the alternative levels of A and S of the previous stage and with the univibrators in their normal quiescent state, i.e. with V_3 and V_5 conducting.

The effect of the pulses of Fig. 3(a) will now be considered. Because S is in its upper state, the d.c. level at the grid of V_2 is up to -18V, while the grid of V_4 changes between -15 and -40V as the A level changes. So the positive pulse arriving at V_2 grid from V_1 cathode changes over the $V_{2,3}$ univibrator, giving an add carry pulse; nothing happens to $V_{4,5}$ at this time. When the glow leaves C_0, which occurs fractionally after the A level falls, a positive pulse is fed from V_1 anode to V_4 grid, but is insufficient to trigger that univibrator from -40V. Thus one count has been added to the next decade, as required.

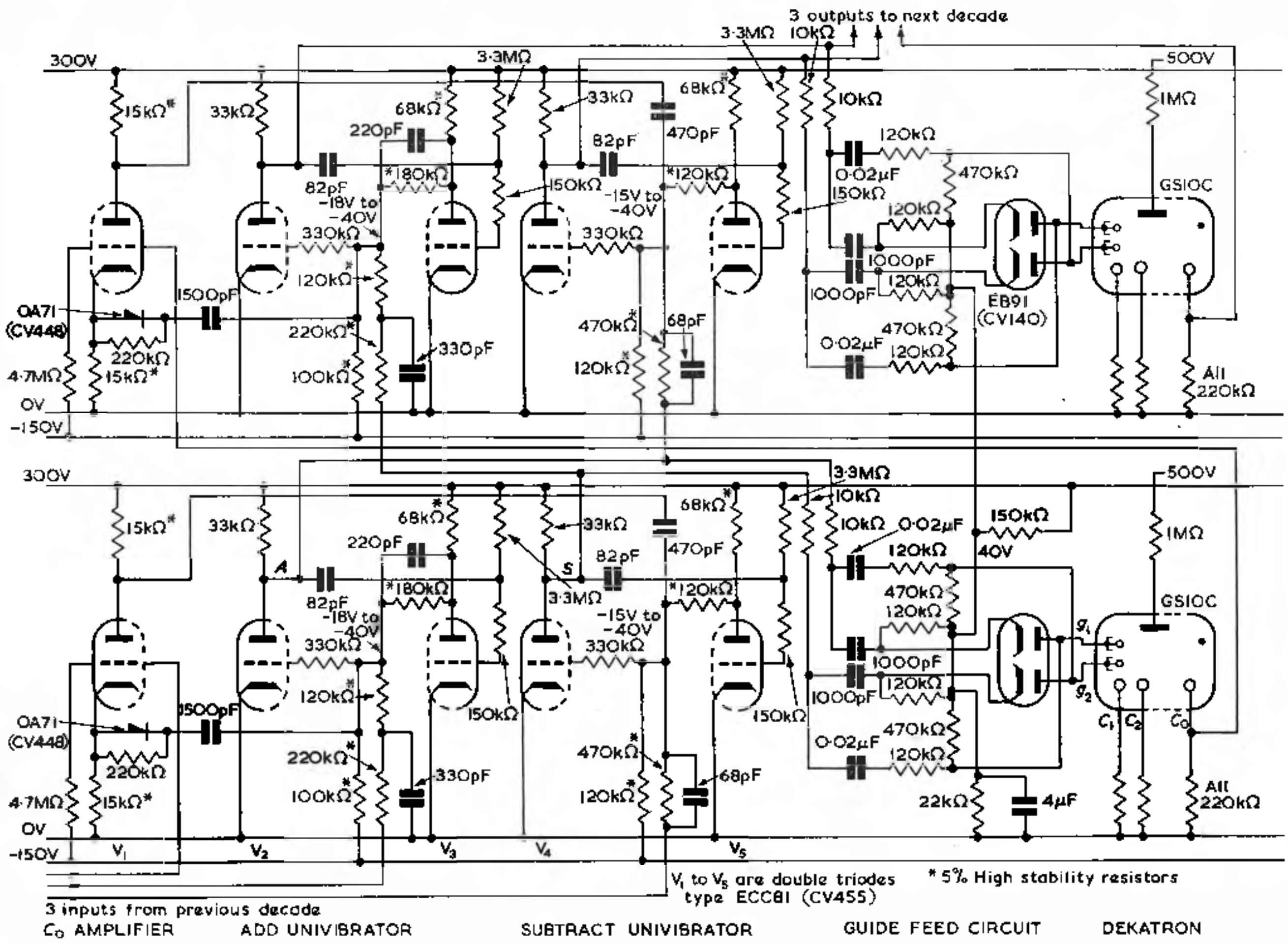

Fig. 2. Two decades of a reversible Dekatron counter

If subtract pulses are being fed to the lower decade as in Fig. 3(b), one subtract carry pulse occurs each time the glow leaves C_0, since in this case the A gating level is high when the positive pulse from V_1 anode arrives, and hence $V_{4,5}$ changes over. As the glow moves from C_1 to C_0, giving a positive pulse from V_1 cathode, it might be supposed that an unwanted add carry pulse would be generated, since C_0 can only glow after the S level has risen. This is avoided by the 220kΩ-330pF delay network included in the gating circuit, which ensures that the gating level will be low when the pulse from V_1 cathode arrives. Thus no spurious add carry pulse can arise.

It will be realized that the potential divider controlling the grid levels of V_2 (and similarly V_4) needs accurate resistance values. It is best to use the 5 per cent high stability type, and if necessary trim one (say that to -150V) to achieve the normal -18V static level. At that end of the 330kΩ resistor remote from the grid of V_2, the measured potentials were as follows:

(1) S low (about 80V) and V_3 anode low (about 40V): -40V.

(2) S high (about 280V) and V_3 anode low (about 40V): -18V.

(3) S low (about 80V) and V_3 anode high (about 220V): -34V.

The minimum useful pulses from V_1 cathode were 17V (the size depends somewhat on the speed at which the Dekatron is being driven), and there were also unwanted pulses of up to 5V occurring as the glow invests C_0 when subtracting. So (2) is the most critical level: -18V is the middle of the range of about 12V for which proper operation can be expected. The pulse sizes at V_4 were slightly different, and -15V is the middle of the somewhat larger operating range in that case.

The guide feed circuit permits some part of the add carry pulse to appear at V_4 anode and vice-versa. The 150kΩ grid resistors for V_3 and V_5 are therefore necessary to prevent the univibrators triggering each other.

The circuit was built with the 500V line shown for supplying the Dekatrons, but this is not essential. In other circumstances, the author has for convenience driven Dekatrons off a 300V supply, with an appropriately lower anode resistor. Often the Dekatron will not strike initially on 300V, but if so the reset mechanism of Fig. 5 serves the dual purpose of transferring the glow to C_o in those Dekatrons which have struck, and initiating a discharge to C_o in the remainder.

Dead Time and Counting Errors

It has been shown that correct carry pulses are generated if the earlier Dekatron is steadily adding or subtracting, and the counting rate is limited to about 4kc/s by the Dekatron tube. The circuit worked satisfactorily in the circumstances described later, but in some applications there may be rapid reversals of counting direction although the maximum steady rate in one direction is not exceeded, and it is important to know what errors might be caused.

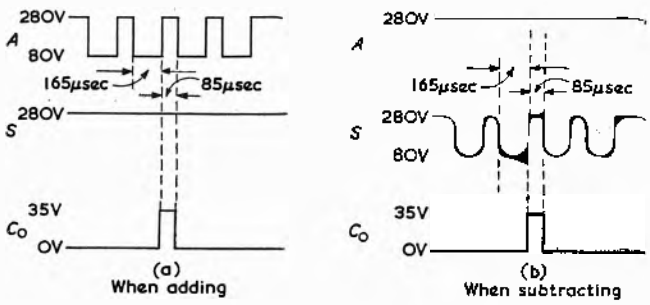

Fig. 3. A, S and C_0 waveforms

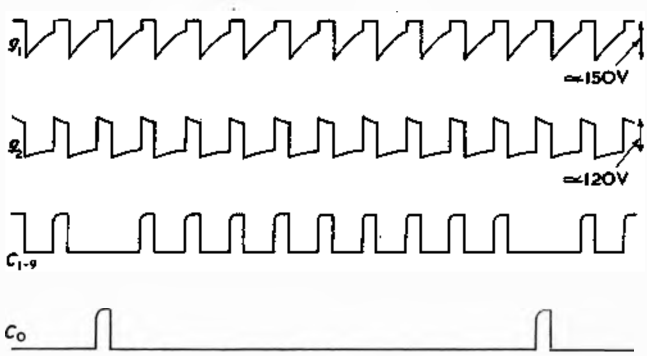

Fig. 4. Dekatron waveforms (shown when adding)

The four basic cases are shown in Fig. 6. For the circuit described here (and some other types) it will be shown that errors may arise if the periods τ are too small, which means the counter has a finite dead time. This will not be embarrassing in most practical applications, implying either that a faster preliminary counter should be used or, in control systems, that some backlash must be introduced if not already present.

Suppose, for example, the counter is being used to give a digital indication of a shaft position, from which add pulses are produced by clockwise rotation and subtract by anticlockwise: then it is necessary that there should always be a slight separation of add and subtract pulses if the rotation direction changes. If the mechanical inertia and backlash are not enough to provide this, it can be simply achieved in the preliminary circuits.

Consider now the performance of the circuit of Fig. 2 with the inputs of Figs. 6. In the first decade, the glow will certainly resume its original position after inputs 6(a) or 6(b), whatever the size of τ; in 6(c) the glow will move to g_1 when the add pulse arrives and then to g_2; at the trailing edge of the subtract pulse it will be back on g_1 and thence pass to the original cathode. This could only be upset if τ were very short and the subtract pulse shorter than the add pulse, to the extent of falling entirely within it. But unless the pulse lengths were very different, so that the trailing edge of the add pulse arrived about 80μsec after that of the subtract, no spurious count in the first decade would occur. The 6(d) case is clearly similar, so it only remains to be seen if spurious carry pulses can arise.

Since pulses from V_1 are needed to generate carries, errors could only occur when C_o in the lower decade is involved. It will be remembered that an add carry occurs if C_o glows and the (delayed) S input is at its upper d.c. level, while a subtract carry occurs if C_o goes dark and the A input is high. The cases will now be considered separately:

Fig. 6(a)

(1) Glow starting on C_9, going to C_o and back to C_9: this will cause both A and S carry pulses, except possibly if τ is so small that C_o never glows properly but only gives an abbreviated pulse. This could lead to errors, for if the pulses from V_1 were barely sufficient to operate the univibrators it is possible only one would change over, unless they were well matched. This point will be considered at the end of this section.

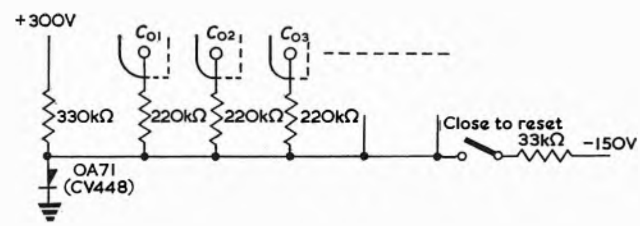

Fig. 5. Dekatron resetting circuit

(2) Glow goes C_o-C_1-C_o: no carry pulses.

Fig. 6(b)

(1) Glow goes C_o-C_9-C_o: S and A carry pulses.

(2) Glow goes C_1-C_o-C_1: no carry pulses.

For Figs 6(c) and 6(d) the only interesting cases are those in which the glow starts and finishes on C_o.

Fig. 6(c)

Glow starts on C_o, moves towards C_1 and back to C_o: no carry pulses.

Fig. 6(d)

Glow starts on C_o, moves towards C_9 and back to C_o: S and A carry pulses occur unless τ is too small, in which case one may trigger without the other.

Thus 6(d) is critical: the backlash represented by τ must be large enough (say 50μsec) to avoid errors in that case.

It would have been possible to arrange that carry pulses were generated at other coincidences, e.g. from the add univibrator when C_o glows and the add input (delayed) is low, and in the subtract channel when C_o darkens and the subtract input is low. Then the 6(c) input would be critical instead of 6(d). The original alternative was chosen because it is better for succeeding decades, in which 6(c) can occur but never 6(d).

It is necessary now to consider again inputs of type 6(a). These may arise in the first decade in some applications, but can also occur in higher decades even if not present in the first, because the subtract carries between all decades occur practically simultaneously whereas the add carries occur sequentially. In many practical applications τ of Fig. 6(a) will not be uncomfortably short for any decade. In cases where trouble is anticipated, the add carry univibrator should be made somewhat more sensitive than the subtract (i.e. the static level at V_2 grid raised from -18 to about -15V) and the sensitizing circuit of Fig. 7 added. This circuit sensitizes the $V_{4,5}$ univibrator for a short while (about 30μsec) after $V_{2,3}$ triggers: the rectifier is needed to avoid desensitizing at the end of an add carry pulse.

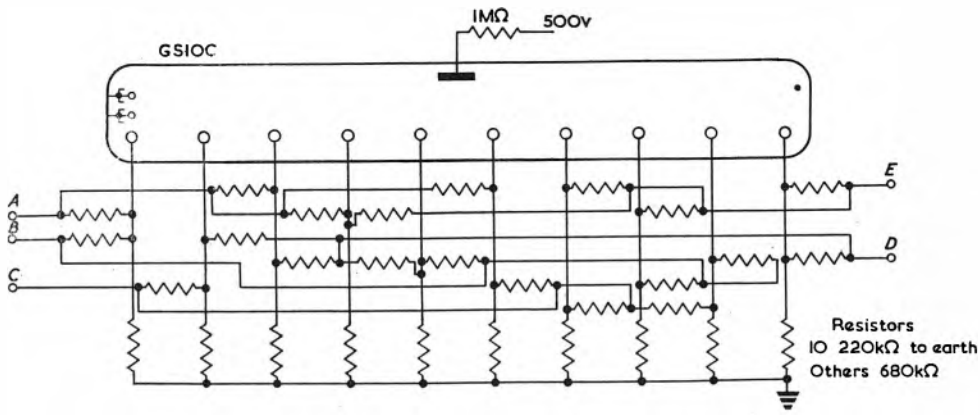

Fig. 8. Coding network

Then if the positive V_1 cathode pulse is large enough to trigger $V_{2,3}$ the positive pulse from V_1 anode arriving a short while later will trigger the sensitized $V_{4,5}$, while if $V_{2,3}$ is not triggered the normally less sensitive $V_{4,5}$ will not change over.

Thus trouble from this sort of input can be avoided, at the cost of some extra complexity in the circuit. It is desirable to have sharp-edged signals on the Dekatron cathodes, which is the reason for the type of guide feed circuit chosen in preference to an integrating type.

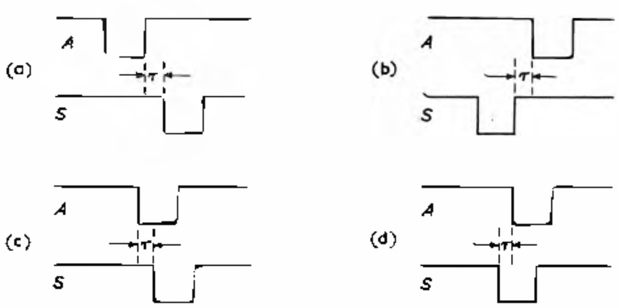

Fig. 6. Reversal of input pulses, possible modes of changeover

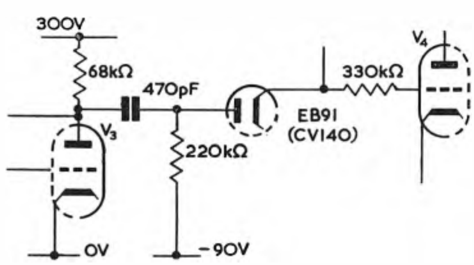

Fig. 7. Sensitizing circuit

In a high-speed unidirectional counter it is normally satisfactory to use high-speed units for the lower decades and low-speed units for the higher decades. Such an arrangement may be unsatisfactory in a bidirectional counter because the speed requirements in the upper decades may be almost the same as in the first for some types of input. This will not always apply, but needs consideration.

Background to the Circuit

The need for reversible Dekatron counters arose in a machine for measuring photographs of nuclear particle tracks automatically. This machine will be described elsewhere: for the present it is only necessary to know that it generates pulses in two channels (add and subtract) and that the required measurement is the number of add pulses less the number of subtract pulses. This algebraic sum is formed in a reversible Dekatron counter.

As the data is subsequently processed in an electronic computer it is necessary to punch out the contents of the Dekatron counter on paper tape. In the normal code of the computer used each row of tape may represent any of the ten decimal digits (or some other symbols): thus there is one row per decade. Punching several rows of tape takes about one second, and to avoid immobilizing the counters for this time a simple buffer store is provided, to which information from all decades of a counter may be transferred simultaneously. Dekatron selector tubes are therefore used, each with a simple resistance network to translate the Dekatron cathode signals into the code needed by the computer. The coding network is shown in Fig. 8: it provides raised potentials at a particular pair of the output points ($A-E$), depending on which cathode is glowing. It is necessary to obtain maximum signals at the cathodes to obtain an adequate output from these networks, which partly accounts for the rather high cathode resistors.

There are of course other ways of printing out the contents of a Dekatron counter. If it is permissible to immobilize the counters during printing the simplest Dekatrons (type GC10B) can be used throughout and the information extracted by a recirculating system previously described[3,4]. Briefly, all the carry pulses are temporarily blocked and ten pulses are fed to each decade in turn, starting with the most significant, causing the glow to rotate one revolution. As it passes C_0 it gates an auxiliary pulse counter attached to the print-out mechanism, so that the remainder of the ten pulses are registered in that counter also. For example, if the glow started from C_6, four pulses bring it to C_0 and the remaining six restore it to C_6 and are also planted in the auxiliary counter for printing.

Acknowledgment

The author is glad to acknowledge the support of the United Kingdom Atomic Energy Authority for the work described, and is grateful for their permission to publish this article.

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A V.L.F. FUNCTION GENERATOR

By L. Whitlow*

A method of synthesizing a repetitive time function with 100 'steps' or 100 'ramps' is described. The frequency range is 0·025 to 15c/s and variations of the output function are less than 0·5 per cent.

(Voir page 796 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 801)

SERVO systems often require repetitive forcing functions that are of an arbitrary nature. These functions are not easily generated by solely electronic methods. Various ways of producing these repetitive functions have been used, such as cams with linear displacement transducers, shaped or tapped potentiometers, and photocells scanning shaped masks in front of cathode-ray tubes or lamps.

Each of these methods has its disadvantages that can cause it to be impracticable in certain cases. Cams are difficult to cut accurately and take a long time to make, they are affected by wear, and the maximum lifting rate of the cam limits the rate of change of the function. Potentiometers also limit the rate of change of the function, due to the shaping or the limited number of tappings; it is difficult to make suitable potentiometers for many of the functions likely to be required. Devices using photocells are affected by changes of sensitivity of the photocell, and changes of light emitted from the light source. These cause unwanted variations of the generated function which affect the accuracy of the servo system.

The method described here, while being basically simple, can generate fast changes of function, unwanted variations of the function are less than 0·5 per cent, and the function can be changed relatively quickly.

Principle of Operation

Any function can be synthesized with a number of steps, the accuracy is dependent on the number of steps used. Where there are no abrupt changes of the function it is possible to get a better approximation by integrating the steps to give an equal number of straight lines of varying slope.

The function generator described here uses 100 steps. These are obtained by successively sampling the voltages on the wipers of 100 potentiometers, $RV_{1\text{-}100}$ (Fig. 1), by means of a 100-way switch S_1. The potentiometers are adjusted so that the voltage on each wiper is equal to the corresponding mean ordinate of the waveform to be generated. The supply to the 100 potentiometers is stabilized so that the generated function does not vary due to changes of the mains supply.

The voltage on the switch wiper is applied to a drift corrected d.c. amplifier A via RV_{101} and R_1. This amplifier fulfils two functions; it acts as a buffer stage and as a computer amplifier. The impedance of the 100-way switch and its associated potentiometers is high and any change of the loading on it would have the same effect as altering the setting of the potentiometers. This is prevented by the amplifier since its input impedance is unaffected by any loading in its output. When the switch S_2 is in the 'steps' position the amplifier functions as a linear amplifier with a gain of $-0{\cdot}1$ to -1, dependent on the setting of RV_{101}.

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In the other three positions of S_2 it has a transfer function of $-A/(1+pT)$ where A can be varied between 1 and 10 and T can be selected to be 0·01, 0·1 or 1sec. This transfer function is very nearly an integration if T is much larger than the period of a single step.

This transfer function has been used instead of a true integration (A/pT) since any drift in the d.c. amplifier,

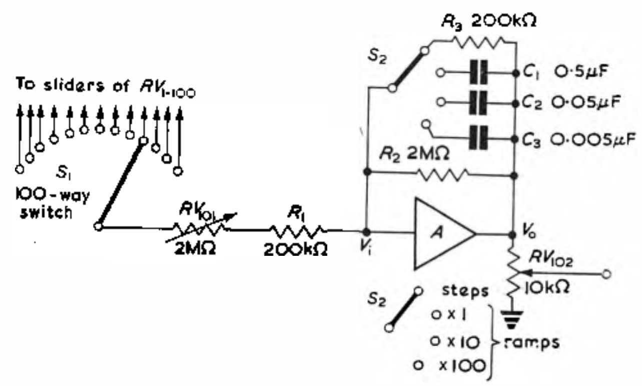


Fig. 1. The function generator

and any difference between the mean potential of the waveform and zero would be integrated. This would cause saturation conditions to occur in the amplifier. By using the transfer function $-A/(1+pT)$ the output is very nearly an integration if T is large compared with the period of a step, and at the same time the amplifier drift and mean output potential is not integrated but amplified A times. The slope of the output can be varied by RV_{101}, which does not alter the time-constant but varies the 'aiming' potential—the potential the capacitor is charging up to. The amplitude of both 'steps' and 'ramps' can be varied by the output control RV_{102}.

Mechanical Details

The frequency of the generated function is dependent on the angular velocity of the switch wiper S_1. The wiper arm is driven from a synchronous motor via a variable speed drive mechanism. A conical wheel (Fig. 2) is rim driven by a synchronous motor, and the drive from this is transferred to a second conical wheel via a transfer pulley. The centres of the two conical wheels are displaced radially by one radius. The speed ratio between the two pulleys is thus proportional to the position of the transfer pulley. This is adjusted by a handwheel on the front panel via a lead screw mechanism. The second conical wheel is connected directly to the wiper arm of the 100-way switch S_1. The frequency range available is 0·025 to 15c/s.

The switch is made from an 8in diameter disk of synthetic resin bonded fibre, which has brass 8 B.A. cheese-head screws let into the periphery to form the 100 contacts.

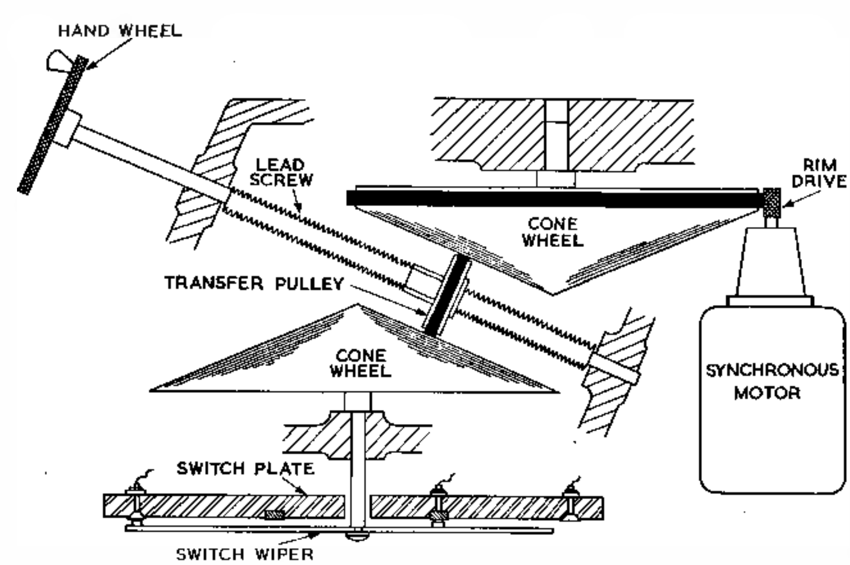


Fig. 2. Mechanical system

The heads of the screws are ground down to remove the screwdriver slot and make them flush with the 8in diameter disk. The wiping contacts are made from beryllium-copper. Each contact is numbered to correspond with similar numbers on the 100 potentiometers, this assists the setting up of any particular function.

Drift Corrected D.C. Amplifier

The d.c. amplifier must have very little drift if it is not to modify the generated function; particularly so when it is used to generate 'ramps' and the drift may be amplified up to 10 times. To keep the drift down to 0·1 per cent of peak of the generated function (20V) it is essential that the drift referred to the input of the amplifier must be less than 2mV. This drift which is due to changes of temperature, supply voltages, cathode emission, grid current etc., cannot be reduced by feedback. The method used to

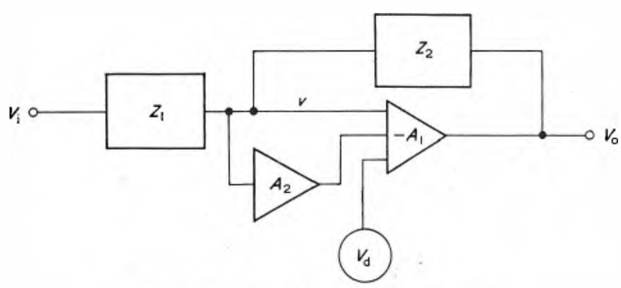


Fig. 3. Equivalent circuit of d.c. amplifier

reduce the drift is due to Goldberg[1]; an auxiliary d.c. chopper amplifier is used to amplify the drift and then apply it in such a polarity to the main amplifier so that it opposes the drift.

The equivalent circuit of the d.c. amplifier is shown in Fig. 3. The drift voltage is represented as being due to a voltage generator V_d, at the input of the main amplifier A_1. The auxiliary amplifier is A_2 and Z_2 and Z_1 are the feedback and input impedances respectively. Since no current flows into the input of A_1 or A_2 then:

$$\frac{(V_i - v)}{Z_1} = \frac{(v - V_o)}{Z_2} \qquad \ldots\ldots\ldots\ldots (1)$$

Since the gain of the main amplifier is $-A_1$ and that of the auxiliary amplifier A_2 then $V_o = -A_1[V_d + v(1 + A_2)]$ this can be re-arranged to give:

$$v = -\frac{V_o + A_1V_d}{A_1(1 + A_2)} \qquad \ldots\ldots\ldots\ldots (2)$$

Combining equations (1) and (2) gives:

$$V_o/Z_2 = -\left[V_i/Z_1 + \frac{V_o + A_1V_d}{A_1(1 + A_2)}(1/Z_1 + 1/Z_2)\right] \qquad \ldots\ldots\ldots\ldots (3)$$

$$\therefore\ V_o\left[1 + \frac{Z_2 + Z_1}{A_1Z_1(1 + A_2)}\right] = -\left[V_iZ_2/Z_1 + \frac{V_d}{1 + A_2}\,\frac{(Z_2 + Z_1)}{Z_1}\right] \qquad \ldots\ldots\ldots\ldots (4)$$

When A_1 and $A_2 \gg 1$ this can be written as:

$$V_o = -\left[V_iZ_2/Z_1 + \frac{V_d}{(1 + A_2)}\,\frac{(Z_2 + Z_1)}{Z_1}\right] \qquad \ldots\ldots\ldots\ldots (5)$$

The drift voltage has now been reduced by the factor $1/(1 + A_2)$ by the use of the auxiliary amplifier.

When the term $V_d(Z_2 + Z_1)/Z_1(1 + A_2)$ is small enough to be neglected, then:

$$V_o/V_i = -(Z_2/Z_1) \qquad \ldots\ldots\ldots\ldots (6)$$

This is defined as the transfer function.

The amplifier A_2 is a chopper amplifier and will only amplify very low frequencies of below about 1c/s. Any low frequency component of V_i will also be amplified by this amplifier, but this has no effect on the overall gain of the d.c. amplifier because $A_1 \gg 1$ and the transfer function of the amplfiier is defined by Z_2 and Z_1 only.

The circuit diagram of the d.c. amplifier is shown in Fig. 4. The input stage is V_{1a}, which is cathode coupled to V_{1b}. The signal voltages on the anodes of V_{1a} and V_{1b} are amplified versions of the difference between the signals on V_{1a} and V_{1b} grids, the outputs are of opposite polarity to each other. The signal on V_{1b} grid is the amplified drift voltage from the auxiliary amplifier. V_{1b} anode is directly coupled to V_{2a} grid and V_{2a} anode is directly coupled to V_{2b} grid, V_{2b} is a cathode-follower. The cathode load of V_{2b} is taken to the -250V supply; the output voltage is taken off from the wiper of RV_{102} which is connected between cathode and earth. The feedback impedance is connected between the cathode of V_{2b} and the grid of V_{1a} via the switch S_2 (Fig. 1). Phase correction capacitors C_4 and C_5 are connected between the anodes of one stage and the grid of the following stage. These prevent parasitic oscillation and extend the frequency range of the amplifier.

Any drift which occurs in the main d.c. amplifier, formed by V_1 and V_2, will be applied to the feedback network and will occur at the grid of V_{1a}—the feedback network will attenuate it in the process. This attenuated drift voltage is amplified by the auxiliary amplifier formed by V_{3a} and V_{3b}. The input to V_{3a} is modulated by the relay contacts A_1, which is operated from the 50c/s supply. This modulated signal is amplified by V_{3a} and V_{3b} which form an a.c. amplifier. The output of this a.c. amplifier is 'clamped' by the relay contacts A_1, which thus acts as a synchronous rectifier. The relay alternately earths the input and output of the a.c. amplifier. The output of the synchronous rectifier is smoothed by R_{22} and C_{12} and then applied to the grid of V_{1b}. The amplified drift voltage applied to V_{1b} is of opposite polarity to the drift voltage on the grid of V_{1a}, and this has the effect of reducing the drift voltage.

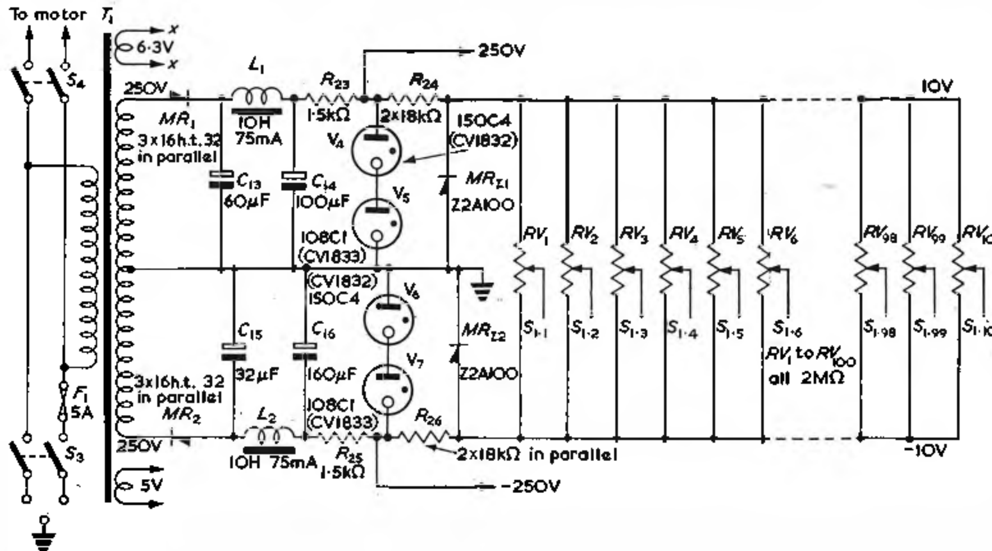
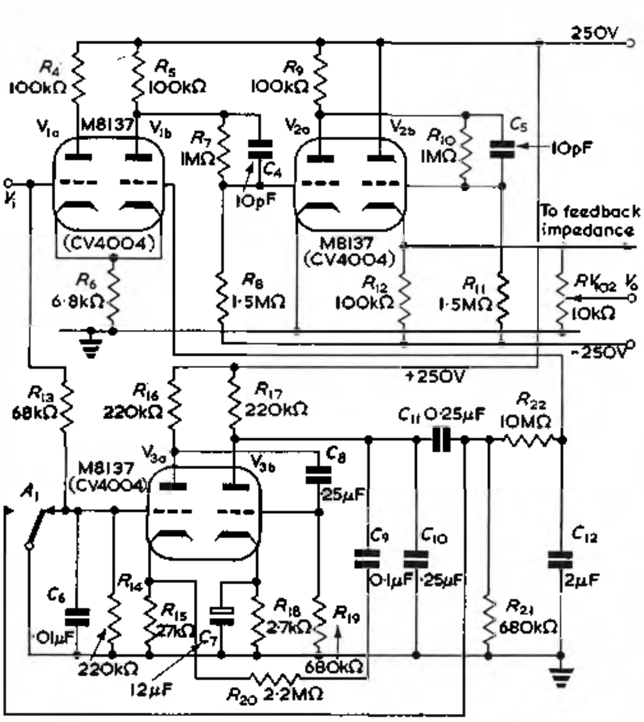


Fig. 5. Power supply

To summarize the action of the drift correction circuit, it is assumed that the drift in the main d.c. amplifier causes the output voltage to go more positive. This is fed back to V_{1a} grid by the feedback impedances, which also attenuate it. This drift voltage charges C_6 via R_{13}; the charge on C_6 is periodically discharged by the relay contacts, A_1. The input of V_{3a} thus consists of positive going square waves of 50c/s; these are amplified by V_{3a} and V_{3b}. The output of V_{3b} is also applied to the relay contacts A_1 via C_{11}; these periodically earth the output, alternately with the earthing of the input. This clamps the output, i.e. makes the positive part of the square wave earth potential, so that the output consists of negative going square waves. These are smoothed by R_{22} and C_{12} and applied as a negative signal to the grid of V_{1b}, this causes V_{1b} anode and hence V_{2a} grid to go positive, which in turn causes V_{2a} anode and also V_{2b} grid and cathode to go negative, and so reduce the positive drift.

The gain of the main d.c. amplifier is 500 and that of the auxiliary amplifier is 750. The drift of the d.c. amplifier, when referred to the input, is less than 1mV over a period of 5 hours. This was taken with the simple voltage stabilizer used for the power supplies. With a more stabilized power supply the drift over a corresponding period was less than 180μV. With feedback resistors selected to give a gain of 10 the bandwidth was 3dB down at 7·5kc/s and 6dB down at 13kc/s.

Fig. 4. D.C. amplifier. Function generator



Power Supplies

The power supplies are $\pm$250V d.c. for the d.c. amplifier and $\pm$10V d.c. for the 100 potentiometers. The output from T_1 (Fig. 5) is rectified by MR_1 and smoothed by C_{13}, C_{14} and L_1. The voltage across C_{14} is 320V and this is stabilized at 250V by R_{23}, V_4 and V_5. The corresponding negative supply is derived from MR_2, C_{15}, C_{16}, L_2, R_{25}, V_6 and V_7. The $\pm$250V d.c. is fed to the d.c. amplifier and also to the $\pm$10V stabilizer formed by R_{24}, MR_{z1} and R_{25}, MR_{z2}. MR_{z1} and MR_{z2} are 10V Zener diodes with a Zener current of 25mA. The $\pm$10V d.c. is used to supply the 100 potentiometers and provision is also made for it to supply the transducers used in the servo system.

The $\pm$250V d.c. supplies each vary approximately $\pm$5V for a $\pm$10 per cent charge of mains supply. The corresponding change of the $\pm$10V d.c. supplies is less than 10mV—less than 0·1 per cent. The temperature coefficient of the Zener diodes is given by the manufacturer as 0·065 per cent/°C.

Acknowledgment

The author would like to acknowledge the work done by Mr. L. C. White, who was responsible for the manufacture and development of the mechanical system.

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Thermal and Optical Behaviour of Photo-Transistors

By D. Shaw*, B.Sc., and B. Crump*

The thermal and optical characteristics of two photo-transistors have been investigated in order to facilitate the design of photo-heads for use under heavy industrial conditions.

Circuits have been devised for one photo-transistor which alloy relay operation in ambient temperatures up to 55°C.

For precise position measurement, the optical-mechanical characteristics are not stable to better than ±0·06in so that individual calibration is necessary to achieve a higher degree of accuracy. This condition is made worse if bi-directional movement employing relay indication is used, the errors typically amounting to ±0·1in.

The second photo-transistor allows operation up to at least 90°C ambient temperature but is about 1 000 times less sensitive than the first in its present form.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

THERE are many applications in the steel industry for a small robust, sensitive photocell which is insensitive to variations in ambient temperature. In addition there are many low temperature heat sources such as cooling ingots and machinery manipulating hot material which radiate large amounts of long wave infra-red energy to which the cell must not respond, although its response to the shorter infrared radiation emitted by material above say 900°C must not suffer. For these applications a germanium photo-transistor would be most satisfactory if it were not for its high thermal drift. This article describes measurements made and recommended circuits to allow operation of an OCP71 photo-transistor controlling a relay at ambient temperatures up to 55°C.

In addition to their use for indicating whether radiation (and therefore an appropriate object) is present or not, the photocells may be used to indicate the position of the object by the variation in radiation received by them. The sensitivity characteristic to an increase in light caused by moving a shutter in front of a photo-transistor having otherwise constant illumination is not given in the manufacturer's literature and has therefore been measured together with the mechanical alignment tolerances.

It appeared from the results gained with the OCP71 that a reduced drift characteristic adequate for operation above 60°C ambient temperature might be found only in a silicon photo-transistor. After a fruitless search, silicon photo-transistors have been made from the OC200 series which although insensitive compared with the OCP71 have improved temperature characteristics and are satisfactory for use up to at least 90°C ambient temperature.

Germanium Photo-Transistor Type OCP71

Thermal Drift of Dark Current

The changes in current occurring in a photo-transistor when its temperature alters are most conveniently considered in terms of its dark current characteristic since its light sensitivity generally increases with increase in temperature. If therefore the light sensitivity is adequate for operation at the lowest ambient temperature encountered, operation at higher ambient temperatures is ensured. However, too great a dark current caused by increasing ambient temperature may result in the photo-transistor circuits remaining 'locked on' in the absence of illumination and methods of preventing this may be necessary.

The way in which the dark current increases with temperature can be seen in Fig. 1. With $R_{be} = \infty$, the photo-transistor is in its normal condition with a sensitivity of the order of 300mA/lm but unfortunately its dark current is also at a maximum (curve (1)). The rate of increase of dark current is about 14 per cent/°C initially but falls off as the temperature increases to a value of about 10 per cent/°C at 60°C.

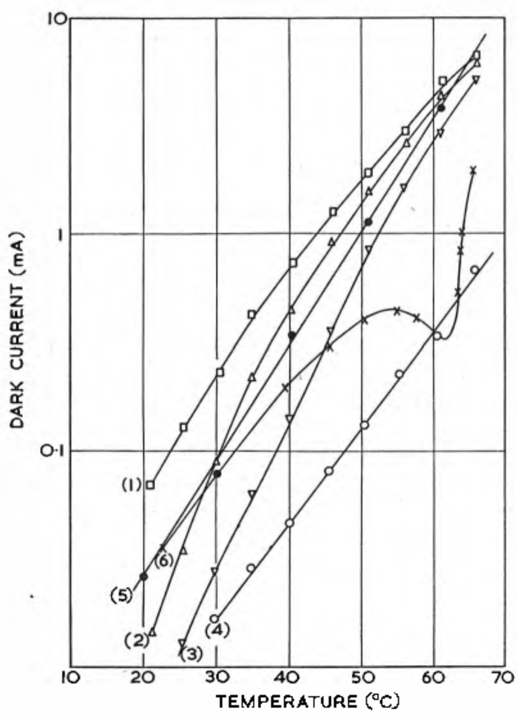

Fig. 1. OCP71 dark current against temperature
curve (1) $R_{be} = \infty$
curve (2) $R_{be} = 22k\Omega$
curve (3) $R_{be} = 4{\cdot}7k\Omega$
curve (4) $R_{be} = 0\Omega$
curve (5) diode compensation
curve (6) transistor compensation

* *The United Steel Companies Ltd.*

The effect of reducing R_{be} progressively can be seen in curves (2) to (4). There is a reduction in dark current which is accompanied by a reduction in light sensitivity until when $R_{be} = 0$ the photo-transistor becomes virtually a photo-diode having an exponential characteristic of thermal drift of $12\frac{1}{2}$ per cent/°C over a range of at least two decades of current. At intermediate values of R_{be} the characteristic is distorted by the input resistance of the photo-transistor changing value with temperature. At low temperatures the input resistance is high so that the transistor sees a relatively low value of external resistance and behaves as though short-circuited. At high temperatures the situation is reversed and there is, therefore, an intermediate region where the temperature coefficient is enhanced up to as much as 25 per cent/°C although the absolute values of the dark current and of the light sensitivity are reduced. Although this effect could probably be made use of for temperature measurement it is of limited value in a steelworks. The reduction in sensitivity of the photo-transistor caused by this type of dark current compensation means that more light must fall on the photo-transistor to cause it to operate but this increase in light is inevitably accompanied by an increase in heat radiation and the photo-transistor may be overheated. This may result in a long time to release, a lock-on or the complete destruction of the photo-transistor depending on the application. Alternative methods of compensation were therefore investigated which do not reduce the sensitivity of the photo-transistor.

The various types of drift compensation applicable to a single d.c. stage which have been proposed previously include

(1) Bias compensation, typically by thermistors

(2) Bridge compensation

(3) Diode compensation

Bias compensation is not applicable in this case since it involves an increase in dark current at low temperatures usually to such a value that the circuit becomes unusable. Furthermore the thermal time-constant of a thermistor is considerably different from that of an OCP71 so that there may be spurious operation if ambient temperatures change rapidly. Bridge compensation[1] is extremely useful if small temperature changes occur but as can be seen from Fig. 1 the dark current of the OCP71 changes by a factor of 100 times from 20°C to 65°C so that satisfactory compensation is difficult to achieve. In addition bridge connexion merely balances out the dark current and does not suppress it. At the maximum ambient temperature the transistor therefore dissipates the full dark current plus the full light current and may well be overloaded. It will in any case experience different conditions from those existing in the compensating transistor and will therefore drift differently so that static dark compensation does not guarantee dynamic light and dark compensation.

Diode compensation was therefore investigated using a diode type GD5 and a silicon diode. The greatest compensating effect occurred with a GD5 connected in the high back resistance condition (curve (5)). Since the diode resistance falls with increasing temperature at about the same rate that the input resistance of the OCP71 falls, the thermal characteristic is roughly exponential with a mean rate of rise of the order of 14 per cent/°C. Illumination of the transistor however produces an increased voltage across the diode which increases its effective resistance. There is thus a slight effective increase in light sensitivity in spite of the compensating action of the diode. The thermal time-constants of the diode and photo-transistor are of the same order and provided they are both exposed to the same conditions satisfactory compensation is achieved at moderate ambient temperatures.

In order to reduce the dark current still further without loss of sensitivity a different approach is required. The requirement not to lose sensitivity implies a high resistance compensation system and if this is to suppress currents of the order of several milliamperes in the photocell then a potential of the order of volts is required for suppression. However, the base-emitter voltage in a single OCP71 stage is only millivolts and hence an external compensating transistor is required. This may as well be another OCP71 since it will then match the characteristics of the photocell OCP71 reasonably closely. However, the compensation OCP71 can be allowed to drift by only a fraction of its true drift current or it will be under thermally different conditions from the suppressed photocell OCP71. This is achieved by operating the compensation OCP71 with its base short-circuited to its emitter. A drift voltage is then developed across a resistor in its collector and injected as a drift current through a high resistance into the base of the photocell OCP71. Curve (6) shows the results achieved in this way.

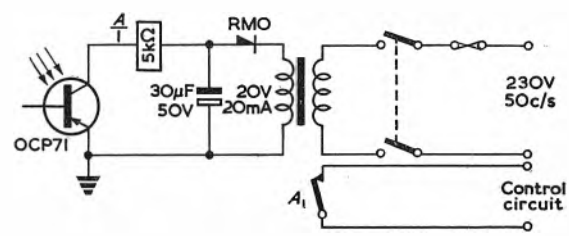

Fig. 2. Recommended circuit for ambients up to 30°C

Thermal Dissipation

Provided that the light actuating the photo-transistor is not accompanied by an appreciable amount of thermal radiation the full thermal dissipation limits may be used. Where thermal radiation is excessive it may be filtered (plain glass is usually adequate) or the transistor may be operated at reduced ratings in which case drift will occur during operation. Appropriate compensation should then be used to ensure that the drift is not excessive.

Current Creep

Current creep[2] is regularly experienced with the OCP71 but it is found to be negligible provided that the transistor is operated at 25 per cent or less of its maximum thermal dissipation. Since a transistor is a current operated device and current drift is experienced, this reduction must be made by reducing the applied voltage. Reduction of operating currents merely reduces the signal current/drift current ratio.

Restriction Due to Use of a Relay

Where the light intensity increases gradually a relay with a snap-action must be used and in practice either a P.O. type 3 000 or a high-speed (Siemens type 89B) relay is normally employed. It has been found convenient to standardize on about 5 to 8mA operating current and the supply voltage is arranged so that the circuit saturates at this current with the transistor bottomed. It is found that these relays release reliably at 0·5mA and this is taken as the upper limit of the dark current. Although relay suppression is often advocated, no ill effects have so far been observed due to its omission although suppression is probably still a wise precaution.

TYPICAL CIRCUITS

(1) *For use up to 30°C ambient*

No compensation is necessary. The circuit is shown in Fig. 2.

(2) *For use up to 45°C ambient*

Diode compensation is adequate. The circuit is shown in Fig. 3. The diode and the transistor should be mounted adjacent to each other and equally exposed to the light source.

(3) *For use up to 55°C ambient*

Transistor compensation is necessary. The circuit is shown in Fig. 4. Although the compensation transistor is short-circuited in its base and its sensitivity is considerably

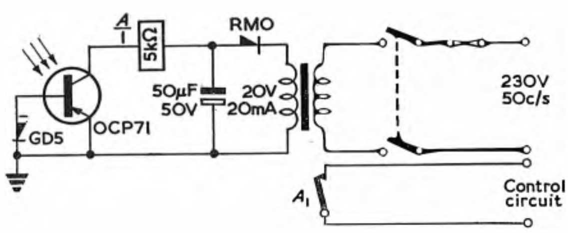

Fig. 3. Recommended circuit for ambients up to 45°C

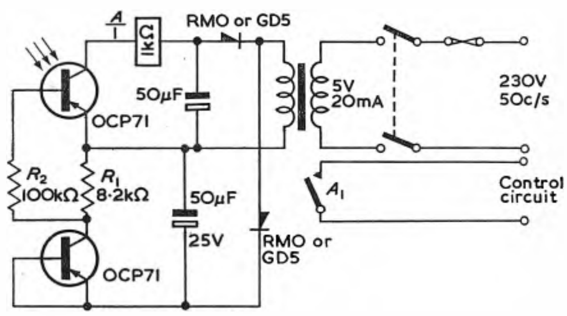

Fig. 4. Recommended circuit for ambients up to 55°C

reduced, it is normally necessary to screen it. It may be painted matt black or covered with a short piece of Systoflex tube. The transistors should be mounted adjacent to each other and equally exposed to the light source.

Some adjustment of the drift characteristic is possible, decrease in R_1 increasing the temperature at which the minimum occurs and increase in R_2 increasing the temperature at which the maximum occurs and the current which flows at the maximum.

In all cases battery supplies may be substituted for the mains supplies shown.

Basic Optical Characteristics of OCP71 at 25°C

The transistor was mounted in a sturdy clamp with the light sensitive area towards a fixed source of parallel light. An opaque shutter, mounted on a micrometer head, was then moved between the transistor and the light source while maintaining constant illumination. The shutter was sufficiently near the transistor for a sharp shadow to be cast. The average characteristic obtained for eleven transistors from three different batches is shown as curve (b), Fig. 5, the upper and lower limits also being shown and this has been called the transverse optical characteristic.

AVERAGE TRANSVERSE OPTICAL CHARACTERISTIC

As the shutter moves across the front of the transistor the current passing increases almost linearly over the active width of the transistor which is about 0·14in and hence a snap-action relay must be used under these conditions since a proportional relay would have a low contact pressure at the instant of closure and could fail due to contact arcing.

TRANSVERSE ERROR DUE TO ELECTRICAL TOLERANCE

If a constant illumination is used for all the transistors then a relay operating point must be selected which is less than the lowest maximum current. There will then be an error if a transistor of higher sensitivity is used since this current will be reached at an earlier point along the characteristic and this error typically amounts to about 0·020in. It may be minimized though not entirely eliminated by adjusting the intensities of the individual light sources to obtain equal maximum currents from the transistors or by using a light intensity of two to three times that required for normal operation and ensuring that bottoming effects limit the current passed by the transistor. This steepens the characteristic thus reducing the error but care should be taken that the increased illumination does not overheat the transistor.

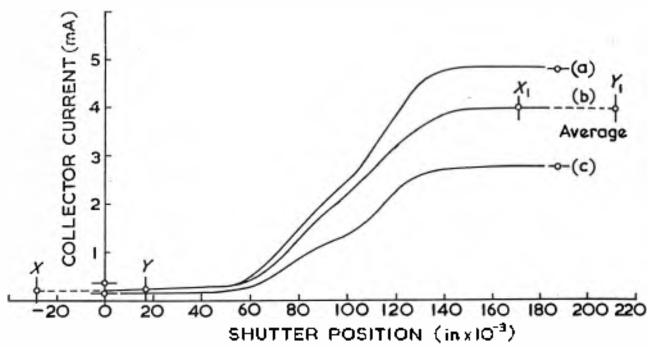

Fig. 5. OCP71 transverse optical characteristic

TRANSVERSE ERROR DUE TO MECHANICAL TOLERANCE

The curves of Fig. 5 have been arranged so that the sensitive portion of the transistor is always in the same position. When this is done, the edges of the transistor lie between X, Y and X_1, Y_1, a range of about 0·040in. If, therefore, the transistor were fixed in a rigid mount, an error of up to 0·040in could occur due to mechanical misalignment in the transistor. This can be minimized either by selection of transistors or by providing for adjustment of the mounting.

SLOT WIDTH ERROR

Furthermore, the curves of Fig. 5 have been derived using a slot of effectively infinite width. When the slot has finite width the sensitivity curves change shape as shown in the inset figures of Fig. 6. Since the sensitive area of the OCP71 is in the form of a ring, a narrow slot characteristic is double humped and relay operating points for bi-directional movement must be on the outer edges of this characteristic. As the slot width increases, the mean error increases until the slot becomes wide enough to be unable to resolve the two peaks and a single peak is observed. The trigger points then move towards each other and a decreased error results. At slot widths greater than the junction width, a flat top appears on the characteristic and the error increases once more. Thus there is a (not very) critical slot width which gives minimum error in a bi-directional system. When working about the critical slot width there may be two or three slot widths which will give the same error and in general the widest slit should be employed since it will pass the most light. It can be seen from Tables 1 and 2 that the accuracy for bi-directional movement can never be as great as that for uni-directional movement but for bi-directional movement in a steel works an error of 0·1in is often entirely adequate.

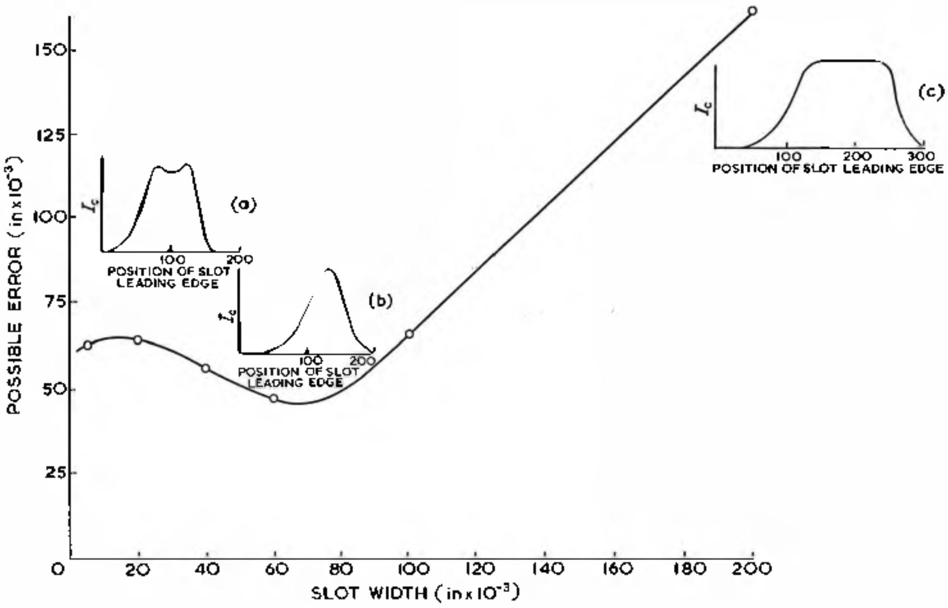

Fig. 6. OCP71—Effect of slot width on positioning error

Characteristics of Silicon Photo-Transistors

In view of the limited temperature characteristics of the OCP71 a search was made for a silicon photo-transistor but without success and several were therefore made by removing the cans from types OC200, OC201 and OC202 and centrifuging the silicone putty away from the junction to expose it to light. This is not entirely satisfactory since some putty always adheres to the inside of the transistor envelope and to the junction but adequate results are obtained. The devices formed by this process have been termed OCP200, OCP201 and OCP202 in line with the manufacturers' terminology.

As would be expected from the characteristics of the transistors from which they are derived, the silicon photo-transistors have very low dark currents, the values usually being unchanged by the process of manufacture provided the transistor envelope has not been damaged in any way. To reach the 0·5mA regarded as the limiting value for the OCP71 would require a temperature of 150°C or more although in view of the removal of the silicone putty from the junction it is probably inadvisable to exceed 100°C. The rate of increase of dark current with temperature, about 10 per cent/°C, is less than that of the OCP71 and no evidence of current creep has been observed in the transistors used so far.

TABLE 1
Bi-directional Movement

	ELECTRICAL TOLERANCE ERROR (in)	MECHANICAL TOLERANCE ERROR (in)	MINIMUM SLOT WIDTH ERROR (in)	TOTAL ERROR (in)
Fixed transistor mount, fixed illumination ..	0·020	0·040	0·050	0·110
Adjusted transistor mount, fixed illumination ..	0·020	0·005	0·050	0·075
Adjusted transistor mount, adjusted illumination ..	0·005	0·005	0·050	0·060

TABLE 2
Uni-directional Movement

	ELECTRICAL TOLERANCE ERROR (in)	MECHANICAL TOLERANCE ERROR (in)	MINIMUM SLOT WIDTH ERROR (in)	TOTAL ERROR (in)
Fixed mount, fixed illumination ..	0·020	0·040	—	0·060
Adjusted mount, fixed illumination	0·020	0·005	—	0·025
Adjusted mount, adjusted illumination	0·005	0·005	—	0·010

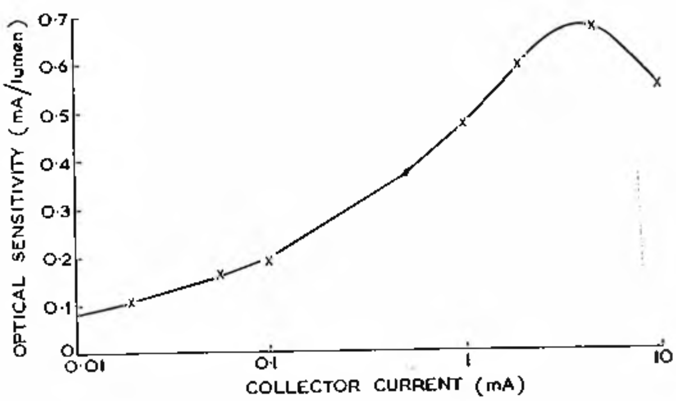

Fig. 7. OCP202—Variation of optical sensitivity with collector current

Basic Optical Characteristics of the Silicon Photo-Transistors

The transverse optical characteristic and the optical polar diagram are generally similar to those of the OCP71 and require no further remarks. The wavelength-sensitivity characteristic of silicon is generally similar to that of germanium but corresponding sensitivities occur at half the corresponding wavelengths due to the larger energy-gap, which is about twice as great in silicon as in germanium, so that the optical sensitivity of the silicon photo-transistors to a tungsten filament lamp is much reduced since they are largely unresponsive to the infra-red radiation from the lamp. In addition the current gain β of a silicon transistor is very dependent on collector current so that the optical sensitivity varies with light

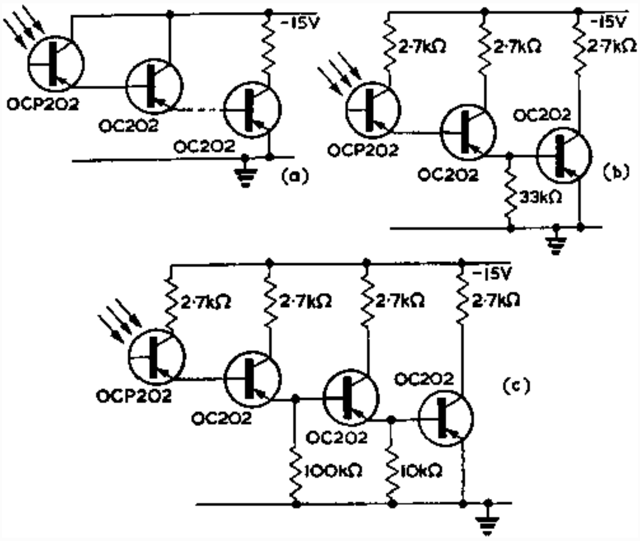

Fig. 8. (a) Basic silicon photo-transistor circuit
(b) Suppressed two-stage amplifier
(c) Suppressed three-stage amplifier

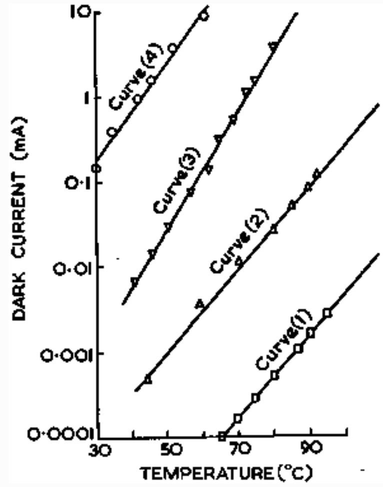

Fig. 9. Unsuppressed thermal dark current
curve (1) single OCP202
curve (2) OCP202 plus 1 stage of OC202 amplification
curve (3) OCP202 plus 2 stages of OC202 amplification
curve (4) OCP202 plus 3 stages of OC202 amplification

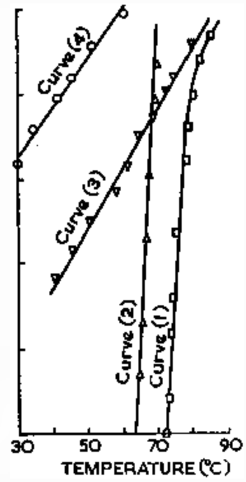

Fig. 10. Suppressed thermal dark current
curve (1) OCP202 plus 2 stages of OC202 amplification
curve (2) OCP202 plus 3 stages of OC202 amplification
curve (3) as curve (3) of Fig. 9 for comparison
curve (4) as curve (4) of Fig. 9 for comparison

level, a typical curve for an OCP202 being shown in Fig. 7.

While there may be occasions when the basic sensitivity of a single silicon photo-transistor is adequate, in general higher sensitivity is desirable and since the dark current of the transistors is so low, it is possible to amplify the output of the photo-transistor without drift suppression and yet still have a usable device. This amplification is most conveniently achieved by the successive use of emitter-followers as shown in Fig. 8(a), the optical sensitivity at an output current of 5mA being given in Table 3 for up to three stages of amplification by OC202 transistors when using an OCP202 photo-transistor. Intermediate values of sensitivity can of course be achieved by substituting type OC201 or OC200 appropriately. Typical thermal dark current curves at the final collector are shown in Fig. 9.

In order to improve the thermal dark current characteristics advantage can be taken of the high impedance of silicon transistors at low input currents, caused by the fact that appreciable current flow in the base-emitter diode does not occur until a potential of about 500mV is applied. If a resistor is placed in the emitter lead of the transistors of such a value that the dark current does not generate 500mV, then the dark current will be attenuated rather than amplified by successive stages and yet provided that the light current is adequate to generate considerably more than 500mV it will suffer little loss in amplification due to the relatively low input impedance of the transistor once conduction has started to occur. The circuits used are shown in Figs. 8(b) and 8(c), the optical sensitivity at 5mA output current again being given in Table 3. Typical thermal dark current curves at the output collector are shown in Fig. 10 for the cases of two and three stages of amplification together with the curves for the unsuppressed stages.

TABLE 3
Optical Sensitivity at 5mA Output Current (mA/lm)

	OCP 202	OCP 202 + 1 OC 202	OCP 202 + 2 OC 202	OCP 202 + 3 OC 202
Unsuppressed	0.64	60	800	8000
Suppressed	—	—	550	2000

It will be observed from Table 3 that a sensitivity at least equal to that of the OCP71 can be achieved by the use of an OCP202 and two subsequent OC202 emitter-follower stages and from Fig. 10 that reliable operation up to 78°C can be achieved by dark current suppression, some 20°C higher than results from the use of two OCP71's. The use of an extra OC202 stage allows a further increase in sensitivity but reduces the temperature limit to 68°C.

The dark current characteristics in the suppressed connexion are interesting because of their rate of increase with temperature. The maximum value observed may be seen from Fig. 10 to be about 500 per cent/°C, the circuits having obvious applications for temperature measurement and control. Adjustment of the temperature required to reach any particular value of output current may conveniently be made by adjusting the value of the resistors in the emitter leads.

Conclusions

The OCP71 is a very satisfactory photocell for use when subjected to moderate ambient temperature provided care is taken in its application. For higher ambient temperatures a silicon photo-transistor would be more satisfactory and the construction and use of such a transistor has been shown possible.

Acknowledgments

The authors wish to express their thanks to Mr. F. H. Saniter, director of the Research and Development Department of the United Steel Companies Ltd, for permission to publish this article.

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Stabilized Voltage Supplies Using Transistors

By J. S. Bell*, A.M.I.E.E., A.F.R.Ae.S., A.M.Brit.I.R.E., and P. G. Wright*

Two methods of obtaining ±300V stabilized supplies from a common low voltage source are described. The first circuit described is of a novel type and the design given is based upon initial investigations only, there being considerable scope for further improvements in design. The second type, which has been extensively investigated, follows the more usual form of series stabilizer, modified to use transistors throughout.

Neither circuit is restricted solely to double voltage supplies. The first type requires minor modifications to accommodate single positive or negative outputs while the second design already consists of two identical stabilizers fed from a common convertor.

(Voir page 797 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 802)

DURING recent work on airborne power supplies it became necessary to investigate the problem of obtaining ±300V d.c. stabilized supplies using a secondary battery as the primary source. Owing to the stringent vibration conditions expected it was decided to use semiconductor devices as the active elements, even although there was at the time no record of successful development in this particular field.

Two lines of development were pursued. The first method exhibited an undesirable characteristic from the point of view of the particular purpose required, and the second method was the one finally employed. However both systems have their advantages and disadvantages and it is likely that both will prove of use for other work.

No detailed analyses of the circuits are given but full descriptions of their operation are presented, which in the first method, in conjunction with transformer specifications and test results should prove sufficient for further design work.

Specification

+ 300V	120mA
− 300V	80mA

Temperature range of operation 0° to + 40°C.

Output impedance at d.c. 20Ω maximum.

(It should be noted that there is no reason why the temperature range of operation should not be extended considerably if required.)

Description of Circuits

FIRST SYSTEM (Control on the low voltage side).

The −300V unit (Fig. 1) contains the master reference voltage and the drive for the invertor in the +300V unit (Fig. 2). First consider the action of the −300V unit.

The general philosophy is to avoid the troubles inherent in the conventional series stabilizer unit where under certain conditions more than 300V could appear across the series control element, which in this case would have led to the destruction of one or more transistors. In order to avoid this the series control element is introduced on the low voltage side and thus the input voltage to the convertor section is regulated in accordance with the signal received by the control amplifier from a tapping on the −300V line.

Four Zener diodes (potted) are used as the reference source for the control amplifier which is a long-tailed pair. A degenerative network consisting of a 1kΩ resistor and a 0·1μF capacitor is used in order to avoid undesirable oscillation. The convertor is quite conventional except for the addition of two windings, one to drive the convertor in the positive supply unit and one to supply the reference voltage for the unit under discussion.

As the complete system was designed originally for stringent vibration conditions it was found necessary to use tantalum capacitor stacks for smoothing owing to the non-availability of a rugged aluminium capacitor.

Care was needed in the design of the circuit responsible for obtaining a satisfactory reference voltage, which must of necessity be higher than the input voltage of −27·6V for satisfactory operation. (An inspection of the control loop will confirm this statement.) It was found necessary to obtain the reference supply from a rectified and smoothed output from the convertor. However, in order to start the convertor an artificial reference supply is connected to the Zener diodes via the IS111 diode shown in Fig. 1. This diode is cut-off as the convertor commences operation.

The +300V unit derives both its reference supply and convertor drive from the −300V supply. It is necessary to feed the potentiometer chain supplying the error signal from the −300V line in order to obtain the negative error signal required to operate the voltage amplifier. The disadvantage of this arrangement is that any fluctuation in the −300V supply will result in an unwanted error signal being injected into the positive supply control loop.

As the master convertor transformer is saturated on each half cycle care was taken to ensure that the slave convertor transformer did not run into saturation and so upset the operation.

It was observed that spikes were present on the collector-emitter voltage waveform of the master convertor transistors, which were taking V_{ce} above 60V (the maximum for the transistor used). The arrangement shown in Fig. 3 was adopted; a standing voltage of −55V was obtained from a resistance chain across the negative output, and this voltage (decoupled), applied via a pair of IS111 diodes to the collectors of the transistors. Thus when the voltage on a collector exceeded 55V plus the forward voltage of the diode, the latter conducted, and the collector voltage was clipped at a safe value.

* *Smiths Aircraft Instruments Ltd.*

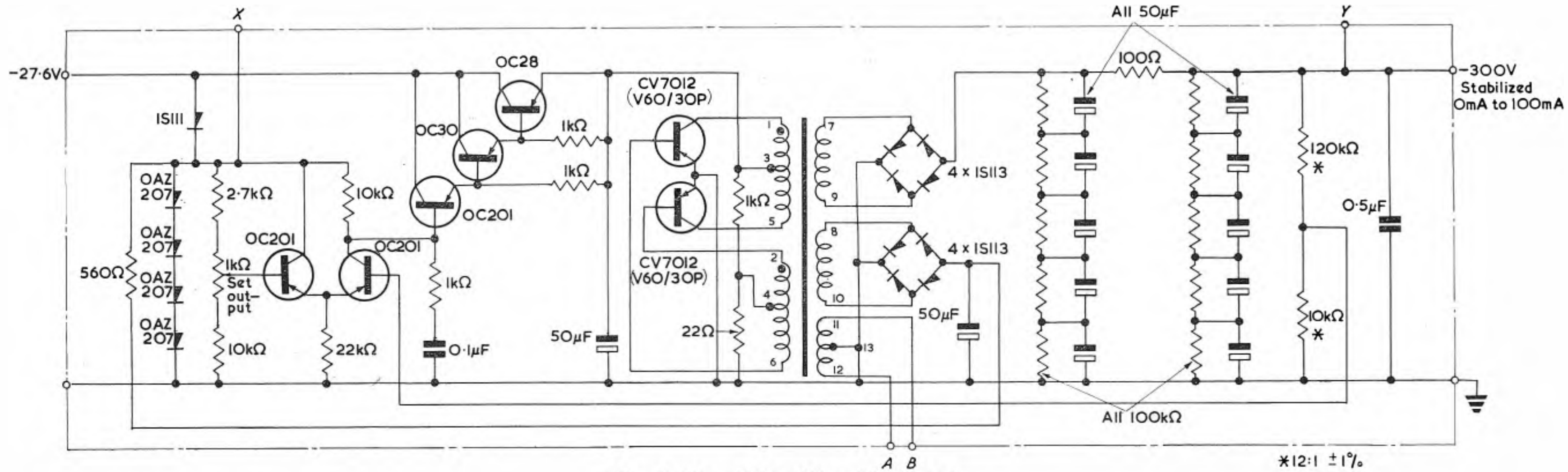


Fig. 1. The −300V stabilizer (First system)

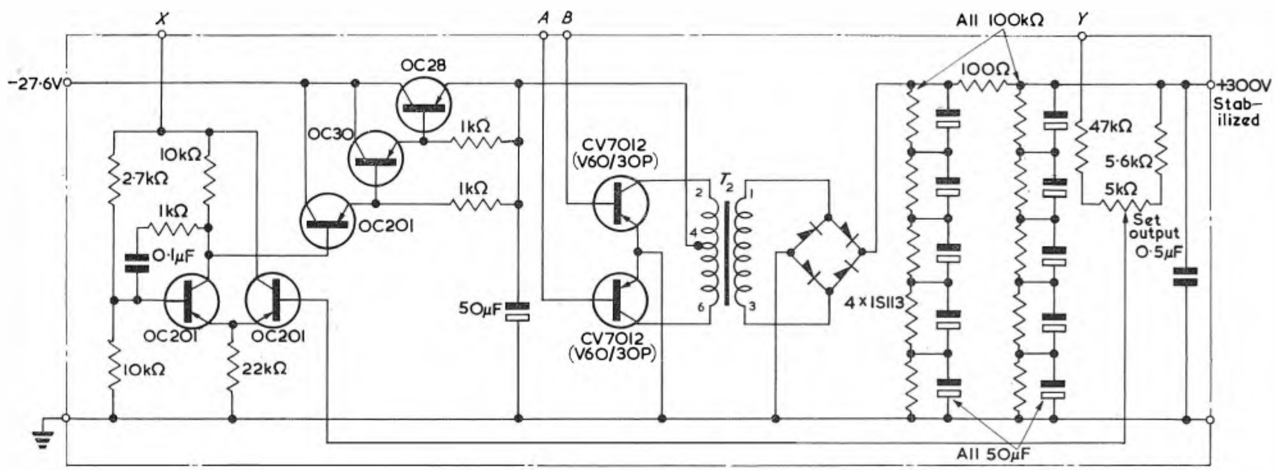


Fig. 2. The +300V stabilizer (First system)

TRANSFORMER SPECIFICATION IN WINDING ORDER

S.W.G.	Turns	Tapped at	Tag No. Start	Tag No. Finish
24	180	90	1	5
34	14	7	2	6
38	1170	—	7	9
38	150	—	8	10
30	8	4	11	12

Material 0·004in Trancor toroid
C.S.A. 0·581cm² Mean diameter 3·5cm

TRANSFORMER SPECIFICATION IN WINDING ORDER

S.W.G.	Turns	Tapped at	Tag No. Start	Tag No. Finish
36	1170	—	1	3
22	180	90	2	6

Material 0·004in Trancor toroid C.S.A. 0 581cm²
Mean diameter 3·5cm

SECOND SYSTEM. (Control on the high voltage side.)

It was found that the voltage from the d.c. convertor used in the foregoing circuit rises almost linearly with time, taking some 50msec to reach full voltage. Under these conditions, the voltage across the series element in a conventional series stabilizer circuit never becomes high, and so a transistor can safely be used in this position. Referring to Fig. 5, the operation of the circuit is as follows.

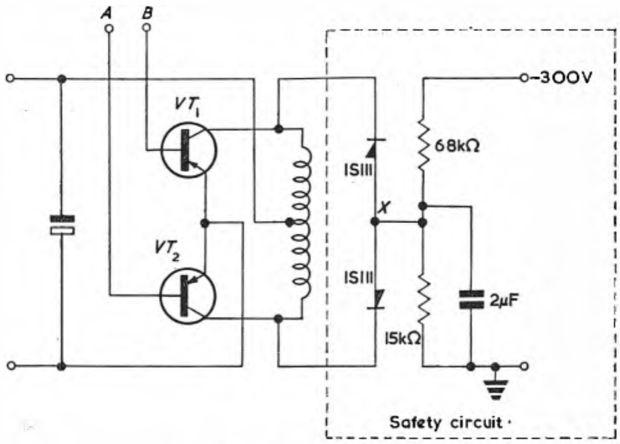


Fig. 3. Safety circuit

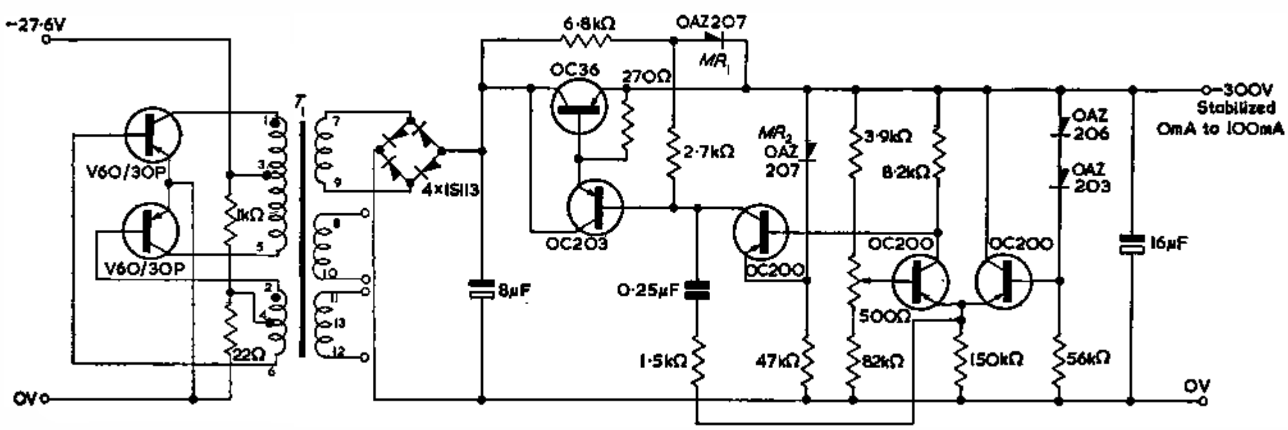


Fig. 5. The −300V stabilizer (Second system)
(For transformer specification see Fig. 1)

Two Zener diodes are used as the reference source for the control amplifier, a long-tailed pair. The error signal is amplified by a further OC200 silicon transistor, and fed to the compound emitter-follower (OC203 and OC36).

The negative supply for the collector of the error signal amplifier is obtained from a Zener diode, MR_1, and is about 9V more negative than the stabilized rail. The emitter of this stage is held about 9V positive to the negative stabilized rail by a further Zener diode MR_2, this diode also serves to decouple the emitter. A degenerative network consisting of a 0·25μF capacitor and a 1·5kΩ resistor is included to avoid oscillation at about 10kc/s. A 270Ω resistor is connected between emitter and base of the main series control element. This is to avoid high leakage currents which upset the stabilization at light loads.

It will be observed that most of the 300V is dropped across resistors, only 15 to 20V appearing across the transistors, this being regulated by the Zener diodes. The resistors in the potentiometer chain, and the pair of reference diodes account for most of the change of output voltage with temperature. If this is undesirable, a suitable thermistor connected in the lower half of the potentiometer can remove the effect almost completely.

The circuit was not developed at first for stringent vibration conditions, and so normal electrolytic capacitors were used for smoothing. For airborne use an arrangement similar to that illustrated in Figs. 1 and 2 would be adopted.

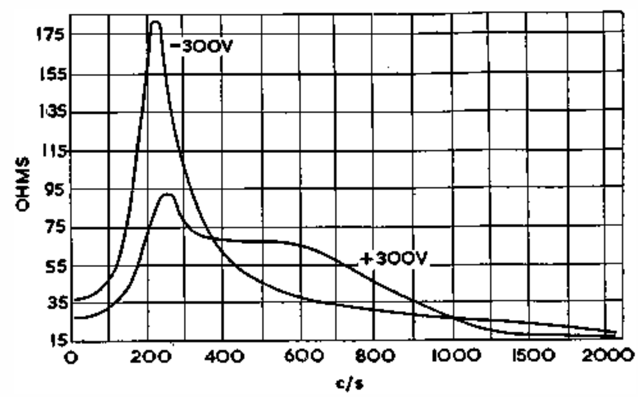


Fig. 4. Output impedance versus frequency (First system)

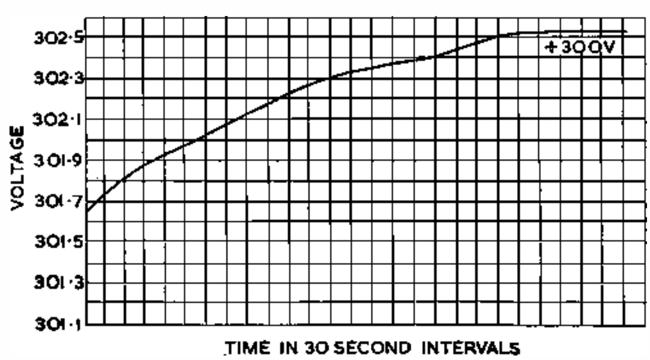


Fig. 6. Voltage build-up versus time (First system)

The convertor supplying the stabilizer is identical with that used for the first system, two of the secondary windings being left unconnected. The stabilizer may be used singly, as in a positive or negative 300V supply, or may be coupled with an identical unit to provide $\pm$300V. If 100mA at $\pm$300V is required, however, the convertor will need slight modification to provide the necessary outputs.

It should be noted that for the control elements used here, the difference between the output voltage and the unstabilized voltage must be greater than 10V, and not greater than 60V, i.e. 310 to 360V input, at all conditions of load.

The output ripple is about 200mV peak-to-peak on no load, falling to 50mV on full load. This can be reduced, if desired, to 60mV peak-to-peak maximum, by the addition of a further 16μF across the output.

is fed from the stabilized negative rail, and thus the stability and regulation of the positive supply can never be better than the negative one. Further designs could no doubt be directed at avoiding this characteristic.

The first is quite robust and will stand appreciable ill-treatment before malfunctioning whereas the second system described is liable to breakdown if the voltage across the series element exceeds the rated V_{ce} of either transistor in the compound emitter-follower. This could occur if the input voltage rose by more than about 15 to 20 per cent, or it could occur instantaneously (with equally destructive effects) if a large capacitor were con-

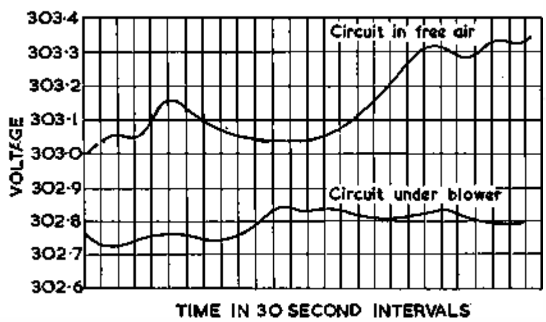


Fig. 7. Drift of output voltage with time (First system)

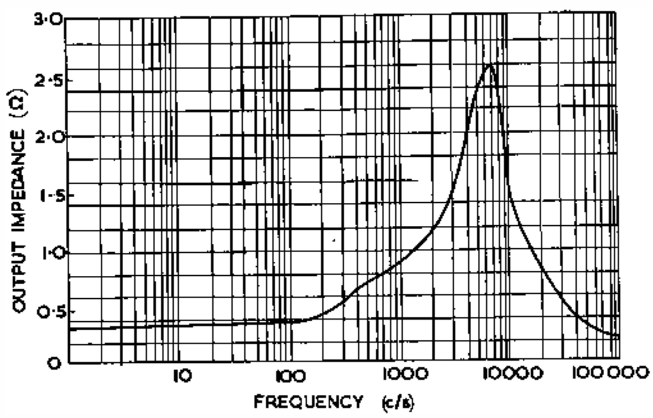


Fig. 9. Output impedance versus frequency (Second system)

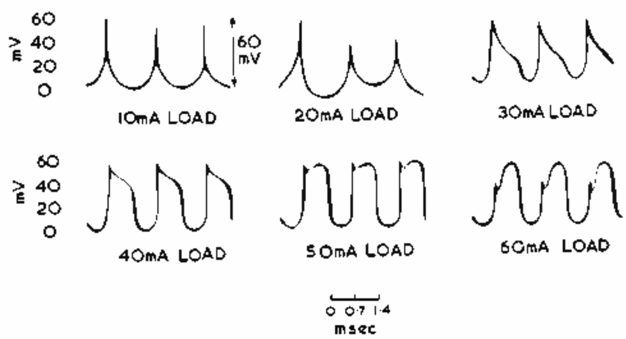


Fig. 8. Output ripple at various loads (First system)

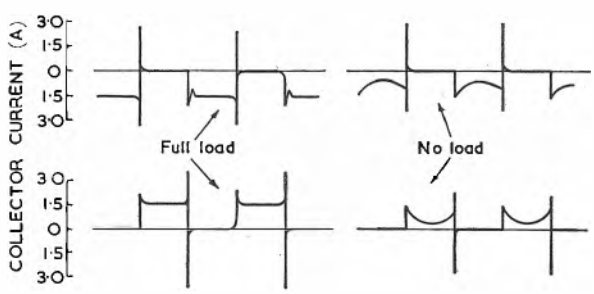


Fig. 10. Current waveforms of master convertor (First system)

Conclusion

The description of two $\pm$300V stabilized supplies has been given. Several units of both types have been constructed and have functioned satisfactorily over a period of several months. Relevant performance curves are given in Figs. 5, 6, 7, 8 and 9, while Fig. 10 shows current waveforms obtained at the convertor.

Although not illustrated graphically, the positive d.c. output resistance obtained using the first system is about 7Ω, the negative is about 4Ω. It is likely that these values can be reduced significantly by increasing the gain of the error amplifier, etc. The d.c. output resistance of the second system is about 0·3Ω.

The principal disadvantage of the first system is the control time-constant introduced by the convertor. This is apparent upon inspecting the plot of output impedance versus frequency, see Fig. 5. Even so this method of controlling on the low voltage side is extremely useful at frequencies removed from this undesirable peak. For particular cases, the frequency of the convertor could be tailored to suit. A further, but minor disadvantage is that one end of the error network in the positive supply

nected across the output when the circuit was operating. The current available from this second system is limited only by the allowable power dissipation in the series control element. The stability is such that over a period of 15 hours continuous running the output voltage changed by less than 20mV. A period of about 10min should be allowed after switch-on however, to enable the Zener diodes, etc., to attain their working temperature.

Both types of stabilizer described were originally developed for airborne use, hence the selection of a 28V d.c. supply. Modifications in the form of the usual mains transformation, rectification and smoothing techniques would enable these units to be used for normal laboratory work.

Acknowledgments

The authors wish to thank Mr. G. G. Roberts, formerly Technical Director of Smiths Aircraft Instruments Ltd, for his kind permission to publish this article, and also Mr. N. L. Sigournay for his assistance in checking the original proofs. Mention must also be made of Mr. R. Galbraith who performed much of the initial experimental work.

Instrumentation Wideband Magnetic Tape Recording

By J. P. Pritchard*

This article deals with the development of an Ampex instrumentation wideband magnetic tape recorder from the 'Videotape' Television Recorder. The equipment is described in general terms, as are the broad requirements of an instrumentation equipment able to record and reproduce a continuous wideband signal, nominally between d.c. and 4Mc/s. The modulator and demodulator and the signal switching arrangements are outlined in some detail. The importance of the recording time-base is stressed and the methods used to ensure accurate reproduction of the recorded signal during playback are discussed.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

WIDEBAND magnetic tape recording[1], nominally between the limits d.c. to about 4Mc/s, is now commonplace as a television programme material storage device. 'Videotape' television recording equipment[3] is in widespread use and has adequately proved the usefulness of the basic record/reproduce technique; a record mode using a rotary multiple head assembly, to record a track in sections transversely on a 2in magnetic tape and a reproduce mode using an electronic signal switcher to reassemble the signal taken from the tape by the same type of rotary head assembly. This method is unique in that it readily provides the effective head-to-tape speed[3] required for wideband recording, without resort to large, unwieldy tape reels and difficult tape handling arrangements.

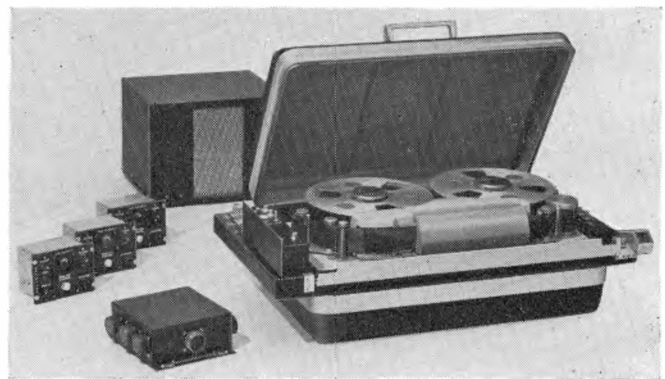
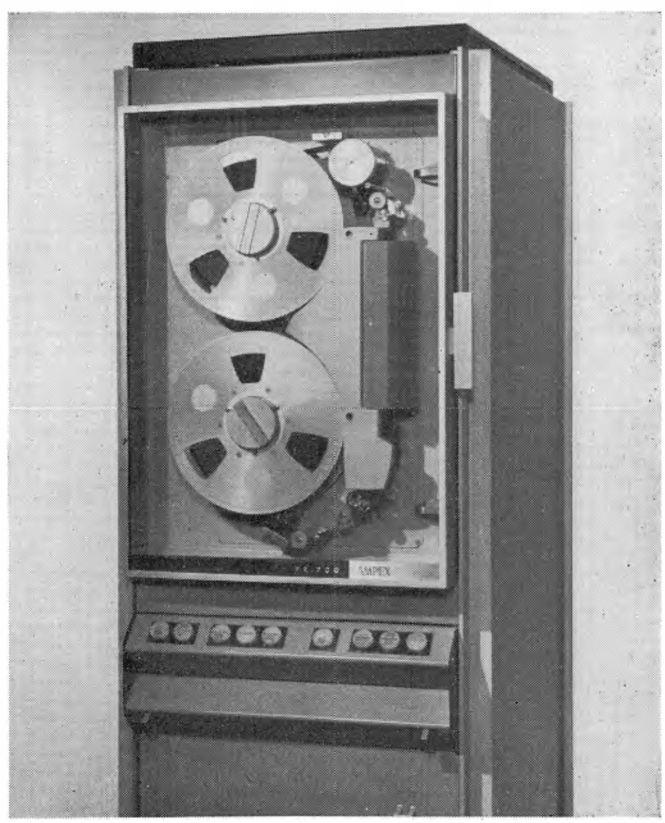


Fig. 1. Airborne wideband magnetic tape recorder

In addition, the transverse record system's 10½in diameter reel provides an hour of record time for a tape speed of 12½in/sec.

The television signal is, of course, a special case when considered as a waveform suitable for recording in sections on magnetic tape, since the television signal itself is virtually in sections, each consisting of one line. It is only necessary for the Videotape designer to ensure that the rotary head speed and the tape speed are suitable to the line scan duration characteristic of the television system concerned so that the head signal switcher can be triggered to function during the time allocated to synchronizing pulses without disturbances of the picture content of the signal.

Fig. 2. Wideband magnetic tape recorder/reproducer



Because of the interest shown in the Videotape recorder as an instrumentation recorder, work has proceeded over the past two years to develop a wideband magnetic tape recorder designed to exploit the Videotape method for wideband recording of continuous signals[4].

The equipment embodying the results from this development work is shown in Fig. 1, the airborne wideband recorder and Fig. 2, the companion ground recorder/reproducer. Both equipments are fully transistorized, and, as is to be expected, show spectacular reductions in weight and bulk over valve designs. The airborne tape transport, which meets MIL-E-5400B, is enclosed in an airtight metal and fibreglass casing with built-in vibration isolation. The ground tape transport is very similar to the airborne version and both transports have forced air temperature control systems. A block diagram, Fig. 3, shows the circuits common to both equipments in solid line and that

* *Ampex Corporation, U.S.A.*

used only in the ground version in broken line. Tapes recorded on this particular airborne equipment are reproduced on a ground equipment.

The equipment will record one or two wideband tracks, two auxiliary audio tracks suitable for supervisory voice control, a monitor track providing operator confidence and a control track to ensure accurate tracking of the rotary heads over the recorded tracks during the reproduce mode. The arrangement of tracks on the tape is shown in Fig. 4. The auxiliary, monitor and control tracks are recorded longitudinally on the tape, while the wideband tracks are recorded transversely. If it is desired to record two wideband tracks the tape speed is doubled from 12·5 to 25in/sec, so that two wideband tracks are interlaced on the tape, and the wideband signal channel (2) circuits are switched in. When recording one channel the record time available is approximately 60min, for a 10½in reel carrying 3 800ft of mylar base tape. The effective wideband tape speed, for one or two tracks recorded, is approximately 1 300in/sec.

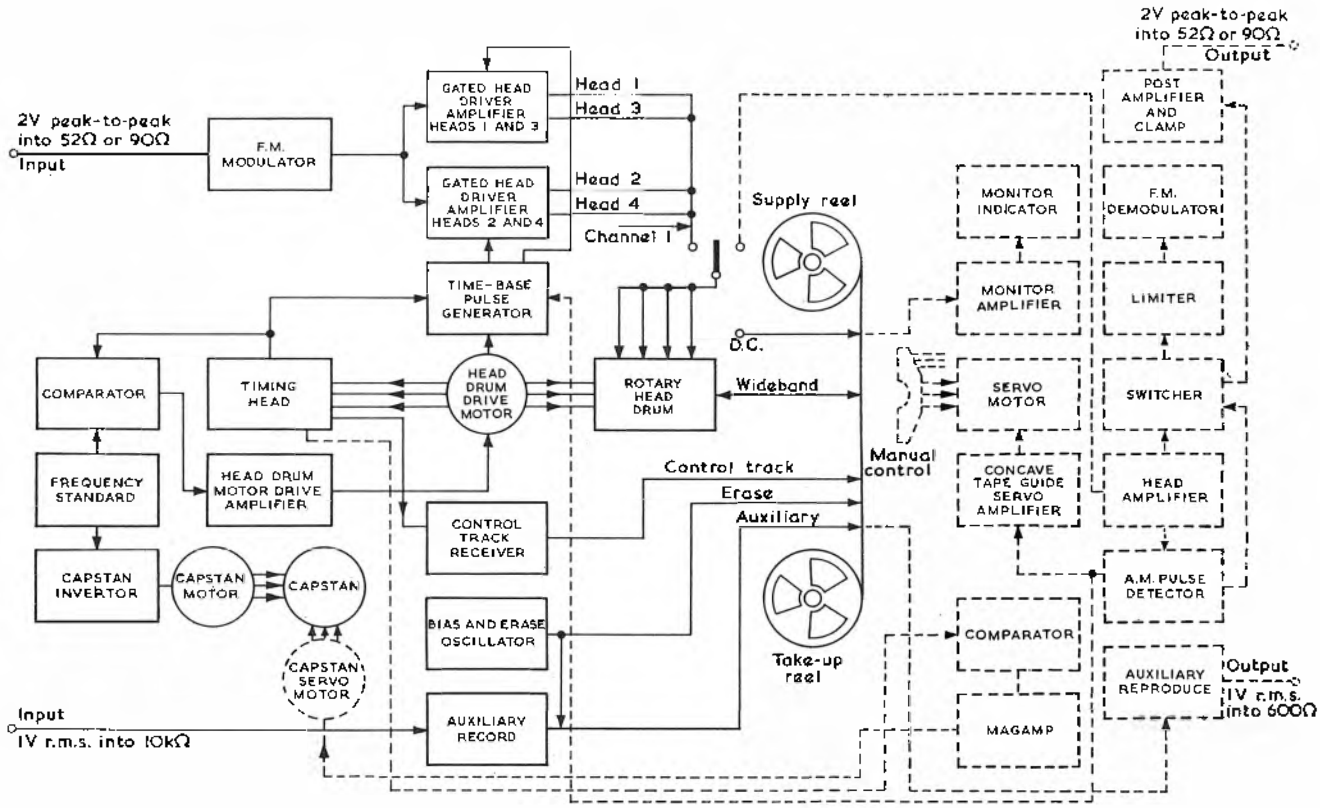


Fig. 3. The wideband recorder/reproducer

Wideband Record

A frequency modulation system is used for two major reasons. It enables the wide bandwidth occupied by the signal to be transferred to coincide with the most efficient part of the recorder's frequency spectrum[3] and the limiting action inherent in an f.m. system provides great advantage in mitigating the effects of partial drop-outs and in overcoming the difficulties arising because the four separate magnetic heads of the rotary head drum assembly have differing efficiencies.

F.M. Carrier-Generation

The f.m. method is a little unconventional in that the highest modulation frequency to be used, 4Mc/s, approaches the highest usable carrier centre frequency, 6Mc/s, considering the pass-band of the record-reproduce process. In consequence the classical equations for a frequency modulated wave, in terms of its centre frequency sidebands, have proved difficult to apply to the system. A major problem encountered in the generation of an f.m. wave when the modulating frequency closely approaches the carrier is the direct transfer or breakthrough of the modulating waveform into the frequency modulated output. Described, in this case, as video feed-through effect, the problem is serious because the two frequencies will fall within each other's pass-band and cannot be separated by filtering. In the frequency modulated output the unwanted direct breakthrough component will cause trouble by beating with components of the f.m. waveform.

The modulation method consists, briefly, of frequency modulating a relatively high frequency oscillator and then heterodyning the modulated oscillator's output to obtain a lower modulated frequency spectrum falling within the pass-band of the head-tape record/reproduce process. This method results in a minimum of video feed-through effect.

Additionally, the modulation efficiency of the system is improved because a higher ratio of modulated oscillator frequency to modulating frequency is achieved, resulting in a greater degree of linearity.

The wideband signal to be recorded covers too many octaves, about 20, for direct record/reproduce techniques utilizing available magnetic heads, which have a capability of about 7 octaves. The f.m. system employed effectively reduces the number of octaves to less than three and by shifting the recorded spectrum upwards, brings it within

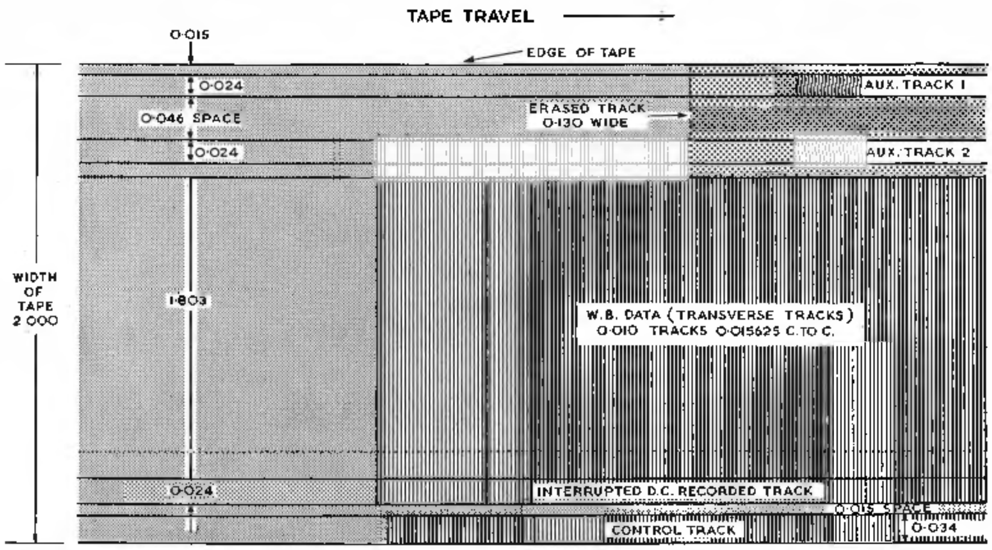


Fig. 4. Arrangement of recorded tracks on magnetic tape

the pulses are use to enable accurate maintenance of tape dimensions and consequently the recorded time-base.

Recovery of the full information content of the recorded signal is ensured by faithful reproduction of the recorded time-base. This is accomplished by servo controlling the head drum drive (effective tape speed), concave tape guide position (tape dimensions) and capstan drive (forward tape speed) during the reproduce mode. The reproducer signal switcher is designed to ensure that the marker pulses initiate the signal switching action and control the concave tape guide, but do not appear in the reproduced signal.

the record/reproduce capability of the wideband head/tape combination.

Wideband Modulator

The wideband input signal frequency modulates the Hartley tetrode transistor 36Mc/s oscillator, Fig. 5, by controlling the two voltage sensitive variable capacitance semiconductors, MR_1 and MR_2. A 0·6V peak-to-peak signal at the junction of MR_1 and MR_2 causes the 36Mc/s carrier to be deviated ± 500kc/s. The very low shunt impedance offered to the modulating frequencies by the tuned circuit of the oscillator is effective in preventing video feed-through effect.

The f.m. signal is heterodyned, with a fixed frequency 30Mc/s oscillator, identical with the 36Mc/s modulated oscillator but less MR_1 and MR_2. The resulting signal has a frequency spectrum suitable for application to the magnetic heads and equalization enables a flat frequency response to be secured.

Gated Head Driver Amplifiers

These provide for amplification of the f.m. signal before it is applied to drive the record current through the heads.

Additionally, since the signal on the tape must be marked to establish the recorded time-base and also to enable correct synchronization of the reproducer signal switcher, each amplifier has a diode bridge gate which is switched, once per revolution of the head drum, to interrupt the wideband signal in each amplifier for 2μsec. The operation of the diode bridges, with a precise time separation, is timed to clamp out the signal while record heads No. 1 and No. 2 are on the tape. The situation is illustrated in Fig. 6, where it can be seen that the first pulse is applied to No. 2 head, arriving at the tape and the second pulse is applied to No. 1 head leaving the tape. When two tracks are recorded, the marker pulses are only recorded on channel (1) track because the two head drums are identically orientated on the head drum drive-motor shaft so that the pulse applied to one head drum provides timing information for both tracks. The separation of the two pulses is set by a precision delay line, a most suitable reference for use in an aircraft equipment and one which can be readily matched in both accuracy and stability in a series of equipments. Because of their inherent accuracy the pulses provide a recorded time-base which is a measure of tape dimensions at the instant of recording. In the reproduce mode

Wideband Rotary Head Drum Assembly

This is very similar to that used in the Videotape equipment and is shown in Fig. 7. Re-design, however, has enabled the previously used vacuum technique, maintaining tape to concave tape guide contact to be dispensed with. Four heads are accurately mounted at 90° intervals around the periphery of each of the rotary drums, there being a head drum for each of the two wideband channels. The heads are used for both record and reproduce modes and a special low capacitance changeover switch is accordingly fitted to the assembly.

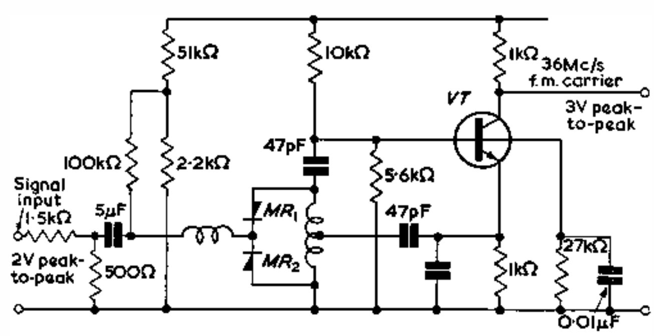


Fig. 5. 36Mc/s frequency modulated oscillator

Concave Tape Guide

The mylar base magnetic tape is held in contact with the rotating drums by a concave tape guide, so adjusted that the tape is stretched over the record heads' tips, which protrude from the drums. In this way firm tape to head tip contact is obtained and proper tape dimensions are established at the moment of recording. Stability of tape dimensions is ensured by establishing the tape temperature at 60°C immediately before it enters the rotary head assembly and by the thermostatically controlled heater attached to the concave guide. The guide opens away from the head assembly to facilitate tape threading.

In the airborne version the tape guide is manually adjusted to a fixed, predetermined position which is known to be at the centre of the travel available to the servo adjusted tape guide in any ground reproducer.

When in the record mode the ground equipment has its tape guide automatically set to a fixed predetermined position, again known to be at the centre of the travel available to the servo adjusted tape guide in any ground equipment in the reproduce mode. The servo adjusting the guide in the reproduce mode is controlled by the two time-base marker pulses taken from the reproduced signal by an a.m. detector. If the detected pulses are too close together, referred to the reproducer's delay line as a standard, the tape guide is moved closer to the head drum to increase the tape stretch, and consequently the time between the pulses. If the pulses are too far apart the tape guide is moved away from the drum to reduce tape stretch to bring the pulses together. This will effectively maintain the time-base established in the record mode, taking into account such things as tape dimension changes and head tip wear. As head tips wear the pulses will appear to move closer together, an effect which will be offset by the tape guide being moved closer to the head drum.

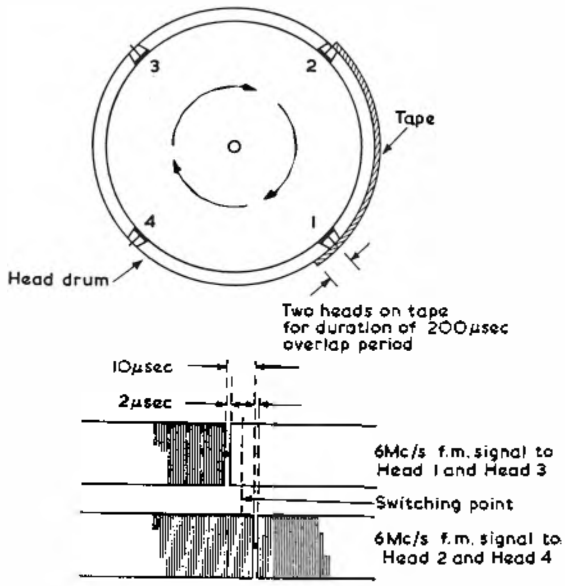


Fig. 6. Application of time-base markers to tape

Head Drum Drive Servo

If the recorded time-base is to be maintained the head drum speed must be constant and, to this end the rotary head drum drive is servo controlled with reference to the equipment 200c/s frequency standard, a temperature controlled crystal oscillator having a stability of 3 parts in 10^5. Both random and cyclic head drum speed variations are taken into account. A cyclic variation is, for example, encountered four times per revolution as a record head tip, protruding three mils from the revolving drum, moves on to the tape, followed almost immediately by the effect of a head tip leaving the tape. It has been found expedient in the design to correct the head drum speed by applying both phase and frequency corrections to the servo's variable frequency oscillator, together or separately depending on the nature of the head drum speed variation. The method used permits phasing of the head drum drive motor to take up short term speed variations without the need for subsequent resetting of the v.f.o. frequency.

Signal Connexions

The same head windings are used for both operating modes and are switched from the record to reproduce circuits as necessary. A special rotary, two-position, low-capacitance switch is used to make the head connexions. One side of each head winding is grounded and the other side is connected to the switch through a slip-ring assembly having two brushes in parallel per connexion to minimize possible effects of brush bounce.

Maintenance

The abrasive characteristic of the tape's iron oxide record surface causes head tip wear and eventually it becomes necessary to replace the head drums. To ease maintenance problems the rotary head drum drive assembly is removable from the tape transport so that the drive motor rotor assembly, including the head drums, can be readily replaced by means of an identical rotor assembly.

Capstan Drive

During record, accuracy of capstan speed of rotation (forward tape speed) is maintained by powering the capstan synchronous drive motor from an invertor controlled by the recorder's very stable frequency standard. During reproduce the 200c/s square wave control track put on the tape in the record mode is recovered and compared with the reproducer's frequency standard. Any error actuates the capstan drive servo to correct the forward tape speed to that used in the record mode to give accurate positioning of the recorded track on the tape under the scan of the reproduce heads. The capstan is driven by a two-speed motor at approximately 706 rev/min (12·5in/sec), or 1 412 rev/min (25in/sec) according to whether the equipment is switched for one or two wideband channels.

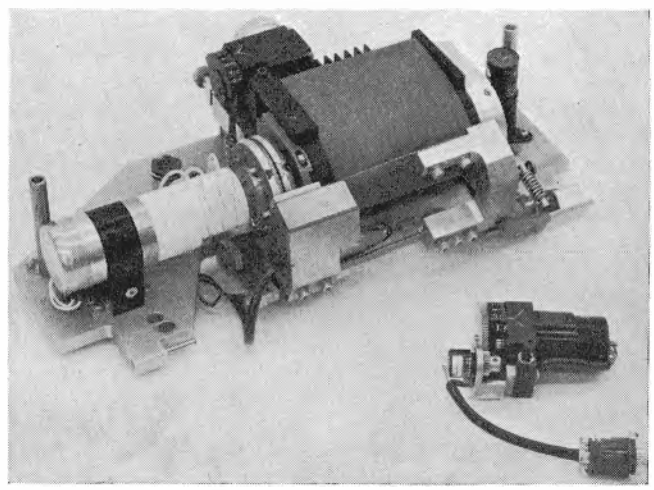


Fig. 7. Wideband rotary head assembly

Wideband Reproduce

Reproduction of the wideband signal involves amplification, reassembly in the correct sequence in the switcher, limiting to remove amplitude modulation and demodulation followed by clamping to remove switching transients.

The requirement for linearity and balance in the system between modulator and demodulator is very severe. Nonlinearity, giving rise to the generation of sum and difference frequencies falling inside the required pass-band is unfortunately unavoidable, for the system uses a limiter and magnetic heads which both have a similar effect on the waveform. Experience has shown, however, that distortion caused by limiting can be tolerated so long as good balance is maintained and the symmetry of the modulated wave is not disturbed.

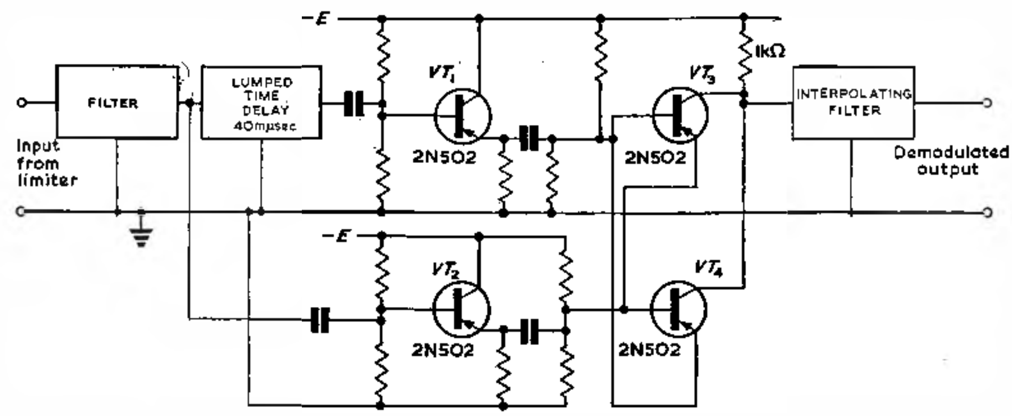


Fig. 8. Wideband demodulator

than is the case with a conventional f.m. system, as the modulating frequencies approach the carrier frequency much more closely than is the normal case. Deterioration of the modulation waveform is minimized by the interpolation filter which fills in the spaces between samples. The design of the filter is based on mutually conflicting requirements and is consequently a compromise determined by the phase and frequency response specifications of a particular recorder/reproducer.

Signal Switcher

The signal taken from the tape by the wideband heads contains the time-base marker pulses which are 2μsec periods of no signal occurring once per revolution of the head drum, while heads No. 1 and 2 are in contact with the tape. It is necessary to arrange that the initial signal switching action, by selection of head output, occurs during the interval between the marker pulses and that the no-signal periods do not appear at the input of the demodulator. This is effected by recovering the pulses from the signal at the wideband heads, by means of an a.m. detector and using them to synchronize the switcher. An a.f.c. circuit is used to ensure that the switching cycle is initiated accurately between the marker pulses. Accordingly, at a suitable time after the first marker obtained from head No. 2, commencing to scan the tape, head No. 1, ending its scan and about to deliver the second marker, is disconnected from the demodulator and head No. 2, which has already delivered its marker, is connected in its place. The switching action occurs between the pulses and as neither head No. 1 nor No. 2 is connected to the demodulator while actually reading a pulse, there is no loss of signal output caused by the presence of the marker pulses. Switching from head to head in sequence to reassemble the signal is now a matter of generating suitable gating pulses in the switcher, synchronized once per revolution of the head drum.

Signal Limiter

The output to the limiter is the combined outputs from the four heads. The signal limiting action required to remove amplitude modulation of the f.m. carrier prior to demodulation is provided by a four stage limiter, progressively yielding some 50dB of limiting at 4Mc/s. The limiter is quite straightforward, using diodes to switch transistors, but care is taken to ensure good balance of both positive and negative limiting.

Wideband Demodulator

A delay line provides the frequency sensitivity required in the demodulator (Fig. 8), causing the signal applied to VT_1 and VT_3 to lag in phase the signal applied to VT_2 and VT_4. This lag is input frequency sensitive so that conduction of VT_3 and VT_4, providing the demodulator voltage output, is a function of input signal frequency variation. The interpolating filter in the output of the demodulator is essential, because an f.m. system, employing a limiting action before the demodulator, is a sampling system with a sampling, or carrier zero crossing, rate of twice the carrier frequency. In the wideband instrumentation recorder application, the samples are relatively farther apart

Post Amplifier

The signal from the demodulator must be amplified to duplicate the input conditions, 2V peak-to-peak into 52 or 90Ω, so that the equipment will be a unity gain link in any system of which it is a part. The post amplifier provides this amplification. In addition the post amplifier is a suitable place to impose a clamping action on the reproduced signal to remove the transient set up by the operation of the signal switcher. The signal is clamped by a pulse from the switcher and to minimize the effect of the action the signal is clamped to its instantaneous amplitude at the time the clamp control pulse arrives from the switcher.

Temperature Control System

It is of paramount importance that tape dimensions are established at the moment of recording, as the tape is stretched over the rotary head tips, and are accurately reproduced during playback. A reel of tape may well be extremely cold when put on the recorder, especially in an airborne equipment, and because of its bulk the reel will tend to remain cold. The rotary head drum assembly, however, will heat up quite considerably in operation. A heater is, in fact, fitted to the assembly to speed the heating process. To prevent cold tape from being drawn into the heated assembly and subjected to a thermal shock at the most critical point in its travel a large heated tape guide drum is mounted in the tape path immediately before the rotary head assembly.

Thermostatically maintained at 60°C, this drum rapidly brings the tape up to temperature to stabilize its dimensions immediately before the wideband track is recorded. The tape is similarly handled during playback. In the airborne equipment a heat exchanger is used to remove excess heat from the tape transport. In the ground equipment filtered air is passed through the equipment.

Acknowledgements

The author wishes to acknowledge the helpful co-operation of S. Smith, Development Engineering Manager, and W. L. Rumple, Project Engineer, both of Ampex Data Products Company.

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A Portable H.F. Spectrum Generator for Antenna Calibration

By N. Burtnyk*

A portable low power spectrum generator suitable for antenna calibration is described. The radiated field intensity at 400ft over poor conducting soil is in the order of 150μV/m at 200kc/s frequency intervals in the h.f. spectrum. A crystal-generated trigger provides sufficient stability to prevent any audible jitter of the 30Mc/s harmonic.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

RECEIVER and antenna performance measurements frequently require the use of a test oscillator as a portable signal source. When a large number of test frequencies are to be selected during the course of such measurements, tunable test oscillators may prove to be somewhat inconvenient. Frequent changes of oscillator frequency during the measurement consume valuable man-hours, and the accuracy of this frequency setting is generally poor. The advantage in the use of a harmonic generator may probably best be appreciated when measurements such as the calibration of a d.f. antenna are being made. A wide band of harmonic frequencies, whose separation is determined by the pulse recurrence frequency of the generator, are radiated simultaneously at known intervals in the frequency spectrum. Thus, the complete range of frequency measurements can be made for each location of the test transmitter with a minimum consumption of engineering man-hours. This advantage can be fully realized, however, only if the weight, size and power requirements are comparable to those of a portable tuned oscillator.

The generation of a spectrum of harmonics extending over the entire h.f. band (3 to 30Mc/s) requires pulses of about 30mμsec duration. Various methods of generating recurring short pulses have been described in the literature[1,2,3], but invariably the circuits required for trigger pulse formation or pulse shaping are bulky and the power requirements are large. The crystal triggered blocking oscillator pulse generator described below provides the desired performance while maintaining a weight and size suitable for a portable field test instrument.

Circuit Operation

The circuit of the generator is shown in Fig. 1 The time-constant in the grid circuit of the blocking oscillator is adjusted to produce a free-running rate slightly below the crystal frequency. The approximately sinusoidal output of the crystal oscillator is shaped into a train of trigger pulses to provide an accurate and stable frequency reference. The jitter in the output pulse is thus reduced to a negligible amount. The diode used for trigger pulse shaping also decouples the anode capacitance of the trigger source from the blocking oscillator when the pulse forming action begins. The output of the blocking oscillator is coupled from the anode into a vertical whip radiator.

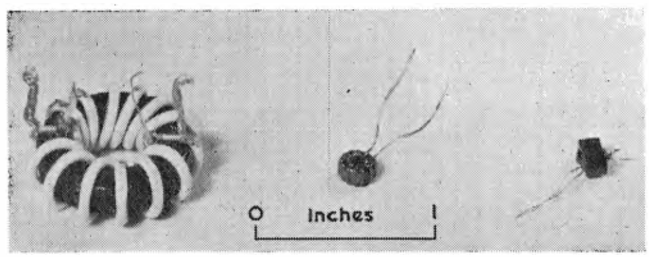


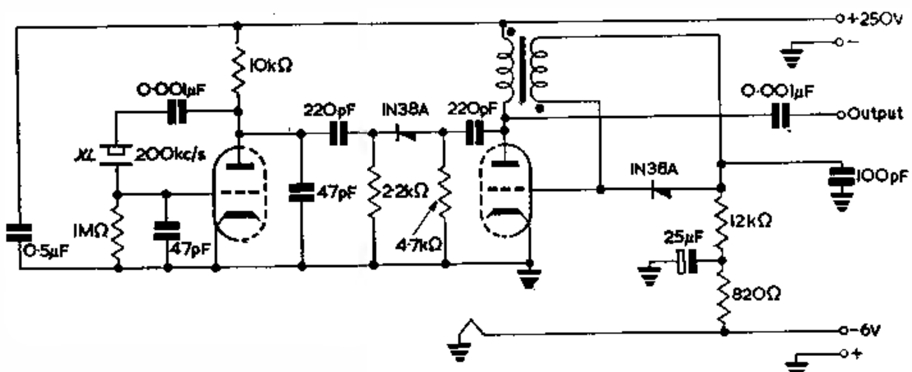
Fig. 2. Pulse transformer
(a) Coaxial line toroid
(b) Twisted wire miniature toroid
(c) Twisted wire miniature shell

A tertiary winding may also be used with the number of turns adjusted to match the load.

The action of the blocking oscillator in pulse formation is as follows:

A negative trigger pulse is applied to the anode while the control grid is at a potential sufficiently negative to prevent valve conduction. This trigger, because of the transformer polarity, appears as a positive pulse on the grid and anode current begins to flow. The increase in anode current and grid voltage is regenerative, so the current rises to saturation. This rise in current is very rapid, controlled by the charging rates of the valve and winding capacitances and the mutual conductance of the triode. During the build-up of the pulse, the grid becomes positive with respect to the cathode; grid current is drawn and the grid capacitor charges negatively to the value of the voltage across the grid winding. At saturation the anode current has stopped increasing, the anode voltage rises and the grid voltage falls. The action is again cumulative and the anode current is reduced to zero at a rate determined by the circuit capacitances. The grid potential continues to drop to the value of the charge on the capacitor and prevents further oscillation, thus constituting the

Fig. 1. The harmonic generator



* *National Research Council, Canada.*

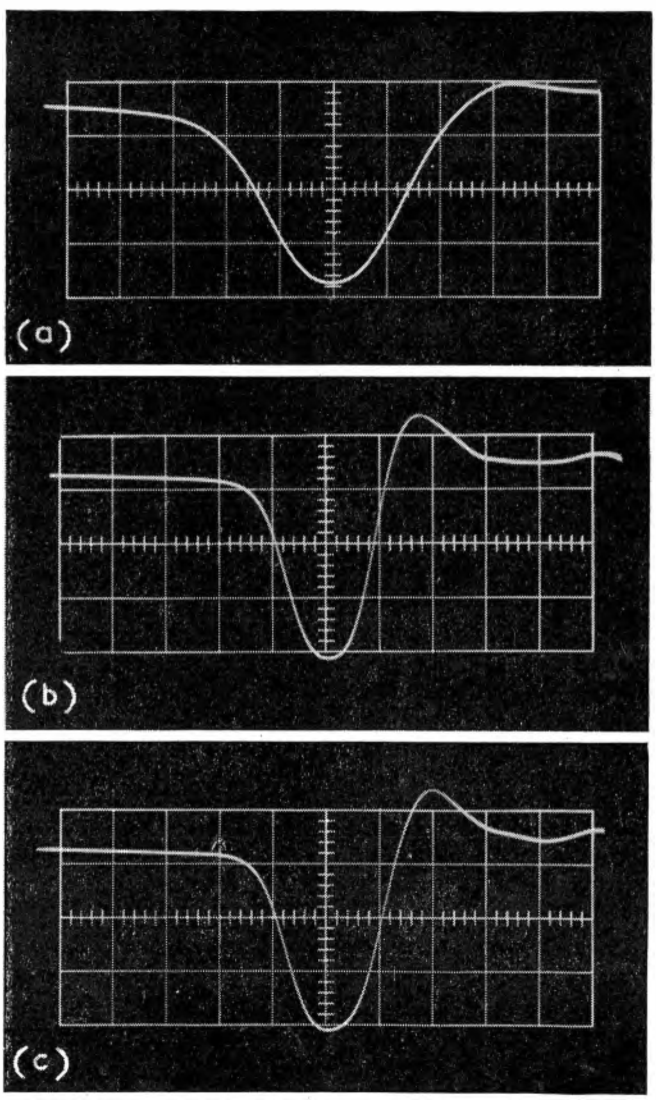
blocking' action. The grid time-constant is set somewhat greater than the desired period and the next trigger again starts pulse formation. Since the output pulse is a damped oscillation, the duration of the pulse is determined by the product of the coil inductance and the circuit capacitances.

Design and Choice of Circuit Elements

The effects of valve and transformer parameters on the output pulse shape of a blocking oscillator have been discussed by Smith[2]. Transconductance and interelectrode capacitance are the main factors in the choice of the triode. The E88CC/6922 appears to be the best choice. Cascode tuner twin triodes as used in television receivers are also suitable, but the performance will generally be poorer because of their lower transconductance.

The high frequency performance of the transformer can be extended beyond the limit necessary for this application by the use of transmission line pulse transformers[4,5,6]. Several types of construction, where the interwinding capacitance is built into the characteristic impedance of a line, are satisfactory. Three types of transformers and their associated output pulse waveforms are shown in Figs. 2 and 3. The coaxial line transformer, Fig. 2(a), is constructed of 50Ω miniature coaxial cable wound on a high frequency ferrite toroid[4]. The miniature toroid, Fig. 2(b), is constructed of 12 turns of a twisted pair of 36 s.w.g. enamelled wire on a high frequency ferrite core. The miniature shell transformer, Fig. 2(c), is constructed of 8 turns of a twisted pair of 36 s.w.g. enamelled wire on two ferrite shielding beads. Cast Teflon tape of ½ mil thickness and 3/16in width is twisted between the enamelled pairs of wires to increase the dielectric strength of the insulation between the two windings. These miniature transformers perform equally well as indicated by their output pulse waveforms of Fig. 3(b) and (c).

Fig. 3. Output pulse waveforms of harmonic generator using:
(a) Coaxial line toroid
(b) Miniature toroid
(c) Miniature shell transformer
(Viewed on Tektronix 545 oscilloscope with 53/54C pre-amplifier. Sweep speed—20mμsec/div. Amplitude—50V/div)



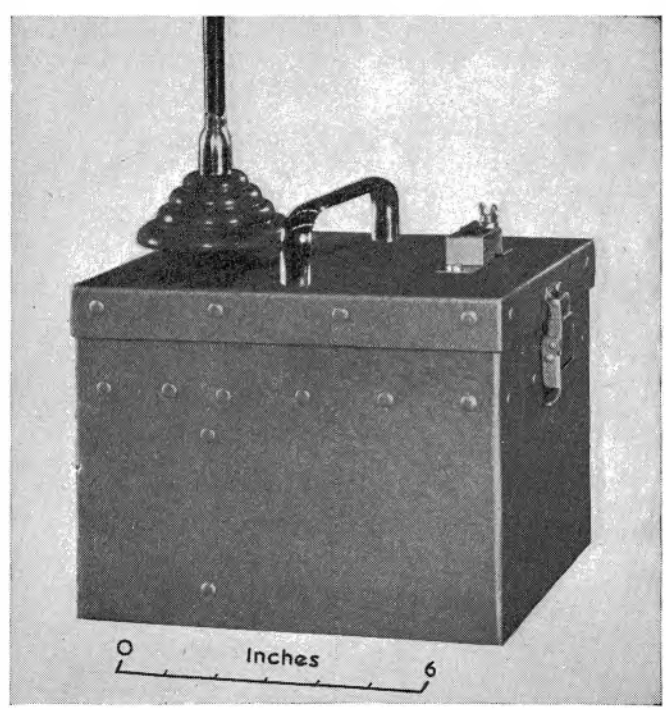
The performance obtained from any of these transformers depends largely on the amount of capacitive loading presented by the circuit and antenna relative to the characteristic impedance of the transformer. For this reason, turn-spaced solenoid windings in this application are inferior to the bifilar designs shown above. The inherent advantage of a tape wound h.f. transformer cannot be fully realized in this application because of its extremely high winding capacitances, though, the frequency response can be extended approximately to 30Mc/s by reducing the tape width below ⅛in.

Performance

A model of the harmonic generator is shown in Fig. 4. The weight of the unit with dry cell battery power supply is approximately 10lb.

The measured field intensity at a distance of 400ft over poor conducting soil ($\sigma = 5 \times 10^{-14}$ e.m.u.), using a nine foot vertical whip radiator, is shown in Fig. 5. Measurements to 25Mc/s were made using a field strength meter and the extrapolation to 30Mc/s was made from relative signal level measurements on another receiver. The decreased field intensity in the vicinity of 25Mc/s is due to the first null in the frequency spectrum envelope of the radiated pulse.

Fig. 4. Harmonic field oscillator



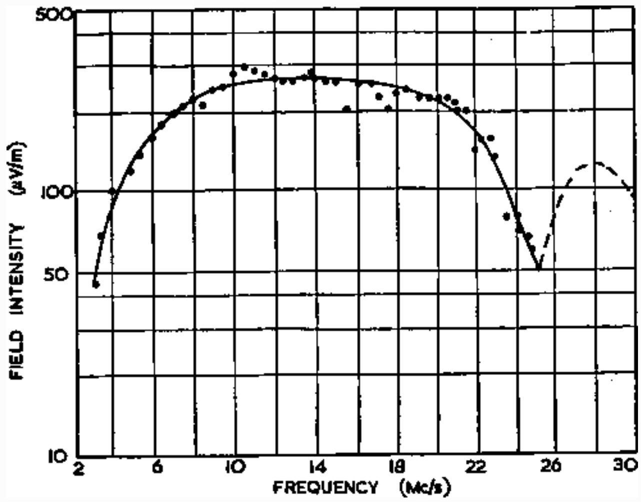


Fig. 5. Measured field intensity at 400ft

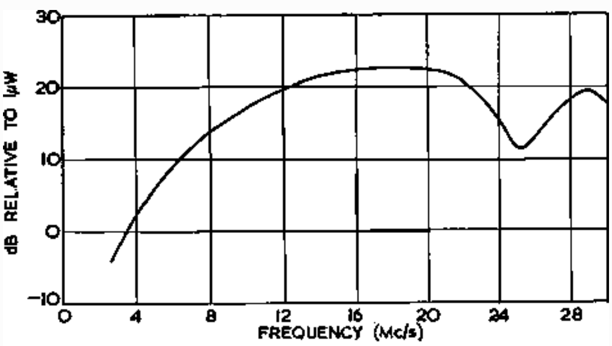


Fig. 6. Radiated power spectrum

The radiated power spectrum of the oscillator is shown in Fig. 6. This includes correction to compensate for the effects of soil conductivity by applying the surface wave propagation coefficient as given by Norton[7] to the measured field intensities of Fig. 5. The low radiated power level of the harmonic components at the low frequency end of the spectrum is due to the extreme inefficiency of the short antenna at these frequencies.

The jitter in the pulse recurrence frequency is so low that no frequency change in the 150th harmonic (30Mc/s) is audible on a receiver.

For operation over extended periods, a d.c. invertor mounted in the dry cell battery compartment with an external 6V storage battery is recommended. Adequate filtering in the anode supply is necessary to reduce ripple below 50mV. A filter for the bias supply is included in the circuit design to remove transients fed back from the invertor which may cause frequency modulation of the repetition frequency.

The performance specifications of the pulse generator using the miniature toroid transformer are:

Pulse rise-time (10 per cent to 90 per cent)	-	$<$ 20mµsec
Pulse width (50 per cent amplitude)	-	35mµsec
Pulse amplitude (peak)	-	175V
Pulse recurrence frequency	-	200kc/s

Conclusions

The harmonic generator described above provides a convenient and compact test transmitter for field calibration use. The radiated field intensity at a distance of 400ft, using a 9ft vertical whip radiator, is about 150µV/m across the h.f. band for soils of average conductivity.

Frequency stability to prevent any audible jitter of the 150th harmonic is obtained with an internal crystal generated trigger. The pulse recurrence frequency can be changed from 200kc/s to any other frequency between 50kc/s and 500kc/s by substituting an appropriate crystal and adjusting the grid time-constant to a suitable value.

For dry cell battery operation, use of the battery types indicated in Fig. 1 maintains synchronous operation over the life of the batteries (about 12 hours continuous) with only a small reduction in output power. A d.c. invertor together with a 6V storage battery is recommended for field use over extended periods.

Acknowledgments

The author wishes to thank Mr. W. F. McGee for doing most of the experimental work and Mr. C. W. McLeish and Mr. L. G. Cox for their helpful suggestions.

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A Radar Traffic Analyser

A radar operated traffic counter system which automatically groups road vehicles into four different categories (i.e., motor cycle, private car, lorry and lorry with trailer) and into speeds between 25 and 110km/h at intervals of 5km/h has recently been developed by Telefunken and is now being used for traffic engineering studies on three of the main motorways in West Germany.

It is claimed that this system is superior in several respects to traffic counting methods using pneumatic strips laid across the road surface. Among the advantages claimed are the following:

(1) Simple installation requiring no cutting of the road surface and consequent traffic interruption.
(2) Rapid and easy change of site.
(3) Accurate counting of the number of passing vehicles and not the number of axles as in the case with pneumatic strips.
(4) Operation of this system independent of weather conditions and road surface. Pneumatic strips frequently fail under snow and ice, and uneven road surfaces may cause vehicles to bounce over the strip.

The equipment consists of a small Doppler radar unit mounted at the roadside or over-head from a lamp-post or bridge, and a recording analyser unit which can be installed at any convenient point remote from the radar unit, connexion between the two being by cable.

The transmitter of the radar unit has an output of 25mW and directs a narrow beam (6° in the horizontal plane and 9° in the vertical) on to a section or lane of the motorway. The transmitted beam is reflected by passing vehicles and is picked up by the radar unit receiver which measures the change in frequency between the transmitted and received signals caused by the passing vehicle.

The amount by which the frequency changes is proportional to the vehicle's speed and the time interval of the frequency change is a measure of the vehicle's length.

The pulses are sorted into four ranges of width and into ten ranges of amplitude, and are recorded on forty electromechanical registers mounted in four rows on the front panel of the recording unit.

Each one of the four rows thus records over a given period of time the total number of vehicles of a given category moving over the ten speed intervals between 25 and 110km/h.

Noise Generation by Coaxial Cables when Subjected to Vibration

By R. D. Hole*

Following a brief appraisal of the factors governing noise generation and the relevant theory, there is a description of the present methods employed to overcome these phenomena. Two cable treatment techniques are suggested that are theoretically preferable to the existing techniques and have great advantages where the diameter and capacitance per foot of a cable are of prime importance.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

THE generation of a noise voltage at the terminal impedance of a cable is due to several factors:

(a) An electrostatic field can induce a signal in the cable.

(b) A charge may be generated in the cable due to friction between the conductors and the insulator. The physical construction of a coaxial cable makes this larger between the outer conductor and insulator than between the inner and insulator.

(c) A very small charge may be generated by intermolecular friction.

(d) If the capacitance of the cable is greatly reduced any charge generated will cause a large voltage to be developed across the terminal impedance.

A signal due to electrostatic induction can be reduced to negligible proportions by means of close weaving of the outer conductor, and by single-point earthing of this conductor. Experimentally it has been found that the capacitance of a cable is not reduced appreciably under vibration; the reduction is small when compared with the very much larger remaining capacitance, so this factor will not account for the voltages experienced across the terminal impedance. Hence the most important factors will be those governing the generation of a charge and its subsequent effect upon the terminal impedance.

Charge Generation Theory

It is believed that when a coaxial cable is subjected to vibration, separation of either conductor from the insulator will occur and that the conductors will become positively and the insulator negatively charged. The polarity of charge is based on the assumption that electrons can leave the conductors more easily than they can leave the insulator. Experimental results show that the frequency of the voltage appearing across the terminal impedance is the same as that of excitation, and that the amplitude of this voltage is proportional to the amplitude of excitation.

With reference to Fig. 1, which shows the separation of only one conductor from the insulator, and the equivalent circuit, it can be seen that a neutralizing current can flow only through the terminal impedance R_T, C_T.

The voltage across R_T is due to mechanical movement of the cable and this must cause movement of the conductors in relation to the insulator.

It is only possible for the conductors to move radially, longitudinally, or circumferentially with respect to the insulator and one or more of these movements must cause the charge generation which is largely responsible for the voltage across R_T. The magnitude of these movements will be assessed and conclusions drawn as to their importance.

Radial Movement

As the inner conductor cannot move radially with respect to the insulator as freely as can the outer, movement of

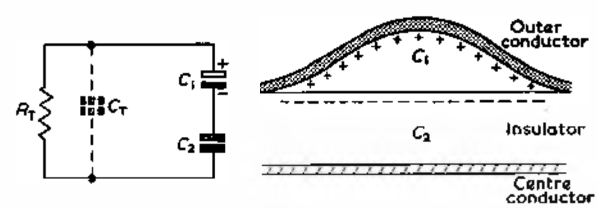

Fig. 1. Separation of one conductor and the equivalent circuit

the outer conductor alone will be considered. A large radial movement of the outer conductor would cause a considerable reduction in cable capacitance and since this is not the case there can be only small radial movement.

Longitudinal Movement

A force causing either compresison or extension of both insulator and conductors will cause shear stresses to be set up between them and since there is very little resistance to these stresses, large movements can be expected.

Circumferential Movement

No circumferential movement is to be expected unless the mechanical movement is applied at a tangent to the cable's cross-section when at some point the cable is held rigidly.

If two surfaces are rubbed together a charge is generated. The small radial movement will not cause a charge generation but will cause separation of the conductors from the insulator. The longitudinal movement, which is large, will cause charge generation. Any circumferential movement will also cause charge generation. Thus the charge generation is largely dependent upon the longitudinal movement of the conductors with respect to the insulator. The magnitude of this charge will be dependent upon the amplitude of movement and the coefficient of friction between conductors and insulator.

Present Methods of Cable Treatment

It has been the practice to reduce the effects of charge

* *English Electric Aviation Ltd.*

generation upon external circuits by reducing the effects of separation. This has been done by the bonding of low-impedance coatings to the surfaces of the insulator or by the addition of a very soft low-impedance film that will remain in contact with the insulator, due to capillary attraction. The equivalent circuit is shown in Fig. 2.

The charge deposited on the surface of the dielectric will immediately leak away via the low-impedance coating. This method is comparatively successful provided that the following precautions are taken:

(a) The outer conductor must be tightly woven and kept in as close contact as possible with the insulator coating.

(b) The close contact must be maintained at all working temperatures.

(c) The resistance of the coating must not increase with age and use, nor must the closeness of contact decrease.

The disadvantages of this method are as follows:

(a) A certain diameter cable will have a higher capacitance when treated than will one that is untreated.

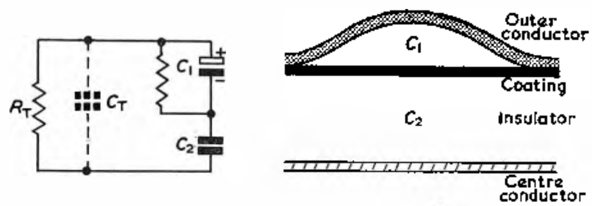

Fig. 2. The use of a low impedance film and the equivalent circuit

(b) It is extremely difficult to maintain very close contact between the conductor and coating, particularly at varying temperatures.

(c) The most successful cables appear to be those which have either large capacitance or larger diameter or have both.

Experimental Cable Treatment

If friction between the conductors and insulator could be eliminated the charge generated would be that very small charge due to inter-molecular friction, and if there is a very small generated charge only very low noise voltages could be developed across the terminal impedance.

Experiments have been carried out with test cables treated so that the reduction of friction between the conductors and insulator was accomplished as follows:

(a) By bonding one conductor to the insulator.

(b) By the introduction of a low coefficient of friction lubricant between one conductor and insulator.

Exact comparison between the two methods is impossible due to the difficulties experienced in manufacturing sample cables. The experiments are intended to give an indication of the success to be expected from development of these techniques and to compare the relative desirability of the two methods.

Experimental Bonding of the Outer Conductor to the Insulator

An 18in length of cable was stripped of its outer sleeving and was mounted in a rig consisting of two fixed supports 12in apart. The centre point of the cable was connected to a vibrator. The outer conductor was insulated from any part of the rig or vibrator and the capacitance was measured as 37pF.

The input impedance of the r.m.s. voltmeter connected to the test cable was 40MΩ and 30pF and the capacitance of the connecting cable 82pF.

With the vibrator excited at 30c/s and at an amplitude corresponding to 0·214in peak-to-peak movement of the cable, the cable output voltage was 235mV r.m.s. The cable was now heated and the outer conductor was pressed into the insulator in four planes. Completely effective bonding was not obtained. The cable capacitance was now 40pF but a reduction in diameter had taken place. With the cable again vibrated at 30c/s under the same conditions as before, the output voltage was now 28mV r.m.s.

Experimental Lubrication of the Outer Conductor and Insulator

Again an 18in length of the same cable was stripped of its outer sleeving and was vibrated under the same conditions as before. The cable capacitance was 37pF and the output voltage 235mV r.m.s.

A thin silicone oil was applied to the outer conductor and was allowed to impregnate for approximately half an hour. The cable capacitance was still 37pF. After the silicone oil had been allowed to impregnate, the cable was again vibrated at 30c/s, this time giving an output voltage of 18mV r.m.s.

Conclusion

The main cause of noise generation in a coaxial cable when subjected to vibration is the longitudinal movement of the conductors against the insulator, with the resultant charge being deposited on the insulator. This charge can only be neutralized by a current circulating through the terminal impedance and through any internal leak path provided in the cable. If, however, this charge generation can itself be minimized, instead of the effects, the reduction in noise voltage across any terminal impedance will be accomplished more successfully. This can be done in two ways: by bonding or by interposing a film of lubricant between conductors and insulator.

The lubrication method appears to be the more desirable commercially, but will not restrain the movement of the conductors when the cable is vibrated at one of its resonances. The capacitance of a certain diameter cable will be at a minimum and the flexibility a maximum.

The bonding method has the advantage of restraining the movement of the conductors at all times, and again the capacitance of a certain diameter cable is at a minimum. The one less desirable feature of this method is the loss of flexibility that will result. This can be kept to a minimum by the choice of a flexible insulator and by keeping the diameter small, but it will nevertheless be a disadvantage in some applications.

It would seem desirable to develop low-noise cables in which the aim is to reduce the cause of charge generation, and not the effect. The maximum flexibility and minimum capacitance of the lubrication method make this technique ideal, for instance, for treatment of cables to be used in connexions between small piezoelectric accelerometers and the associated measuring equipment.

Acknowledgment

The author acknowledges permission received from the English Electric Co. Ltd. to publish this article.

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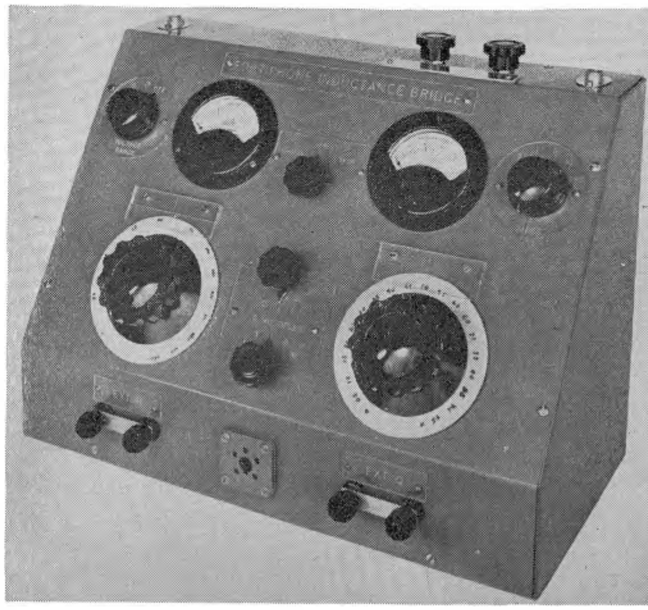
The Specification of Miniature Iron-Cored Inductors

By E. A. Grover*



Miniature and sub-miniature chokes and transformers, the use of which, until recent years was restricted to one or two specialized industries, are now accepted as commonplace and find applications in many widely differing fields of electrical engineering.

The introduction of the transistor and the subsequent demand for other circuit components of comparative size, has been largely responsible for this trend. Despite their increased use, however, much confusion still arises over the methods generally used for specifying and measuring their inductance

This article describes two methods of measurement and the relationship between them.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

THE growing need for smaller light weight electrical components for use in high speed aircraft, space probes, guided missiles etc., demands exact specification and measurement of the various parameters involved, in order to ensure accurate reproduction. In this respect, a particular problem arises in connexion with coils wound on very small closed ferromagnetic cores. The parameters in this instance are inductance and electrical losses.

At first glance it may not be apparent that there is any greater problem for miniature cores than any other type: inductance is by definition related to the number of turns on the coil and the current which it carries, and can therefore have only one 'true' value for any given conditions. Further investigation, however, soon shows how easy it is to make ambiguous statements, and that to ensure a complete understanding between designer and manufacturer, a precise definition is required.

It has been shown that the Q factor of coils such as these, is necessarily low[1]. In fact a transformer measuring $\frac{3}{8}$in by $\frac{3}{8}$in by $\frac{1}{4}$in, which is by no means the smallest size in common use, may have a Q factor only of the order of unity. Under these conditions it will have two apparent values of inductance according to the method of measurement employed. Furthermore, these values may be of widely differing magnitudes. Neither of these is the true value. They are introduced by a combination of the low Q factor and the bridge network used for the measurement, which is basically, an impedance measuring device.

When the Q factor is high, i.e. the ratio of losses to inductance reactance ($\omega L/R$) is high, measurements made in this way approximate so cosely to the truth, that for all practical purposes they are acceptable. With low Q factor coils, however, this is not so, and for an inductance value to have a real meaning, its loss configuration must also be clearly stated, otherwise considerable confusion may result.

There are, of course, two configurations by means of which a coil and its electrical losses may be expressed. They can be represented by a shunt resistor, which for maximum efficiency, will be infinitely great: alternatively they can be represented by a series resistor, which in this case will be zero for maximum efficiency.

Since either configuration may be used to represent a given coil, they must be electrically 'identically equal' to one another. It follows from this, that $Z_s \equiv Z_p$ and therefore:

$$R_s + j\omega L_s = \frac{j\omega R_p L_p}{R_p + j\omega L_p}$$

or:

$$R_s + j\omega L_s = \frac{j\omega R_p^2 L_p + \omega^2 L_p^2 R_p}{R_p^2 + \omega^2 L_p^2} \quad \ldots\ldots\ldots (1)$$

Equating the real parts:

$$R_s = \frac{\omega^2 L_p^2 R_p}{R_p^2 + \omega^2 L_p^2}$$

or:

$$R_s = \frac{R_p}{(R_p^2/\omega^2 L_p^2) + 1} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Since the Q factor of a parallel circuit $= R_p/\omega L_p$

Equation (2) may be re-written as:

$$R_s = \frac{R_p}{Q^2 + 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Equating also the imaginary parts of equation (1):

$$L_s = \frac{R_p^2 L_p}{R_p^2 + \omega^2 L_p^2}$$

or:

$$L_s = \frac{L_p}{1 + (\omega^2 L^2_p / R_p^2)}$$

From which

$$L_s = \frac{L_p}{1 + (1/Q^2)} \quad \ldots\ldots\ldots\ldots (4)$$

(since $Q = R_p/\omega L_p$).

It is immediately apparent from equation (4), that for a coil with a Q factor of 1, L_p is equal to twice L_s. If, however, the Q factor is 100, then L_p is only 1·0001 L_s. When the Q factor is only 10, the differences between L_p and L_s can still be ignored for most applications.

When a coil has a Q factor of less than 10 it is generally necessary to qualify any statement of inductance by the loss configuration to be associated with it. This should be done

* *Fortiphone Ltd.*

The above photograph shows a Hay/Maxwell inductance bridge.

by referring to either 'parallel effective resistance' or 'effective series resistance'.

The choice of configuration will depend from the specification writers' point of view, on the application of the coil. From the point of view of a coil manufacturer, however, the method of test used will probably be the deciding factor.

Conversion from one to the other by means of equations

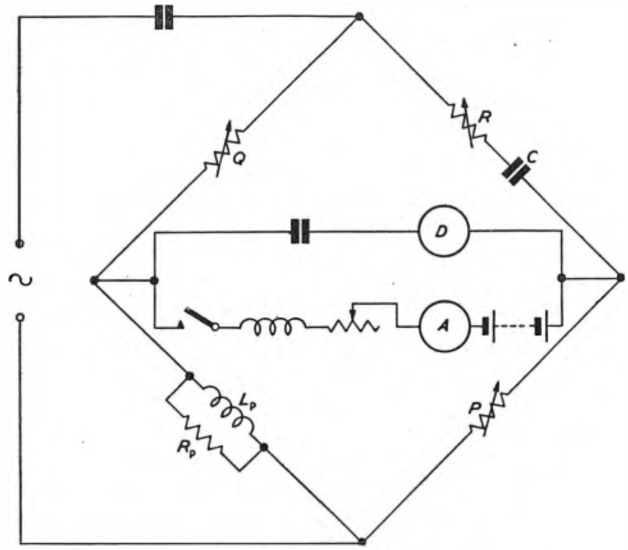


Fig. 1. The Hay bridge

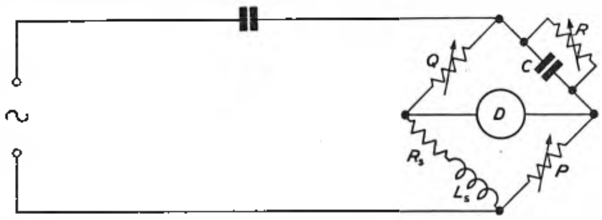


Fig. 2. The Maxwell inductance bridge

(3) and (4) is relatively simple, and by means of a combination of two types of bridge circuit, inductance measurements over a wide range in either parallel or series configurations can be made.

One type of bridge circuit required for these measurements is the Hay bridge, as shown in Fig. 1. Here the parallel configuration is used for the inductance to be measured.

It can be shown that at balance:

$$QP = \left(\frac{j\omega R_p L_p}{R_p + j\omega L_p}\right)(R - (j/\omega C))$$

$$= \left(\frac{j\omega R_p^2 L_p + \omega^2 L_p^2 R_p}{R_p^2 + \omega^2 L_p^2}\right)(R - (j/\omega C))$$

$$= \frac{j\omega(R_p^2 R L_p - (L_p^2 R_p/C)) + \omega^2 L_p^2 R_p R + (R_p^2 L_p/C)}{R_p^2 + \omega^2 L_p^2}$$

Equating real and imaginary parts:

$$PQ = \frac{\omega^2 L_p^2 R_p R C + R_p^2 L_p}{C(R_p^2 + \omega^2 L_p^2)} \quad \dots\dots (5)$$

also:

$$R_p^2 R\omega L_p = \frac{\omega^2 L_p^2 R_p}{C}$$

$$\therefore \quad L_p = R_p RC \text{ or } R_p = (L_p/RC)$$

Substituting $L_p = R_p RC$ in equation (5) then:

$$PQ = R_p R \text{ or } R_p = (PQ/R) \quad \dots\dots (6)$$

Since:

$$R_p = (LP/RC) \text{ then } L_p = PQC \quad \dots\dots (7)$$

It will be seen that these balance conditions are independent of supply frequency, and furthermore, by making the Q arm a multiplier of 100, 1 000 or 10 000Ω and the P arm multiples of 1 000Ω, the bridge can be made direct-reading[2].

A further advantage of this circuit is the comparative simplicity with which it may be adapted for measuring the inductance of coils carrying direct current (see Fig. 1).

Now if the series configuration is used in this bridge circuit it can be shown that the balance conditions are:

$$L_s = \frac{PQC}{1 + \omega^2 C^2 R^2} \quad \dots\dots (8)$$

and:

$$R_s = PQ\left(\frac{\omega^2 C^2 R^2}{1 + \omega^2 C^2 R^2}\right) \quad \dots\dots (9)$$

With these conditions, not only must the frequency of the supply voltage be considered, but also the formulae are very much more difficult to manipulate than those obtained from the same bridge circuit using the parallel configuration (equations (6) and (7)).

By means of a simple switching operation, however, the Hay circuit can be converted to the second type required, which is the Maxwell circuit as shown in Fig. 2.

Using the series configuration for the inductance to be measured, the following balance conditions are obtained:

$$PQ((1/R) + j\omega C) = R_s + j\omega L_s$$

or:

$$(PQ/R) + j\omega PQC = R_s + j\omega L_s$$

from which:

$$R_s = (PQ/R) \quad \dots\dots (10)$$

and:

$$L_s = PQC \quad \dots\dots (11)$$

These are the same balance conditions as apply to the Hay bridge using the parallel configuration. This time, however, the reactive and resistive parts are in series.

The combination of these two circuits, therefore, provides an extremely useful, and simple method of measuring inductance in whichever configuration may be required.

It is important, when designing miniature iron-cored coils and transformers, to remember that the common factor in the 'parallel' and 'series' configurations is the impedance which they may be used to represent. Only when the Q factor is less than 10 will there be any appreciable difference between the inductive reactance elements as measured, and only then will it be necessary to label the inductance 'parallel' or 'series'.

It must not be assumed, from the foregoing remarks, that coils with a high Q factor cannot be built on miniature cores. The introduction of a carefully determined air-gap in the magnetic circuit can often improve the Q factor of a coil from 1 or 2 to the order of 10 to 20. At higher frequencies, of course, even larger Q factors can be obtained by using miniature ferrite cores.

Acknowledgment

The author wishes to thank his colleagues at Fortiphone Ltd for their helpful discussions and criticism.

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Read-out Systems for Transistor Scalers

By T. G. Benbow*

Three types of read-out display using a meter movement, filament lamp and neon lamps, are considered for use with the transistor operated scalers developed and made at AWRE Aldermaston: and practical circuits are shown for the preferred system of switched neon lamps.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

THE electronic scaler is widely used in industry, medicine and atomic energy establishments as a basic element in radiation detection and measuring equipment, both fixed and portable. This integrating system is accurate at low count rates but conventional scaling circuits require heavy equipment and use much power. As a result, many portable equipments use ratemeter types of circuit with consequent loss of accuracy.

Transistor versions of scalers retain the required accuracy and at the same time overcome the disadvantages of weight and power consumption. The scalers weigh only one-twentieth that of typical hard valve units and consume only one-hundredth the power. Moreover, only a low voltage supply is needed: this advantage is particularly attractive in the field of medical electronics.

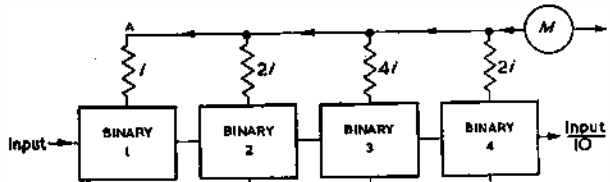

Fig. 1. Arrangement for decade unit with meter read-out

Scalers developed and constructed at the Atomic Weapons Establishment, Aldermaston, count up to speeds of 10^6 pulses per second and store 9 digits. The units have been designed to operate from self-contained batteries and from vehicle and aircraft power supplies: any supply from 11·5V to 26V d.c. is accepted and stabilized in the unit to give a 10·5V rail.

Design is based upon the use of a number of 'divide by ten' units derived from suitably fed-back binary stages. The logical development of a miniature 'read-out' system for these units is described.

Three methods of read-out of information after a scaling event, have been considered for these decade units, which are at present operated from a 10·5 volt supply.

(1) Staircase waveform providing current increments displayed as 10 discrete steps on a moving-coil meter.

(2) Indication of binary positions (1-2-4-8) by illuminating filament lamps.

(3) Indication of binary positions (1-2-4-8) by discharge of midget neon indicators.

Method 1

As illustrated in Fig. 1, four bistable circuits each has a resistive return to a common rail A from their halves which are non-conducting in the 'Scaler Zero' position. The rail A is returned through a meter movement of f.s.d. $= (9i)$ to a potential of V = potential on A with scaler at 'Zero' position.

The resistive return values are arranged to give the current values indicated when the associated binary halves are in the conducting state (referred to as 'binary on'). Pulse feedback paths are arranged to give the sequences shown in Table 1.

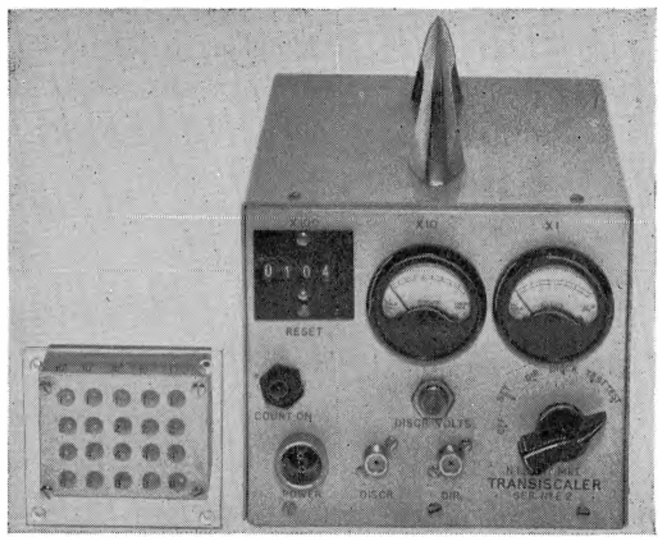

Fig. 2. Five-decade neon display panel compared with typical meter read-out

Display systems have been constructed utilizing 1·5in diameter 250μA meter movements appropriately calibrated, individual preset voltage returns and meter shunts are essential, and long term stability is dependent upon these values and the stability of the supply rail. The arrangement for a portable 10kc/s counting unit is illustrated in Fig. 2.

TABLE 1

INPUT PULSE NO.	BINARY 1	BINARY 2	BINARY 3	BINARY 4	METER
0	Off	Off	Off	Off	0
1	on	off	off	off	$1i$
2	off	on	off	off	$2i$
3	on	on	off	off	$3i$
4	off	off	on	off	$4i$
5	on	off	on	off	$5i$
6	off	on	on	off	$6i$
7	on	on	on	off	$7i$
8	off	on	on	on	$8i$
9	on	on	on	on	$9i$
10	off	off	off	off	0

* *Atomic Weapons Research Establishment*

Methods 2 and 3

These methods utilize an alternative pulse feedback system illustrated in Fig. 3, and indicators are arranged to be illuminated when the appropriate binary half is conducting.

The sequence obtained is shown in Table 2.

A survey of available low voltage filament lamps indicates that minimum current consumption is fulfilled by B.S.S.1050 a P.O. type, 6V 41mA indicator.

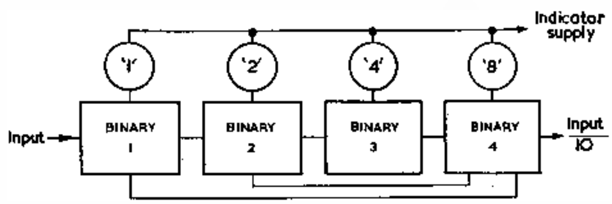

Fig. 3. Arrangement for decade unit with lamp read-out

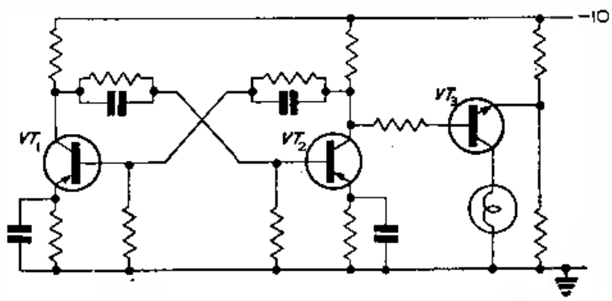

Fig. 4. Simplified binary with filament lamp indication

A simplified circuit in Fig. 4 illustrates a method of indicating the binary state in a pnp scale of two using such a lamp.

Transistor VT_3 has its emitter returned to a voltage positive to V_c for VT_2 when VT_2 is cut-off.

With VT_2 conducting, VT_3 base becomes positive and VT_3 conducts.

A high value of forward current transfer ratio for VT_3

TABLE 2

INPUT PULSE NO.	BINARY 1	BINARY 2	BINARY 3	BINARY 4	ILLUMINATED INDICATORS
0	off	off	off	off	None
1	on	off	off	off	'1'
2	off	on	off	off	'2'
3	on	on	off	off	'1'+'2'
4	off	off	on	off	'4'
5	on	off	on	off	'1'+'4'
6	off	on	on	off	'2'+'4'
7	on	on	on	off	'1'+'2'+'4'
8	off	off	off	on	'8'
9	on	off	off	on	'1'+'8'
10	off	off	off	off	None

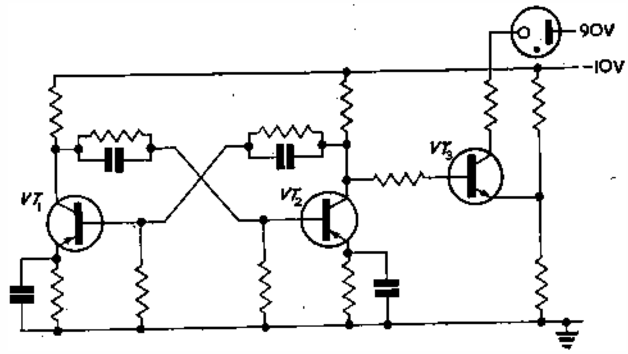

Fig. 5. Simplified binary with silicon-switched neon read-out

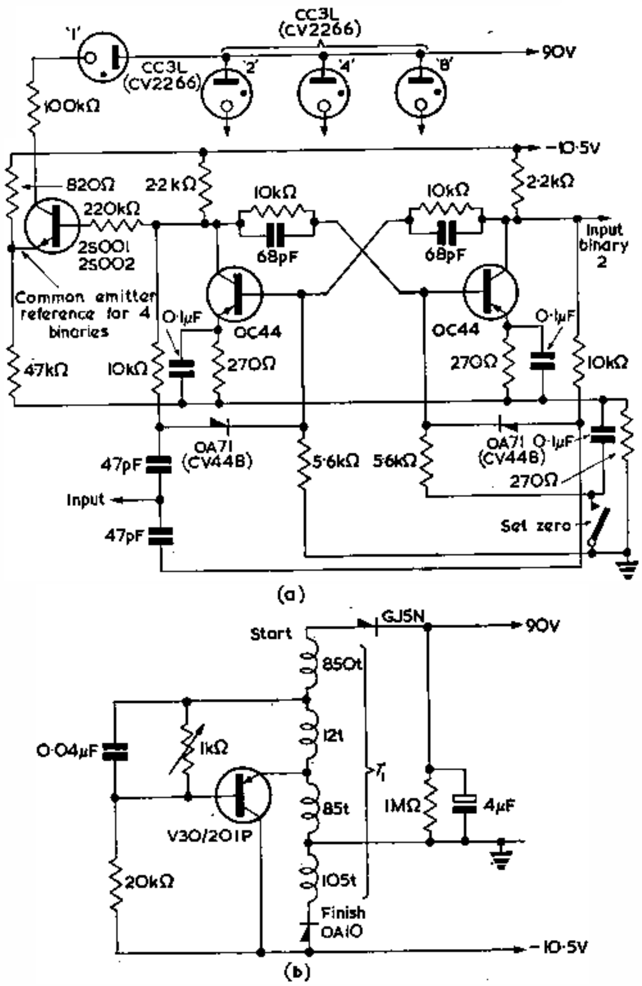

Fig. 6. (a) Complete binary section for 1Mc/s scaler
(b) H.T. supply unit for five-decade display panel

is essential and thermally conductive mounting preferred.

Suitable types of transistor for VT_3 are selected ($\beta > 60$); type 2N388 germanium, or 2S019 silicon.

The indicator used for method 3 is the CV2266 subminiature gas-filled stabilizer for which a burning current of 0·2mA has been found to give adequate end-view illumination in high levels of ambient lighting. An npn transistor is again used as a current switch, only small current transfer ratio is required, but very small values of I_{co}' are required. The Texas 2S001 silicon transistor fulfils these requirements and has been switched continuously for over 10^7 operations over a 20°C to 75°C temperature cycle. The switch is shown in Fig. 5 with its associated binary.

The two conditions for the switching transistor are:

(a) Off $V_c = 0$ Reverse $V_{be} = 0{\cdot}75V$

(b) On $V_c = 20V$.

The transient value for V_c at initiation of ionization of the indicator appears to be within safe limits.

The decade units are used in a five decade scaler arrangement, the 90V indicator supply being obtained from a transistor ringing choke convertor the primary of which is supplied from the decade units 10·5V rail.

The maximum display requirement for such a five decade system is for a count of 77777, the total demand from the 90V rail being 3 × 5 × 0·2mA, requiring a 40mA convertor primary supply.

The final arrangement of one bistable element is shown in Fig. 6 with an indicator supply for a five-decade scaler system and the mechanical arrangement of a five-channel miniature display panel is illustrated in Fig. 2.

Conclusion

Table 3 offers a comparison for the three indication methods based upon a five decade read-out.

TABLE 3

METHOD	POWER CONSUMPTION (W)	DISPLAY AREA (cm)	COST (£)
1	0·25	72·5	27
2	3·6	35	25
3	0·4	27	60

Method 3 although more expensive, offers a very large reduction in display area and being a switched system, can tolerate rail voltage changes and removes the need for preset potentiometers used in the meter 'read-out' described as Method 1.

Acknowledgment

The Author is indebted to the Director, Atomic Weapons Research Establishment, for his permission to publish this article and to Mr. N. T. Clarke for his initiation of the work.

A Colloquium on Electrostatics

An International Colloquium, held under the auspices of the Centre National de la Recherche Scientifique, took place at Grenoble from 24th September to 1st October 1960. The subjects discussed covered the generation of electrical power by electrostatic means and the applications of these machines.

After a description of the early days of electrostatic machines in Grenoble, given by Professor Neel, the lectures were inaugurated by a talk by Professor Felici on the types of electrostatic generator and his hopes for the next generation of electrostatic machines. This, in conjunction with a talk by Professor Trump of Massachusetts Institute of Technology, indicated in broad outline the scope of present possibilities and the problems of the future. There are two types of electrostatic generator in current use: first the Van de Graaff belt type machine and secondly the Felici insulating transporter cylindrical machine. Both have their advantages and disadvantages. Briefly, for high voltages and very low currents the Van de Graaff is better and for low voltages (below 1MV) and higher currents (up to 50mA) the Felici machines are better. For long term continuous running, the cylinder machine is undoubtedly more reliable but in its present state of development it cannot provide the very high voltages or current that may be required.

In Professor Trump's talk he discussed a further type of electrostatic generator, the disk machine, and it seems to be generally agreed that this type of design has the greatest development possibilities, particularly for space travel, where the problem of insulation is much reduced.

Several papers were presented which discussed the application of this type of electrostatic generator for ion propulsion. Considerable research is being carried out both in France and the U.S.A. on electrostatic machines for this purpose. The design of a generator delivering 1 250kW at 200kV is being studied at H.V.E.C. in Massachusetts. Parallel studies are proceeding in France.

The future development of the cylinder machine is being studied to increase the currents available and other dielectrics, including various liquids, are being studied.

Engineers who have been involved in the practical problems of designing the Felici generators and producing a standard range of models for industry, gave an insight into the complexities of electrostatics as opposed to the comparative simplicity of electromagnetic machines and an impressive array of standard machines was described.

The remainder of the lectures dealt with the applications of electrostatic machines. Dr. Allen, of U.K.A.E.A. Harwell, and Mr. Julian, of U.K.A.E.A. Aldermaston, described the achievements of the staff of the U.K.A.E.A. in constructing two 12MeV tandem accelerators which have now been in operation for the last year.

In the more commercial field of precipitation and mineral separation, the use of electrostatic generators has, as yet, had little application apart from the deposition of paint. For other heavier precipitation processes, the electrostatic machine, so far, does not yet deliver sufficient current. Considerable research is going on in the U.S.A. in mineral separation, and in Europe on insecticidal spraying in agriculture.

Future applications in the nuclear field would appear to lie with neutron sources of higher fluxes than at present available. If fluxes of the order of 10^{12} to 10^{14} neutrons per second could be produced economically, there would be a demand from those at present forced to use reactors for activation experiments.

Tinplate Mill Control

A system of automatic gauge and tension control which means the production of a more consistent tinplate product and a reduction in off-gauge material has been devised by the Electrical Engineering Department at the Ebbw Vale Works of Richard Thomas and Baldwins Limited. It consists essentially of a gauge sampling system initiating correction by means of pulses.

The control covers a total range of ±10 per cent of the present gauge, and of this the inner dead band covers an adjustable area from 1 to 2 per cent; this is the area within which no control is needed. The control is then applied to correct errors in gauge up to the limit of ±10 per cent. Beyond this range it is considered that the mill set-up is likely to be faulty, and the equipment then cuts out automatically and an alarm is given so that the set-up can be brought within range by manual means.

The circuits are so arranged that the length of each individual correcting pulse is a function of the error signal, in that the larger the error the longer the correcting pulse, while the overall pulse time can be preset to the desired value which will give the maximum correction without instability. The adjustment of the space time between pulses is also possible and can be preset to allow the correct sampling time.

It should be noted that there is no automatic change of the sampling time in line with the speed of the mill, because it has been found that the advantages to be gained from this complicated piece of equipment are relatively small, and, in fact, the whole system is based on a policy of doing automatically what the operator would normally do without such equipment.

In addition, a series of protective arrangements to ensure the equipment will automatically fail to safety in the event of faulty operation is included, and this leaves the mill control in such a condition that the operator who receives a warning of such an occurrence can take over and carry on with normal manual operation which can over-ride the automatic system at all times.

A DIGITAL MILLIVOLT RECORDER

By G. P. Tonkin*, B.Sc.

The measurement of millivolt signals at rates up to six channels per second with a 0·1 per cent resolution is catered for by the instrument described. Low level relay digitizing in decimal-binary code is employed with output on typewriter and punched-paper-tape.

(Voir page 797 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 802)

As part of an effort both to save testing time and assist data handling, the multi-channel digital millivolt recorder Mk. III has been produced at Bristol Aircraft Limited. Previous test work involving hundreds of channels of strain gauges or temperature measurement had required the use either of manually balanced and switched bridges or chart recorders, and while the latter at least are accurate instruments, it has not been possible to achieve speeds of better than 1 channel every 2sec in practice, and this with the inconvenience of manual transcription of trace reading.

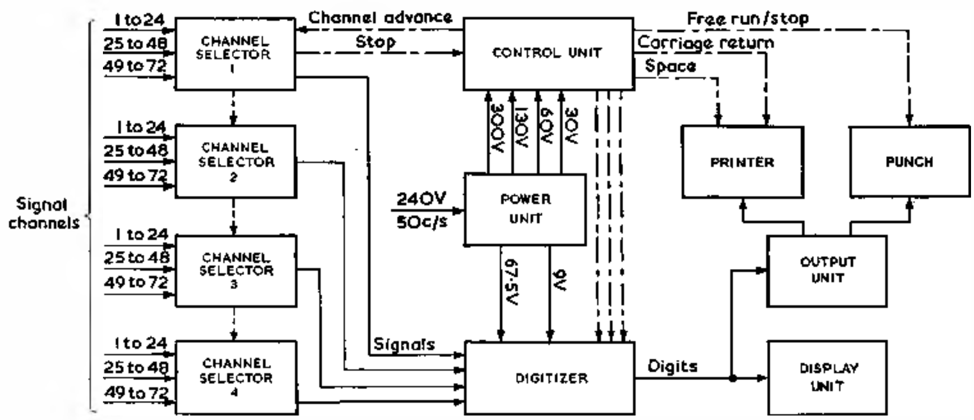

Fig. 1. The multi-channel digital recorder Mk. III

The present instrument is the engineered successor to the previous Mk. I and Mk. II, and is rather more compact than either. Its specification is given in Table 1, and it is intended primarily for testing in its present form, though it will have applications to process monitoring.

It will be seen that a high degree of resolution has been achieved, and this brings with it problems of stability at several points. The philosophy has been to accept these, providing the operator with some simple adjustments prior to a reading sequence.

A step-by-step potentiometer principle, controlled in concert with channel selection and recording, is shown by the block diagram, Fig. 1, and abbreviated measuring circuit, Fig. 2.

To achieve the desired speed, channels are switched by uniselectors in threes to a trio of digital convertors working at millivolt level. The coded output of these is stored, and serially read out during the next digitizing cycle, decoded into decimal form. The output devices are typewriter and/or tape punch with any desired five-unit code for the latter.

The digital conversion is based upon three decimal character relay sub-units and a detector amplifier sub-unit. The simplified circuit shows the potentiometer action, with the conditions at balance: the digitizer resistors are weighted in fours on the basis of a 5-2-1-1 arithmetic code. (This permits the use of preferred resistance values while not having an arithmetic sum exceeding nine.)

Special attention has been given to a variety of operation modes to suit the exigencies of tests. Besides the full cycle of 288 possible channels, any channel may be called alone

TABLE 1

Number of Channels:	288 max. in units of 72
Signal Input:	Thermocouple operation. 15mV to 50mV full scale. Strain gauge operation 2% dR/R or 5% dR/R full scale.
Signal Source Impedance:	200Ω max. (120Ω strain gauges recommended).
Strain Gauge Energizing D.C. Voltage:	External
Number of Decades:	3
Accuracy:	1 part in 999 of maximum signal level.
Channel Selection:	Automatic or Manual.
Read-out Systems:	(1) Paper Tape Punch. (Code as per customer's requirements). (2) Electric Typewriter. (3) Tape Punch and Typewriter. (4) Visual Numeral Display. (5) Systems 1, 2 and 3 may be operated direct from keyboard.
Read-out Speed:	Typewriter: 120 channels/min. Tape Punch: 300 channels/min.

* *Bristol Aircraft Limited.*

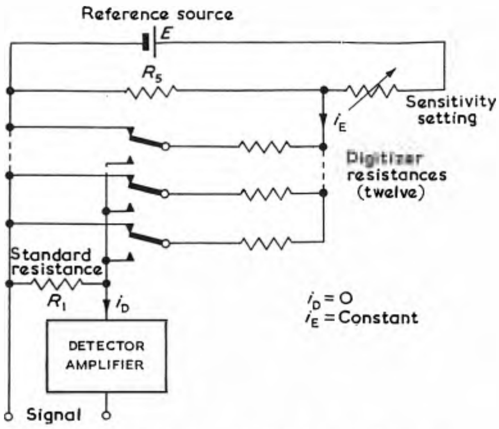

Fig. 2. Action of digital potentiometer

at will, or may be the beginning of the cycle. For single readings a visual character indicator is provided: this is invaluable in a setting up period for an instrumentation system.

The presence of three separate digitizers with their own zero and sensitivity preset controls gives an added flexibility when several different types of measurement are being made in the same sequence. Provision is also made for manual or other digital data interposition to permit recording of 'fixed' information.

The modular principle of construction has been used wherever possible, and the selector units are arranged in banks of 72 channels.

The instrument must be regarded as near the limit to which relay circuits can be taken safely, but gives a medium speed of reading with comparative simplicity. Work on successors to it is progressing in two directions: higher speed on the one hand, and lower speed with further simplification on the other. The former requires expensive transistor circuits and has difficulties at the millivolt levels, but it is felt that the latter has a definite application so long as the speed does not drop below 2 channels per second.

Acknowledgments

A full account[1] of the recorder appears in the Journal of the British Institution of Radio Engineers, to whom the author is indebted together with Bristol Aircraft Limited for permission to publish this note. Acknowledgments are due to Messrs. Hathway and Yard of this Company, and to Messrs. Southern Instruments Ltd who have been associated.

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Rapid Beam Switching in Waveguide Antennae*

RAPID beam switching in waveguide antennae is achieved by using ferrite attenuators as the switching elements. To take advantage of the high speed operation of which ferrite switches are capable, it is necessary to produce rapid changes of current in the control windings of the switches, and a suitable circuit for producing these current changes is shown and described.

In direction-finding radar, the direction of a reflecting object relative to a radar transmitter can be determined by receiving echoes reflected from the object on a number of aerials suitably positioned, in azimuth and elevation, and comparing the echoes. Normally, four such aerials are used, one pair spaced apart vertically and the other pair spaced horizontally, so that the four aerials, referred to as the Up, Down, Right and Left aerials, form the corners of a square. Echoes are received from each of the four aerials sequentially, and when waveguide aerials are used, mechanical switching is used to render three of the aerials non-receptive while an echo is being received on the fourth. Mechanical switching has, however, severe limitations as regards choice of switching sequence, and, what is more important, speed of operation. An electrically controlled switch would appear to have greater possibilities for high speed operation, and the advent of ferrite attenuators has provided a convenient switch element.

* *Communication from E.M.I. Ltd.*

A suitable ferrite switch is shown in Fig. 1. Briefly, it consists of a ferrite rod (17) imbedded in a plug (16) of p.t.f.e. enclosed in a length of circular waveguide (15). The switch, which is controlled by a coil (18) wound round the centre section of the circular waveguide is coupled to the waveguides in the system by means of flanges (19) and

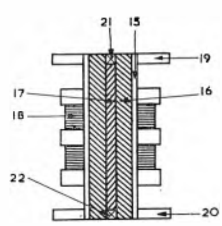

Fig. 1. The ferrite switch

(20) at either end. In operation, the switch allows incident waves to pass unattenuated when its control coil is de-energized. When the coil is energized, however, a plane wave has its polarization rotated, and by choice of control current, a rotation of 90° can be produced. If the input and output waveguides, between which the switch is located, have the same orientation, the output guide will be unable to propagate the rotated wave and a short-circuit will be produced.

The application of this type of switch to a direction-finding aerial system is shown in Fig. 2. Signals from a radar transmitter pass via the main feeder (7), twin feeders (8) and ferrite switches (11), (12), (13) and (14) to the transmit-receive waveguide feeders (1), (2), (3) and (4). Echoes from the reflecting object are received on the same four aerials and pass by the same route to the receiver. In practice, however, only one switch would be in the open or de-energized condition, and only the signal picked up by that aerial is passed to the receiver. A typical switching sequence would be (a) all switches open to transmit, (b) (3) open to receive, switches (2), (3), (4) closed, (c) all open to transmit, (d) (3) open to receive; (1), (2) and (4) closed; (e) as (a), (f) (2) open; (1), (3) and (4) closed; (g) as (a), (h) (4) open; (1), (2) and (3) closed.

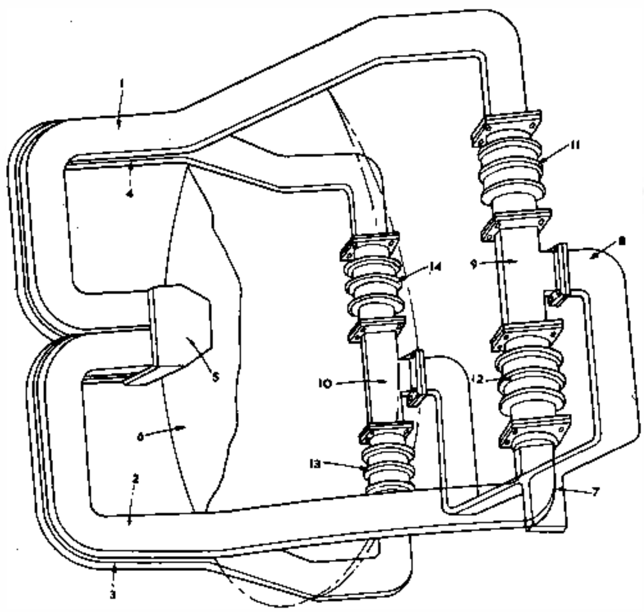

Fig. 2. Application to d.f. system

Thus echoes from the object are received from each of the four aerials in turn, and can then be processed to derive the direction of the object or to adjust the orientation of the aerial system.

To take full advantage of the high speed of operation of which ferrite switches are capable, it is necessary to produce rapid changes of current in the control windings of the switches. With, for example, an object situated about 1 000ft from the aerial, the beginning of the received echo occurs about 1μsec after the end of the transmitted pulse, and the current to operate the waveguide switches must therefore be established within 1μsec. The operating current for a ferrite switch may, moreover, be required to be of the order of several amperes. Conventional switching circuits are therefore inadequate, and to meet the requirements the circuit shown in Fig. 3 has been devised.

In Fig. 3, pentode V_2 is connected as a blocking oscillator and functions as a gate. Positive trigger pulses, one of which occurs each time an echo from an object at a selected range should be present, are derived from a range unit. These are applied via C_5 to V_2 anode, which is connected by the transformer winding T_1 and resistor R_4 to a source of positive potential. Negative control signals, from a unit which controls the switching sequence, are applied to input point A and via d.c. restoring diode V_1 and parallel leak resistor R_5 to the suppressor grid of V_2. The function of these negative control signals is to inhibit operation of V_2 when such a pulse is present. In the absence of a negative control signal a positive range trigger pulse applied to V_2 anode initiates oscillation, but due to the tight coupling between T_1 and T_2 and the feedback connexion to the control grid, the valve is immediately shut off by the large negative potential set up across C_1. A single pulse is therefore produced and applied to the control grid of thyratron V_3 via transformer winding T_3, R_6 and C_6 in parallel, and

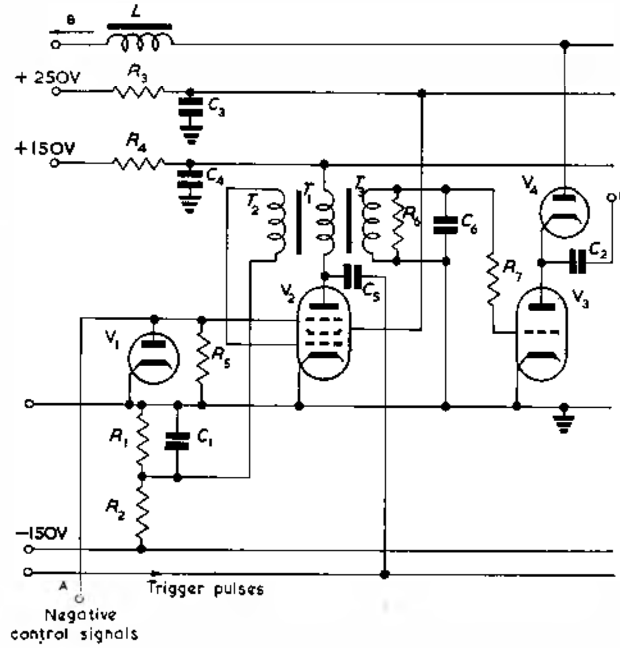

Fig. 3. A suitable switching circuit

resistor R_7. V_3 acts as a switch, and on the application of this positive pulse to its control grid immediately conducts to discharge capacitor C_2, through the control winding (18) of the ferrite switch shown in Fig. 1. Capacitor C_2 is charged from the source B via choke L and diode V_4. It will be understood that one such switching circuit is necessary for each ferrite switch, and as the charging source B and choke L are common to all four circuits, the diode V_4 is necessary to isolate the circuit from the other three, and to prevent C_2 from discharging through the other circuits. Choke L and capacitor C_2 form a resonant charging circuit, and assuming the switching sequence described above, in which three of the circuits fire simultaneously in alternate periods, C_3 and L (whose C is the value of C_2) are chosen to resonate at a frequency equal to half the pulse repetition frequency (as for normal d.c. resonant choke charging circuits). However, as the pulse forming circuits are underdamped the capacitor C_2 charges to a value higher than twice the applied voltage, enabling a larger current pulse to be produced from a relatively low voltage supply.

It is also possible to eliminate the normal pulse shaping network in the discharge path. The discharge current pulse is determined by the value of C_2 and the inductance of the ferrite switch, and is approximately a half sine wave. The amplitude or duration of the current pulse may thus be varied by varying the inductance of the ferrite switch control winding relative to the value of C_2.

LETTERS TO THE EDITOR

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

Introduction to the Ternary Code Number System

DEAR SIR,—Arithmetic to the base of 3 has exactly the same fundamental laws as to the base 10, so to a non-specialist like myself, not immediately anxious to change my tables, the key part of the article by Mr. Morris and Dr. Alexander (September, 1960) is their assertion that 3 is the integer requiring least equipment. This assertion, if true, is certainly of general interest.

The authors write two 'equations', $N = R^n$ and $E = nR$ for the information and the corresponding amount of equipment. By differentiating, they find that minimum equipment occurs for the base 2·718, or 3 to the nearest whole number. These equations are stated quite without justification, and I fancy their foundations are slightly shaky. One cannot help wondering how, in a discussion of arithmetic, two integers suddenly assume the dimensions of information, and also of 'amount of equipment'.

One could proceed more safely by enquiring which base will allow one to name a given natural number with the fewest symbols. For example, to count up to 100 with 10 as base, we need 0, nine digit symbols, and symbols for 10 and 100, total 12. The most economical are 3, 4, and 5, all of which need only 7 symbols (or number-words). For numbers up to a million, 4, 5, and 6, are the best bases needing 13 symbols each, against 15 for either 3 or 10. For numbers up to 10^{10}, base 3 needs 23 symbols, base 2 needs 35, base 10 needs 20, and 6 and 7 only require 18.

One might leap from these true statements about arithmetic, to a hazardous guess about engineering design, and see if the amount of equipment followed a similar law, being determined by $n + R$ rather than by nR. For example, consider a counter with number wheels, to read up to 10^{10}. Base 3 requires 20 wheels each with 3 facets, while base 7 requires 11 wheels each of 7 facets. I have little doubt that I could manufacture the latter more cheaply, having fewer parts, and the cost of a 7 facet wheel would be substantially the same as a 3 facet wheel. I suspect the same applies in an electrical device, or might; but my guess will be no better for writing it as an equation and differentiating!

That the ternary system is in some ways better than the binary is plain enough, but its real merits will require a very different sort of 'proof' from this.

Yours faithfully,

R. STEEL
Servomex Controls Ltd,
Sussex.

The Authors' Reply:

DEAR SIR,—Referring first to the third paragraph of Mr. Steel's letter which relates to the use of the smallest number of symbols and choosing the number 100 in radix 10. Writing this down completely instead of the shorthand form given, i.e., 100, we have $(1) \times 10^2 + (0) \times 10^1 + (0) \times 10^0$.

Therefore, to count up to a hundred, the device used must accommodate any number from zero to a hundred, which implies 10 symbols associated with 10^0, plus the same 10 symbols but this time associated with 10^1, plus the one symbol associated with 10^2, although this column could also accommodate the same 10 symbols as used with the lower powers of 10. This involves, in a normal counting system or device, 10 counting elements for each power of 10. Any number between 0 and 99 is accommodated by 20 such elements.

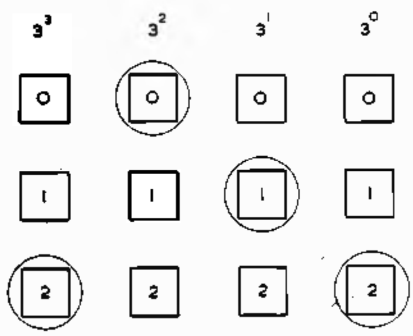

Fig. 1. Utilization of equipment

By the statement 'amount of equipment' the authors imply 'the number of major components (for example, valves or transistors) required to store a fixed number N in any code system'. The example shown in Fig. 1 demonstrates this point, each square indicating a valve or a transistor.

In the ternary system, each power of three will require three valves. Thus the total number of valves to store a number up to 3^4 will be 12 ($= E = n \, . \, R = 4 \times 3$) illustrated by the above squares. To store the decimal number 59, which in ternary will be 2012, in the above pattern, will require the operation of all the valves which have a circle round them.

This equation $E = n \, . \, R$ will apply to any code system including, of course, the decimal codes. A number up to a 100 in the decimal system will require 20 valves, 10 valves for 0 to 9 and 10 other valves for 10 to 90.

If, however, there exists a component which has the number of states equal to the radix, then the amount of equipment will be $E = n$. For example, a Dekatron tube for the decimal code, a core (or an ordinary light switch) for binary or a three facet wheel for ternary. It is also possible to build up a circuit for a higher radix by the combination of smaller radixes, e.g., the storage of decimal code can be accommodated by four independent circuits of two stable states.

In practice the two main considerations are that of switching speed and cost of the components. To reduce cost the number of components must be kept to a minimum. This article dealt with the problem only from a theoretical point of view without any specific components in mind. The article, from this point, proves that the ternary system is the most economical one.

Finally, returning to the method described by Mr. Steel, the only system the authors can visualize is one which could take the form of a modified typewriter where the number of keys would be equal to $n + R$. For example, to write a number up to 100 with 10 as base, 10 keys are required from 0 to 9, one key for 10 and one key for 100, total 12 keys. To write 77, key 7 will have to be operated twice. This method, however, seems almost impossible to apply in practical switching techniques.

Yours faithfully,

D. J. MORRIS, W. ALEXANDER,
University of Nottingham.

The D.C. Stabilization of Transistor Circuits

DEAR SIR,—In the article by Messrs. Mehrtens and Zakrzewski (October) the d.c. stabilization of transistors by silicon resistors having temperature coefficients of the order of 0·7 per cent/°C is described and it is pointed out that difficulty may be experienced since the resistance-temperature law for these resistors is exponential rather than linear. However, resistors having a positive linear temperature coefficient of 0·4 per cent/°C or 0·6 per cent/°C may be obtained by winding resistors with copper or nickel respectively, and these resistors should be relatively cheap, stable and obtainable in a wide range of resistance values.

Is the extra 0·1 per cent/°C essential or are the resistor manufacturers so preoccupied in producing zero temperature coefficient resistors that they have overlooked the need for resistors with a temperature coefficient?

Yours faithfully,

D. SHAW,
The United Steel Companies Ltd,
Rotherham.

The Authors' Reply:

DEAR SIR,—We were interested in Mr. Shaw's suggestions, but during the period when the work reported was carried out, we had no knowledge of the availablity of the special resistors which Mr. Shaw mentions. Furthermore, enquiries which we have just made reveal that these resistors are not available from any normal source at present.

Such resistors could certainly be used where a linear law is desired, but in many cases this is not so. For example, with germanium transistors, where I_{co} is important, an exponential law is required for the stabilizing device, as illustrated in Fig. 8 of the article.

In further instances a law deviating to an even greater extent from the linear than that of the present silicon resistors would be desirable.

Curve 1 of Fig. 15 illustrates this point, showing as it does, the characteristic required for a power transistor.

It is hardly necessary to point out that the self-inductance and capacitance of wirewound components may be embarrassing at high frequencies.

Yours faithfully,

D. H. MEHRTENS and J. T. ZAKRZEWSKI,
E.M.I. Electronics Ltd.,
Middlesex.

The Tunnel Diode

DEAR SIR,—There is now considerable interest in the Esaki or tunnel diode which exhibits a negative resistance characteristic as shown in Fig. 1. With suitable series resistance R_s there is bistable

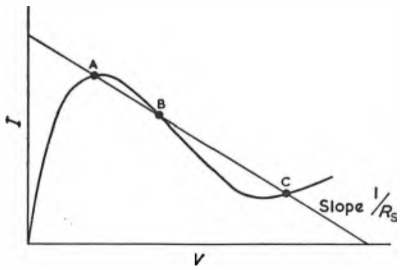

Fig. 1. The tunnel diode characteristics

operation with a very fast switching action from A to C or vice versa, the point B being unstable.

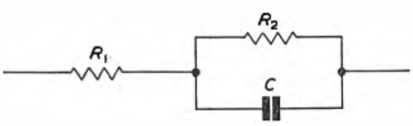

Fig. 2. Equivalent circuit of germanium rectifier

Reverse bias germanium point contact rectifiers also have this form of characteristic—voltage operated as in the tunnel diode—and a similar but current operated negative resistance range appears in the thermistor which may be utilized at very low frequencies. The physical mechanism involved is different in the three cases, although the practical application of the effect is based on the same principle.

It has been pointed out by Burgess[1,2,3] that thermistors and germanium rectifiers biased beyond turnover and operated under small signal conditions, i.e. in the quasi-linear mode, show a semicircular impedance locus differing only in the frequency range involved.

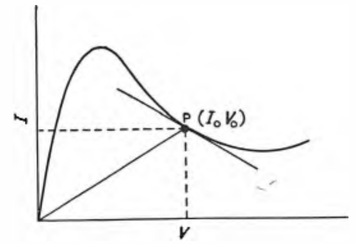

Fig. 3. The low frequency resistance

An equivalent circuit of the thermistor has been derived by Ekelof[4] and of the thermistor and germanium rectifier by Burgess (Fig. 2.) Burgess and Ekelof use different terminologies, that of Ekelof being simpler.

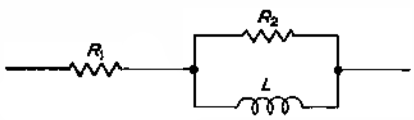

Fig. 4. Equivalent circuit of tunnel diode

In Fig. 3, the low frequency resistance is defined as the differential resistance at an operating point $(I_0 V_0)$:

$$r = (dV/dI)$$

The high frequency resistance is:

$$R = (V_0/I_0)$$

Defining $F = \dfrac{R - r}{R + r}$, the component values of the equivalent circuit of Fig. 2 are:

$$R_1 = r;\ R_2 = R - r;\ L = RT\frac{2F}{(1 + F)^2}$$

T being the thermal time-constant of the thermistor.

The operational impedance at the operating point P (Fig. 3) then reduces to:

$$Z_p = R\left(\frac{1 - F + pT}{1 + F + pT}\right)$$

a very concise form.

Burgess gives the equivalent circuit of a germanium rectifier as capacitive for reasons stated in his papers. The equivalent circuit of the tunnel diode is given as Fig. 4. The tunnel diode has recently been used as a low noise amplifier[5] and as a v.h.f. oscillator. It might be of interest to examine the possibility of its use as a v.h.f. frequency modulator, since the effective reactance is a function of the applied voltage.

A study of thermistors as components of v.l.f. filters was made in this laboratory in 1957 and the results obtained (so far unpublished) seem to indicate that tunnel diodes might find an application in v.h.f. filters.

Large signal theory appears even more promising as pointed out by Chang[6].

It would be useful to have a negative resistance element exhibiting appreciable reactance in the low frequency range above that possible with thermistors as now manufactured. Recent inquiries have elicited the statement that the manufacture of thermistors having a considerably lower time-constant than the lowest now available is not contemplated.

Yours faithfully,

P. M. WILL and A. M. HARDIE,
Robert Gordon's Technical College,
Aberdeen.

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Measurement of Energy Content

DEAR SIR,—It is sometimes desired to measure the energy content of signals of unpredictable amplitude and occurrence.

If a direct measurement is attempted, trouble will be experienced from the level of background noise, which, after integration over a long time, will become excessive; and from the small dynamic range (typically 12dB) of conventional energy detectors.

Both these difficulties may be overcome by recording the signals on magnetic tape (dynamic range about 50dB) and then replaying only the portion containing the signal of interest into the energy measuring equipment. Several attempts may be made with a known degree of attenuation between the replay amplifier and the energy measuring equipment to load the latter to its optimum level.

This process can be made automatic.

Yours faithfully,

W. D. GILMOUR,
E.M.I. Electronics Ltd.
Wells.

Correction

In the letter by Mr. R. R. Vierhout in the October 1960 issue, page 645, the words 'time wave' appeared, this should have read 'sine wave'.

BOOK REVIEWS

Electronic Circuits, Signals and Systems

By S. J. Mason and H. J. Zimmermann. 616 pp. 463 Figs. Medium 8vo. John Wiley and Sons Inc., New York: Chapman and Hall Ltd, London. 1960. Price 100s.

THIS is the second contribution from Professors Mason and Zimmermann, of the Massachusetts Institute of Technology, to the collection of volumes on basic electrical engineering science which has become known as the M.I.T. 'Core Curriculum'. In their first volume, *Electronic Circuit Theory, Devices, Models, and Circuits,* the subject is developed to a level suitable for the study of simple networks and analytically simple waveforms. In this new volume the subject is extended to the study of more general networks and more general waveforms. The treatment leads to a change of viewpoint from that of network theory to that of system theory.

The system concept is introduced in the opening chapter. It is explained that whereas network theory is based on ideal elements abstracted from physical elements, system theory is based on ideal elements representing desired system functions without reference to how the elements are realized physically. The second chapter deals with the nodal matrix analysis of networks. Among the topics discussed are Shekel's floating admittance matrix, Strecker and Feldtkeller's six two-port matrices, and the significance of Hermitian matrices in connexion with complex power. The third chapter is devoted to a development of Kirchhoff's 1847 rule for determining the response of a network according to the topology of its linear graph and the fourth and fifth chapters are concerned with signal-flow graph analysis. The method of signal-flow graphs was introduced by Professor Mason in 1953, since when this reviewer has tried unsuccessfully to convince himself of the superiority of the method over that of traditional network analysis. Despite the many examples given, he remains unconvinced.

Signal analysis and the transmission of signals through linear systems are the subjects of the following two chapters. The treatment of these topics is perhaps the most comprehensive to be found in the literature. It is based on the correlation function, the Fourier series, the Fourier integral, and the two-sided Laplace transform. Pulse, periodic, almost-periodic and random signals are discussed at length. In the eighth chapter, non-linear and time-varying linear systems are considered. The final chapter deals with the concept of negative feedback.

It can hardly be said that we are suffering from a dearth of texts on electronic engineering theory, but this book has something more to offer than most. It contains over three hundred problems to be worked by the reader, but answers are not provided. In view of the price it is doubtful if the book will find a place on many private bookshelves.

S. R. DEARDS

Introduction to Laplace Transforms for Radio and Electronic Engineers

By W. D. Day. 183 pp. 57 Figs. Demy 8vo. Iliffe & Sons Ltd. 1960. Price 32s. 6d.

IT is fair to say that to most of the older generation of engineers, Laplace transforms were little more than a name—something strictly for the higher mathematician and specialist. But in the past few years the position has entirely changed; Laplace transforms are included in the syllabus for the Higher National Certificate, and, what is at least as important, today, any radio or electronic engineer without a sound knowledge of their applications to electrical circuits finds himself seriously handicapped. This volume is written by a radio engineer for radio engineers and deals with electrical circuits from the very first paragraph, rapidly building up to the stage when the student is using transforms to investigate transient conditions. The first five chapters are designed for home study, and by the time he has mastered them the student should be able to write down the transform of a particular circuit at sight and then proceed rapidly to the final solution. The second half of the book is more condensed and is designed as an introduction to more advanced texts.

Nonlinear Electrical Networks

By W. L. Hughes. 296 pp. 123 Figs. Medium 8vo. The Ronald Press Co., New York. 1960. Price $10.00.

THIS book is intended as a text book for a graduate course in non-linear circuit analysis and as a reference book for research and development engineers and physicists. In consequence it attempts to cover the subject at all levels from undergraduate onwards. The experienced engineer may, therefore, find large parts of the initial chapters long winded and trite; the later chapters however become rather more involved and demand more concentrated reading.

Although the title implies the study of non-linear networks, the book is in fact almost entirely mathematical, and any circuits which appear in the book are included merely to illustrate mathematical methods.

Thus even in Chapter 1, "Characteristics of Non-linear Elements" little attempt is made to characterize well known non-linear circuit elements: four typical characteristic curves for silicon diodes, Thyrite resistors and thermistors, and expressions such as $L(i)=d\lambda(i)/dt$ (where λ is flux), are the main results. True, a vacuum diode is proved from physical principles to have the 3/2 law, but despite the fact that semiconductor diodes, for instance, have been used for several years as logarithmic elements (whose characteristics may be accurately predicted from the physics of the device) the reader is recommended to try the curve fitting process of Chapter 3 ("Some useful mathematical methods"), in order to obtain a mathematical statement of their law. Similarly non-linear resistances tend to remain as black boxes marked $v = Ki^2$ throughout the book.

The resulting mathematical analyses are carried out satisfactorily (albeit in a rather chatty transatlantic manner—not wholly a bad feature), but one wonders whether more could have been achieved by including as examples physical elements of known and calculable non-linearity. Certainly practising circuit engineers would welcome such a reference book.

In fairness it should be noted, however, that occasional examples do occur such as the biased diode function generator included in Chapter 2 ('non-linear circuits without energy storage') in the section on operational amplifiers, but this is a case where a non-linear V-I relationship is being built up and not an analysis of a circuit where a non-linearity happens to be present.

Chapters 3, 4, 5 and 6 are mainly concerned with the mathematical background of non-linear analysis. This section appears to be a comprehensive account of the main mathematical methods which are useful for non-linear analysis. Both steady state and transient methods are included with fairly extensive treatment of transform methods. The next two chapters are concerned with the stability of non-linear networks and the ninth chapter deals with non-linear oscillations. The tenth (and final) chapter is on the subject of sub-harmonics.

Throughout the second half of the book many alternative methods of analysis are included where possible. The point might be made that the engineer is given no indication as to which approach is liable to be most successful in a given case, but as the text-book aspect of the book seems to be predominant, this is not entirely a valid criticism.

To sum up, therefore, the reader who expects to find a quick solution to his non-linear problem is likely to be disappointed in this book, but anyone who wishes to study non-linear analysis would get a great deal from a serious study of this work, especially the later chapters. He would still have to formulate his own problems and select his own methods of attack, but the fact that the book is slanted towards electrical networks makes it particularly suited for circuit engineers. One or two errors and misprints were noted, but they are unimportant and are easily recognized without confusion.

M. R. GAVIN

Direct Conversion of Heat to Electricity

Edited by J. Kaye & J. A. Welsh. 353 pp. 153 Figs. Medium 8vo. John Wiley & Sons Inc, New York: Chapman & Hall Ltd, London. 1960. Price 70s.

THIS book is an edited collection of papers which have been prepared by principal persons in the new technology of direct conversion. It includes fundamental discussions in thermoelectric energy conversion (the thermocouple), thermionic energy conversion (the vacuum tube and the gaseous tube), magneto hydrodynamic conversion (separating the positive and negative charges in a gas), and fuel cells (the separation of positive and negative charges during a chemical reaction). The contributors offer considerations of the practical applications and problems associated with each type of conversion scheme.

The Dynamic Behavior of Thermoelectric Devices

By Paul E. Gray. 133 pp. 47 figs. Medium 8vo. John Wiley & Sons Inc., New York. Chapman & Hall Ltd, London. 1960. Price 28s.

THE great improvement in materials over the past few years has made practicable a number of thermoelectric applications, particularly those relating to heat-pumping. For a number of these applications, a knowledge of how the thermojunctions will behave under static conditions is inadequate; something must also be known about their dynamic behaviour. The problem of calculating the dynamic performance of a thermojunction is indeed formidable. The author has simplified this problem by confining his attention to the small-signal response. His solutions are realistic in that they are relevant to the task of controlling thermoelectric devices. The validity of the theoretical study has been confirmed by experimental measurements on a thermoelectric heat pump.

This book contains a clear and well-presented account of the author's work. It is, of course, much too specialized to be of great interest to the general reader. However, it can be recommended to the engineer who is responsible for the development of thermoelectric devices and for whom the prediction of their static behaviour is insufficient.

H. J. GOLDSMID

Polythene. The Technology and Uses of Ethylene Polymers

Edited by A. Renfrew & P. Morgan. 874 pp. 242 Figs. Medium 8vo. Iliffe & Sons Ltd. 1960. 2nd Edition. Price 165s.

THE basic facts of all aspects of polythene production, properties, handling techniques and major uses are set out in this book in an authoritative appraisal which should be helpful to all technologists in the plastics industry and in many industries where polythene is assuming an important role.

This second edition contains approximately 300 more pages than the previous one; chapters have been so revised that the original text has been largely re-written in order to bring the book in line with the rapid developments, particularly in relation to high density materials, which have occurred since the first edition was published in 1957.

Microminiaturization of Electronic Assemblies

By Eleanor F. Horsey. 265 pp. 100 Figs. Medium 8vo. Reinhold Publishing Corp. Chapman & Hall, London. 1958. Price 88s.

ON 30 September and 1 October 1958, a Symposium was held in the U.S.A. on "Microminiaturization of Electronic Assemblies", organized by the Diamond Ordnance Fuze Laboratories in Washington, at which some 21 papers were presented on the state of the art of microminiaturization as it was in 1958. These papers have now been published in book form, and provide a useful review of work on "flat plate" or two-dimensional microminiaturization techniques. No paper, of course, covers solid circuit or molecular electronic techniques, as it is mainly in the past year or so that work in this field has been published, although a chapter at the end deals briefly with recent developments.

The papers are grouped into six sections:

(1) Techniques
(2) Semiconductors
(3) Components
(4) Circuits
(5) Missile Systems
(6) Micro-electronics in Industry.

Section 6 was added after the Symposium in order to cover additional and later work on solid circuits, etc.

Some of the papers such as those on "Fine-Line Etched Wiring" by Olsen, "Survey of Equipment Adaptable to Microminiature Circuit Technology" by Sensi, "Layerized High-Dielectric Constant Capacitors" by Maxwell, Freifelder and Franklin, and most of the circuit papers, are still valuable contributions today.

The papers on transistor packaging are mainly concerned with encapsulation techniques, which are now regarded as doubtful in their long term reliability. Most microminiature transistor packages now use metal or inorganic material sealing, but the papers in this field are useful as a record of progress.

While, as mentioned, a useful attempt is made at the end of the book to bring it up to date, the techniques are changing so rapidly that it is not possible to record the latest changes. However, there is no doubt that the book makes a useful introduction to the art of microminiaturization, and it is useful to see proceedings of a symposium published in book form.

One valuable feature covered in the papers is that the whole equipment miniaturization problem is dealt with, not just components and transistors, i.e., there are papers on aerial miniaturization, on miniature microwave magnetrons, and even a paper on miniature incandescent indicator lamps.

Naturally most of the papers are by Diamond Ordnance Fuze Laboratories staff, but to them goes the credit for considerable pioneering effort in this field.

G. W. A. DUMMER

Television Explained

By W. E. Miller. Revised by E. A. W. Spreadbury. 202 pp. 89 Figs. Demy 8vo. 7th Edition. Iliffe & Sons Ltd. 1960. Price 12s. 6d.

THIS book assumes a knowledge of the ordinary sound radio receiver, but no previous knowledge of television circuits. It is non-mathematical, written in simple language, and comprehensively illustrated by many diagrams and photographs. The main difference between this edition and the previous one is that a chapter has been included on combined television and f.m. receivers; though the opportunity has been taken to revise the rest of the book where necessary to keep pace with the constantly changing pattern of the services available to the television viewer.

An Introduction to Statistical Communication Theory

By D. Middleton. 1102 pp. 228 Figs. Medium 8vo. McGraw Hill Publishing Co. 1960. Price 194s.

CAN a book of over a thousand pages with hundreds of mathematical examples, both worked and unworked, legitimately be called 'an introduction'? This volume is probably the most extensive and comprehensive yet written on the subject; the author is well known for his mathematical papers in the field, especially for his studies of random processes.

The literature of Communication and Information Theory has grown to a vast scale during the past ten years and there have appeared some dozen books during that time concerned specifically with the statistical theory—perhaps too many. The bibliography in Middleton's volume contains 500 references, though the names of Barnard, Jack Good, Mackay and others make strange omission.

Broadly the scope of this book is entirely within mathematical statistics and probability theory; noise and other chance processes, application to telecommunication systems of many specific kinds, the theory of inferential detection (decision theory), filtering and prediction, etc. Although mathematical, the treatment is in familiar terms, with considerable discussion of concepts (for, in my view, the difficulties of the subject are largely conceptual, rather than mathematical). The worked and unworked examples included make a most valuable addition.

The opening chapters deal with the basic statistical theory; random processes, discrete and indiscrete, characteristic functions, etc., followed by linear and non-linear operations upon the statistical signal and noise ensembles, such as occur in typical telecommunication systems. The theory is then extended by introduction of correlation functions and energy spectra and of the Sampling Theorem, thereby clarifying the operations of modulation, detection, etc., and of estimating ultimate signal-to-noise ratios.

Chapter 6 starts Communication Theory proper; alphabets and signal ensembles, coding and decoding, noisy and noiseless channels, equivocation and the Capacity Theorem. This leads to a description of the optimal setting-up of a channel—coding statistics to minimize the 'cost' of reception (p. 327).

It is this which breaks away from the traditional view that the purpose of a communication channel is restricted to reproducing waveforms accurately (which still seems to be widely held among engineers—Fourier analysis and all that).

Parts II and III of the book greatly extend the theory of random sources and of various linear and non-linear operations; also of the theory of signals in noise—Gaussian and impulsive. Later the theory of prediction and filtering is presented.

In my view it is Part IV which gives this book its unique character; this deals with the statistical theory of reception, being an application of Communication Theory to give a general and unified approach to system performance.

In this approach reception is regarded as a problem in statistical Decision Theory. Possible sent signals are regarded as alternative hypotheses which are tested against the evidence provided by the noisy received signals. If our received signals are made uncertain by mixture with noise then . . . statistical inference is the only process we can use. According to what prior knowledge we have about the noise and the transmitted signals, and to what penalties we are prepared to pay for errors, so different inferential techniques apply.

Detection is a 'search for knowledge'; the communication engineer has now rediscovered the teachings of John Locke and Thomas Bayes in the eighteenth century, that '. . . inference is the only process by which new knowledge comes into the world'.

C. CHERRY

Thyratrons

By C. M. Sweene, 82 pp. 69 Figs. Foolscap 4to. Cleaver-Hume Press Ltd. 1960. Price 12s 6d.

THIS booklet is intended to be an introduction into a small, but significant field of industrial electronics: the application of thyratrons. It is specially addressed to the engineer, who is, on account of his profession, already familiar with electrical engineering, but who is more being confronted with electronics. It employs only the most elementary mathematical expressions and operations, and is intended for those who want to get a general impression of an important field of industrial electronics.

Photoconductivity of Solids

By R. H. Bube. 433 pp. 229 figs. Medium 8vo. John Wiley & Sons Inc., New York. Chapman & Hall Ltd. London. 1960. Price 118s.

IN the past decade rapid advances have been made in the knowledge of photoconductive processes, and this advance is being sustained at the present time. In this book by a prominent and very active worker in the field, the basic concepts governing photoconductivity are treated and a carefully selected presentation is given of the wealth of data on this subject published up to about 18 months ago. There must inevitably be many "loose ends", one important reason is the difficulty of preparing photoconductive materials under adequately controlled conditions, for as Dr. Bube remarks "attempts to improve the speed of response of photoconductors by reducing the density of trapping centres through chemical or physical treatment are still in an embryonic stage . . . some measure of success will undoubtedly come through control of crystal purity and perfection . . ."

In the opening chapters, the relations between crystal structure, the band scheme and the various carrier properties are reviewed. Next the main techniques of preparing photoconductors are described, in particular growth from the vapour phase, which is often used to prepare the most sensitive photoconductors such as cadmium sulphide and lead sulphide.

The behaviour of photoconductive materials can be very dependent on the nature of the electrical contacts, and this problem is dealt with in a chapter devoted to electrode effects, which lead to a consideration of space charge limited currents. The following chapters deal with imperfection photoconductivity, energy bands and excitation transitions, free carrier scattering and mobility, traps and trapping effects and recombination processes.

In a chapter entitled "theoretical viewpoints on photoconductivity", some simple models are treated mathematically and more complex situations are considered phenomenologically, as a rigorous mathematical treatment soon becomes difficult and does not readily yield a physical insight into the problem. In the final chapter on "related topics", subjects ranging from the photovoltaic effect to organic photoconductors are briefly discussed.

This book, with examples of photoconductive phenomena drawn from many different kinds of materials, and with its extensive bibliography, will be of value to the research worker rather more than to the student wishing to obtain an introduction to the subject.

J. FRANKS

Surface Microtopography

By S. Tolansky. 290 pp. Medium 8vo. Longmans, Green & Co. Ltd. 1960. Price 55s.

THIS book shows what can be achieved by precision multiple-beam interferometry when applied to the microtopographies of surfaces, and aims to illustrate the wide field open to study and to present a good deal of original material.

The author gives a full presentation of the theory and practice of those interferometric techniques that he has developed and some 350 new interferograms are given, which demonstrate a powerful three-dimensional microscopy: in the up-down direction magnifications of $\times 500\,000$ and resolutions of even quite small crystal lattice spacings have been achieved, yet by very simple means.

The numerous topics illustrated, for which new information is given, include microtopographical studies on both natural and cleavage faces of a variety of crystals; the etching of crystals; studies of oscillating quartz crystals; the finish of machined and polished surfaces; the study of hardness test indentations; erosion effects produced by high speed impact; and erosion due to electric sparks.

The book will be of special interest to industrial and academic physicists, crystallographers, mineralogists, engineers, chemists and metallurgists, to electrotechnics specialists and to the diamond, machine tool and watch industries.

Short News Items

Premiums for Technical Writing. To compete for the six premiums of 25 guineas each awarded by the Electronic Engineering Association and the Radio Industry Council to authors of technical articles on British electronic developments, published during 1960, entries must be submitted by 31 December. They should be sent to the Electronic Engineering Association at 11 Green Street, London, W.1, and should consist of a copy of the journal or the relevant pages, proof or reprint. Entries must be accompanied by a signed declaration of eligibility, showing that the entrant is not paid a salary solely for writing and not earning 25 per cent or more of his income from articles or book contributions. The former ruling does not apply to authors of articles published in the following journals as the members of the panel of judges automatically receive copies of these: British Communications and Electronics; Electronic Engineering; Electronic Technology; The Post Office Electrical Engineers Journal; Radio Constructor; Wireless World.

The Analogue Data Processing Technical Committee of the Electronic Engineering Association is compiling a list of the available types of transducers. It is collating information not only on current types, but also on types under development and seeks the help of manufacturers or users outside the membership of the Association who will be given the full results of the survey. A questionnaire indicating precisely the information required is available to those interested in helping the Association in this way on application to J. F. Richardson, Technical Secretary, Electronic Engineering Association, 11 Green Street, London W.1.

The Twenty-Eighth National Radio and Television Exhibition is to be held at Earls Court, London, next year, from Wednesday, 23 August, to Saturday, 2 September, with a preview for overseas and other special visitors on Tuesday, 22 August. It will mark the Silver Jubilee of television programmes which were first seen at "Radiolympia" in 1936. The Exhibition is organized by Radio Industry Exhibitions Ltd.

A team of United Kingdom communications experts arrived in Washington on 23 October for a series of technical discussions on matters associated with the possible use of communications systems via earth satellites. These technical discussions are being held with a number of agencies of the United States Government and with private firms. The team is headed by Major General L. de M. Thuillier and includes Captain C. F. Booth and Mr. W. J. Bray of the Post Office. The office of the Minister of Science, the Ministry of Aviation, the Admiralty and the Ministry of Defence are also represented. Visits to a number of technical installations of the National Aeronautics and Space Administration, the Department of Defence, and private firms are taking place during the tour which is expected to last several weeks.

The Agricultural Research Council has placed an order with Ferranti Ltd for an Orion computer which will be installed in the Statistics Department of the Rothamsted Experimental Station at Harpenden, Herts, the oldest agricultural research station in the world, where it will be used for statistical analysis work on problems concerning crops and their cultivation, animal feeding and stock breeding. A small computer has been in use at Rothamsted for the past six years. It has been employed on very varied statistical work for biologists and agriculturists both in this country and the Commonwealth. The increase in the volume of work and in the complexity of the problems to be handled now make it necessary to install a larger and more powerful machine.

Queen's University, Belfast, has signed a contract with the United States Advanced Research Projects Agency which will provide funds for the University's Applied Mathematics Department to expand its programme of space research. A computer centre is being built and a Deuce computing system has been ordered from the English Electric Company. Both centre and computer installation are to be completed early next year. The American financial commitment is the largest made in Western Europe in this field. The contract follows a visit last year by Professor D. R. Bates, Head of the Applied Mathematics Department, to Washington. From his conversations with American scientists there appeared to be some lack of facilities in the United States for the work in which his Department at Belfast specializes—upper atmosphere space research and the reactions of atoms and molecules together and with electrons. Professor Bates put forward a scheme for United States Government financial backing which will allow the Department to expand this work, particularly on the properties of atoms and molecules which have a bearing on missiles and conditions in space. The research will not be secret.

The Annual Exhibition of The Institute of Physics and The Physical Society will be held at the Royal Horticultural Society's Old and New Halls, Westminster S.W.1, from 16-21 January 1961. The Handbook of Scientific Instruments and Apparatus published in connexion with the Exhibition will be available in December, price 6s; by post 8s. Tickets and further particulars may be obtained from: The Institute of Physics and the Physical Society, 47 Belgrave Square, London S.W.1.

The 58th Annual Exhibition of the Société Française de Physique is to be held at the new Palais des Expositions du Centre National des Industries et des Techniques in Paris from 9-17 May 1961. Entitled MESUCORA (*MESU*re, *CO*ntrole, *R*egulation, *A*utomatisme) the Exhibition is being organized by professional organizations in France in the fields of measurement, control, regulation and automation, including the Fédération Nationale des Industries Electroniques. An International Congress will be held concurrently with the Exhibition. Full details of the Exhibition can be obtained from the Secrétariat Général, MESUCORA, C.N.I.T. 20 rue Carpeaux, Puteaux (Seine).

Engineers and Technicians of Cable and Wireless Ltd. will shortly be leaving England to take up special duties at Kano (Nigeria) and Zanzibar in connexion with the tracking of the first American-manned space satellite, which the U.S. National Aeronautics and Space Administration expect to launch sometime next year. This first manned flight is expected to circle the earth three times, 100 miles up and at a speed of 1 800 miles/h. The total flying time will be about 4½ hours. The stations at Kano and Zanzibar will form part of a chain of 18 reporting posts set up round the world from which telemetric data received from the satellite and tracking information will be passed to the computing centre in the U.S.A. Cable and Wireless Ltd. has been made responsible for maintaining the point-to-point communications at these two stations from which connexion will be by a high frequency radio link to London, and onwards by transatlantic cable to the U.S.A. Cable and Wireless (West Indies) Ltd is also concerned in the provision of voice and radioteleprinter channels connecting a further reporting station in Bermuda with the U.S.A. This station is of major importance in the communication arrangements. Three permanent teleprinter circuits are to be set up, and the voice channel will include special technical features to ensure reliability during critical tracking operations. A channel in the Company's Pacific cable system will also be made available during shoots for reporting between Australia and the U.S.A.

The Racal Organization of Bracknell, Berkshire, announce that they have received three major orders totalling £560 000 through their agents in Canada, Instronics Limited of Stittsville, Ontario, from the Department of Defence Production. The largest order covers installation equipment for vehicle-borne military radio stations, and consists of control and distribution boxes for the radio set and intercommunication systems of the vehicles, together with microphones and telephones. Nearly 500 RA17 type communication receivers have been ordered and they have been designed with components which are interchangeable with those available in Canada and U.S.A. A number of major components of Canadian manufacturers have been incorporated in the receivers.

The U.K. Atomic Energy Authority reactor operating staff have developed an intercommunication system in which every station is capable of transmitting to all other stations simultaneously. The system, which is being patented, was devised at Dounreay and has been installed in the Materials Testing Reactor there. It provides an improvement on known systems which are generally of the master and slave type. Such systems suffer from the disadvantage that each slave station is wired to the master station and can only transmit to it. Generally speaking, it is not possible for a slave station to transmit to all others simultaneously. The D.M.T.R. system is flexible and new stations can easily be added. Furthermore, distances between stations are not unduly limited and signal-to-noise ratio is adequate because signals are amplified before transmission. Further information is available from the Patents Exploitation Officer, U.K. Atomic Energy Authority, 11 Charles II street, London S.W.1.

The Hughes Medal of the Royal Society has been awarded to Dr. J. L. Pawsey, F.R.S., assistant chief of the Division of Radiophysics of the Commonwealth Scientific and Industrial Research Organization, Australia, for his distinguished contributions to radio astronomy both in the study of solar and of cosmic radio emission.

Armstrong Whitworth Equipment, the Gloucester unit of Sir W. G. Armstrong Whitworth Ltd, have been given a contract by a Government Department for a scheme to operate a complete machine shop by remote control. Although specially built for specific machining operations, the machines to be controlled are basically conventional precision tools but because of unsuitable working conditions for the operators they have to be controlled by remote operation. The basis of the scheme will be the electro-hydraulic servo valve, developed by A.W.E. as an industrial unit. Operators watching television screens in a control room some distance away will be able to carry out high precision machining operations by operation of a small control panel. If necessary, the control room can be several miles away from the machine shop.

The Electrical Research Association, which has a membership of 350, has recently revised its structure and has reduced the twenty Sectional Committees previously advising the Council to six Divisional Committees. The provisional titles of the new Committees are Insulation, Generating Plant, Power Supply Transformers and Switchgear, Power Supply Lines and Cables, Light Equipment, Heavy Equipment. A Research Advisory Committee will be appointed by each Division, and scientists and engineers from universities and elsewhere will be invited to serve.

Microcell's Electronics Division has developed an electronic pre-packing machine that will automatically sort out vegetables, weigh them to a high degree of accuracy and pack them in polythene bags. The object of this design has been to develop a cheap and robust unit for packing potatoes, apples, carrots and other vegetables with greater speed than semi-automatic machines. The usual method is to pass the potatoes or other vegetables across a small conveyor forming part of the machine and into the scale pan. The potatoes are then adjusted by hand to the correct weight by exchanging potatoes in the scale pan for larger or smaller ones taken from the conveyor. The Microcell device which is fully transistorized automatically diverts the small potatoes from the main supply on the machine, leaving the large ones to be fed into the scale pan. The pan is then topped up to correct weight by feeding in the screened small potatoes, one at a time. The machine is fitted with a solenoid lock which prevents the operator inadvertently discharging an underweight quantity into the bag.

Elliott-Automation Ltd have announced that complementary agreements have been signed between its subsidiary Elliott Brothers (London) Limited and F.X.R. Inc. of Woodside, New York, under which the two companies will make and sell in their respective territories each other's range of microwave instruments. The Elliott territory includes the whole of the British Commonwealth, excluding Canada; that of F.X.R. the United States, its possessions overseas and Canada. F.X.R. Inc. has developed a wide range of microwave laboratory instruments covering the frequency bands from 350Mc/s to 220 000Mc/s while Elliott Brothers have developed advanced techniques of instrument manufacture which have been applied so far principally in laboratory instruments and equipment for the frequency bands from 7 000Mc/s to 75 000Mc/s.

The Exhibition Committee of the Radio and Electronic Component Manufacturers' Federation has announced that the 17th Radio and Electronic Component show will be held at Olympia from 30 May to 2 June, 1961, and that it is expected that the Show will be three to four times the size of the Show previously held at Grosvenor House. Some 124 manufacturers have so far applied for stand space, applications for which must be received by Industrial Exhibitions Ltd, 9 Argyle Street, London W.1, not later than 1 December.

A new telephone cable has recently been opened for direct service between the United Kingdom and Sweden. The cable, which was laid this summer by H.M.T.S. "Monarch" between Gothenburg, Sweden, and Marske, near Middlesbrough, is a joint undertaking of the G.P.O. and the Royal Swedish Board of Telecommunications. The complete cable system, which comprises 530 nautical miles of submarine cable, 29 submerged repeaters, submerged equalizers and shore-based terminal equipment, was supplied by Standard Telephones and Cables Limited, London, to the order of the British Post Office. The repeaters used on the new cable are of the same type as those to be supplied for CANTAT, the 1961 UK-Canada cable, the first link in the proposed round-the-world Commonwealth cable. Like the CANTAT repeaters, they have a bandwidth sufficient to carry 60 two-way telephone circuits of 4kc/s spacing. This is the first direct telephone cable between the United Kingdom and Sweden and is the longest submarine telephone cable system in European waters. It is also the longest using a single cable for both directions of transmission.

The Development section of the Instrument Division of E.M.I. Electronics Ltd will in future operate from Wells, Somerset, instead of Hayes, Middlesex. Among units now in production by E.M.I. Electronics' Instrument Division are oscilloscopes, colour television cameras and associated equipment, closed circuit television equipment, and the EMIRAD range of nuclear health instruments.

The Third International Conference on Analogue Computation is to be held in Belgrade from 4-9 September 1961. The conference, organized by the International Association for Analogue Computation and the Yugoslav National Committee for ETAN (*E*lectronics, *T*elecommunications, *A*utomation and *N*uclear Engineering), will be divided into four sections:

(1) Theoretical considerations.

(2) Analogue computing equipment.

(3) Application of analogue methods and devices.

(4) Relationship between analogue and digital techniques.

An exhibition of analogue computing equipment and components will be organized during the Conference in conjunction with the International Fair of Technical Achievements. Particulars relating to the Conference can be obtained from Yugoslav Committee for ETAN, Terazije 23/VII, Belgrade, Yugoslavia.

The Process Heating Division of Pye Ltd, Cambridge, is to hold a further course in Induction Heating on 7-8 February 1961. This course is free of charge and will again be held at the Globe Hotel, Cambridge. Further details may be obtained from Mrs. E. Raeburn, Pye Process Heating, 28 James Street, Cambridge.

The BBC has chosen a site at Dryden Hill, near Galashields, for its new station in South-East Scotland. This station will transmit BBC Television, and also the Scottish Home Service, the Light Programme, and the Third Programme, with Network Three, on v.h.f. The television station will work in Channel 1 with vertical polarization, and the frequencies to be used for the v.h.f. sound transmissions, which will be horizontally polarized, will be as follows:

Light Programme	89·1Mc/s
Third Programme and Network Three	91·3Mc/s
Scottish Home Service	93·5Mc/s

A new applied electronic laboratory has now been opened at Portsmouth by the General Electric Co. Ltd. This laboratory is one of a group of three operated by the Company on behalf of the Ministry of Aviation and engaged on research and development on electronic equipment for defence purposes. The other laboratories are at Stanmore, Middlesex, and Salisbury, South Australia. The Salisbury laboratory is concerned with trials of guided weapons equipment– developed at Stanmore and Portsmouth—at the Woomera Range of the Australian Weapons Research Establishment. Two of the principal developments in the laboratory have been the guidance equipment for the ship-to-air weapon Seaslug and the airborne radar for the Royal Navy's aircraft, the "Sea Vixen". A feature of the laboratory is the extensive range of mechanical and climatic test equipment which is used to test prototype equipment.

Texas Instruments Incorporated is establishing a new subsidiary company—Texas Instruments France—to manufacture semiconductor devices and components in France for the European Common Market. Various sites near Nice are being studied and when a selection has been made the land will be purchased and a modern plant constructed. The new French subsidiary company will manufacture a full line of Texas Instruments silicon and germanium transistors, silicon diodes and rectifiers such as the company already produces at Dallas, U.S.A., and Bedford, England.

The Sixth Annual Conference on Magnetism and Magnetic Materials was held at the Hotel New Yorker, New York City, from 14 to 17 November 1960. About 160 technical papers, covering all phases of magnetism, were included in the programme. Ten invited papers were read from the United States, Japan, Holland, France and England. Among the topics discussed were the formation of thin films of magnetic materials and their application as memory units for computers, the study of magnetic resonance phenomena, magnetic ordering in helical spin systems, and the properties of magnets made of particles of extremely small size.

Alma Components Ltd held an Open Day on 26 September in connexion with their new factory and laboratory at Diss, Norfolk, for the manufacture of high precision wire wound resistors.

PUBLICATIONS RECEIVED

BBC ENGINEERING DIVISION MONOGRAPH, number 32, is entitled 'A New Survey of the BBC Experimental Colour Transmissions.' About six monographs are produced every year, each dealing with a technical subject within the field of television and sound broadcasting. This series should be of interest to engineers engaged in the fields of broadcasting and of telecommunications generally. Individual copies 5s. post free, annual subscription £1 post free. Orders can be placed with BBC Publications, 35 Marylebone High Street, London, W.1.

SOLUS-SCHALL booklet on Non-Destructive Testing contains information on the site methods of non-destructive testing provided by the Company. Visual welding inspection, X-radiography, gamma radiography, penetrants, ultrasonic flaw methods and magnetic particle inspection are discussed. Copies are available free of charge from Solus-Schall Ltd, County Building, Honeypot Lane, Stanmore, Middlesex.

'WIRELESS WORLD' Diary, 1961, contains technical and general information in an 80 page reference section, addresses of over 150 radio and allied organizations, together with usual diary pages. Copies, size 4½in × 3⅜in. can be obtained from T. J. and J. Smith Ltd, 12 Hanover Square, London, W.1. Price: for leather cover 6s. 9d., for rexine cover 4s. 9d., plus 4d. postage.

CO-OPERATION BETWEEN INDUSTRY AND EDUCATION is a booklet which gives an account of arrangements in some 40 industries for co-operation between those industries and various educational bodies at national, regional and local levels in respect of the further education and training of work people up to the craft level. The booklet is published by The Industrial Training Council, 36 Smith Square, Westminster, S.W.1.

BRITISH STANDARDS YEAR BOOK 1960 has been issued by the British Standards Institution, British Standards House, 2 Park Street, London W.1, and contains information about the Institution and the services it offers. It lists the British Standards current at 1 January 1960 and gives a brief description of each. Price 15s.

TELEVISION FIELD TRIALS OF 405-LINE AND 625-LINE SYSTEMS IN THE U.H.F. AND V.H.F. BANDS 1957-8 is the title of a report published by the British Broadcasting Corporation, Shirland Road, Maida Vale, London W.9. In 1952 the Postmaster General set up a Television Advisory Committee to advise him on the development of television in the United Kingdom. The Committee in turn set up a Technical Sub-Committee and the present Report has been made by a Working Party of this Sub-Committee, which had the task of co-ordinating tests of television transmission in Band V (610-960Mc/s). The introduction to Part I of the Report explains the circumstances in which the tests were carried out and the Report itself gives the results of field trials of 405-line television transmission in Band I (41-68Mc/s) and Band V, and also of 625-line transmission in Band V. The conclusions given in the Report on the comparison between 625-line and 405-line pictures in Band V are based on the use of the Western European standard for the 625-line system, which employs a video bandwidth of 5Mc/s and a channel width of 7Mc/s. The organizations which participated were the General Post Office, the Department of Scientific and Industrial Research, the Independent Television Authority, the Mullard Research Laboratories, and the BBC Price 20s.

MECHANICAL WORLD YEAR BOOK 1960, published by Emmott & Co. Ltd, 31 King Street West, Manchester 3, and 158 Temple Chambers, Temple Avenue, London E.C.4, is the 73rd edition of a collection of data for everyday use by engineers. Price 5s.

MACHINE TOOL DRIVES is a new AEI publication well illustrated in colour and offers valuable assistance to machine tool manufacturers in the selection of suitable electrical and electronic equipment to meet the need of modern design practice. A good deal of space is devoted to the wide variety of AEI control equipment, ranging from the more conventional starters to static switching and servo speed control equipments. Published by Associated Electrical Industries (Rugby) Ltd, Crown House, Aldwych, London W.C.2.

ELECTRONIC EQUIPMENT

A description, compiled from information supplied by the manufacturers, of new components, accessories and test instruments.

(Voir page 793 pour la traduction en français : Deutsche Übersetzung Seite 798)

ATTENUATOR

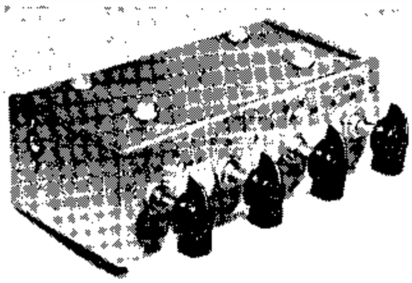
Airmec Ltd, High Wycombe, Buckinghamshire

(Illustrated below)

Of Post Office design, this attenuator is for use in 75Ω circuits. Four rotary switches provide a total attenuation of 0 to 70dB in 0·5dB steps with high accuracy. From d.c. to 100kc/s, the 0·5dB section has an accuracy of ±0.015dB, and the 2dB section ±0·03dB and the two 10dB sections ±0·1dB each. At 30Mc/s the error of each section is ±0·1dB and the overall error is generally less than the sum of the permissible errors of each section. The additional error at 100Mc/s is not more than 1dB.

By selection of resistance values and careful design of the terminations, zero inaccuracy and return loss are kept to a minimum. Both input and output terminations accept standard Post Office free coaxial sockets type W.1.

The unit is 6¼in wide, 2⅜in high and



4¾in deep over projections. A separate escutcheon and variety of tapped fixing holes enable the attenuator to be easily incorporated into complete equipments. While for bench use the holes are plugged by nylon screws which insulate the unit electrically.

EE 28 751 *for further details*

TRANSISTORIZED OSCILLOSCOPE

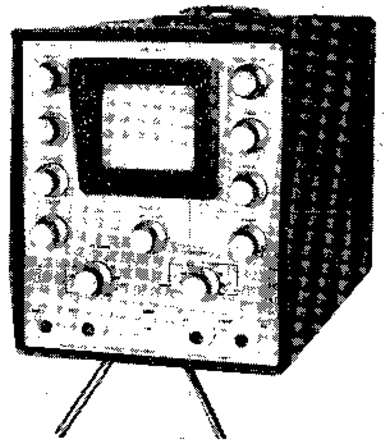
Microcell Ltd, Blackwater Industrial Estate, Camberley, Surrey

(Illustrated above right)

In this portable oscilloscope maximum use has been made of semiconductors and printed wiring.

Power for the oscilloscope is derived from its internal pack of rechargeable high capacity silver-zinc cells, and a charging circuit is incorporated which may be connected to the mains supply. The battery pack will provide eight hours of continuous use, in the absence of a suitable mains supply.

The Y amplifier has a bandwidth of d.c. to 10Mc/s (−3dB) and a sensitivity variable between 100mV/cm and 100V/cm. The X amplifier has a handwidth of d.c. to 5Mc/s and a sensitivity variable between 300mV/cm and 1·5V/cm. The



time-base has a sweep range variable between 10μsec and 3sec and a ×5 expansion facility and is designed for triggered or synchronized operation.

EE 28 752 *for further details*

ROTARY POSITION SELECTOR

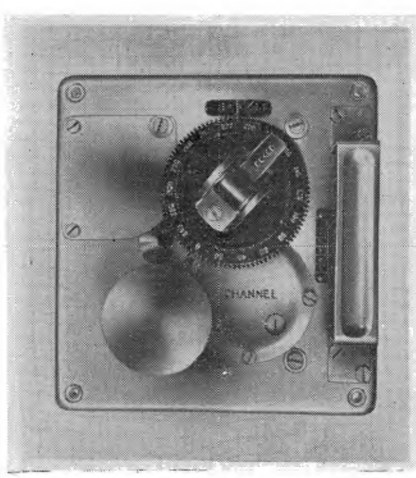
The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(Illustrated below)

A remotely controlled device with applications in many fields where it is required to rotate a shaft with a high degree of accuracy has been developed by The Plessey Company in conjunction with the Ministry of Supply for use with multi-channel transmission and receivers.

The unit, which is designed to rotate a shaft to any one of twelve positions, each position being set up independently, with an accuracy of within six minutes or arc, is available for 12 to 48V d.c. operation in two panel sizes (4in by 4in or 3½in by 4⅞in) and with a torque of either 35oz-in or 60oz-in.

Visible indication from the front of the unit shows the selected position and



a built-in switch can be used for confirming the position to the remote control site. A further built-in switch allows a number of selector units to be operated in sequence.

All materials used in this unit are to Specification DEF 5000; operational temperature range is from −40°C to +70°C.

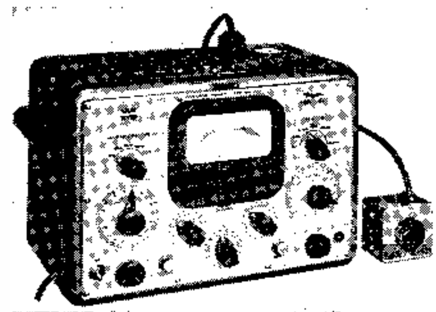
EE 28 753 *for further details*

VALVE TESTER

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Illustrated below)

The valve tester (model 45C) is capable of testing over 5 000 different types of valves, British, American, and Continental. Two ranges of mutual conductance are provided, 0 to 3mA/V and 0 to 15mA/V, and tests are also incorporated for inter-electrode short circuits, cathode leakage and emission. A separate c.r.t. adaptor, model 445, is



available (shown in illustration) which now incorporates a special base for wide angle 110° tubes. An important feature of this new instrument is the incorporation of test facilities for checking 12V car radio valves.

Valves can be measured rapidly by unskilled operators due to the simplicity in operation of the valve tester, and the moving-coil meter enables the valves to be 'matched' or compared for push-pull circuits. The 45C incorporates 21 valve holders and is supplied complete with instruction book and valve characteristic manual.

EE 28 754 *for further details*

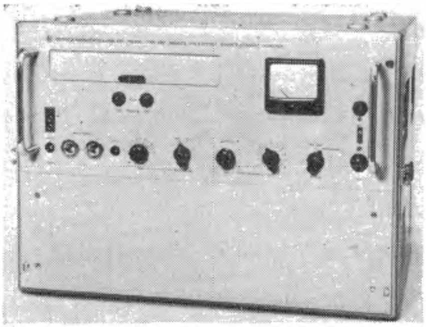
TELEVISION DEMODULATOR

Distributed by: Aveley Electric Ltd, South Ockendon, Essex

(Illustrated above right)

The television demodulator type AMF, which is manufactured by Rohde and Schwarz, is a high grade monitoring receiver for the sound and vision signals of a television transmitter. It is available in versions for Band I, Band III and Bands IV and V.

It can be used for the following purposes on vision transmitters:



(a) Display of the transient response of the picture transmitter, measurement of the video frequency response, of the phase and group-delay times.
(b) Checking of the video phase pre-equalization.
(c) Measurement of the grey-scale distortion.
(d) Monitoring of the transmitter modulation in order to maintain the 10 per cent residual carrier.
(e) Monitoring of the picture quality during transmission.

On sound transmitters it can be used for:

(a) Measurement of the audio-frequency response.
(b) Measurement of the modulation distortion.
(c) Measurement of the intercarrier signal-to-noise ratio.
(d) Monitoring of the sound quality during transmission.

EE 28 755 *for further details*

TEMPERATURE INDICATOR CONTROLLER

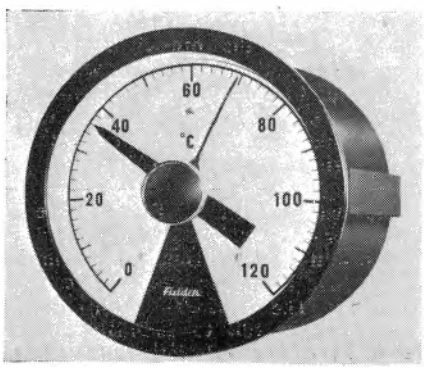
Fielden Electronics Ltd, Withenshawe, Manchester

(Illustrated below)

A new electronic temperature indicator-controller is now available in the Fielden Bikini range of instruments for temperature measurement.

Like the Bikini indicator it is housed in a 6in diameter panel-mounting case and has a 13in scale calibrated in any of 73 standard ranges for temperatures between −200°C and +850°C (−330° to 1 550°F). The control point is set by a pointer operated from the knob in the centre of the dial, while the indicating pointer is motor-driven from a servo-system.

The instrument is completely transistorized and no maintenance is required. It can be operated from 12V d.c. or the usual mains supply.



The platinum resistance measuring bulb used with the indicator-controller is housed in a robust stainless steel sheath of ¼in diameter and can be located at any distance up to 300ft away from the instrument. The control relay, which has contacts rated at 10A to provide both changeover and 'normally open' switching, can be located up to 300ft or more distant from the instrument if required.

The makers claim a calibration accuracy of ±0·5 per cent of the scale and a repeatability of 0·25°C on most ranges.

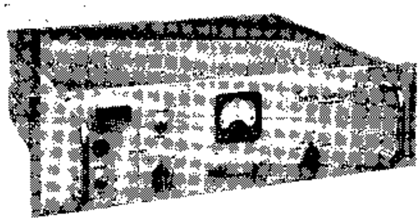
EE 28 756 *for further details*

DATA AMPLIFIER

Blackburn Electronics Ltd, Brough, Yorkshire

(Illustrated below)

This transistorized data amplifier has been designed to meet the demand for precision amplification of microvolt output signals from transducers in instrumentation and control systems. The input, which is completely floating, has a common mode rejection ratio of 10^6:1 at d.c., and an impedance of 3MΩ which ensures that the unit will not load the signal source. The total noise and drift in the amplifier is below 5μV. The gain of the unit is switchable from 10 to 1 000, and has a linearity of 0·1 per cent with a maximum output swing of ±10V at 0·5A.



EE 28 757 *for further details*

LEVEL RECORDER

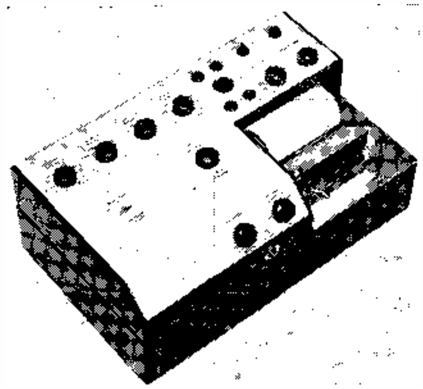
Distributed by: B. and K. Laboratories Ltd, 4 Tilney Street, Park Lane, London W.1

(Illustrated above right)

The high speed level recorder type 2305, manufactured by Bruel and Kjœr of Denmark, is a development of their previous type 2304. A number of new features have been incorporated which greatly extends its range of application.

The type 2305 covers the frequency range 10c/s to 200kc/s within 0·2dB as well as d.c. and will record any voltage level between 5mV and 100V. An innovation is the inclusion of three full-wave rectifier circuits enabling true r.m.s. average and peak detection of the input signal to be obtained whereas the type 2304 only gives half-wave peak rectification. Another new feature is the incorporation of two writing widths of 100mm and 50mm.

By an increase in the number of lamallæ on the potentiometer from 108



to 216 a higher resolving power has also been achieved, and from the nine writing speeds of the type 2304 the number has been enlarged to fifteen covering the two paper widths with speeds from 2mm/sec to 2 000mm/sec. The inclusion of a simple arrangement allows the direct recording of polar diagrams without the necessity of additional equipment.

In conjunction with the electronic, new mechanical features have also kept in step. When connected to other B & K instruments the motor is used to drive the tuning mechanism of the respective oscillator or analyser, thus enabling synchronized speeds of preprinted frequency calibrated recording paper and the tuning mechanism to be automatically obtained. A friction clutch facilitates the synchronous commencement of the paper in relation to the tuning mechanism.

When the type 2305 is to be used for production control or in the laboratory a method has been incorporated so that a single chart can be run off, and where it is necessary to record several curves on the same chart, the motor can be reversed and a single chart run re-commenced without losing synchronization.

A mechanical arrangement enables the pen to be lifted from the paper and a marking button will 'event mark' the outer rim of the paper with a dip when pressed. These latter features, along with the paper drive motor clutch, can be remotely controlled. Within the type 2305 there are two built-in switches, one to control the electro-mechanical drive of the B and K spectrometer type 2111 and the other to give successive switching of two different inputs into a single output, when this is required.

EE 28 758 *for further details*

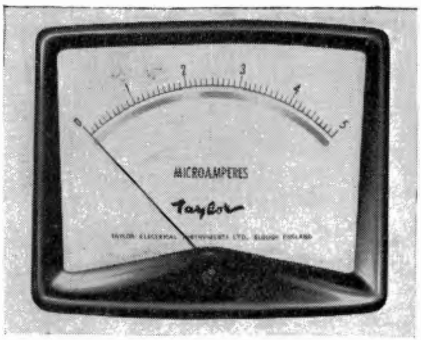
PANEL METERS

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Illustrated top next column)

The 'Vista' range of panel meters are of contemporary design and incorporate the now well established centre pole meter movement. They are available with d.c. sensitivities commencing from 1μA.

Four models are available with nominal scale lengths from 1⅞in to 4¼in. The bases of all instruments are made so that the meters can be interchanged with



standard type meters of earlier design. The ranges available include moving-coil d.c. or a.c. with rectifiers, thermocouple from 10mA to 5A and moving-iron types from 10mA to 50A. Mirror scales and special scales to customers' own requirements can be supplied in addition to knife edge or spade type pointers.

EE 28 759 *for further details*

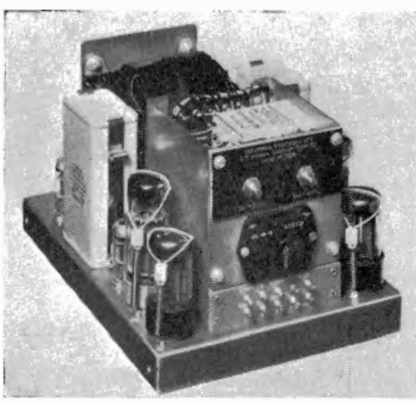
STABILIZED POWER UNIT

Servomex Controls Ltd, Crowborough, Sussex

(Illustrated below)

The DC105 is a general purpose power supply unit intended for incorporation into other equipment. It provides both positive and negative d.c. supplies at 300V, 50mA. In addition, two 6·3V, 2A a.c. outputs are provided.

Eleven voltage selector settings are



provided to cover input voltages ranging from 105V to 250V, and the stabilizer is designed to operate continuously with changes of up to ±7 per cent from the nominal.

The stabilization factor is about 200 on the positive supply and 400 on the negative supply, the output impedance being less than 1Ω from d.c. to 100kc/s. The ripple and noise on the d.c. outputs is less than 2mV r.m.s.

EE 28 760 *for further details*

INCREMENTAL INDUCTANCE BRIDGE

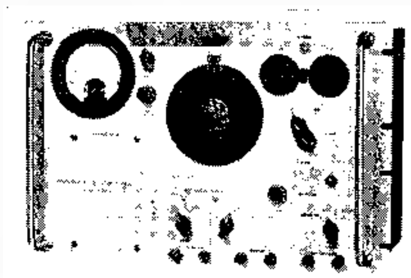
Furzehill Laboratories Ltd, 57 Clarendon Road, Watford, Hertfordshire

(Illustrated above right)

This instrument uses a Hay bridge circuit in which the unknown inductance is balanced against a standard polystyrene capacitor. The ratio arms are vitreous-enamelled wire-wound resistors designed to carry substantial d.c. polarizing current (supplied from an external source).

Reactive and resistive balance are rapidly determined by reason of the logarithmic null indicator incorporated. The reactive dial is calibrated direct in inductance while the resistive balance is calibrated in resistance from which the Q of the inductor is readily determined for the frequency in use.

The bridge output is fed to the null indicator through a tuned amplifier to eliminate possible inaccuracies due to harmonics produced by iron distortion in the inductor on test and/or impurities in the input waveform. Internal a.c.



excitation is available at mains frequency but the bridge is designed to accommodate external excitation at any frequency in the range 25 to 3 000c/s. The voltage actually across the inductor on test may be monitored by using the null indicator as a valve-voltmeter.

The range covered by the bridge is 0·05 to 500H.

EE 28 761 *for further details*

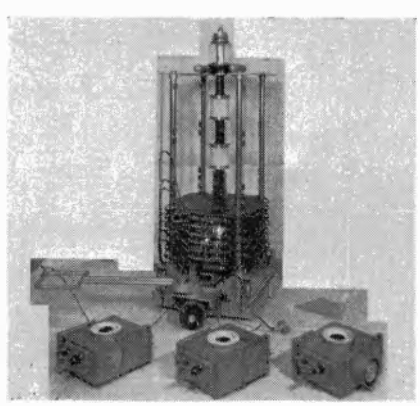
HIGH POWER KLYSTRON

English Electric Valve Co. Ltd, Chelmsford, Essex

(Illustrated below)

The English Electric K347 is claimed to be the first high power klystron designed specifically for use in commercial radars. With an applied pulse of 6μsec and a duty cycle of 0·0024, the K347 will deliver a peak output power of 600kW at a power gain of 33dB; the efficiency being 40 per cent.

This forced air-cooled, external cavity, tunable klystron amplifier was developed primarily for pulse service in airport surveillance radars and similar equipments operating in the frequency range of 580 to 615Mc/s.



There are three separate tuning cavities, tuned over the frequency range by means of sliding plungers, and with this design all the tuning arrangements are completely external to the vacuum envelope. Replacement costs are limited to the tube only and this results in considerable economy at the eventual end of tube life.

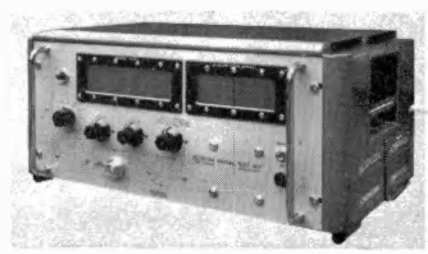
Repeated tuning operations, to meet changing operational requirements, can be performed without stressing or damaging the tube, so that besides providing flexibility of operation the external tuning arrangement reduces the risk of tube failure.

In application, this klystron is particularly suitable for use with airfield radar equipments incorporating moving target indication display facilities to enable the radar to discriminate against a mass of permanent echoes, and thereby leaving the display screens clear for the plotting of aircraft.

At the frequency range in which the K347 operates, aircraft are not obscured by any precipitation although very heavy rainstorms can be seen faintly on the display screen.

The photograph shows the K347 in position in the output stage of a Marconi radar transmitter, the solenoid coils have been lowered and the cavities have been removed and placed in the foreground.

EE 28 762 *for further details*



RESISTOR DIGITAL TEST SET

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustrated above)

The resistor digital test set type EM 1006 provides a swift and accurate means of measuring the percentage deviation of a resistor in relation to its nominal value.

The nominal value of the resistor under test is selected by means of three switches, the value selected being clearly displayed to the operator in digital form. The instrument measures the resistor on receipt of a command signal, and the deviation from the pre-set nominal is digitally indicated together with the polarity of the deviation. The command to digitize can be derived in one of three ways: manually, internally at repetition rates variable from 1 to 10sec or by remote contact closure.

The reading time of the machine is 0·2sec per resistor; thus, if it is used in conjunction with a printer, a maximum rate of five resistors per second can be recorded. The EM 1006 will handle resistors from 10Ω to 15·9MΩ and the maximum indicated deviation is ±9·9 per cent. Accuracy and stability are guaranteed to be better than 0·1 per cent.

EE 28 763 *for further details*

TIME INDICATORS

Industrial Instruments Ltd. 9 Paved Court, Richmond, Surrey

(Illustrated below)

A series of compact, electro-chemical, elapsed time indicators have been introduced by Industrial Instruments Ltd. for the recording of the total operation time of electrical equipment.

These indicators, known as the Selachron range, have been designed in forms suitable for either a.c. or d.c. operation and in sizes for use with voltages of from 6V to 300V, thus obviating the need for any extra switches or relays and allowing them to be wired to the terminals of the equipment being timed. The indicators use no moving parts and consist of cartridges which contain small, replaceable electro-chemical cells, embodying an

anode, cathode and electrolyte. The anode is consumed as current passes through the cell, the length diminishing in proportion to the accumulated hours of operation, this being shown by a calibrated scale alongside the anode.

EE 28 764 *for further details*

MULTI-PIN CONNECTORS

The Plessey Co. Ltd. Vicarage Lane, Ilford, Essex

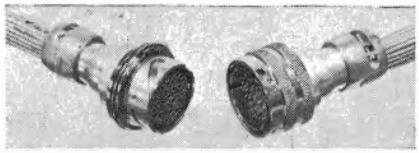
(Illustrated above right)

The aluminium mark 6 connectors embody a number of novel features and accommodate a considerably greater number of contacts than other Plessey connectors of similar size.

These connectors are available in four shell sizes with a fixed and free unit in each size; both units are obtainable with either a plug or socket and are easily convertible to coupler units by the attachment of cable fittings. A single moulding of silicone rubber bonded to the housing forms the insulator and is designed to fully shroud each individual contact, cable joint and a portion of the cable dielectric.

Insulation resistance between contact and earth throughout the range is in excess of 10^5MΩ at 500V.

Contacts are silver plated brass and socket inserts are designed to give a line contact with equal mating loads irres-

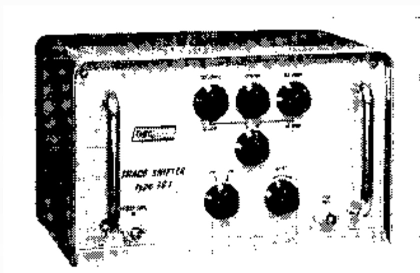


pective of the length of engagement. A damage prevention device is also incorporated in all socket inserts.

A standard voltage rating of 1kV r.m.s., irrespective of contact class, applies to all four sizes of connectors, at ground level, reducing to 350V at altitudes of 70 000ft or under equivalent conditions. Current ratings range from 5 to 12A and the connectors have been proved satisfactory for operation in ambient temperatures between -55°C and $+155$°C.

An unusual feature of these new connectors allows them to be used in four alternative positions by varying the position of the bayonet couplings. This feature prevents mis-coupling to wrong units and also prevents mis-mating.

EE 28 765 *for further details*



TRACE SHIFTER

Cawkell Research and Electronics Limited, Scotts Road, Southall, Middlesex

(Illustrated above)

We regret that an incorrect photograph was associated with our description of this instrument on page 727 of the November issue. The correct photograph is shown above.

EE 28 766 *for further details*

MICROWAVE BENCH OSCILLATORS

Flann Microwave Instruments Ltd, 9 Old Bridge Street, Kingston-on-Thames, Surrey

(Illustrated below)

A range of three cavities is available of which the types CLL and CLS are of the orthodox type. These two cavities utilize the plug-in klystrons types 6BM6A and R9559 and are tuned with non-contacting pistons of the S type. They cover the frequency range 850 to 3 200Mc/s and 1 300 to 5 500Mc/s respectively. Changes in frequency are indicated directly on large diameter dials with effective scale lengths (including vernier) of approximately 4ft.

Output from the cavities is taken

through a probe and split collet arrangement which is adjusted from the front panel of the unit by the operator.

The highest frequency model (type CLX) which covers the 4·2 to 12Gc/s range is a more complex and unorthodox coaxial line cavity. Output level from the cavity is fixed since power is coupled through the piston which performs as a band-pass filter. Special arrangements have been made to ensure freedom from mode crossing and radial line resonances at the high frequencies, which normally limit the usefulness of orthodox coaxial oscillators.

All instruments are supplied complete with klystrons in sloping panel cases of standard 19in width, with klystron electrodes brought out individually to terminals on the front panel. Type N connectors are used throughout.

In all cavities extensive precautions have been taken to ensure maximum Q values, good contacting and a low level of external leakage (approximately 100dB down, when output is into a solid coaxial line).

EE 28 767 *for further details*

MINIATURE POWER UNITS

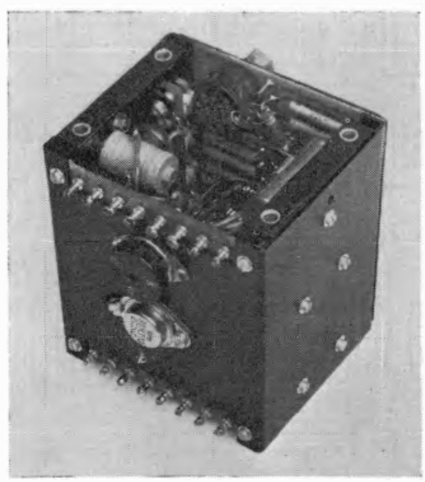
Distributed by: Metrix Instruments Ltd, 54 Victoria Road, Surbiton, Surrey

(Illustrated below)

A series of new miniature sub-units has been added to the range of stabilized transistor power supplies made by Belix Co. Ltd, and distributed by Metrix Instruments Ltd.

Designed for use where space is strictly limited, the units whose overall dimensions of only 4½in by 4in by 3½in can be supplied with fixed or continuously variable output voltages betweeen 0 and 24V at current ratings of 100mA, 300mA or 500mA. Single and twin units are also available with any pre-set output voltage within the range 0 to 24V at 1A maximum, the potentiometer adjustment giving ±0·5V variation about the specified figure.

Stability figures of considerably better than 0·1 per cent have been achieved, and the ripple is less than 0·5mV peak-to-peak under all conditions.



EE 28 768 *for further details*

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

Unless otherwise stated, all meetings will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1., commencing at 6.30 p.m.

Computer Group

Date: 2 December.
Lecture: Progress in Microminiature Circuit Techniques for Digital Computers.
By: D. Roberts, D. S. Campbell and P. M. Thompson.

Radar Group

Date: 7 December.
Lecture: Flight Evaluation of Airborne Electronic Equipment.
By: H. G. Hinkley.

Electro-Acoustics Group

Date: 13 December.
Lecture: A Pulse Multiplex Stereophonic Broadcasting System.
By: G. D. Browne.

Southern Section

Date: 14 December. Time: 7 p.m.
Held at: Lanchester Building, University of Southampton.
Lecture: Some New Piezo-electric Devices.
By: A. E. Crawford.

South Midlands Section

Date: 2 December. Time: 7 p.m.
Held at: North Gloucestershire Technical College, Cheltenham.
Lecture: The Place of the Electric Rocket in Space Propulsion.
By: W. A. S. Murray.

North Western Section

Date: 1 December Time: 7 p.m.
Held at: Reynolds Hall, College of Technology, Manchester, 1.
Lecture: Industrial Television.
By: J. M. Waters.

North Eastern Section

Date: 7 December. Time: 6 p.m.
Held at: Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne.
Lecture: Human Engineering.
By: S. G. Ramsay.

Merseyside Section

Date: 14 December. Time: 7 p.m.
Held at: The Adelphi Hotel, Liverpool.
Lecture: V.H.F. Sound Broadcasting.
By: L. G. Dive.

THE INSTITUTE OF NAVIGATION

Date: 16 December. Time: 5.15 p.m.
Held at: The Royal Geographical Society, 1 Kensington Gore, London, S.W.7.
Lecture: The Single-Handed Transatlantic Race.

THE INSTITUTION OF ELECTRICAL ENGINEERS

All London meetings will be held at Savoy Place, commencing at 5.30 p.m., unless otherwise stated.

Ordinary Meeting

Date: 1 December.
Lectures: Our Civic Lighting: Gloom or Gaiety? A Survey of Street Lighting and its Future.
By: W. R. Stevens and H. M. Ferguson.

Medical Electronics Discussion Group

Date: 2 December.
Lecture: Telemetering Biological Data.
By: G. H. Byford and Dr. K. G. Williams.

Informal Meeting

Date: 5 December.
Lecture: National Proving of Domestic Electrical Equipment.
By: C. A. Zweigbergk.

Measurement and Control Section

Date: 6 December.
Lecture: A Universal Non-Linear Filter, Predictor and Simulator, which Optimizes Itself by a Learning Process.
By: Professor D. Gabor, W. P. L. Wilby and R. Woodcock.

Utilization Section

Date: 8 December.
Lecture: The Determination of the Electrical Characteristics of an Arc Furnace.
By: J. Ravenscroft.

Electronics and Communications Section

Date: 12 December.
Lecture: Topology Concepts in Network Theory.
By: P. R. Bryant.

Supply Section

Date: 14 December.
Lecture: A Basis for Short-Circuit Ratings for Paper-Insulated Cables up to 11kV.
By: L. Gosland and R. G. Parr.
Lecture: Short-Circuit Ratings for Mains Cables.
By: G. S. Buckingham.

Education Discussion Circle

Date: 15 December.
Lecture: How to Pass Examinations or the Psychology of Study.
By: Professor C. A. Mace.

Measurement and Control Section

Date: 20 December.
Lecture: Digital Transducers.
By: L. Airey.

Electronics and Communications Section

Date: 21 December.
Lecture: Microminiaturization.
By: L. J. Ward.

Mersey and North Wales Centre

(Liverpool meetings held at the Royal Institution, Colquitt Street, at 6.30 p.m.; Chester meetings held at the Town Hall, at 6.30 p.m.)
Date: 5 December.
Held at: Liverpool.
Lecture: The Determination of the Electrical Characteristics of an Arc Furnace.
By: J. Ravenscroft.
Date: 12 December.
Held at: Chester.
Lecture: The Potentialities of Artificial Earth Satellites for Radiocommunication.
By: W. J. Bray.
Date: 16 December.
Held at: Chester.
Lecture: The Logmotor—A Cylindrical Brushless Variable-Speed Induction Motor.
By: Professor F. C. Williams, E. R. Laithwaite and J. F. Eastham.

North Eastern Centre

Date: 9 December. Time: 7 p.m.
Held at: Carlisle Technical College.
Lecture: The Shielding for Overhead Lines against Lightning.
By: J. H. Grindley.
Date: 12 December. Time: 6.15 p.m.
Held at: Neville Hall, Westgate Road, Newcastle-on-Tyne.
Lecture: Street Lighting.
By: W. R. Stevens and H. M. Ferguson.
Date: 13 December. Time: 7 p.m.
Held at: Workington College of Further Education.
Lecture: The Transmission of News Film over the Transatlantic Cable.
By: C. B. B. Wood and I. J. Shelley.

North-East Measurement and Electronics Group

Date: 5 December. Time: 6.15 p.m.
Held at: Rutherford College of Technology, Northumberland Road, Newcastle-upon-Tyne.
Lecture: Radar Observations of Birds and 'Angels'.

Tees-side Sub-Centre

Date: 7 December. Time: 6.30 p.m.
Held at: Cleveland Scientific and Technical Institution, Middlesbrough.
Lecture: The Logmotor—A Cylindrical Brushless Variable-Speed Induction Motor.
By: Professor F. C. Williams, E. R. Laithwaite, J. F. Eastham, and L. S. Piggott.
Lecture: Brushless Variable-Speed Induction Motors using Phase-Shift Control.
By: Professor F. C. Williams, E. R. Laithwaite, J. F. Eastham and W. Farrer.

North Midland Centre

Date: 6 December. Time: 6.30 p.m.
Held at: Leeds and County Conservative Club, South Parade, Leeds.
Lecture: Thermistors—Their Theory, Manufacture and Application.
By: R. W. A. Scarr and R. A. Setterington.

Sheffield Sub-Centre

Date. 14 December. Time: 6.30 p.m.
Held at: University, Mappin Street, Sheffield
Lecture: The Determination of the Electrical Characteristics of an Arc Furnace.
By: J. Ravenscroft.

North-Western Centre

Date: 13 December. Time: 6.15 p.m.
Held at: Engineers' Club, Manchester.
Lecture: The Teaching of Electrical Network Theory and its Applications in Electrical Engineering.
By: F. E. Rogers.

North-Western Electronics and Communications Group

Date: 7 December. Time: 6.15 p.m.
Held at: Rutherford College of Technology, Northumberland Road, Newcastle-upon-Tyne.
Lecture: New Semiconductor Devices.
By: A. A. Shepherd.

North-Western Utilization Group

Date: 6 December. Time: 6.15 p.m.
Held at: Engineers' Club, Albert Square, Manchester.
Lecture: Electrical Characteristics of the Argon Arc Welding Process.
By: J. C. Needham and L. H. Orton.

North Lancashire Sub-Centre

Date: 14 December. Time: 7.15 p.m.
Held at: N.W.E.B. Lecture Theatre, Jubilee Street, Blackburn.
Lecture: Discrimination between H.R.C. Fuses.
By: E. Jacks.

Northern Ireland Centre

Date: 12 December. Time: 6.30 p.m.
Held at: Civil Engineering Department, David Keir Building, The Queen's University, Stranmillis Road, Belfast.
Lecture: Pumped Storage.
By: R. W. Mountain.

South Midland Centre

Date: 5 December. Time: 6.30 p.m.
Held at: College of Technology, Birmingham.
Lecture: Radiocommunication in the Power Industry.
By: E. H. Cox and R. E. Martin.
Date: 5 December. Time: 7.30 p.m.
Held at: Winter Gardens, Gt. Malvern.
Lecture: Parametric Amplifiers.
By: R. V. R. Carter and I. A. Bagnall.

North Staffordshire Sub-Centre

Date: 12 December. Time: 7 p.m.
Held at: Duncan Hall, Stone.
Lecture: Recent Developments in Colour Television.
By: I. J. P. James.

Rugby Sub-Centre

Date: 14 December. Time: 6.30 p.m.
Held at: Rugby College of Technology and Arts.
Lecture: Some Considerations in the Application of Power Rectifiers and Convertors.
By: J. P. McBreen.

Southern Centre

Date: 1 December. Time: 6.30 p.m.
Held at: South Dorset Technical College, Weymouth.
Lecture: Instrumentation of Nuclear Reactors.
By: D. Harrison.
Date: 6 December. Time: 6.30 p.m.
Held at: University Southampton.
Lecture: F.M./A.M. V.H.F. Portable Transistor Receivers.
By: L. E. Jansson.
Date: 7 December. Time: 6.30 p.m.
Held at: South Eastern Electricity Board Office, 10 Queens Gardens, Hove.
Lecture: Radiocommunication in the Power Industry.
By: E. H. Cox and R. E. Martin.
Date: 9 December. Time: 6.30 p.m.
Held at: S.E.B. Showrooms, Newport, I.O.W.
Lecture: Discussion and Demonstration of Stereophonic Sound.

Western Centre

Date: 12 December. Time: 6 p.m.
Held at: South Wales Institute of Engineers, Cardiff.
Lecture: Engineering Education at the Technical Universities in Western Germany.
By: D. B. Welbourn, Professor D. B. Spalding, and G. L. Ashdown.

South-Western Sub-Centre

Date: 14 December. Time: 3 p.m.
Held at: Washington-Singer Laboratories, Exeter University, Prince of Wales Road, Exeter.

West Wales (Swansea) Sub-Centre

Date: 13 December. Time: 6.30 p.m.
Held at: Brangwyn Hall, Swansea.
Lecture: Transistors, and All That.
By: L. J. Davies.

Cambridge Electronics and Measurement Group

Date: 8 December. Time: 8 p.m.
Held at: Cavendish Laboratory, Cambridge.
Lecture: Recent Progress in Microwave Valves.
By: A. H. W. Beck.

Maidstone

Date: 5 December. Time: 7 p.m
Held at: Maidstone Technical College.
Lecture: Uses and Manufacture of N.I.C.C. Cable.
By: G. E. D. Redman.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Date: 5 December. Time: 5 p.m.
Held at: Institution of Electrical Engineers, Savoy Place, London, W.C.2.
Lecture: Telephone Equipment Connexions.
By: K. W. Hix.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

Control Section

Date: 14 December. Time: 7 p.m.
Held at: Mansion House, 26 Portland Place, London, W.1.
Lecture: Speed Control of Aircraft Gas Turbines for Jet Propulsion
By: R. J. Walsh and R. W. Haigh.

THE TELEVISION SOCIETY

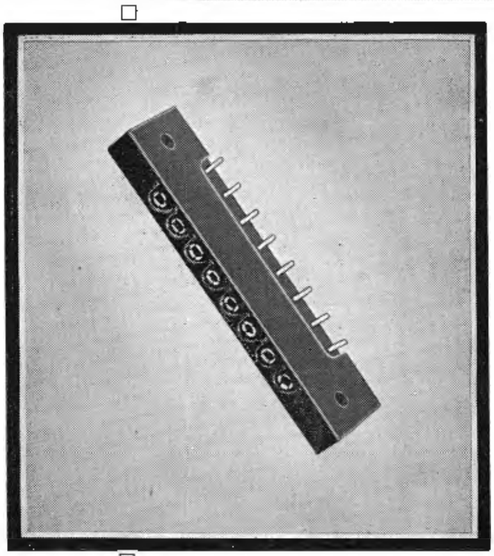
Date: 14 December. Time: 7 p.m.
Held at: Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.
Lecture: The All Transistor Receiver: Where do we stand?
By: A. Landman.

New!

from

CONTINENTAL

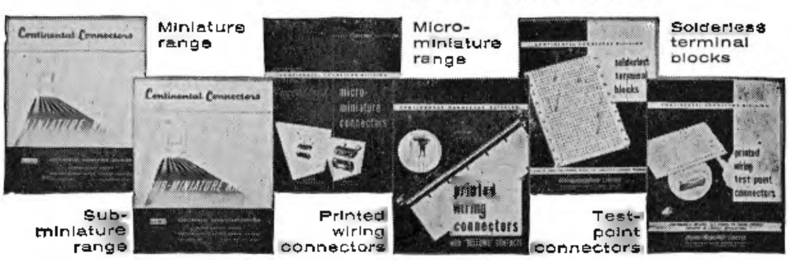
EIGHT-WAY TEST-POINT CONNECTOR



The new eight-way test-point connector is the first of a new series being made available for use with printed wiring boards. It enables test points to be conveniently located on the printed board so that measurements can be made with the board in position.

This connector uses the new accepted standard of ·150″ pitch and employs the closed entry ring contact, which will accept and hold securely a test probe of ·062″ diameter.

ASK FOR THESE BOOKLETS NOW



WRITE TO

CONTINENTAL CONNECTORS LTD.
Industrial Estate, Long Drive
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(associated with the
Ultra Group of Companies)

Continental Connectors

MCN 102

The following pages *contain French and German translations of our "Electronic Equipment" pages and summaries of the main articles. It will be noted that each item in the "Electronic Equipment" Section concludes with a number. These numbers are for the use of readers who require further information about particular items and should be quoted on the Reader Information Service Card at the end of the journal.*

Advertisement pages, facing matter, can be included in this Language Section for British and Overseas advertisers. Details on application to "The Advertisement Manager".

Les pages qui *suivent contiennent des traductions en français et en allemand de nos pages d'ÉQUIPEMENT ELECTRONIQUE, ainsi que des resumés des principaux articles.*

On remarquera que chaque article dans la section ÉQUIPEMENT ELECTRONIQUE se termine par un numéro. Ces numéros sont à l'usage des lecteurs qui pourraient avoir besoin de renseignements complémentaires au sujet de certains de ces articles et ils doivent donc être rappelés sur la carte du "Service de Renseignements aux Lecteurs" à la fin de la revue.

Des pages d'annonces et de publicité en regard d'elles peuvent être réservées dans cette Section Etrangère aux annonceurs britanniques et d'outre-mer. Pour plus de détails, s'adresser au Chef de la Publicité.

Auf den folgenden *Seiten bringen wir französische und deutsche Übersetzungen der Seiten „Elektronische Geräte" und der Zusammenfassungen der Hauptbeiträge.*

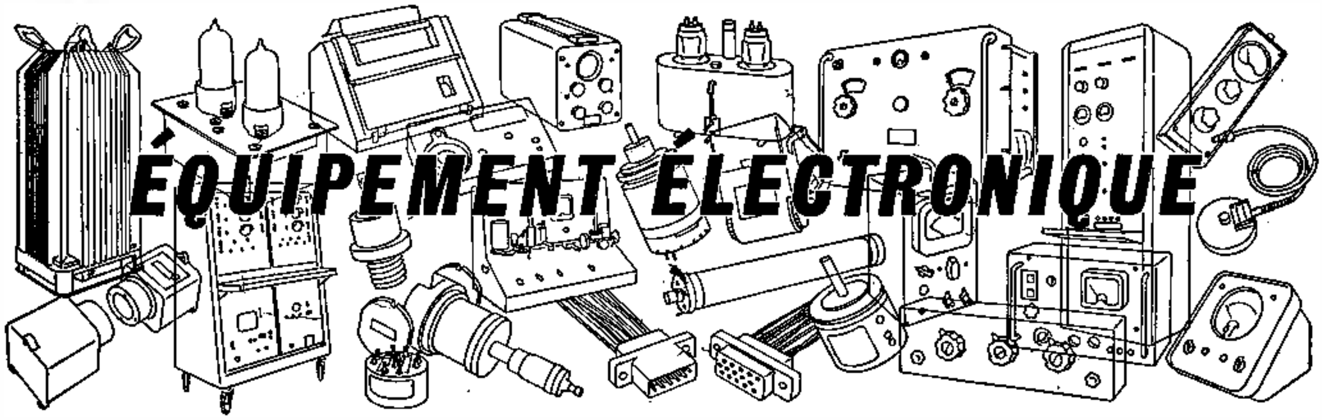
Am Fusse jeder Beschreibung in der Rubrik „Elektronische Geräte" steht eine Nummer. Leser, die an weiteren Auskünften über bestimmte Geräte interessiert sind, werden gebeten, diese Nummer auf der Leserdienstkarte am Ende des Heftes anzugeben.

Anzeigen britischer und ausländischer Firmen können auf Seiten gegenüber fremdsprachigem Text erscheinen. Einzelheiten bitten wir vom „Leiter der Anzeigenabteilung" anzufordern.

Electronic Engineering

28 ESSEX ST., STRAND, LONDON, W.C.2, ENGLAND

Telephone: CENtral 6565 *Telegrams: 'Lectroning, Estrand, London'*



Une description basée sur des renseignements fournis par les fabricants de nouveaux organes, accessoires et instruments d'essai

Traduction des pages 788 à 791

ATTÉNUATEUR

Airmec Ltd, High Wycombe, Buckinghamshire

(*Illustration à la page 788*)

Conçu selon les normes des P.T.T., cet atténuateur est destiné à l'utilisation dans des circuits de 75 ohms. Quatre sélecteurs rotatifs assurent une atténuation totale de 0 à 70 dB par degrés de 0,5 dB, de la plus haute précision. Du courant continu à 100 kHz, la section de 0,5 dB a une précision de ±0,015 dB, la section de 2dB a une précision de ±0,03dB et les deux sections de 10dB ont une précision de ±0,1dB chacune. A 30MHz, l'erreur de chaque section est de ±0,1dB et l'erreur totale est généralement inférieure à la somme des erreurs admissibles dans chaque section. L'erreur supplémentaire à 100MHz ne dépasse pas 1dB.

Grâce à un choix judicieux des valeurs de résistance et à la conception des extrémités, l'imprécision de zéro et les pertes de retour sont réduites au minimum. Les extrémités d'entrée aussi bien que celles de sortie peuvent recevoir les prises coaxiales libres courantes de l'administration des postes du type W.1.

Les dimensions hors-tout de l'appareil sont de 15,8 cm × 12 cm. × 6 cm. Un écusson à part et une variété de trous de fixation à prises permettent d'incorporer facilement l'atténuateur à des installation complètes. Pour l'usage d'établi, les trous de fixation sont fermés par des vis de nylon assurant l'isolement électrique de l'atténuateur.

EE 28 751 *pour plus amples renseignements*

OSCILLOSCOPE TRANSISTORISÉ

Microcell Ltd, Blackwater Industrial Estate, Camberley, Surrey

(*Illustration à la page 788*)

Un usage maximum a été fait dans cet oscilloscope des semi-conducteurs et des circuits imprimés.

Le courant lui est fourni par son bloc intérieur d'éléments rechargeables de zinc argenté de grande capacité. Un circuit de charge incorporé peut, en outre, être branché sur l'alimentation secteur. Le bloc à piles assure 8 heures d'utilisation continue en l'absence d'une alimentation secteur appropriée.

L'amplificateur Y a une largeur de bande allant du courant continu à 10 MHz (−3dB) et sa sensibilité varie de 100 mV/cm à 100 V/cm. L'amplificateur X a une largeur de bande allant du courant continu à 5 MHz et sa sensibilité varie de 300 mV/cm à 1,5 V/cm. La base de temps a une gamme de balayage variant entre 10 μsec et 3 sec et un dispositif d'extension ×5. Il est prévu pour le fonctionnement par déclenchement ou synchronisation.

EE 28 752 *pour plus amples renseignements*

SÉLECTEUR DE POSITION ROTATIF

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(*Illustration à la page 788*)

La susdite société a mis au point, en collaboration avec le Ministère de l'approvisionnement, un dispositif télécommandé trouvant des applications dans de nombreux domaines où il est nécessaire de faire tourner un axe avec un degré élevé de précision, en particulier les émetteurs et récepteurs multivoies.

Le sélecteur a été étudié pour faire tourner un axe sur n'importe laquelle des douze positions prévues, chacune d'elles étant fixée indépendamment, avec une précision de près de six minutes d'arc. Il est fourni pour le fonctionnement sur 12 à 48V c.c. en deux dimensions de panneau (10,1 × 10,1 cm ou 8,2 × 11,1 cm) et un moment de torsion de 390 g-cm ou de 670 g-cm.

L'indication visible de l'avant du panneau montre la position choisie, cependant qu'un commutateur incorporé peut être employé pour confirmer la position à l'emplacement de télécommande. Un autre commutateur incorporé permet d'actionner en succession un nombre de sélecteurs.

Tous les matériaux employés dans ce dispositif sont conformes à la Spécification DEF-5000. La gamme opérationnelle de températures va de −40°C à 70°C.

EE 28 753 *pour plus amples renseignements*

CONTRÔLEUR DE LAMPES

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(*Illustration à la page 788*)

L'appareil de contrôle type 45C peut contrôler plus de 5000 types différents de lampes, britanniques, américaines et continentales. Deux gammes de conductance mutuelle sont prévues, à savoir 0 à 3mA/V et 0 à 15mA/V et on peut également contrôler les courts-circuits interélectrodes, les fuites et émissions de cathodes. Un adapteur à part de tube cathodique, modèle 445, peut être fourni (voir la gravure). Il comprend une base spéciale pour tubes de 110° à angle étendu. Ce nouvel appareil se caractérise en particulier par son dispositif incorporé de contrôle de lampes de radio d'automobiles de 12 volts.

Les lampes peuvent être vérifiées rapidement, même par des opérateurs non qualifiés, en raison de la simplicité du fonctionnement de cet appareil. D'autre part, le dispositif de mesure à bobine mobile permet "d'équilibrer" les lampes ou de les comparer pour des circuits push-pull. Le contrôleur 45C comporte 21 porte-lampes et il est livré complet avec manuel d'emploi et notice de caractéristiques des lampes.

EE 28 754 *pour plus amples renseignements*

DÉMODULATEUR DE TÉLÉVISION

Distribué par: Aveley Electric Ltd, South Ockendon, Essex

(*Illustration à la page 789*)

Le démodulateur de télévision type AMF, fabriqué par Rohde & Schwartz, est un récepteur de contrôle de haute qualité pour les signaux sonores et visuels de l'émetteur de télévision. Il est fourni en modèles pour Bande I, Bande III, Bande IV et Bande V.

Il peut être affecté aux usages suivants sur les émetteurs de télévision:

(a) Représentation de la réponse transitoire de l'émetteur d'image; mesure de la réponse de vidéo-fréquence, du temps de phase et de propagation de groupe.

(b) Vérification de préégalisation de phase vidéo.

(c) Mesure de distorsion d'échelle grise.
(d) Contrôle de la modulation de l'émetteur afin de maintenir 10% de courant porteur résiduel.
(e) Contrôle de la qualité de l'image durant l'émission. Sur les émetteurs de son, il peut être utilisé pour:
(a) La mesure de réponse d'audio-fréquence.
(b) La mesure de la distorsion de modulation.
(c) La mesure du rapport bruit/signal interporteuse.
(d) Le contrôle de la qualité du son pendant l'émission.

EE 28 755 *pour plus amples renseignements*

CONTRÔLEUR-INDICATEUR DE TEMPÉRATURE

Fielden Electronics Ltd, Wythenshawe, Manchester

(Illustration à la page 789)

Un nouveau contrôleur-indicateur électronique de température est offert maintenant dans la gamme des instruments Fielden Bikini pour mesurer la température.

A l'instar de l'indicateur Bikini, il est logé dans un coffret de 15 cm de diamètre pour montage sur panneau et il a une échelle de 33 cm étalonnée dans n'importe laquelle des 73 gammes normales pour des températures allant de −200°C à +850°C (−330°F à 1 550°F). Le point de contrôle est réglé par une aiguille dirigée à partir du bouton au centre du cadran, tandis que l'aiguille indicatrice est entraînée par moteur à partir d'un système d'asservissement.

L'instrument est entièrement transistorisé et ne nécessite aucun entretien. Il fonctionne sur courant continu de 12 volts ou l'alimentation secteur habituelle.

L'ampoule de mesure à platine de résistance, utilisée avec l'indicateur-contrôleur, est logée dans un robuste fourreau d'acier inoxydable de 6,3 mm de diamètre et elle peut être placée à n'importe quelle distance de l'instrument allant jusqu'à 91,5 m. Le relais de contrôle, dont les contacts ont une capacité nominale de 10 A afin d'assurer tant la commutation "de passage" que celle d'ouverture normale du circuit, peut être fixé, le cas échéant, à une distance de l'instrument pouvant atteindre 91,5 m ou davantage.

La précision de l'étalonnage serait de ±0,5% et la répétabilité de 0,25°C dans la plupart des gammes, ainsi que l'assure le fabricant.

EE 28 756 *pour plus amples renseignements*

AMPLIFICATEUR DE DONNÉES

Blackburn Electronics Ltd, Brough, Yorkshire

(Illustration à la page 789)

Cet amplificateur transistorisé de données a été mis au point pour pouvoir réaliser l'amplification de précision de signaux de sortie microvolts provenant de transducteurs de systèmes de commande et d'instrumentation. L'entrée, qui est entièrement flottante, a un rapport de rejet de mode commun de 10^6: 1 au courant continu, et une impédance de 3 Mégohms qui empêche l'appareil de charger la source de signaux. Le bruit et le glissement totaux dans l'amplificateur sont inférieurs à 5μV. Le gain de l'appareil peut être commuté de 10 à 1000, et il a une linéarité de 0,1% avec une puissance de sortie maxima de ±10V à 0,5A.

EE 28 757 *pour plus amples renseignements*

ENREGISTREUR DE NIVEAU

Distribué par: B. and K. Laboratories Ltd, 4 Tilney Street, Park Lane, London W.1

(Illustration à la page 789)

L'enregistreur de niveau à action rapide type 2305, construit par Bruel & Kjær du Danemark, est un perfectionnement de leur enregistreur antérieur, type 2304. Il comporte un nombre d'innovations qui étendent considérablement la variété de ses applications.

Le type 2305 couvre la gamme de fréquences de 10 Hz à 200 kHz jusqu' à 0,2 dB, ainsi que le courant continu, et il peut enregistreur n'importe quel niveau de tension de 5 mV à 100 V. Une de ses innovations est constituée par l'inclusion de 3 circuits redresseurs à deux alternances permettant d'obtenir la moyenne efficace réele et la détection de pointe du signal d'entrée, tandis que le type 2304 ne donne que le redressement d'une seule alternance de pointe. Il se caractérise aussi par deux largeurs d'écriture de 100 mm et de 50 mm.

En augmentant le nombre de lamelles sur le potentiomètre de 108 à 216 on a obtenu également un plus grand pouvoir de séparation, de sorte que les neuf vitesses d'enregistrement du type 2304 ont été portées à quinze, couvrant les deux largeurs de papier à des vitesses de 2 mm/sec à 200 mm/sec. D'autre part, par l'adjonction d'un simple dispositif, on peut effectuer l'enregistrement direct de diagrammes polaires sans avoir besoin d'appareillage supplémentaire.

Ces perfectionnements électroniques vont de pair avec de nouvelles caractéristiques mécaniques. Lorsque le moteur est relié à d'autres intruments B & K, il entraîne le mécanisme d'accord de l'oscillateur ou de l'analyseur respectifs, permettant ainsi d'obtenir automatiquement les vitesses synchronisées de papier enregistreur étalooné à une fréquence préimprimée ainsi que le mécanisme d'accord. Un embrayage à friction facilite le déroulement synchrone du papier en fonction du mécanisme d'accord.

Lorsque le type 2305 est employé pour le contrôle de production ou au laboratoire, un dispositif incorporé permet de faire passer un diagramme, et lorsqu'il y a lieu d'enregistrer plusieurs courbes sur le même diagramme, le moteur peut être inversé et le passage d'un diagramme peut être recommencé sans perdre la synchronisation.

Un système mécanique permet de lever la plume du papier, dont le bord extérieur est marqué en fonction des "événements" au moyen d'un bouton marqueur. Ce dernier, ainsi que l'embrayage du moteur d'entraînement du papier, peuvent être télécommandés. Le type 2305 comporte en outre deux commutateurs incorporés, dont l'un commande l'entraînement électromécanique du spectromètre **B & K** type 2111 et l'autre assure, le cas échéant, la commutation successive de deux entrées différentes dans une seule sortie.

EE 28 758 *pour plus amples renseignements*

APPAREILS DE MESURE POUR PANNEAUX

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Illustration à la page 790)

La série des appareils de mesure pour panneaux 'VISTA' est de conception moderne et comporte le mouvement de mesure à pôle central dont la renommée est désormais bien établie. La gamme de sensibilités c.c. de ces appareils s'étend de 1 μA à des valeurs supérieures.

Quatre modèles sont fournis, dont les longueurs d'échelle nominales vont de 4,12 cm à 11,4 cm. La base de tous les instruments est ainsi faite que les appareils de mesure sont interchangeables avec les appareils de forme classique de la gamme précédente. Les modèles livrables comprennent ceux à c.c. ou c.a. à bobine mobile, avec redresseurs, thermocouple de 10 mA à 5 A, et les types à fer mobile de 10 A à 50 A. Des échelles à miroir et des échelles spéciales répondant aux besoins particuliers du client peuvent être fournes en plus des aiguilles du type à lame de couteau ou à "bêche".

EE 28 759 *pour plus amples renseignements*

BLOC D'ALIMENTATION STABILISÉE

Servomex Controls Ltd, Crowborough, Sussex

(Illustration à la page 790)

Le bloc d'alimentation universel **DC105** a été étudie pour être incorporé à d'autres appareils. Il fournit une alimentation en courant continu positive aussi bien que négative à 300 V, 50 mA. De plus, il comporte deux sorties de courant alternatif de 6,3 V, 2 A.

Onze réglages sélecteurs de tension permettent de couvrir des tensions de sortie s'étendant de 150 V à 250 V, et le stabilisateur est prévu pour le fonctionnement continu avec changements pouvant atteindre ±7% de la valeur nominale.

Le facteur le stabilisation est d'environ 200 pour l'alimentation positive et de 400 pour l'alimentation négative, l'impédance de sortie étant inférieure à 1 ohm du courant continu à 100 kHz. Le bourdonnement et le bruit sur les sorties de courant continu sont inférieurs à 2mV efficaces.

EE 28 760 *pour plus amples renseignements*

PONT D'INDUCTANCE DIFFÉRENTIELLE

Furzehill Laboratories Ltd, 57 Clarendon Road, Watford, Hertfordshire

(Illustration à la page 790)

Cet instrument utilise un circuit en pont de Hay dont l'inductance inconnue est compensée par un condensateur classique en polystyrène. Les bras de rapport sont constitués par des résistances bobinées à émail vitreux, étudiées pour pouvoir porter un courant continu polarisateur important (fourni par une source extérieure).

L'équilibre réactif et résistif est rapidement déterminé grâce à l'indicateur de zéro logarithmique incorporé. Le cadran réactif est étalonné directement en inductance tandis que l'équilibre résistif est étalonné en résistance dont le facteur de qualite de l'inductance est aisément déterminé pour la fréquence utilisée.

La puissance de sortie du pont est introduite dans l'indicateur de zéro au moyen d'un amplificateur accordé afin d'éliminer d'éventuelles erreurs dues aux harmoniques produits par la distorsion de fer dans la bobine d'inductance soumise à l'essai ou les impuretés dans la forme d'onde d'entrée. L'amorçage de courant alternatif interne se fait à la fréquence secteur mais le pont a été étudié pour pouvoir recevoir une excitation extérieure à n'importe quelle fréquence dans la gamme de 25 à 3 000 Hz. La tension parcourant effectivement l'inductance soumise à l'essai peut être contrôlée en utilisant l'indicateur de zéro comme voltmètre électronique.

La gamme couverte par le pont est de 0,05 à 500 H.

EE 28 761 *pour plus amples renseignements*

KLYSTRON DE GRANDE PUISSANCE

English Electric Valve Co. Ltd, Chelmsford, Essex

(Illustration à la page 790)

Le klystron K347 English Electric est, affirme-t-on, le premier klystron de grande puissance spécifiquement prévu pour les radars commerciaux. Grâce à son impulsion appliquée de 6 μsec et son facteur d'utilisation de 0,0024, le K347 fournit une puissance de sortie de pointe de 600 kW pour un gain de puissance de 33 dB, l'efficacité étant de 40%.

Cet amplificateur klystron accordable, à cavité extérieure et refroidissement par air forcé, a été réalisé principalement pour les impulsions de radars de veille d'aéroports et appareils analogues fonctionnant dans la gamme de fréquences de 580 à 615 MHz.

Il est muni de trois cavités d'accord à part, accordées à la gamme de fréquences au moyen de noyaux plongeurs glissants. En raison de cette construction, tous les dispositifs d'accord sont complètement externes à l'enveloppe de vide. Les frais de remplacement se limitent au tube uniquement et ceci garantit une économie considérable au terme de la durée du tube.

Des opérations d'accord répétées, afin de répondre aux besoins opérationnels changeants, peuvent être effectuées sans crainte d'endommager le tube, de sorte qu'en plus de sa souplesse de fonctionnement, le dispositif d'accord extérieur réduit le risque de panne du tube.

En application, ce klystron convient particulièrement à l'emploi avec des appareils de radar d'aérodromes se prêtant à la représentation de cibles mobiles, pour permettre au radar de séparer une masse d'échos permanents et de rendre ainsi l'écran libre pour le report d'avions.

A la gamme de fréquences à laquelle le K347 fonctionne, les avions ne sont pas obscurcis par une précipitation quelconque, quoique des pluies très fortes puissent être distinguées sur l'écran.

Notre gravure montre le K347 monté dans l'étage de sortie d'un émetteur de radar Marconi; les bobines de solénoïdes ont été abaissées et les cavités ont été enlevées et placées au premier plan.

EE 28 762 *pour plus amples renseignements*

APPAREIL DE CONTRÔLE NUMÉRIQUE DE RÉSISTANCE

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustration à la page 790)

L'appareil de contrôle numérique de résistance type EM1006 constitue un moyen précis et rapide pour mesurer la déviation de pourcentage d'une résistance par rapport à sa valeur nominale.

La valeur nominale d'une résistance soumise à l'essai est choisie à l'aide de trois commutateurs, la valeur choisie étant clairement indiquée par l'opérateur sous forme numérique. L'appareil mesure la résistance au reçu d'un signal d'instruction, la déviation de la valeur nominale préréglée étant indiqué numériquement ainsi que la polarité de la déviation. L'ordre d'indication numérique peut être donné de trois manières différentes, à savoir, manuellement, intérieurement à des vitesses de répétition variant de 1 à 10 sec. ou par fermeture de contact à distance.

Le temps de lecture de l'appareil est de 0,2 secondes par résistance. Ainsi, s'il est utilisé en liaison avec un enregistreur, une vitesse maxima de cinq résistances par seconde peut être enregistrée. Il peut contrôler des résistances de 10 ohms à 15,9 mégohms et la déviation maximum pouvant être indiquée est de ±9,9%. La précision et la stabilité sont garanties comme étant supérieures à 0,1%.

EE 28 763 *pour plus amples renseignements*

INDICATEURS DE TEMPS

Industrial Instruments Ltd, 9 Paved Court, Richmond, Surrey

(Illustration à la page 791)

Une série d'indicateurs électro-chimiques compacts de temps écoulé vient d'être lancée par la société Industrial Instruments Ltd. pour enregistrer la durée totale de fontionnement d'installations électriques.

Ces indicateurs, appartenant à la gamme Selachron, ont été étudiés pour être utilisés soit sur courant alternatif soit sur courant continu. Leurs dimensions se prêtent à l'emploi avec des tensions de 6 à 300 Volts, rendant ainsi superflus tous commutateurs ou relais supplémentaires et permettant de les relier aux bornes de l'installation dont on veut minuter la durée de fonctionnement. Les nouveaux indicateurs n'ont pas de parties mobiles et se composent de cartouches contenant de petites cellules électrochimiques remplaçables, comportant une anode, une cathode et un électrolyte. L'anode se consume à mesure que le courant passe par la cellule, la longueur diminuant par rapport au nombre d'heures accumulées de fonctionnement qui sont indiquées par une échelle étalonnée le long de l'anode.

EE 28 764 *pour plus amples renseignements*

CONNECTEURS À BROCHES MULTIPLES

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(Illustration à la page 791)

Les connecteurs en aluminium Mark 6 comportent diverses innovations ainsi qu'un nombre beaucoup plus grand de contacts que les autres connecteurs Plessey de même grandeur.

Ils sont livrables en quatre grandeurs de cuirasse avec un élément fixe et un élément libre dans chaque grandeur. Les deux éléments s'obtiennent soit avec prise soit avec fiche et peuvent être convertis facilement en éléments coupleurs en leur fixant des raccords de câble. Un moulage unique de caoutchouc au silicium assemblé au carter forme l'isolateur de manière à blinder entièrement chaque contact individuel, joint de câble une partie du diélectrique de câble.

La résistance d'isolement entre le contact et la masse dans toute la gamme dépasse 10^5 Mégohms à 500 V.

Les contacts sont en laiton argenté et les prises de courant sont prévues pour donner un contact de ligne avec des charges de couplage égales, quelle que soit la durée d'embrayage. Un dispositif empêchant l'endommagement est également incorporé à toutes les prises.

Une capacité nominale de tension standard de 1 kV efficace, quel que soit le genre de contact, s'applique à toutes les quatre grandeurs de connecteurs, au niveau du sol, tombant à 350 V à des altitudes de 21 336 mètres ou dans des conditions équivalentes.

Les valeurs nominales du courant vont de 5 à 12 A et les connecteurs se sont avérés satisfaisants pour le fonctionnement dans des températures ambiantes de −55°C à +155°C.

Une caractéristique inédite de ces nouveaux connecteurs permet de les utiliser dans quatre positions différentes en faisant varier la positions des couplages à baïonnette. Cette caractéristique empêche les erreurs de couplage à des éléments inappropriés ainsi que les erreurs d'accouplement.

EE 28 765 *pour plus amples renseignements*

DÉCALEUR DE TRACE

Cawkell Research & Electronics Ltd, Scotts Road, Southall, Middlesex

(Illustration à la page 791)

Nous nous excusons vivement d'avoir publié par erreur, à la page 727 de notre numéro de Novembre, la gravure d'un instrument ne se rapportant pas à celui décrit sous le susdit titre. La gravure appropriée se trouve à la page 791.

EE 28 766 *pour plus amples renseignements*

OSCILLATEURS D'ÉTABLI POUR MICRO-ONDES

Flann Microwave Instruments Ltd, 9 Old Bridge Street, Kingston-on-Thames, Surrey

(Illustration à la page 791)

Une série de trois cavités est réalisée par cette société, dont les modèles CLL et CLS sont du type classique. Ces deux cavités utilisent les kylstrons à fiches, types 6BM6A et R9559, et elles sont accordées avec des pistons non-contactants du type S. Elles "couvrent" les gammes de fréquences de 850 à 3200 MHz et de 1 300 à 5 500 MHz respectivement. Les changements de fréquence sont indiqués directement sur des cadrans de grand diamètre à longueurs d'échelles effectives (vernier compris) d'environ 121,9 cm.

La puissance de sortie des cavités est prise au moyen d'une sonde et d'un dispositif à collet fendu que l'opérateur règle à partir du panneau frontal de l'appareil.

Le modèle CLX, à gamme de fréquences maxima, soit 4,2 à 12 MHz, est une cavité à ligne coaxiale plus compliquée et moins classique. Le niveau de sortie de la cavité est fixe car la puissance est accouplée à travers le piston qui fait fonction de filtre passe-bande. La cavité a été réalisée de façon à supprimer le croisement du mode et les résonances de lignes radiales aux fréquences élevées qui limitent généralement l'utilité des oscillateurs coaxiaux ordinaires.

Tous les instruments sont fournis complets avec klystrons en coffrets à panneaux inclinés d'une largeur courante de 48,2 cm, et électrodes klystrons rattachées individuellement aux bornes sur le panneau frontal. Des connecteurs du type N sont employés exclusivement.

Dans toutes les cavités le plus grand soin a été pris en vue d'assurer les valeurs Q maxima, un bon contact et un niveau réduit de fuite extérieure (ne dépassant pas 100 dB lorsque la puissance de sortie va dans un câble coaxial solide).

EE 28 767 *pour plus amples renseignements*

BLOCS D'ALIMENTATION MINIATURES

Distribué par: Metrix Instruments Ltd, 54 Victoria Road, Surbiton, Surrey

(Illustration à la page 791)

Une série de sous-ensembles miniatures a été ajoutée à l'assortiment de blocs d'alimentation stabilisée à transistors fabriqués par Belix Co. Ltd., et distribués par Metrix Instruments Ltd.

Prévus pour l'utilisation dans les espaces restreints, ces éléments, dont les dimensions totales ne sont que de 11,4 cm × 10,1 × 8,8 cm, peuvent être fournis avec tensions de sortie fixe ou à variation continue de 0 à 24 volts, à des valeurs nominales de courant de 100 mA, 300 mA ou 500 mA. Il existe également des blocs simples ou doubles, avec n'importe quelle tension de sortie préréglée, dans la gamme de 0 à 24 V à 1 A maximum, le réglage du potentiomètre donnant une variation de ±0,5 V par rapport au chiffre spécifié.

Des chiffres de stabilité considérablement supérieurs à 0,1% ont été atteints, et le bourdonnement est inférieur à 0,5 mV de crête a crête dans toutes les conditions.

EE 28 768 *pour plus amples renseignements*

Résumés des Principaux Articles

L'Analyseur différentiel numérique CORSAIR par P. L. Owen, M. F. Partridge et T. R. H. Sizer

Le principe de fonctionnement des analyseurs différentiels est la réduction de tout calcul à une seule opération d'intégration. Les variables peuvent ainsi être intégrés par rapport à des valeurs autres que le temps et c'est précisément cet particularité qui permet au calculateur de résourde des problèmes non-linéaires.

L'intégration numérique se fait par la sommation de rectangles dans un processus échelonné. Les vitesses électroniques de l'opération permettent de présenter des valeurs continues avec grande précision. Les intégrateurs sont reliés entre eux par des impulsions émettrices qui représentent les augmentations de la valeur calculée.

Dans l'analyseur CORSAIR, l'état de chaque intégrateur est décrit au moyen de deux chiffres en code linéaire emmagasinés dans une matrice à noyau de ferrite. Ces paires de chiffres sont lus successivement et un processus d'intégration s'effectue dans un élément arithmétique central à partage de temps.

Résumé de l'article aux pages 740 à 745

Un circuit réversible à tubes Dékatron par A. J. Oxley

Cet article décrit un compteur réversible fabriqué avec des tubes Dékatron du type à action lente (CS10C, GC10B, etc.) La vitesse est donc limitée à environ 4 kHz, mais les mêmes principes pourraient être appliqués à un compteur utilisant les tubes à action rapide (GS10D). Le fonctionnement du circuit est expliqué et un aperçu est donné de son application originale. Les erreurs éventuelles pouvant résulter d'un comptage de signes opposés se suivant de trop prés sont ensuite examinées en détail et la conclusion est tirée que, dans une limite spécifiée, le circuit peut être rendu exempt d'erreurs logiques pour de telles entrées.

Résumé de l'article aux pages 746 à 749

Un générateur de fonctions à très basse fréquence par L. Whitlow

Résumé de l'article aux pages 750 à 752

Cet article traite d'une méthode pour la synthétisation d'une fonction de temps à répétition par 100 étapes ou 100 paliers. La gamme de fréquences est de 0,025 à 15 Hz et les variations de la fonction de sortie sont inférieures à 0,5%.

Le comportement thermique et optique des phototransistors par D. Shaw et B. Crump

Résumé de l'article aux pages 753 à 757

Les caractéristiques thermiques et optiques de deux phototransistors ont été étudiées afin de faciliter la réalisation de têtes photo-électriques destinées à être employées dans des conditions industrielles astreignantes.

On a ainsi mis au point les circuits d'un phototransistor, permettant l'utilisation de relais dans des températures ambiantes pouvant atteindre 55°C.

Pour la mesure précise de positions, les caractéristiques optico-mécaniques ne sont pas stables à plus de ± 1.5mm, de sorte que l'étalonnage individuel est nécessaire pour obtenir un degré élevé de précision. Cette condition devient plus ardue encore si l'on emploie un mouvement bi-directionnel à indication par relais, les erreurs types s'élevant alors à ± 2.5mm.

Un second phototransistor permet le fonctionnement dans une température ambiante atteignant 90°C au minimum, mais il est environ 1000 fois moins sensible que le premier, tout au moins dans sa formeactuelle.

Deux circuits d'alimentation stabilisée de ±300 Volts à transistors par J. S. Bell et P. G. Wright

Résumé de l'article aux pages 758 à 761

Cet article traite de deux méthodes pour obtenir des alimentations stabilisées de ±300V à partir d'une source commune de basse tension. Le premier circuit décrit est d'un type inédit dont la conception n'est basée que sur des recherches préliminaires car il y a encore des possibilités considérables d'en améliorer le dessin. Le second circuit qui, lui, a fait l'objet d'une étude approfondie, se rapproche de la forme habituelle de stabilisateur série, adapté à l'emploi généralisé de transistors.

Aucun des deux circuits n'est restraint qu'aux seules alimentations de double tension. Celui du premier type ne nécessite que de légères modifications pour comporter des sorties uniques positives ou négatives, tandis le circuit du second type se compose déjà de deux stabilisateurs identiques, alimentés par un convertisseur commun.

Enregistrement sur large bande magnétique pour installation d'instruments par J. P. Pritchard

Résumé de l'article aux pages 762 à 766

Cet article traite d'un enregistreur sur large bande magnétique d'une installation d'instruments Ampex, réalisé à partir de l'Enregistreur de Télévision "Videotape". L'appareil est décrit en termes généraux, ainsi que les conditions essentielles exigées d'un appareil pour l'enregistrement et la reproduction d'un signal continu à large bande, nominalement entre le courant continu et 4 MHz. Une description détaillée est donnée du modulateur, du démodulateur ainsi que du dispositif de commutation du signal. L'importance de la base de temps enregistré est soulignée et ceci est suivi d'une analyse des méthodes utilisées pour assurer une reproduction précise du signal enregistré pendant le ré-enregistrement.

Un générateur de spectre portatif à haute fréquence pour l'étalonnage d'antenne par N. Burtnyk

Résumé de l'article aux pages 767 à 769

L'auteur décrit un générateur de spectre portatif à faible puissance pour l'étalonnage d'antenne. L'intensité de champ rayonnée à 12m dans un sol de mauvaise conductibilité est de l'ordre de 150 V/m à des intervalles de fréquence de 200kHz dans le spectre de haute fréquence. Un circuit de déclenchement piloté par quartz assure une stabilité suffisante pour empêcher tout vacillement audible de l'harmonique de 30 MHz.

Production de bruits par câbles coaxiaux soumis aux vibrations par R. D. Hole

Résumé de l'article aux pages 770 à 771

Après un bref exposé des facteurs régissant la production des bruits et la théorie y relative, l'auteur décrit les méthodes utilisées actuellement pour surmonter ces phénomènes. Il préconise deux modes de traitement des câbles qui sont, théoriquement tout au moins, préférables aux techniques employées jusqu'ici et présentent de gros avantages lorsque le diamètre et la capacité par pied de câble sont de première importance.

La mesure et la spècification d'inductance de bobines miniature à noyau de fer et de transformateurs par E. A. Grover

Résumé de l'article aux pages 772 à 773

Les selfs de choc et les transformateurs miniature et subminiature dont l'emploi était jusqu'a il y a quelques années limité a une ou deux industries spécialisées, sont maintenant d'un emploi généralisé et trouvent des applications dans les domaines les plus divers de l'électrotechnique.

L'introduction du transistor, suivie par la demande d'autres pièces de circuit de grandeur comparable, sont dans une grande mesure à l'origine de ce succès. Malgré leur emploi accru, cependant, il eixste encore pas mal de confusion quant aux méthodes généralment appliquées pour spécifier et mesurer leur inductance.

Cet article décrit deux méthodes de mesure et leurs rapports mutuels.

Systemes de lecture pour échelles de comptage à transistors par T. C. Benbow

Résumé de l'article aux pages 774 à 776

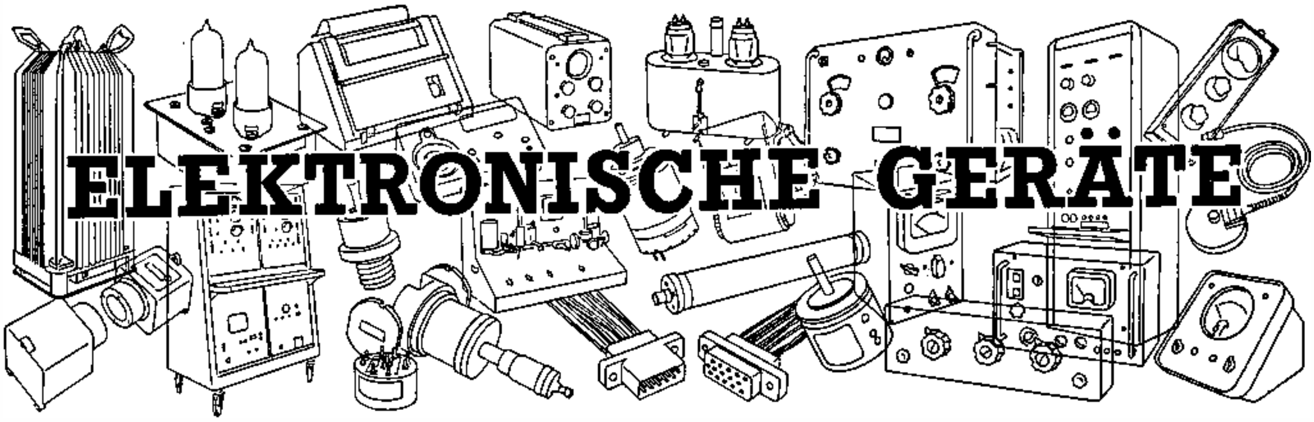
Trois types d'affichage de lecture à mouvement d'appareil de mesure, lampe à filament et lampes au néon, sont étudiés en vue de leur utilisation avec les échelles de comptage actionnées par transistors, concues et fabriquées par A.W.R.E., Aldermaston. Des circuits pratiques sont présentés pour le système le plus en faveur, à savoir celui des lampes au néon à commutation.

Un millivoltmètre numérique par G. P. Tonkin

Résumé de l'article aux pages 777 à 778

La mesure des signaux en millivolts á des vitesses allant jusqu'á six voies par seconde, avec une définition de 0,1%, peutêtre effectuée par l'enregistreur décrit dans cet article. Cet instrument utilise un système de numérotation par relais á faible niveau. á code décimal/binaire, dont les indications sont données sur machine á écrire et bande de papier perforée.

ELEKTRONISCHE GERÄTE



Beschreibung neuer Bauelemente, Zubehörteile und Prüfgeräte auf Grund der von Herstellern gemachten Angaben.

Übersetzung der Seiten 788 bis 791

ABSCHWÄCHER

Airmec Ltd, High Wycombe, Buckinghamshire

(Abbildung Seite 788)

Dieser Abschwächer ist eine Konstruktion der Postbehörden für Einsatz in 75Ω-Kreisen. Vier Drehschalter geben mit grosser Genauigkeit eine Gesamtdämpfung von 0 ... 78 dB in Stufen von 0,5 dB. Von Gleichstrom bis 100 kHz hat der 0,5 dB Teil eine Genauigkeit von ±0,015 dB, der 2-dB-Teil ±0,03 dB und die beiden 10 dB-Teile je ±0,1 dB. Bei 30 MHz ist der Fehler für jeden Teil ±0,1 dB, und der Gesamtfehler ist geringer als die Summe aller zulässigen Fehler. Der zusätzliche Fehler für 100 MHz ist nicht mehr als 1 dB.

Durch ausgesuchte Widerstandswerte und sorgfältige Konstruktion der Abschlüsse wurden Nullungenauigkeit und Fehlerdämpfung gering gehalten. Sowohl Eingangs- wie Ausgangsabschlüsse akzeptieren Post-Koaxialstecker Baumuster W.1.

Die Aussenabmessungen sind 159 mm breit, 60 mm hoch und 120 mm tief einschliesslich aller vorstehenden Teile. Mittels eines getrennten Rahmenschildes und verschiedener Gewindebefestigungslöcher kann der Abschwächer leicht in andere Geräte eingebaut werden. Für Benutzung auf dem Tisch werden die Löcher zwecks elektrischer Isolation mit Polyamidschrauben verschlossen.

EE 28 751 *für weitere Einzelheiten*

TRANSISTORISIERTER OSZILLOGRAPH

Microcell Ltd, Blackwater Industrial Estate, Camberley, Surrey

(Abbildung Seite 788)

In diesem tragbaren Oszillographen haben Halbleiter und gedruckte Schaltungen grösstmögliche Verwendung gefunden.

Die Stromversorgung des Oszillographen erfolgt durch aufladbare Silber-Zink-Zellen, für die eine Ladeschaltung eingebaut ist, die an ein geeignetes Netz angeschlossen werden kann.

Der Y-Verstärker hat eine Bandbreite von Gleichstrom bis 10 MHz (−3 dB) und eine Empfindlichkeit, die zwischen 100 mV/cm und 100 V/cm eingeregelt werden kann. Der X-Verstärker hat eine Bandbreite von Gleichstrom bis 5 MHz und eine einstellbare Empfindlichkeit zwischen 300 mV/cm und 1,5 V/cm. Das Kippgerät hat einen Ablenkbereich von 10 µs bis 3 c und einen 5 fachen Multiplikator. Es ist für Triggerung und synchronisierten Betrieb ausgelegt.

EE 28 752 *für weitere Einzelheiten*

DREHSTELLUNGSWÄHLER

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(Abbildung Seite 788)

Eine ferngesteuerte Vorrichtung mit Verwendungsmöglichkeiten auf vielen Gebieten, in denen es auf sehr genaue Verdrehung eines Schaftes ankommt, wurde von der Plessey Company in Zusammenarbeit mit dem Versorgungsministerium für mehrkanälige Sender und Empfänger entwickelt.

Das Gerät ist für Drehung eines Schaftes in jede von 12 Stellungen ausgelegt, wobei jede Stellung unabhängig mit einer Genauigkeit von sechs Bogenminuten eingestellt werden kann. Es ist für Speisung mit 12 ... 48 V Gleichspannung in zwei Frontplattengrössen (101,6 × 101,6 mm und 82,5 × 111 mm) und mit einem Drehmoment von 390 gcm oder 670 gcm lieferbar.

Die gewählte Einstellung wird auf der Frontplatte sichtbar angezeigt. Mittels eines eingebauten Schalters kann diese Einstellung vom ferngesteuerten Ort aus bestätigt werden. Ein weiterer eingebauter Schalter ermöglicht Folgesteuerung mehrerer Wählergeräte.

Alle in den Geräten benutzten Materialien entsprechen der Norm DEF 5000. Der Betriebs-Temperaturbereich liegt zwischen −40°C und +70°C.

EE 28 753 *für weitere Einzelheiten*

RÖHREN-MESSGERÄT

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Abbildung Seite 788)

Das Röhrenmessgerät Modell 45 C kann über 5000 verschiedene amerikanische, britische und europäische Röhrentypen prüfen. Zur Steilheitsmessung sind die Bereiche 0 ... 3 mA/V und 0 ... 15 mA/V vorgesehen, und die Tests erstrecken sich auch auf Kurzschluss zwischen Elektroden, Heizfaden-Kathodenisolation und Emission. In der Abbildung ist ein getrenntes Anpassungs-Modell 445 für Elektronenstrahlröhren abgebildet, das nunmehr auch eine besondere Fassung für 110° Röhren hat. Besonders wichtig sind die in dem neuen Gerät eingebauten Prüfkreise für 12 V-Röhren für Autoempfänger.

Durch die einfache Bedienung des Messgerätes können auch ungelernte Arbeitskräfte Röhren schnellstens prüfen; das Drehspulinstrument ermöglicht „Anspassen" oder Vergleichen von Röhren für Gegentaktstufen. Modell 45 C hat 21 Röhrenfassungen und wird mit Bedienungsvorschriften und Röhren-Handbuch geliefert.

EE 28 754 *für weitere Einzelheiten*

FERNSEH-DEMODULATOR

Vertrieb durch: Aveley Electric Ltd, South Ockendon, Essex

(Abbildung Seite 789)

Der von Rohde und Schwarz hergestellte Fernseh-Demodulator Typ AMF ist ein hochwertiger Monitor-Empfänger für die Ton- und Bildsignale eines Fernsehsenders. Er ist in Ausführungen für Band I, Band III und Band IV und V lieferbar.

Einsatz mit Bildsendern erfolgt für folgende Zwecke:

(a) Sichtanzeige des Frequenzganges von Einschwingvorgängen im Bildsender, Messung des Video-Frequenzganges, der Phasen- und Gruppenverzögerungszeiten.
(b) Prüfung der Phasenvorentzerrung.
(c) Messung der Verzerrung der Graustufen-Skala.
(d) Überwachung der Sendermodulation zur Aufrechterhaltung des 10% Restträgers.
(e) Kontrolle der Bildqualität während der Sendung.

Einsatz am Tonsender für:
(a) Messung des Tonfrequenzganges.
(b) Messung der Modulationsverzerrung.
(c) Messung des Geräuschabstandes zwischen Trägern.
(d) Kontrolle der Tonqualität während der Sendung.

EE 28 755 *für weitere Einzelheiten*

TEMPERATURWÄCHTER

Fielden Electronics Ltd, Wythenshawe, Manchester

(Abbildung Seite 789)

Im Fielden-Bikini-Fertigungsprogramm für Temperaturmessgeräte ist nunmehr ein neuer elektronischer Temperaturanzeiger und -regler lieferbar.

Das für Schalttafelmontage konstruierte Gehäuse hat wie der Bikini-Anzeiger einen 15 cm Durchmesser und eine 33 cm lange Skala, die für jeden der 73 Standardbereiche zwischen −200°C und +850°C geeicht werden kann. Der Sollwert wird mittels eines im Zentrum der Skala liegenden Knopfes eingestellt, während die Istwertanzeige durch Motorantrieb von einem Servosystem erfolgt.

Das Gerät ist volltransistorisiert und erfordert keine Wartung. Es kann von 12 V Gleichstrom oder dem normalen Netz betrieben werden.

Der mit dem Wächter verwendete Messfühler hat ein Platinwiderstandselement und ist in einem 6,35 mm Schutzrohr aus rostfreiem Stahl untergebracht. Der Fühler sowohl wie das Reglerrelais können bis zu 100m oder mehr vom Wächter entfernt aufgestellt werden. Letzteres hat Kontakte für 10 A Nennstrom, die sowohl Umschaltung als auch „normalerweise offen“ vorsehen.

Die Hersteller geben für die meisten Bereiche eine Eichgenauigkeit von ±0,5% der Skala und eine Reproduzierbarkeit von 0,25°C an.

EE 28 756 *für weitere Einzelheiten*

DATEN-VERSTÄRKER

Blackburn Electronics Ltd, Brough, Yorkshire

(Abbildung Seite 789)

Die Entwicklung des transistorisierten Daten-Verstärkers entspricht einem Bedarf für Präzisionsverstärkung der Mikrovolt-Ausgangssignale von Gebern in Mess- und Reglersystemen. Der völlig schwebende Eingang hat ein Störsignal-Schwächungsverhältnis von $10^6:1$ für Gleichstrom und eine Impedanz von 3 MΩ, so dass das Gerät die Signalquelle nicht belastet. Das gesamte Rauschen und die Drift sind unter 5 μV. Die Verstärkung kann von 10 auf 1000 umgeschaltet werden und hat eine Geradlinigkeit von 0,1% mit einem Ausgangsspannungsbereich von ±10 V bei 0,5 A.

EE 28 757 *für weitere Einzelheiten*

PEGELSCHREIBER

Vertrieb durch: B. and K. Laboratories Ltd, 4 Tilney Street, Park Lane, London W.1

(Abbildung Seite 789)

Der Pegelschnellschreiber Typ 2305 wird von Brühl and Kjoer in Dänemark hergestellt und ist eine Entwicklung ihres älteren Types 2304. Eine Anzahl neuer Konstruktionsmerkmale dehnen den Anwendungsbereich wesentlich aus.

Typ 2305 überstreicht den Frequenzbereich 10 Hz...200 kHz innerhalb 0,2 dB sowie Gleichstrom und zeichnet jeden Spannungspegel zwischen 5 mV und 100 V auf. Neu ist der Einbau von drei Doppelweg-Gleichrichterschaltungen, durch die die echten Effektiv-, Mittel- und Scheitelwerte des Eingangssignals nachgewiesen werden können. Typ 2304 sieht nur Einweg-Gleichrichtung der Spitzenwerte vor. Neu ist auch der Einbau von zwei Schreibweiten: 100 und 50 mm.

Durch Erhöhung der Potentiometer-Kontaktstufen von 108 auf 216 wird eine höhere Auflösung erreicht. Die neun Schreibgeschwindigkeiten von Typ 2304 wurden auf 15 erhöht, die die beiden Papierbreiten mit Geschwindigkeiten von 2 mm/s bis zu 2000 mm/s beschreiben. Eine vorgesehene einfache Einrichtung ermöglicht die Aufzeichnung von Polardiagrammen ohne Zusatzgeräte.

Die neuen mechanischen Konstruktionsmerkmale haben mit den elektronischen Entwicklungen Schritt gehalten. Bei Verbindung mit anderen B & K-Geräten kann der Motor zum Antrieb der Abstimmvorrichtung der entsprechenden Oszillatoren oder Analysatoren benutzt werden, wodurch die Geschwindigkeit vorgedruckter Registrierstreifen mit Frequenzeinteilung und der Abstimmvorrichtung automatisch synchronisiert wird. Eine Reibungskupplung erleichtert die Startsynchronisation des Registrierstreifens und der Abstimmvorrichtung.

Wenn Typ 2305 für Produktionskontrolle oder im Laboratorium eingesetzt wird, ist eine Methode nützlich, nach der mehr als eine Kurve auf einem einzigen Streifen aufgezeichnet wird. Zu diesem Zweck kann der Motor umgekehrt werden, so dass die Aufzeichnung wieder beginnt, ohne dass der Gleichlauf verloren geht.

Durch eine mechanische Anordnung kann der Schreibstift vom Papier abgehoben werden, und durch Pressen eines Knopfes „Vorgangsmarke“ wird an der Aussenkante des Papiers eine Marke erzeugt. Die letztere Einrichtung sowie die Kupplung des Papierantriebmotors können ferngesteuert werden. Im Typ 2305 sind zwei Schalter eingebaut: ein Schalter steuert den elektromechanischen Antrieb des B & K-Analysators Typ 2111, und der andere schaltet, wo erforderlich, hintereinander zwei verschiedene Eingangssignale in einen Ausgang.

EE 28 758 *für weitere Einzelheiten*

SCHALTTAFELINSTRUMENTE

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Abbildung Seite 790)

Die Schalttafelinstrumente der Vista-Serie sind von moderner Konstruktion und mit dem nunmehr gut eingeführten Mittelpol-Messwerk ausgerüstet. Sie sind mit Gleichstromempfindlichkeiten von 1 μA ab lieferbar.

Die vier neuen Modelle haben Skalenlängen von 41 bis 114 mm. Die Basis aller Instrumente ist so gehalten, dass sie gegen Standard-Messgeräte älterer Konstruktion ausgewechselt werden können. Unter den lieferbaren Geräten befinden sich Drehspulinstrumente für Gleichstrom und mit Gleichrichtern für Wechselstrom, Thermoelemente von 10 mA bis 5 A und Weicheisentypen von 10...50 A. Spiegelskalen und Sonderskalen nach Angaben unserer Kunden sowie Messer- und Spatenzeiger sind auch lieferbar.

EE 28 759 *für weitere Einzelheiten*

STABILISIERTES NETZGERÄT

Servomex Controls Ltd, Crowborough, Sussex

(Abbildung Seite 790)

Typ DC105 ist ein Mehrzwecknetzgerät für Einbau in andere Geräte. Es gibt positiven und negativen Gleichstrom von 300 V 50 mA ab.

Für Eingangsspannungen von 105 ... 250 V stehen elf Umschaltstufen zur Verfügung. Der Stabilisator kann auch bei Schwankungen von ±7% vom Nominalwert fortlaufend arbeiten. Der Stabilisierungsfaktor für die positive Spannung ist ungefähr 200 und für die negative 400. Der Ausgangswiderstand ist von Gleichstrom bis 100 kHz unter 1Ω. Restwelligkeit und Rauschen des Gleichstroms sind geringer als 2 mV_{eff}.

EE 28 760 *für weitere Einzelheiten*

ZUSATZINDUKTIVITÄTS-MESSBRÜCKE

Furzehill Laboratories Ltd, 57 Clarendon Road, Watford, Hertfordshire

(Abbildung Seite 790)

Das Gerät benutzt eine Hay-Brückenschaltung, in der eine unbekannte Induktivität gegen ein Polystyrol-Kondensatornormal abgeglichen wird. Die Verhältnisarme bestehen aus glasierten Drahtwiderständen, die für beträchtliche, von aussen angelegte Gleichstrom-Polarisationsströme bemessen sind.

Mittels des eingebauten logarithmischen Nullanzeigers wird der Abgleich sowohl für Blind- als auch ohmische Widerstände schnell eingestellt. Die Skala für den Blindwiderstand ist in Induktivität geeicht und die für den ohmischen Abgleich in Widerstandswerten, durch die das Q der Induktivität für die benutzte Frequenz einfach bestimmt werden kann.

Der Brückenausgang wird dem Nullanzeiger über einen abgestimmten Verstärker zugeführt, um alle möglichen Ungenauigkeiten durch Harmonische auszuschliessen, die durch Eisenverzerrungen im Prüfling und/oder unreine Eingangswellenformen hervorgerufen werden. Für die Netzfrequenz ist interne Erregung vorgesehen, die Brücke ist aber auch für Fremderregung zwischen 25 ... 3000 Hz ausgelegt. Durch Verwendung des Nullanzeigers als Röhrenvoltmeter kann der Spannungsabfall am Prüfling überwacht werden.

Der Messbereich der Brücke ist 0,05 ... 500 H.

EE 28 761 *für weitere Einzelheiten*

HOCHLEISTUNGSKLYSTRON

English Electric Valve Co. Ltd, Chelmsford, Essex

(*Abbildung Seite 790*)

English Electric bezeichnet Typ K347 als das erste für kommerzielles Radar entwickelte Hochleistungsklystron. Bei Beaufschlagung mit einem 6µs—Impuls und einem Tastverhältnis von 0,0024 liefert das K347 eine Spitzenausgangsleistung von 600 kW bei einer Leistungsverstärkung von 33 dB; der Wirkungsgrad ist 40%.

Dieses abstimmbare Klystron mit externem Hohlraum und zwangsläufiger Luftkühlung wurde in erster Linie für Impulsbetrieb im Flughafen-Radarleitdienst und ähnlichen Geräten entwickelt, die im Frequenzbereich 580 ... 615 MHz arbeiten.

Drei getrennte Abstimmhohlräume sind vorgesehen, die mittels gleitender Kolben über den Frequenzbereich abgestimmt werden, wobei die Abstimmvorrichtungen bei dieser Konstruktion vollständig ausserhalb des Vakuumkolbens liegen. Die Ersetzungskosten sind nur auf die Röhre beschränkt, so dass am Ende der Röhrenlebensdauer wesentliche Ersparnisse anfallen.

Wiederholte Vornahme von Abstimmungen zur Anpassung an wechselnde Betriebsverhältnisse können ohne Beanspruchung oder Beschädigung der Röhre ausgeführt werden. Dadurch wird nicht nur anpassungsfähiger Betrieb erzielt, sondern auch die Gefahr des Röhrenausfalls durch die externe Abstimmung reduziert.

Im Einsatz ist dieses Klystron besonders für Flughafen-Radarleitdienst mit Sichtanzeige für bewegliche Ziele geeignet, um Unterscheidung gegen massenhafte Dauerechos zu ermöglichen und somit das Schirmbild für die Aufzeichnung der Maschine freizulassen.

In dem von der K347 überstrichenen Frequenzbereich wird das Flugzeugecho nicht durch irgendwelchen Niederschlag verwischt, sehr schwere Regenstürme können jedoch schwach auf dem Bildschirm erscheinen.

Die Photographie zeigt das K347 in der Endstufe eines Marconi-Radarsenders. Die Spulen sind nach unten verschoben und die Hohlräume entfernt und im Vordergrund angeordnet.

EE 28 762 *für weitere Einzelheiten*

DIGITALER WIDERSTANDSTESTER

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(*Abbildung Seite 790*)

Der digitale Widerstandstester Typ EM1006 gibt schnelle und genaue Messresultate für die prozentuale Abweichung eines Widerstands von seinem Sollwert.

Der Widerstandssollwert des Prüflings wird mittels dreier Schalter eingestellt, wobei der gewählte Wert dem Benutzer klar in digitaler Form angezeigt wird. Bei Erhalt eines Befehlssignals wird der Widerstand gemessen und die prozentuale Abweichung vom vorgewählten Sollwert digital zusammen mit der Polarität der Abweichung angezeigt. Der Befehl zur Digitaldarstellung kann auf drei verschiedenen Wegen ausgelöst werden: von Hand, intern mit Wiederholungsgeschwindigkeiten, die von 1 ... 10 s einregelbar sind, oder durch ferngesteuertes Schliessen eines Kontaktes.

Die Messgeschwindigkeit des Gerätes ist 0,2 s, so dass bei Zusammenschaltung mit einem Drucker bis zu max 5 Widerstände pro Sekunde gemessen werden können. Das Gerät hat einen Widerstandsmessbereich von 10Ω ... 15,9 MΩ, und die grösste angezeigte Abweichung ist ±9,9%. Genauigkeit und Stabilität sind garantiert besser als 0,1%.

EE 28 763 *für weitere Einzelheiten*

ZEITANZEIGER

Industrial Instruments Ltd, 9 Paved Court, Richmond, Surrey

(*Abbildung Seite 791*)

Industrial Instruments Ltd haben eine Reihe kompakter, elektrochemischer Zeitfolgeanzeiger zur Aufzeichnung der Gesamtbetriebszeit elektrischer Geräte eingeführt.

Diese als Selachron-Serie bekannten Anzeiger wurden in geeigneten Formen für Gleich- oder Wechselstrom und geeigneten Grössen für Spannungen von 6 ... 300 V entwickelt. Extra Schalter und Relais werden vermieden, und die Anzeiger können direkt mit den Ausgangsklemmen des Gerätes, dessen Zeitverlauf gemessen werden soll, verschaltet werden. Die Anzeiger enthalten keine beweglichen Teile und bestehen aus Patronen, die kleine, auswechselbare elektrochemische Zellen mit Anode, Kathode und Elektrolyt enthalten. Durch den die Zelle durchfliessenden Strom wird die Anode verzehrt; ihre Verkürzung ist proportional zu den verflossenen Betriebsstunden und wird auf einer geeichten Skala angezeigt.

EE 28 764 *für weitere Einzelheiten*

MEHRFACH-STECKVERBINDUNGEN

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(*Abbildung Seite 791*)

Die Al-Steckverbindungen Baumuster 6 weisen verschiedene neue Konstruktionsmerkmale auf und bringen bei gleicher Grösse mehr Kontakte unter als andere Plessey-Stecker.

Diese Steckverbindungen sind in vier Gehäusegrössen mit einem ortsfesten und einem freien Teil für jede Grösse lieferbar. Jedes der beiden Teile kann entweder mit Steckern oder Buchsen ausgerüstet werden; durch Anbringen von Kabelbefestigungen können sie leicht in Kupplungen umgewandelt werden. Ein mit dem Gehäuse verbundener Pressling aus Silikongummi bildet den Isolator und ist so konstruiert, dass jeder einzelne Kontakt, Kabelverbindung und ein Teil des Kabeldielektrikums umhüllt sind.

Der Isolationswiderstand zwischen Kontakt und Erde ist für die ganze Bauserie über 10^5 MΩ für 500 V.

Die Kontakte bestehen aus versilbertem Messing, und die Buchsen sind so konstruiert, dass sie bei gleicher Eingriffsbelastung unabhängig vom Einsteckweg entlang einer Linie Kontakt machen. Um Beschädigung zu verhüten, ist in alle Buchsen eine Schutzvorrichtung eingebaut.

Für alle vier Steckverbindungsgrössen ist die Nennspannung unabhängig von der Kontaktklasse in Bodennähe 1 kV_{eff}, fällt jedoch für Höhen von 21 300 m oder ähnliche Bedingungen auf 350 V ab. Der Nennstrombereich geht von 5 ... 12 A, und die Steckverbindungen haben sich in Umgebungstemperaturen zwischen −55°C und +155°C bewährt.

Ein ungewöhnliches Konstruktionsmerkmal dieser neuen Verbindungen ermöglicht Verwendung in vier verschiedenen Positionen durch Positionsänderung der Bajonettkupplung. Dadurch werden auch Falschkupplungen zu falschen Teilen und falscher Eingriff vermieden.

EE 28 765 *für weitere Einzelheiten*

SPURLAGENVERSCHIEBER

Cawkell Research and Electronics Limited, Scotts Road, Southall, Middlesex

(*Abbildung Seite 791*)

Wir bedauern, dass mit unserer Beschreibung dieses Gerätes auf Seite 727 der November-Ausgabe ein falsches Foto gezeigt wurde. Die richtige Abbildung erscheint auf Seite 791.

EE 28 766 *für weitere Einzelheiten*

MIKROWELLEN-TISCHOSZILLATOR

Flann Microwave Instruments Ltd, 9 Old Bridge Street, Kingston-on-Thames, Surrey

(*Abbildung Seite 791*)

Die Firma liefert drei verschiedene Hohlraumtypen. Typen CLL und CLS sind von üblicher Konstruktion und werden mit Einsteck-Klystrons 6BM6A und R9559 benutzt. Abstimmung erfolgt mittels kontaktfreier S-Typen-Kolben über den Frequenzbereich 800 ... 3200 MHz bzw. 1,3 ... 5,5 GHz. Frequenzänderungen werden direkt auf Grossdurchmesserskalen angezeigt, deren effektive Skalenlänge einschliesslich Nonius ungefähr 122 cm beträgt.

Die Hohlraumleistung wird durch einen in einer Spannpatrone gehaltenen Stift ausgekoppelt. Diese Anordnung kann von der Frontplatte des Gerätes bedient werden.

Typ CLX ist ein Modell für den höchsten Frequenzbereich 4,2 ... 12 GHz und besteht aus einem koaxialen Hohlraum, dessen Anordnung komplexer und ungewöhnlicher ist. Da die Leistung durch den Kolben, der als Bandfilter wirkt, ausgekoppelt wird, steht der Ausgangspegel des Hohlraums fest. Sonderanordnungen gewährleisten Freiheit von Wellenkreuzungen und Radialleitungsresonanz bei hohen Frequenzen, die normalerweise die Verwendungsmöglichkeit herkömmlicher, koaxialer Oszillatoren einschränken.

Alle Geräte werden mit Klystrons bestückt in genormten, 19 Zoll (48 cm) breiten Gehäusen mit schräger Frontplatte geliefert, zu der die Anschlüsse des Klystrons einzeln herausgeführt werden. In allen Fällen werden N-Typ-Anschlüsse benutzt.

Durch umfangreiche Vorkehrungen werden für alle Hohlräume hohe Q-Werte, gute Kontakte und geringe Aussenstreuung (ungefähr −100 dB, wenn der Ausgang in eine feste koaxiale Leitung geht) gewährleistet.

EE 28 767 *für weitere Einzelheiten*

MINIATURNETZGERÄTE

Vertrieb durch: Metrix Instruments Ltd, 54 Victoria Road, Surbiton, Surrey

(*Abbildung Seite 791*)

Das Lieferprogramm von Belix Co. Ltd hergestellter und von Metrix Ltd vertriebener transistorstabilisierter Netzgeräte wurde durch eine Serie neuer Miniatur-Bausteine erweitert.

Die Gesamtabmessungen der für kleinsten Raumbedarf konstruierten Geräte sind nur 114 × 102 × 89 mm. Sie werden für vorgegebene oder stufenlos einregelbare Ausgangsspannungen zwischen 0 und 24 V mit Nennströmen von 100 mA, 300 mA oder 500 mA gebaut. Einzel- oder Doppelgeräte können auch für jede vorgewählte Ausgangsspannung im Bereich 0 bis 24 V für 1 A max mit einem Potentiometer geliefert werden, dessen Einstellung den Sollwert um ±0,5 V ändert.

Erreichte Konstanthaltungswerte sind bedeutend besser als 0,1%, und die Restwelligkeit ist unter allen Bedingungen geringer als 0,5 mV doppelter Spitzenwert.

EE 22 768 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

CORSAIR: Ein Digital-Differentialanalysator von P. L. Owen, M. F. Partridge und T. R. H. Sizer

Zusammenfassung des Beitrages auf Seite 740-745

In Differentialanalysatoren werden alle Rechnungen auf Integration als einzigen Vorgang reduziert: Variable können in Bezug auf andere Quantitäten als Zeit integriert werden, was dem Rechner ermöglicht, nichtlineare Probleme zu bearbeiten.

Digitale Integration wird durch Summierung von Rechtecken in einem Schrittverfahren durchgeführt; durch die elektronischen Arbeitsgeschwindigkeiten können fortlaufend Quantitäten mit grosser Genauigkeit dargestellt werden. Integratoren werden durch übertragungsimpulse miteinander verbunden, die den Zuwachs der errechneten Quantität darstellen.

Im CORSAIR wird der Zustand jedes Integrators mittels zweier Zahlen oder Worte eines linearen Codes beschrieben, die in einer Ferritkernmatrize gespeichert sind. Diese Nummernpaare werden nacheinander abgelesen, und die Integration findet in einem zentralen zeitanteiligen arithmetischen Rechenwerk statt.

Eine umkehrbare Dekatron-Schaltung von A. J. Oxley

Zusammenfassung des Beitrages auf Seite 746-749

Der Beitrag beschreibt einen umkehrbaren Zähler, der mit den langsameren Dekatronröhren (GS10C, GC10B usw.) bestückt ist und daher auf ungefähr 4 kHz beschränkt ist. Dieselben Gesichtspunkte kommen für einen Zähler mit schnelleren Röhren (GS10D) in Betracht. Die Arbeitsweise der Schaltung wird erwähnt und ihre ursprüngliche Verwendung umrissen. Fehler, die durch zu schnelles Aufeinanderfolgen entgegengesetzter Vorzeichen entstehen können, werden eingehend untersucht und daraus der Schluss gezogen, dass die Schaltung innerhalb angegebener Grenzen für solche Eingaben von logischen Fehlern freigemacht werden kann.

Ein Funktionsgeber für sehr niedrige Frequenzen von L. Whitlow

Zusammenfassung des Beitrages auf Seite 750-752

Verfahren zur künstlichen Erzeugung einer sich wiederholenden Zeitfunktion mit 100 "Stufen" oder 100 "Rampen" wird beschrieben. Der Frequenzbereich liegt zwischen 0,025 und 15 Hz. Die Abweichungen der Ausgangsfunktion sind unter 0,5%.

Thermisches und optisches Verhalten von Phototransistoren von D. Shaw und B. Crump

Zusammenfassung des Beitrages auf Seite 753-757

Die thermischen und optischen Kenndaten zweier Phototransistoren wurden untersucht, um die Konstruktion von Photomessköpfen für Einsatz unter rauhen industriellen Bedingungen zu erleichtern.

Für einen Phototransistor entwickelte Schaltungen erlauben Relaisbetrieb in Umgebungstemperaturen bis zu 55°C.

Für genaue Positionsmessungen ist die Konstanz der optischmechanischen Kenndaten nicht besser als ±1,5 m, so dass für höhere Genauigkeit Einzeleichung erforderlich ist. Dieses Verhalten wird im Falle von beiderseitiger Bewegung und Benutzung von Relaisanzeigen noch schlechter, so dass typische Fehler von ±2,5 mm vorkommen.

Der zweite Phototransistor ermöglicht Einsatz in Umgebungstemperaturen bis zu mindestens 90°C, ist jedoch in seiner gegenwärtigen Form ungefähr 1000× weniger empfindlich.

Zwei konstante Stromquellen für ±300 V mit Transistorbestückung von J. S. Bell und P. G. Wright

Zusammenfassung des Beitrages auf Seite 758-761

Zwei Methoden werden beschrieben, nach denen konstante Spannungen von ±300 V von einer gemeinsamen Niederspannungsquelle erzielt werden. Die erste Schaltung ist neuartig, und die angegebene Auslegung stützt sich nur auf die ursprünglichen Untersuchungen; für Verbesserungen besteht reichlich Spielraum. Die zweite Schaltung wurde viel eingehender untersucht und folgt der herkömmlicheren Serienstabilisatorform, die für Volltransistorisierung abgewandelt wurde.

Keine der Schaltungen ist ausschliesslich auf Doppelspannungsquellen beschränkt. Die erste Schaltung erfordert geringe Abwandlungen für die Abgabe einzelner positiver oder negativer Spannungen, aber die zweite Schaltung besteht bereits aus zwei gleichen Serienstabilisatoren, die von einem gemeinsamen Umformer gespeist werden.

Messwerterfassung mittels Breitband-Magnetbandaufzeichnung von J. Pritchard

Zusammenfassung des Beitrages auf Seite 762-766

Der Beitrag befasst sich mit der Konstruktion des Ampex Breitband-Magnetbandregistriergerätes, einer Weiterentwicklung des Fernseh-Videomagnetbandgerätes. Behandelt werden die Metallkonstruktion des Gerätes sowie die allgemeinen Ansprüche einer Messanlage an die Aufzeichnung und Wiedergabe eines kontinuierlichen Breitbandsignals, das nominell zwischen Gleichstrom und 4 MHz liegt. Modulator, Demodulator und Signalumschaltung werden ausführlich beschrieben. Die Bedeutung der aufgezeichneten Zeitbasis wird hervorgehoben, und die zur genauen Darstellung aufgenommener Signale während der Wiedergabe benutzten Methoden werden besprochen.

Ein tragbarer HF-Spektrumgenerator für Antenneneichung von N. Burtnyk

Zusammenfassung des Beitrages auf Seite 767-769

Ein tragbarer Spektrumgenerator geringer Leistung wird beschrieben, der für Antenneneichung geeignet ist. Die ausgestrahlte Feldstärke ist für Frequenzabstände von 200 kHz im HF-Spektrum in der Grössenordnung von 150 µV/m in 12 m Höhe über schlecht leitendem Boden. Ein quarzerzeugter Trigger gibt ausreichende Stabilität, um hörbare Unsicherheit der 30 MHz-Harmonischen zu verhindern.

Rauscherzeugung in Koaxialkabeln, die Schwingungen ausgesetzt sind von R. D. Hole

Zusammenfassung des Beitrages auf Seite 770-771

Einer kurzen Bewertung der die Rauscherzeugung bestimmenden Faktoren und der bezüglichen Theorie folgt eine Beschreibung der zur Zeit üblichen Methoden zur Beseitigung dieser Erscheinungen. Zwei Behandlungsverfahren für Kabel werden vorgeschlagen, die theoretisch der bestehenden Technik überlegen sind und grosse Vorteile haben, wo der Durchmesser und die Kapazität pro Meter von grösster Bedeutung sind.

Induktivitätsmessung und -datenangaben für Miniaturspulen und -übertrager mit Eisenkern von E. A. Grover

Zusammenfassung des Beitrages auf Seite 772-773

Die Verwendung von Miniatur- und Kleinstdrosseln und -übertragern war bis zu den letzten Jahren auf ein oder zwei spezialisierte Industrien beschränkt. Heute werden sie als alltäglich betrachtet und auf den verschiedensten Gebieten der Elektrotechnik benutzt.

Einführung der Transistoren und der damit verbundene Bedarf für Schaltungselemente vergleichbarer Grösse sind für diese Entwicklung weitgehend verantwortlich. Trotz wachsender Verwendung besteht jedoch noch viel Verwirrung bezüglich der für Datenangaben und Messung ihrer Induktivität allgemein benutzten Methoden.

Der Beitrag beschreibt zwei Messmethoden und die zwischen ihnen bestehenden Beziehungen.

Anzeigesysteme für Transistor-Untersetzer von T. G. Benbow

Zusammenfassung des Beitrages auf Seite 774-775

Für einen im Forschungsinstitut für Heereswaffen in Aldermaston entwickelten Transistor-Untersetzer wurden drei Ableseanzeigen in Betracht gezogen: ein Messwerk, eine Fadenlampe und eine Neonlampe. Praktische Schaltungen für das vorgezogene System mit umgeschalteten Neonlampen werden gegeben.

Ein Millivolt-Digitalschreiber von G. P. Tonkin

Zusammenfassung des Beitrages auf Seite 777-778

Das beschriebene Gerät misst Millivoltsignale mit einer Abtastfrequenz von bis zu sechs Kanälen pro Sekunde und einer Auflösung von 0,1%. Die Digitaldarstellung erfolgt mittels Relais für niedrige Ansprechpegel unter Benutzung dezimal-binärer Verschlüsselung mit Schreibmaschinen oder Lochstreifen als Ausgabe.