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Commentary

'THE Engineer and the Community' was the title of the President's Address to the British Institution of Radio Engineers, given last December and published in the January issue of the Institution's Journal. In it, as one would expect from a man of his mental perception and agility, Professor Zepler raised a number of matters which provide considerable food for thought and which are of considerable significance to the professional engineer in his relation to the remainder of the community. We feel that it is worthwhile to comment further on one or two of the points raised.

The subject matter of the address falls broadly into two parts; what can the community expect from the engineer and, conversely, what can the engineer expect from the community in the way of recognition, prestige and, on a more mundane, but to the individual essential, plane, financial reward. If one agrees 'that one gets out of life what one puts into it' then it follows that the two halves of this problem are inextricably entwined but, unfortunately perhaps, it will also be appreciated that so far as human relationships are concerned the time-constant between cause and effect may well be too long to afford any personal satisfaction from the process.

But, be that as it may, few engineers will disagree with the Professor when he states that 'those who apply science, and are usually called engineers, are still not sufficiently appreciated as belonging to a profession requiring just as much study, ethical behaviour and responsibility as, for example, the medical, legal or accountancy professions'. It may be, though, that the last dozen or so words of this statement require some slight modification, and this will be referred to later.

Further on in his address the Professor compared the engineering and medical professions in more detail and he pointed out that there is a fundamental difference between them, and it is a difference which may have a significant influence on the disparity between the social standing of the two: a doctor is not allowed to practise unless he is on the Register of the General Medical Council. It is pointed out that the power of this body over the members of the profession is very great, but that at the same time it speaks for them and that the high esteem in which the medical profession is held is proof of the great work that it has done. The question is then posed, 'could a similar state of affairs exist in the engineering profession and would it be desirable?

In this country at least there is no 'engineering' equivalent or near equivalent of the Medical Council, for to draw a comparison between the Council and any of the engineering institutions is in no way valid. Apart from compulsory registration there are two other matters, which were not dealt with by the Professor, which need to be considered. The first is that the Medical Council lays down strict requirements for the academic standards and methods of training for its members and there is, thus, a far greater degree of uniformity and supervision in the training of doctors than of engineers. This of course is highly necessary, particularly in the latter stages of training since human bodies are by no means so easily procurable, nor on a short term basis so easily replaceable, as nuts and bolts or resistors and capacitors. The second matter is one which no doubt has a profound influence on the status of the profession and which may cause some slight amendment to the passage already quoted from Professor Zepler's address. It is that the Medical Council not only has power over the academic attainments of its members but that it also lays down a fairly rigid code of ethics and devotes considerable attention to their maintenance. If a doctor is guilty of gross negligence his patient may die and, if the facts come to light, he may well be struck off the Register and thus debarred from practising his profession; he will meet with a similar fate if he is found guilty of any of the acts which the Council would describe as 'unprofessional conduct'. An engineer may commit similar crimes and, although he may lose his job, it is unlikely that he will be 'drummed out' of his professional institution. In other words, unless the engineer can prove himself more capable than most at obtaining something for nothing, if he wants the status he must pay the price!

Finally, and inevitably in a discussion of this type one comes to the thorny question, what is an engineer? Here, unfortunately the Professor not only gives us no help, he tends to create a difficulty, for he first poses the question 'do we seriously contend that the total membership' of our engineering institutions represents anything like the total number of qualified engineers? He then goes on to point out that the answer is a definite no. It would, therefore, appear that before any great improvement in his status can be brought about it must be clearly defined what entitles a man to describe himself as an 'engineer' and this would seem to be a matter calling for a combined operation between the major engineering institutions in the country.

AN EIGHT DIGIT WORD GENERATOR

using Surface Barrier Transistors and Direct Coupled Technique

(Part 1)

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

This article describes a binary word generator built as a piece of test equipment for the subsequent development of digital computer elements. During the initial phase of the work, the authors were attracted by the simplicity of the direct coupled technique and the logical design of the equipment was consequently based upon its use.

A brief explanation is given of serial and parallel operation leading to the conception of serial word representation and thus the need for a word generator as a basic tool in this kind of work. A simple word generator is then described together with a definition of logical symbols used in the diagrams.

A description of the direct coupled technique using surface barrier transistors is given, followed by a section on transistorized logical elements and a detailed description of the equipment. The article ends in a review of the limiting conditions of the technique.

The conception of the transistor as a logical switch is introduced in an appendix and it is shown that, in the case of a pnp device there is a relation between the speed of operation, the hole storage in the base region and the degree ofsaturation. It is emphasized, however, that this relationship is discussed only far enough to show that a fast switching speed is possible without control of saturation conditions provided certain types of transistor are used such as the surface barrier SB240 or the micro-alloy MA393.

(Voir page 191 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 199)

THE word† generator described in this article was designed to provide digital representation, in serial binary form, of any two numbers between $2^8 - 1$ and zero. These two numbers: X and Y, each consisting of a maximum of eight digits, were used as a test source in the subsequent development of digital computer elements. The design also formed an exercise in the use of surface barrier transistors and direct coupled logic. Both numbers, or words, repeated every 16μsec in synchronism but word X could generate a different number from word Y depending upon toggle switch settings. In addition to the two numbers the equipment generated four pulse trains for controlling the mark-to-space ratio of the word pattern.

During the initial phase of the work, the authors were attracted by the simplicity of the direct coupled technique, and the subsequent design of the equipment was based on its use in serial logic. As explained later in the article, the requirements of the technique are critical and at the time the work was done only one transistor, the Philco (U.S.A.) germanium surface barrier transistor 2N240 was easily available in the U.K. This device is now manufactured by Semiconductors Ltd, under the designation SB240.

It is emphasized that the work described in this article has been carried out at an ambient temperature not exceeding 30°C at an average dissipation of 12mW per transistor, just under half the maximum specified dissipation. Under these conditions no failure in 83 transistors has occurred in about fifteen hundred hours' running time. If a failure rate to match resistors is desired, say better than ¼ per cent per 1 000 hours, then from the manufacturers' published reliability curves the ambient temperature should not exceed 35°C.

Word Representation

Digits and Words

Logically, any code may be used in a digital computer but, in practise, a binary or two state code is most suitable since such codes are easily realizable in terms of circuit elements.

Fig. 1 shows the natural binary representation of the integers 0 to 15. Each number is represented by a combination of 0's and 1's, and each particular 0 or 1 is known

0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
⋮	⋮	⋮	⋮	⋮
15	1	1	1	1

Fig. 1. Natural binary code

as a digit. Similarly, any other type of information, such as orders, may also be coded. The basic unit of information in a digital computer is therefore the binary digit and this may be represented physically in the computer as some physical quantity such as voltage, charge, or current which need only take two levels. Conventionally, a 1 may be associated with a high level and a 0 with a low level.

A number or an order is represented by a group of digits, the size of the group being dependent on the range of numbers or orders which it is required to represent. Such a group of digits is known as a word and this information structure is common to all digital computers. A device for generating such words is therefore essential for the development of components for a digital computer.

Serial and Parallel Operation

Transference of information in digital computers may be effected in two ways. In the first method there are as many transfer channels as there are digits in a word and all the digits are transferred simultaneously. This is known as parallel transfer, and a typical operation is illustrated in

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† *The term ' word ' is used throughout the article in the accepted sense in computer terminology. For readers new to this field it should be noted that, in general, ' word ' refers to the whole of an available period in time in which a number is to be represented in binary form. A detailed explanation is given later.*

Fig. 2. In the second method a single channel is used and the digits are transferred in successive periods of time. This is known as serial transfer and a typical operation is illustrated in Fig. 3. Serial and parallel operation may both be present in the same computer but usually one particular type of operation predominates and the computer may be known as 'serial' or 'parallel.'

It is thus necessary to have serial or parallel word generators according to the type of transfer required. Of the two kinds, the serial word generator is more interesting logically and the description is confined to this type.

Serial Word Representation

Before describing the word generator it is felt that it may be helpful to make a few remarks about serial word representation.

The main essential is that the total time for a computation be divided into word periods and each period be

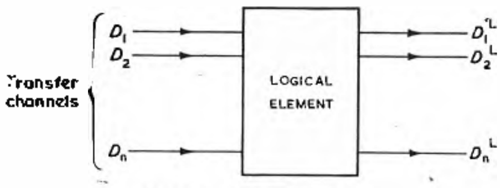


Fig. 2. Parallel operation

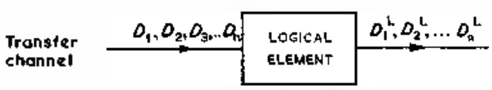


Fig. 3. Serial operation

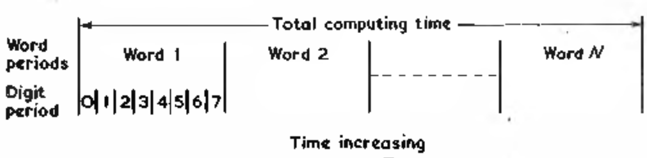


Fig. 4. Sub-division of total computing time

further divided into digit periods. Fig. 4 shows the division of computing time into words of eight digits. It follows that any serial computer is essentially synchronous and requires a basic timing reference or clock.

When a word is transferred from one logical element to the next, the information only is transferred. In no sense can it be said that a physical quantity has been transferred. For instance, if the channel is an electric conductor and 1 is represented by a high voltage, this voltage is not transferred in any physical sense since both ends of the channel are at the same voltage. Thus it is necessary to regard the complete channel as being in the 0 or the 1 state. When a 0 is transferred in a particular digit period the channel remains in the 0 state for this period and when a 1 is transferred the channel is in the 1 state for the whole or part of the digit period. Thus when a word is transferred the channel takes up the corresponding states during the appropriate digit periods. There is an exception to this method of transfer in the case of delay lines where a delay is deliberately introduced for logical reasons.

It is possible to have a range of representations of the digit 1 according to what proportion of the digit period the channel is in the 1 state. The ratio of the time in the 1 state to the time in the 0 state is known as the mark-to-space ratio and the representations are logically equivalent for all mark-to-space ratios. In a computer it is found

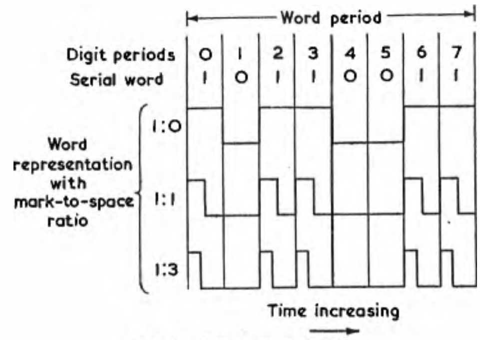


Fig. 5. Serial representation

that different mark-to-space ratios are used in different parts according to the demands of practical circuits.

The serial representation of a word may be illustrated graphically by plotting the state of the channel as a function of time to give a logical waveform. Fig. 5 shows the logical waveforms for the word 10110011 with three different mark-to-space ratios.

Logical Description of a Serial Word Generator

Basic Logical Elements

The word generator is constructed from four basic logical devices, the invertor, the AND gate, the OR gate, and the simple binary counter.

The invertor is a one input one output device, the relation between the input and output states being given by Table 1.

The AND gate is minimally a two input one output device, the relation between the output state and the input states being given by Table 2.

The output of the AND gate is thus 1 only when all of the inputs are 1 and 0 for all other states.

The OR gate is minimally a two input one output device, the relation between the output state and the input state being given by Table 3.

The output of the OR gate is thus 1 when at least one of the inputs is 1, and 0 when both inputs are 0.

It is possible to generalize AND and OR gates to have more than two inputs. A multi-input AND gate is a device which gives 1 as an output when all the inputs are 1, and 0 for all other input combinations. A multi-input OR gate gives a 1 output if at least 1 input is 1 and a 0 output if all the inputs are 0.

The simple binary counter has one input and two outputs and one output is always the inverse of the other. For

TABLE 1

Input State	Output State
0	1
1	0

TABLE 2

Input State	Output State
0,0	0
1,0	1
0,1	1
1,1	1

TABLE 3

Input State	Output State
0,0	0
1,0	0
0,1	0
1,1	1

instance if one output is 0, the other is 1 and vice versa. The device has two stable states corresponding to the two values which a particular output may take and is caused to change state by the transition of the output from 0 to 1. A constant input or the transition from 1 and 0 has no effect on the state of the counter. Fig. 6 shows the state of a particular output of the simple binary counter as a function of the input waveform, and illustrates the change of state as the input changes from 0 to 1.

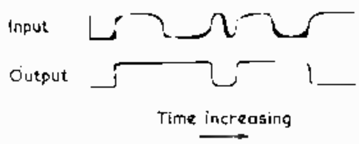


Fig. 6. Relation of input/output for a simple binary counter

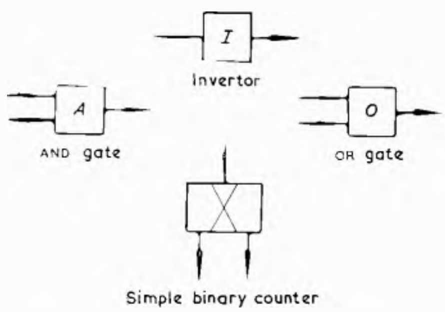


Fig. 7. Symbols for basic logical elements

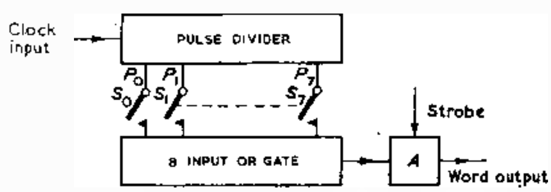


Fig. 8. Elementary word generator

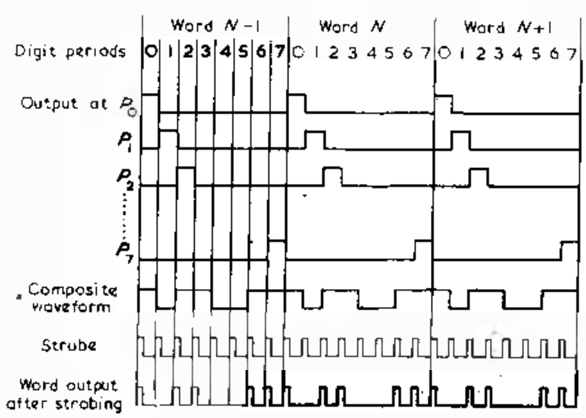


Fig. 9. Word generator logical waveforms

For the purpose of illustrating the logical block diagrams it is convenient to have conventional symbols to represent the fundamental logical elements which have been described; a suitable set is shown in Fig. 7.

The Elementary Word Generator

An elementary word generator is shown in Fig. 8, it consists of a clock, a pulse divider, a multiple input OR gate, an AND gate and a set of manually controlled switches.

The pulse divider may be constructed out of the logical elements shown in Fig. 7, the detailed description is given later. For the purpose of this preliminary description it may be regarded as a device which generates the basic waveforms from which the words are synthesized. It has one clock input and as many outputs as there are digits in a word. In this case there are eight outputs for an eight digit word and the outputs are labelled $P_0, P_1 \ldots . P_7$. The eight output waveforms are shown in Fig. 9, each output is 1 for a particular digit period of the word and 0 for the remainder of the word. As its name suggests, the pulse divider divides the digit pulses into eight separate channels so that each channel receives one pulse in eight.

To generate a word, say 10110011, the switches S_0, S_2, S_3, S_6, S_7 are closed to transmit the appropriate outputs of the pulse divider to the eight input OR gate which adds the pulses in digit periods 0, 2, 3, 6, 7 to form a composite waveform. This composite waveform is shown in Fig. 9

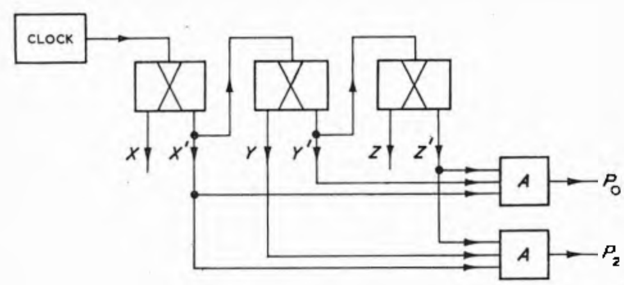


Fig. 10. The pulse divider

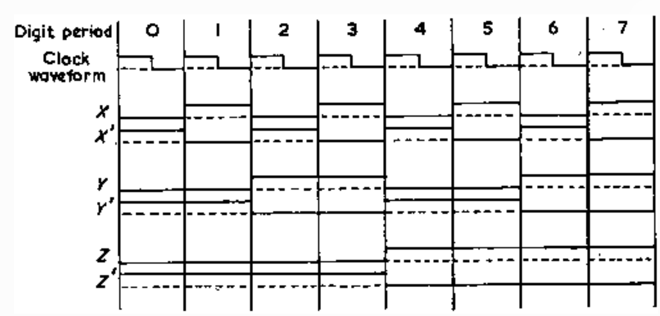


Fig. 11. Pulse divider waveforms

and comparison with the waveforms in Fig. 5 shows that it is, in fact, the 1 : 0 mark-to-space ratio representation. In order to obtain a different mark-to-space ratio, if required, the composite waveform is passed through an AND gate which is opened by a strobe signal to give the final waveform of Fig. 9.

The Pulse Divider

The pulse divider is shown in Fig. 10 and is constructed from three simple binary counters and two AND gates. In order to assist in the explanation of the pulse divider it is convenient to make use of logical symbolism. The input to the first counter is the clock waveform shown in Fig. 11 and the outputs are described by two logical symbols X and X'. X is a variable which is associated with a particular output of the counter and it takes two values only, viz 0 or 1 depending on the state of the particular output. The other output, which is always the inverse, is denoted by X' and, therefore, $X' = 0$ when $X = 1$ and vice versa. Thus the graphs of X and X' as a function of time are identical to the logical waveforms which emerge from the outputs.

Referring to Fig. 11 it is seen that the 0 to 1 transition of the clock waveform which causes the first counter to change state occurs at the beginning of each digit period and if the counter starts with $X = 0$ in the first digit period, the X and X' waveforms are as shown in the second and third lines respectively of Fig. 11. If now the X' output is connected to the input of the second counter, input transitions from 0 to 1 occur at the beginning of digit periods, 2, 4, and 6 and give rise to output waveforms Y and Y' which are shown as the fourth and fifth lines respectively of Fig. 11. Taking the Y' output as the input to the third counter gives rise to the Z and Z' waveforms which are the sixth and seventh lines of Fig. 11.

A set of three simple binary counters which are cascaded as in Fig. 10 is called a three digit binary counter. Since each individual stage may take one of two states, it follows that the three digit counter may take $2^3 = 8$ distinct states which may be associated with eight distinct combinations of the output variables X, Y, and Z. Reference to Fig. 11 shows that the counter changes state on the arrival of each clock pulse, eight consecutive clock pulses causing it to pass through its complete cycle of eight states. Table 4 shows the eight digit periods and the corresponding combinations of values of the output variables.

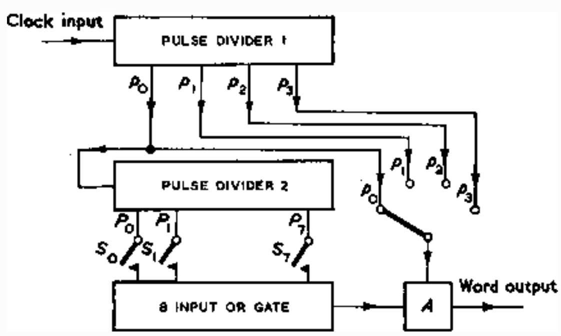


Fig. 12. Simplified word generator

Consider now the three outputs X', Y',Z' of the counters. Reference to Table 4 shows that these outputs are all 1's only during digit period 0. Thus, if X', Y', Z' are connected to a three input AND gate, the output of this gate is 1 only during digit period 0 and this is the output P_0 of Fig. 9. Similarly the other outputs $P_1, \ldots P_7$ may be obtained by connecting suitable outputs of the three digit counter to AND gates. For instance, the three outputs X', Y, and Z' are simultaneously 1 during digit period 2 and connecting these outputs to an AND gate produces the P_2 waveform of Fig 9. Fig. 10 shows the selections of outputs necessary to produce P_0 and P_2 and the complete pulse divider has altogether eight outputs corresponding to $P_0 \ldots P_7$ of Fig. 9.

The Strobe Generator

For a mark-to-space ratio other than 1:0 it is necessary to gate the output of the OR gate with a strobe signal which is some fraction of the digit period. The type of circuit for which the word generator has been designed requires a 1:3 mark-to-space ratio and it is necessary that the strobe period be one-quarter of the digit period. A suitable way of generating the required strobe signal is to introduce an additional four output pulse divider as shown in Fig. 12. One of the outputs goes to the main pulse divider and, in effect, becomes the clock input of Figs. 10 and 11. Any one of the outputs may be used as a strobe signal and for the sake of flexibility a selector switch to the final AND gate is used.

If the outputs of the first pulse divider are p_0, p_1, p_2, p_3 the complete set of waveforms are as shown in Fig. 13. The last two lines show the output waveform for the word 10110011 strobed by p_0 and p_2 respectively. The digit now is comprised of four clock pulses as compared to the elementary generator of Fig. 8 in which the digit period consists of one clock pulse. Thus, in order to achieve the same digit rate for the complete word generator, it is necessary to speed the clock up by a factor of four.

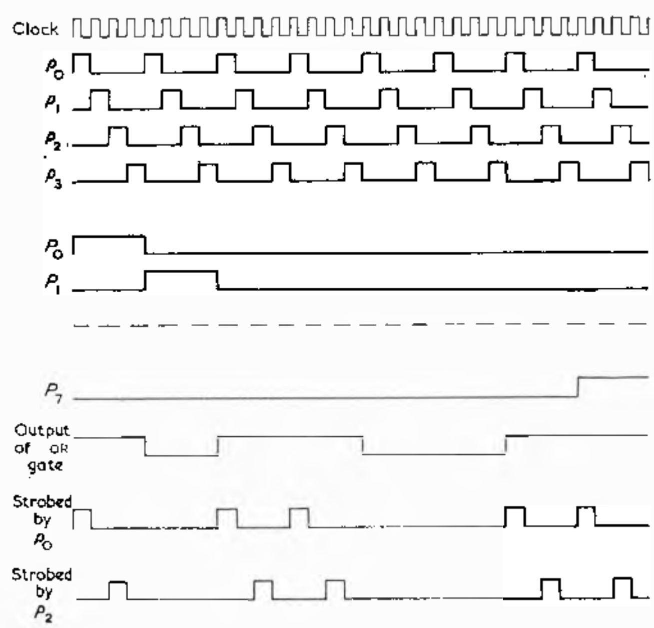


Fig. 13. Waveforms of simplified word generator

TABLE 4

DIGIT PERIOD	X	Y	Z	X'	Y'	Z'
0	0	0	0	1	1	1
1	1	0	0	0	1	1
2	0	1	0	1	0	1
3	1	1	0	0	0	1
4	0	0	1	1	1	0
5	1	0	1	0	1	0
6	0	1	1	1	0	0
7	1	1	1	0	0	0

The Use of Transistors as Logical Elements

The Direct Coupled Technique[1]

Before showing how transistors may be used to build up the logical devices which have been described, it is necessary to give a description of the direct coupled technique as applied to transistors.

The following explanation makes use of the fact that a transistor may be considered as two diodes back-to-back. It must be understood that this conception is of limited use only. In this case a suitable basis is formed for the explanation of direct coupled logic. More detailed information is given in the Appendix.

A common method of coupling two switching transistors is to connect the collector of one to the base of another by means of a series resistor in parallel with a capacitor as shown in Fig. 14(a). The charge on the capacitor tends to neutralize the charge remaining in the base region of VT_2 as VT_2 is switched off. A positive bias may also be applied by means of the bias resistor so that the base-emitter diode of VT_2 is actually reverse-biased while in the off state.

Generally speaking, the values of the components C, R_1, R_2 R_3 and R_4 and the value of bias voltage influence the hole storage time of VT_2 and hence these values have to be considered when the time of switching is important.

In the case of direct coupled circuits, the resistors R_2 and R_4, and the capacitor, bias supply and diodes, in so far as they control saturation, may be eliminated and, as shown in Fig. 14(b), a direct connexion may be made between the collector of VT_1 and the base of VT_2. Several types of transistor, both pnp and npn, may be direct coupled, but when a high switching speed is required the choice becomes limited.

The requirements for operation in the mode are critical and the most convenient method of showing them is by means of a graph as shown in Fig. 15, and the circuit of Fig. 14(b). The graph shows the collector characteristic for different base currents of transistor VT_1 in the circuit.

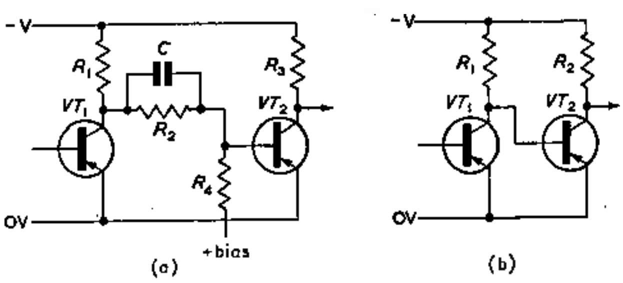


Fig. 14. Examples of RC coupled and d.c. coupled stages

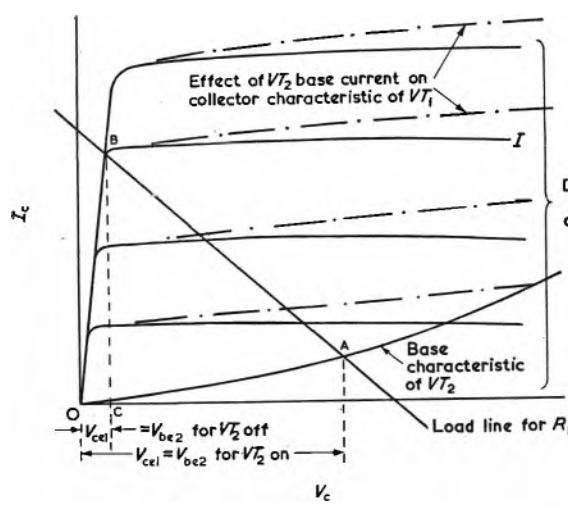


Fig. 15. Requirements for direct-coupled transistors

A load line for value R_1 is superimposed. However, the base characteristic of VT_2 is, in fact, in parallel with this set of characteristics and hence each curve has to be modified as shown by the chain dotted line.

Assume VT_1 is non-conducting, the collector-emitter potential of VT^1 is the base emitter potential of VT_2. For a given collector load R_1, the base emitter potential settles at point A in Fig. 15 so that the base-emitter diode is biased into a state which allows VT_2 to switch into the saturation region.

If now the base-emitter potential of VT_1 is made increasingly negative, I_{b1} increases, V_{ce1} gets less negative. Point A moves along the load line to B and V_{be2} is the value given by OC which must be near enough to zero to put the base-emitter diode of VT_2 into a high impedance state so that the transistor is non-conducting.

For the given collector load, R_1, the lowest value of base current of VT_1 to move A to B is I. Values below this will move A to intermediate positions and the base-emitter potential of VT_2 will be such that the 'off' state of VT_2 is never accurately defined. It is of importance, therefore, in direct coupled circuits that all transistors, when passing collector current, shall be well in the saturation region and V_{ce} 'on' at a minimum. Conversely, when a transistor is intended to be non-conducting the leakage currents of the two diodes shall be negligibly small.

A study of the detailed specification for the 2N240

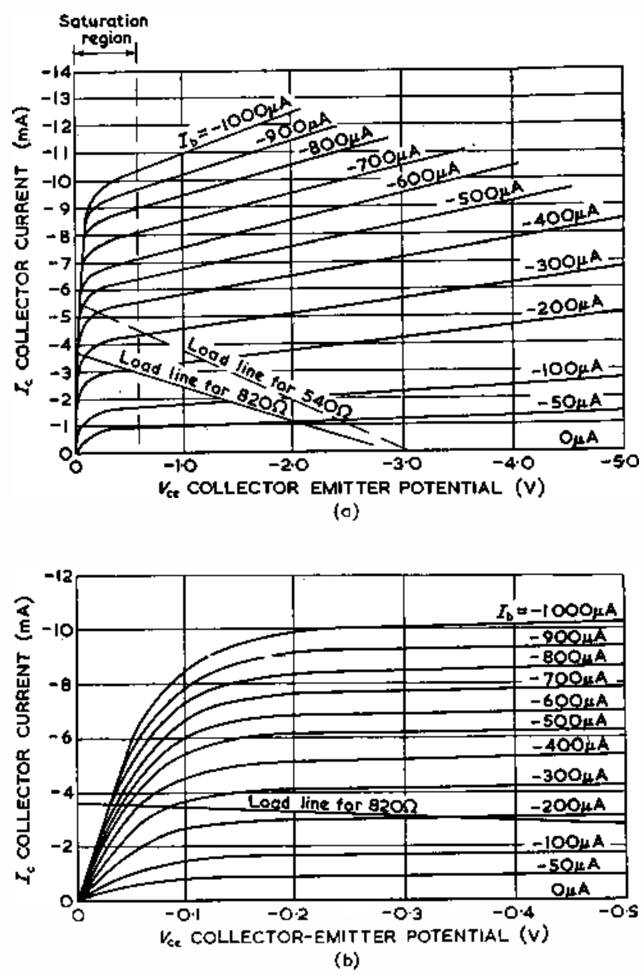


Fig. 16. Typical collector characteristics of 2N240 at 25°C

shows that the collector-emitter potential is limited to a maximum of $-0{\cdot}07$V at a collector current of 2·0mA and a base current of 0·03mA. When the device is non-conducting both the diodes are in a high impedance state, I_{cbo} and I_{ebo} being limited at 25°C to a maximum of 3μA each, a figure which is sensibly negligible. Typical collector characteristics are given in Figs. 16(a) and (b). Fig. 16(b) shows the same characteristics in the saturation region with a load line for the 820Ω collector resistor superimposed.

At a base current of -1mA the collector-emitter potential is reduced to about $-0{\cdot}03$V; values of base current greater than this will not reduce the voltage appreciably. The transistor can thus be considered as a closed switch with a voltage drop across it of $-0{\cdot}03$V. In practice, the base current is in the region of 1·5 to 4·0mA. Typical base characteristics are shown in Figs. 17(a) and (b).

Consider the two transistors in Fig. 14(b) connected between $-3{\cdot}0$V and earth with R_1 and R_2 equal to 820Ω. In the 'off' state of VT_1, V_{ce1} will be held at a potential determined by the value of R_1 and the base impedance of VT_2. Fig. 17(a) shows that the slope impedance, conducting, is 100Ω. Extending the linear portion of the curve, the base potential axis is intersected at $-0{\cdot}22$V. The equivalent circuit can now be constructed as shown in Fig. 18 and from this circuit the equation for V_{ce1} can be derived:

$$V_{ce1} = \frac{(v - V) \cdot R_b}{(R_1 + R_b)} - v$$

where $V = -3$V $R_1 = 820\Omega$

$v = -0{\cdot}22$V $R_b = 100\Omega$

Therefore:

$$V_{ce} = -0{\cdot}52\text{V}.$$

Summarizing the foregoing, if the base of VT_1 is at zero potential its collector is at $-0{\cdot}52$V as is the base of VT_2 hence VT_2 is conducting, its collector is at zero potential and may be connected to the base of VT_1. Suppose now the collector of VT_1 is momentarily returned to zero volts,

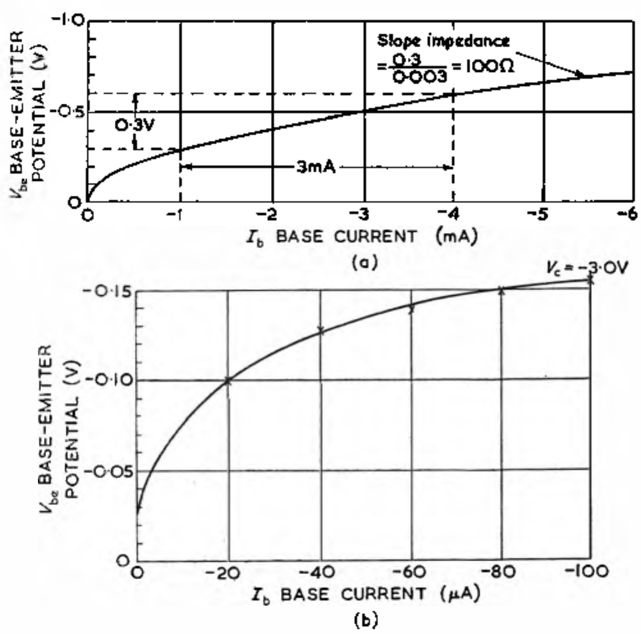


Fig. 17. Base-emitter characteristics of 2N240 at 25°C

the base of VT_2 follows switching 'off' VT_2. Its collector goes to $-0{\cdot}52$V which is the base potential of VT_1, hence VT_1 conducts. A two stable state device, or flip-flop, results; the circuit is shown in Fig. 19.

Logical Elements

The use of transistors as switches to perform logical operations is discussed in the apendix where it is shown that only two electrical states of the transistor are used; the low impedance state which corresponds to a closed switch and the high impedance state which corresponds to an open switch. In consequence, the steady potential at any point of a circuit containing transistors may only take one of two values. With the particular transistors used here the two values are $-0{\cdot}03$V and $-0{\cdot}5$V approximately. Conventionally assigning 0 and 1 to the least negative and most negative potentials respectively, it is then possible to represent digital information by the states of a transistor circuit.

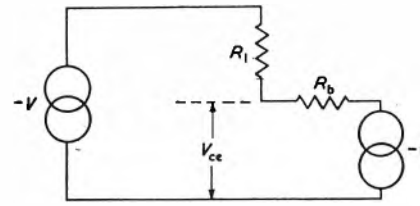


Fig. 18. Equivalent circuit for determining V_{ce}

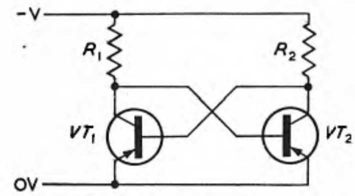


Fig. 19. A direct coupled flip-flop

The word generator is constructed from three basic logical elements, the AND gate, the OR gate, and the binary counter. These circuits, however, are all combinations of one basic element, the invertor.

REFERENCE

1. Beter, R. H., Bradley, W. E., Brown, R. B., Rubinoff, M. Directly Coupled Transistor Circuits. *Electronics 28*, 132 (June, 1955).

(To be continued)

Metallux Resistors

Under an agreement made between the Plessey Company Ltd and Electronica Metal Lux of Italy, the former Company has now undertaken the manufacture of Metallux resistors at its Swindon factory.

Metallux resistors are constructed of a special nickel-chrome alloy deposited on a ceramic former or core by a vacuum deposition process. This process results in a robust and durable film of resistive alloy permanently bonded to the core. Stability, noise, temperature coefficient and voltage coefficient characteristics of the completed resistor are, it is claimed, better than those of conventional fixed resistors.

After deposition and stabilization, the individual resistors are measured for their ohmic value known as the 'pre-value' and are segregated according to their 'pre-value' and temperature coefficient.

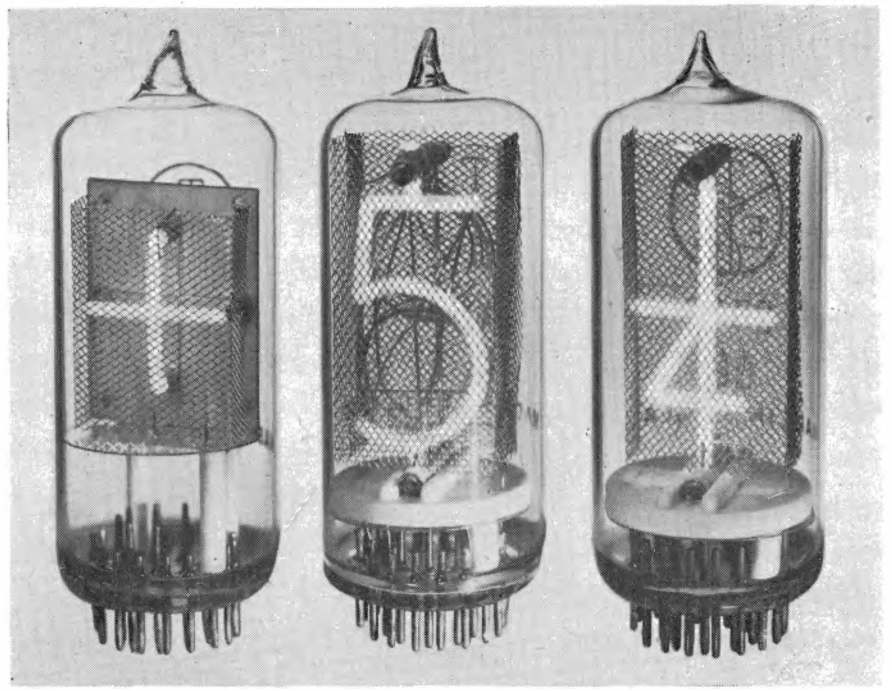
The final value of resistance is obtained by grinding a spiral groove through the protective coating and metal film.

The range of Metallux resistors and their general characteristics are given in the following table:

TYPE	APPLICATION	RESISTANCE RANGE	TEMP. COEFF. (per cent/°C)	VOLTAGE COEFF. (per cent)
AT	General purpose.	0·1 Ω—2M Ω	±0·01 to ±0·0015	0·0003 for 1/16W to 0·00005 for 4W
SRC/ORO	Replacement for high stability wire wound resistors.	10 Ω—1M Ω	±0·005 to ±0·0015	0·0003 to 0·00005
RP	Power resistor.	—	> 0·02	—
AF/CLA	Power resistor for transmitter testing and high frequency uses.	(Effective impedance change at 1 000 Mc/s > 5 × d.c. value.)	±0·005 to ±0·0025	—
CASE/ORO	Replacement for high stability carbon and wire wound resistors.	All values.	±0·005 to ±0·0015	Better than 0·0003

The DIGITRON: A Cold-Cathode Character Display Tube

By N. McLoughlin*,
D. Reaney*, A.M. Brit. I.R.E.,
A. W. Turner*, B.Sc.



A range of cold-cathode display tubes is described and relative merits of side and end-viewing tubes are compared. The principles of d.c. operation and use of the design data are explained. Various circuits for use with these tubes are given together with methods of using a.c. supplies.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

IN any form of computing or scaling mechanism, electronic or otherwise, it is necessary to have some form of indicating or read-out device to show the result of the operation performed by the machine. This indicator may be purely mechanical, as in the Post Office register, or it may be an electronic device such as a set of small neon indicating lamps or a Dekatron† counter tube.

A new form of visual indication which has recently been developed is the Digitron†, a cold-cathode character display tube. This tube, unlike the Dekatron, is not a counting device but is used to indicate the state of count or of switching position in the associated circuits. It may contain numerals, letters of the alphabet, various mathematical or other signs.

These character display tubes are cold-cathode, gas-filled devices having a common anode and a number of independent cathodes, each in the shape of one of the characters it is desired to display. Under the recommended circuit conditions a glow covers the chosen cathode and the illuminated character so formed is visible at a considerable distance, characters 1½in high being legible up to 50ft.

Advantages of Display Tubes

Character display tubes have a number of advantages over other forms of read-out device. For comparable sizes of character, the space occupied and the initial cost compare very favourably with other forms of display. The display tube imposes no limitation on the speed of count, and although it may extinguish at very high speeds it will immediately register the correct figure when the count ends.

The direct numerical or alphabetical read-out is much more legible at a given distance than, for example, a group of small neon bulbs or the figures on the normal type of mechanical register.

Display tubes have, in general, a wider useful viewing angle than other display devices. Furthermore, the character brightness does not fall off as the viewing angle is increased.

Design Details

The most obvious use for these tubes is as a read-out device for decimal counting systems, where the display tube will normally contain the digits 0 to 9. The number of characters in one tube is limited by physical considerations, and where letters are required it is convenient to use two tubes to cover the alphabet, each containing about 12 letters.

The size and nature of the characters can, of course, be varied within quite wide limits to suit the purpose to which the tube is to be put, ranging from very small tubes suitable for desk instruments to very large ones designed to give legible displays over considerable distances.

The above photograph shows three Digitron display tubes, the GR2G sign tube containing a plus and minus sign, the GR10G containing the digits 0 to 9 and the GR4G fraction tube containing ¼, ½, ¾ and 1.

The GR10G tube has nickel characters 30mm high, with a maximum width of 18mm. These characters are arranged one behind the other and spaced from each other at top and bottom by ceramic washers. The numbers are mounted close together to minimize the change in apparent position of the number when switching from one to another. Since the glow itself is wider than the character on which it occurs, each digit is clearly and independently visible.

A nickel mesh surrounding all the cathodes acts as the common anode and also serves to reduce the amount of sputtered material reaching the glass bulb from the glowing cathode. This sputtered material, if not intercepted, would cause blackening of the bulb, with consequent reduction in character visibility. Undesirable images could also be formed by reflection in this sputtered surface at the rear of the bulb.

* *Ericsson Telephones Ltd.*
† *Registered Trade Mark.*

The electrode assembly is supported on a ceramic disk which rests on the unconnected inner ring of pins of the B26A base. Each cathode and the anode is brought out to a separate pin on the outer ring of the base.

An inert gas mixture is used, giving a characteristic yellow-orange glow. The pressure of this gas is an important parameter and it is chosen to be sufficiently low to allow the current necessary to cover the characters to be of the order of a few milliamperes, but high enough to prevent the characters from appearing woolly and indistinct.

The GR4G has a similar construction to the GR10G, whereas in the GR2G the signs are supported on mica plates.

As will be seen from the photograph, the three tubes which have been mentioned so far are viewed through the side of the bulb. However, it is also possible to mount the characters so that they can be viewed through the end of the bulb. Each method has certain advantages.

The side-viewing tube permits the use of larger characters than can be used in an end-viewing tube having the same bulb diameter. At the same time a wide angle of view is offered and the tubes can be mounted close together, so that larger digits are displayed in a given horizontal dimension.

The side-viewing tube needs less space from front to rear than the end-viewing tube. On the other hand, the end-viewing tube needs less panel height. Also it is rather easier to change from the front of the panel and is more suited to vertical stacking.

A typical end-viewing tube, the GR10H, is shown in Fig. 1. For comparison, a miniature side-viewing tube, the GR10W, is also shown to the same scale.

The operation of the tube is similar whichever type is used.

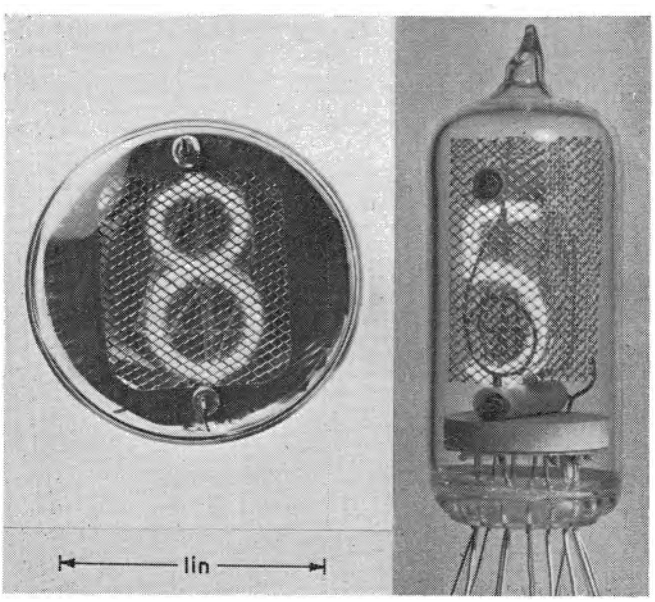
Principles of Operation

As stated above, each character in a display tube can act as the cathode of a gas-discharge diode. A common anode is provided.

The basic circuit is shown in Fig. 2. A d.c. voltage V_b is applied between the anode and the selected cathode, a resistor R_a limiting the anode current to the required value.

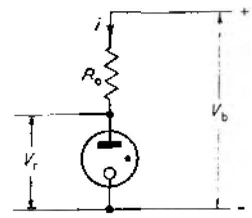
Consider V_b to be increasing slowly from zero. The voltage across the tube will increase until a potential V_s,

Fig. 1. GR10H and GR10W



called the striking potential, is reached. At this point the gas will begin to conduct, a current will flow between cathode and anode and some or all of the cathode will be covered with glow. When current begins to flow, the voltage between the anode and cathode of the tube will fall to V_r, the running voltage of the tube. The current will then be given by $i = \dfrac{V_b - V_r}{R_a}$

Fig. 2. Basic display tube circuit



In general, with the recommended value of R_a the character will not be completely covered in glow at this value of the applied voltage, and in order to cover it, V_b must be further increased. The tube is then said to be running in the abnormal glow region, i.e. the normal operating current is greater than the value required to cover the character. However, since the rate of sputtering is proportional to current, a maximum current rating is recommended to ensure a long life.

The values of V_s and V_r depend upon both cathode material and gas mixture, whereas the colour of the glow is characteristic of the gas mixture only.

It will be seen that the tube is essentially a current operated device and that three conditions must be met in a practical circuit:—

(1) The value of V_b must be such that the tube will ionize.

(2) The current must be sufficient to cover the whole of the cathode with glow.

(3) The current must not exceed a stated maximum or the life of the tube will be seriously curtailed.

Characteristics

Due to the spread of parameters occurring during production, and the need to maintain a stated performance during life, circuit design should be based on the following method.

Typical basic design information is given in the form of a graph of tube limiting characteristics. Reference to Fig. 3(a) illustrates the main points. Two limit lines are shown—these represent the maximum and minimum running voltages which will be found over the specified current range. This current range is limited at the lower end by the need to cover any cathode and at the upper end by the maximum permissible cathode current. It is desirable to be able to draw load lines for differing supply voltages and this is done as follows:—

The distribution of running voltage is shown in Fig. 4 and this leads to a mean value of 185V, also the optimum current is 6·5mA. This is point P in Fig. 3(a) and load lines should be drawn to pass through this point from the chosen supply voltage. Examples for 250V and 300V are shown. These curves have been drawn assuming that the current taken by each character is roughly the same, but digits 1 and 7 have substantially smaller areas than the other digits and it is necessary to insert resistors in these cathodes. These are referred to as equalizing resistors and enable the design graphs to be used as described.

It will be noted that as the supply voltage V_b is increased the effect of variations in running voltage is decreased, and it is good practice to use the highest value of V_b which is conveniently available.

Switching Circuits

A number of possible switching circuits are available and these can be grouped according to the maximum speed of operation. It should be stressed that the speed need in no way be limited by the display tube—any limitation being inherent in the circuit. At very high counting speeds (> 200kp/s) the tube may de-ionize but will strike and indicate the count correctly when required.

The basic circuits are as follows:—

(1) Mechanical-switch, uniselector, relay, etc. These are very reliable but are limited in application due to the slow speed of operation.

(2) Low speed ring counters, using gas-filled trigger tubes.

(3) Medium to high speed counters using either high speed cold-cathode trigger tubes, thermionic valves, transistors, or Dekatrons.

(4) High speed counters using Trochotron beam switching tubes.

The low speed type of ring counter using a GTR120W trigger tube is shown in Fig. 5. This is suitable for operation of the GR10G side-viewing tube, but can readily be adapted for use with the GR10W wire-ended miniature tube. The circuit is a ring counter, the anode voltage of the trigger tube which is conducting gates the triggering for the next tube in the ring. When the next tube fires it provides an extinguishing pulse for the preceding tube. The maximum speed of operation is 100p/s; the input pulse required is 80 to 100V positive with a minimum duration of 100μs.

Counting up to medium or high speed (0 to 20kp/s) is most conveniently done using Dekatrons, and the GR10G side-viewing tube or GR10W miniature tube can be used to give either alternative or remote read-out.

Details of a suitable circuit are given in Fig. 6. A triode is used for each digit, and is d.c. coupled to the cathode of the Dekatron. The circuit conditions are arranged so that when the triode grid is driven positive, the resulting anode current is the recommended value for the GR10G. The grid-cathode operates as a diode and clamps the grid voltage to that of the cathode. The cathodes of the triodes are connected together and returned to earth through a common resistor and the reset line. A capacitor is provided for smoothing. The voltage developed across this resistor is such that the other triodes are cut off. Switching is accomplished by the output from the Dekatron which drives the appropriate grid positive and causes that triode to conduct, the other triodes being cut off as previously

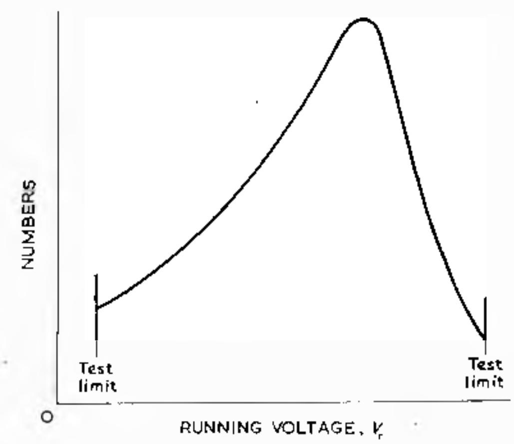


Fig. 4. V_r distribution

described. The cathode resistor also provides some negative current feedback and tends to reduce variations between individual triodes.

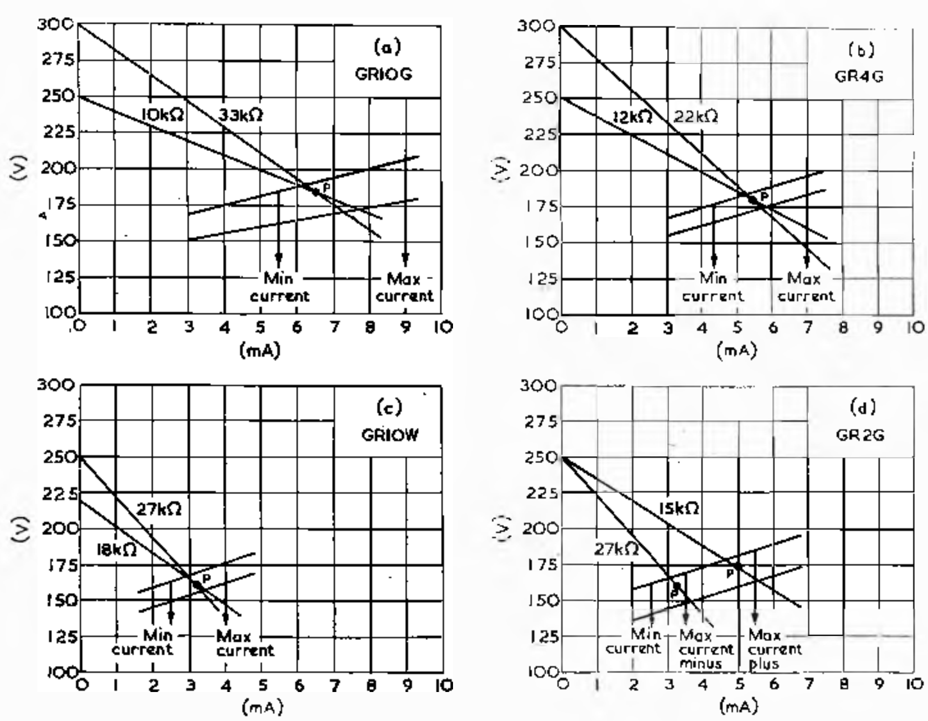
A 'carry' for counting purposes can be taken from the anode of the '0' triode.

At speeds in excess of 20kc/s a Trochotron beam switching tube, such as the VS10H may be used (Fig. 7). This will operate up to 2Mc/s and will deliver a target current up to 18·0mA. This type of tube is ideally suited to use with Digitrons as it is a constant current device. The magnitude of the current delivered by the target is controlled by the spade voltage, other potentials being as shown. An input of -55V is required, with a duration in excess of 0·5μsec. In order to achieve the necessary striking voltage, a fixed potential of 100V is maintained across the GR10G and the balance is provided by the output current of the Trochotron flowing in the target resistor. As previously mentioned at speeds in excess of about 200kc/s the Digitron will extinguish—this does not affect the counting in any way and on cessation of counting the tube strikes and displays the correct figure.

A.C. Operation

Although the cold-cathode display tube was originally developed for use in d.c. circuits, it is equally suitable for

Fig. 3. Graph of tube characteristics



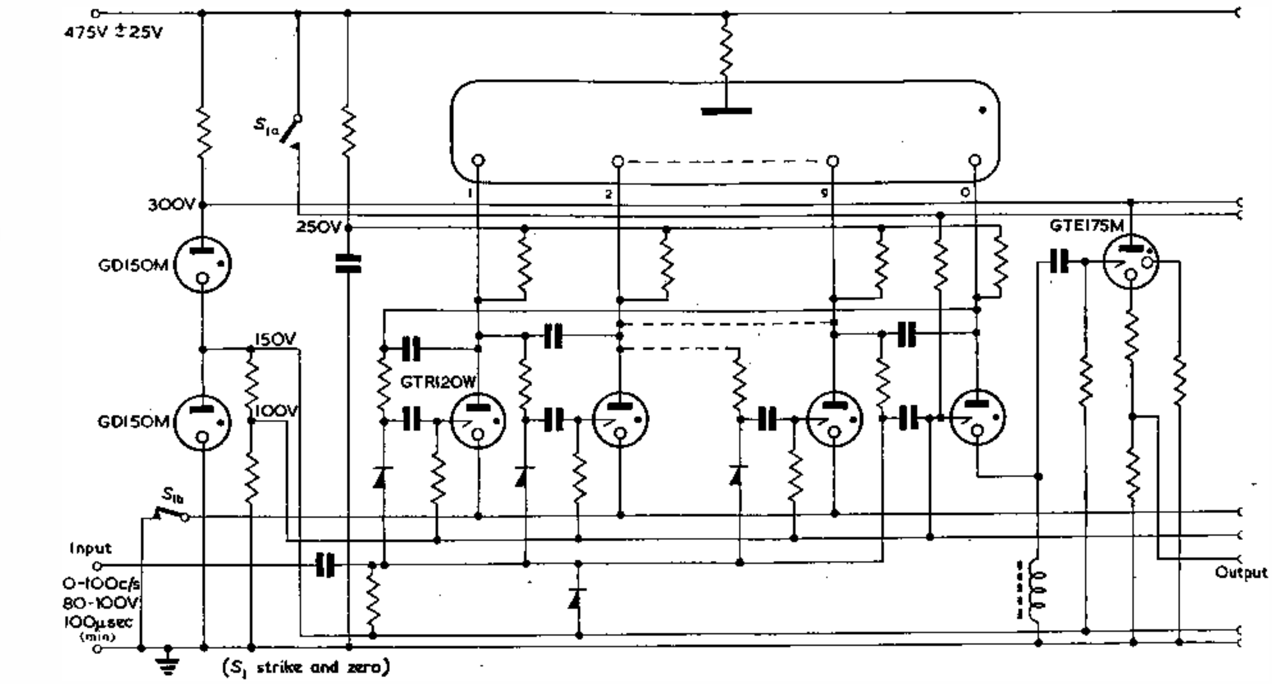
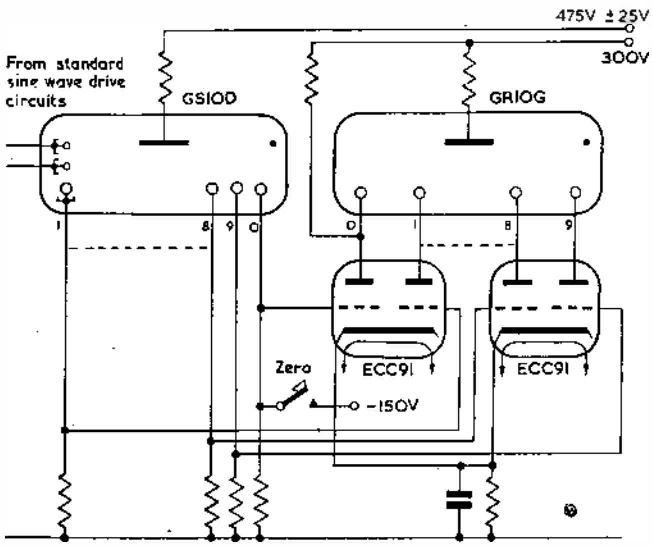
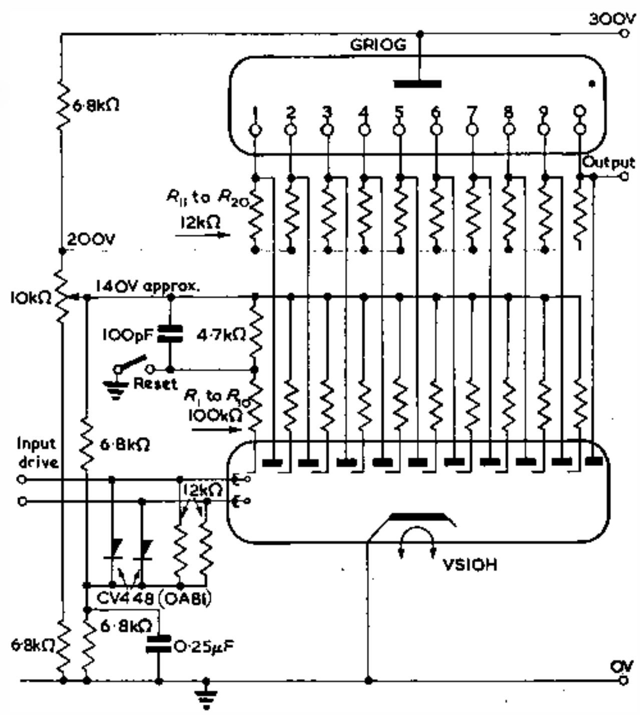


Fig. 5 (above). Ring counter with GR10G read-out

Fig. 6 (below). GS10D with GR10G read-out

Fig. 7 (right). VS10H with GR10G read-out





use on unsmoothed half-wave rectified a.c. The peak value of current should not exceed the maximum recommended d.c. value, and since the mean value of the a.c. will be considerably less than in the d.c. case, the tube life is correspondingly longer. However, as the light output is proportional to the mean current, some reduction in character brightness occurs.

With some modification to the electrode arrangement such as has been incorporated in the design of the GR10H, it is possible to use unrectified a.c. An auxiliary electrode, termed the a.c. anode, is provided in such a way that glow on it cannot be seen from the viewing position. The a.c. is connected, via a suitable resistor, between this electrode and the selected cathode. On one half-cycle the required cathode will glow, and on the next, the a.c. anode. However, since the latter is hidden from view, only the required character will be visible. The main anode is connected to the a.c. anode through a high resistance to assist striking.

Conclusion

Tubes of the Digitron range are now well established as fast and reliable read-out devices, with numerous applications in all branches of science and industry. Typical applications include displays for all kinds of counting and computing systems, cash display, alphabetic code signalling and lift indicators. While a few standard types will probably cover most requirements, these are adaptable to specialized applications by the substitution of appropriate characters. Digitrons have a high degree of reliability and provide an attractive and economic form of display.

Acknowledgments

The authors wish to thank Dr. J. H. Mitchell, Director of Research, and the directors of Ericsson Telephones Limited, for permission to publish this article.

A Method of Testing Television Camera Tube Colour Response

By A. G. Warren*

Previously, there has been no easy way of obtaining the complete colour response of a monochrome television camera, but it is proposed, in this article, to show how this can be done with fairly simple equipment. A display of effective camera colour response to any chosen illuminant can be obtained with the apparatus described, but tests so far have been confined mostly to studio tungsten-type lighting.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

DURING a series of tests in television studios of various coloured paints in current use, it was found that appreciable variations in sensitivity between camera tubes of any one manufacture occur when televising rather saturated orange and red colours under studio lighting. In addition, the effective sensitivity of the cameras using tungsten incandescent lighting is considerably higher at both the red and blue ends of the spectrum than the human eye, but it appears that the lower saturation of bluish paints and other similarly coloured materials which are used in the studios makes for closer agreement between visual and camera brightness appreciation than occurs with reddish colours.

As far as incandescent studio lighting is concerned, reddish objects appear in the monochrome reproduction as a lighter shade than they are visually in the studio so that there is a tendency for lips to appear too pale and the reproduction of scenery and costumes is difficult to forecast. But for this disparity between visual and camera colour response, the very convenient Munsell system of checking coloured materials could be used with certainty by designers, lighting supervisors and wardrobe and make-up staff.

It was apparent that a means of revealing the overall camera colour response without the limitations involved in the use of colour filters would be an advantage in investigating the problem and it was therefore decided to project the colour spectrum of the illuminant concerned on to the photo-sensitive surface of the camera tube by means of a spectroscope.

It is desirable that the spectrum should be a normal one, i.e. a linear relationship to exist between wavelengths of light and their spacing along the spectrum image; for this reason a diffraction spectroscope was chosen of the transmission type to allow for ease of mounting on the camera optical axis. The Beck diffraction spectroscope type 2447 was suitable as it had the conveniently small maximum dimensions of approximately 2in by 1⅜in. Also the relatively simple optical system has only crown glass components of small optical path length so that the absorption of light is kept low.

If television cameras operating under tungsten incandescent lighting are being investigated, then the illuminant for the spectroscope slit would be a tungsten filament lamp simulating the studio lighting in spectral quality. Similarly, to obtain the response with any other type of scene lighting would require duplication of its spectral quality.

A second illuminant consisting of a spectral discharge lamp is used to provide marker lines at specific wavelengths, against which the camera colour response can be checked.

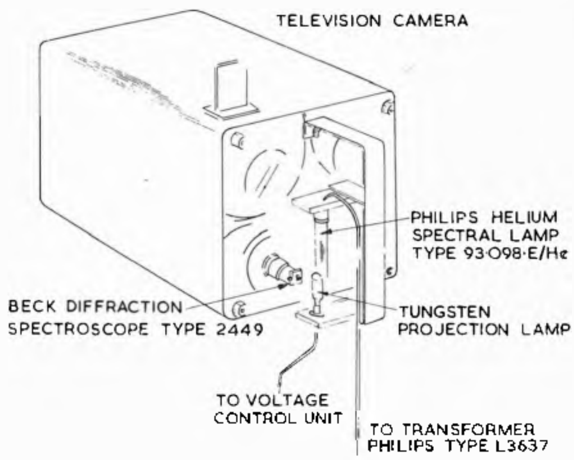


Fig. 1. Camera tube colour response tester

Description and Method of Use of the Apparatus

Fig. 1 shows a simple mechanical layout of the apparatus for projecting the spectra on to the camera tube.

By means of a suitably dimensioned sleeve, the spectroscope body replaces the hood of a 2in camera lens so that the eye-piece of the spectroscope is close to the front lens element, the actual distance not being critical. The normal camera focus control is then operative after a rough adjustment of the spectroscope focus itself. The camera lens iris should be at maximum aperture.

The mountings of both light sources are made adjustable relative to the spectroscope so that the required intensity of illumination at the slit is obtained.

Fig. 2 gives a more detailed view of the spectroscope head and it can be seen that the top half of the slit receives light from the incandescent source (or other type of light source if required) while the lower half of the slit, being covered by the right-angled prism, receives light from the spectral lamp. On a picture monitor the monochrome reproductions of the two spectra should then lie one above the other in the centre of the picture and in length should occupy about one-half of the total picture width. Provided the images are kept well clear of the picture boundaries the reponse does not appear to vary significantly at different parts of the photo-emissive surface of the camera tube.

* British Broadcasting Corporation

When investigating colour response under studio lighting a tungsten filament lamp is employed and the operating voltage is adjusted so that the colour temperature is representative of average studio lighting. The measurement of colour temperature must, of course, be made by means of an appropriate meter. The colour response to other light sources can be obtained by substituting these for the tungsten lamp or less accurately by applying colour correction filters to the latter. The response to an equal energy spectrum source can readily be calculated from the graph obtained with a tungsten source of known colour temperature.

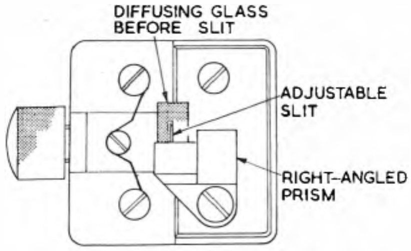


Fig. 2. Front view of spectroscope

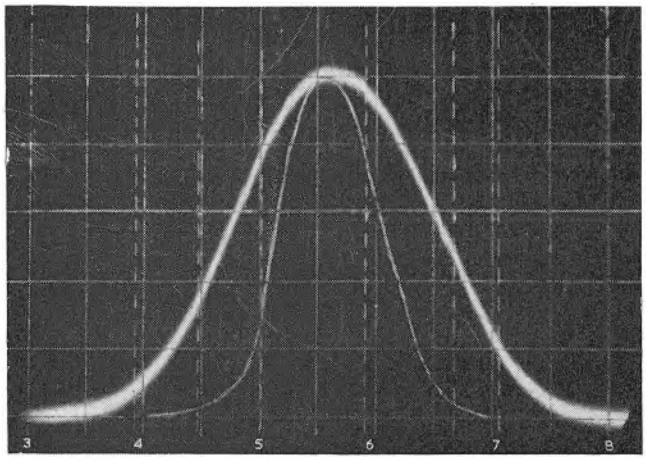


Fig. 4. Colour response of a camera tube having a bismuth-silver photo-cathode.

Colour temperature of light source 2 750°K

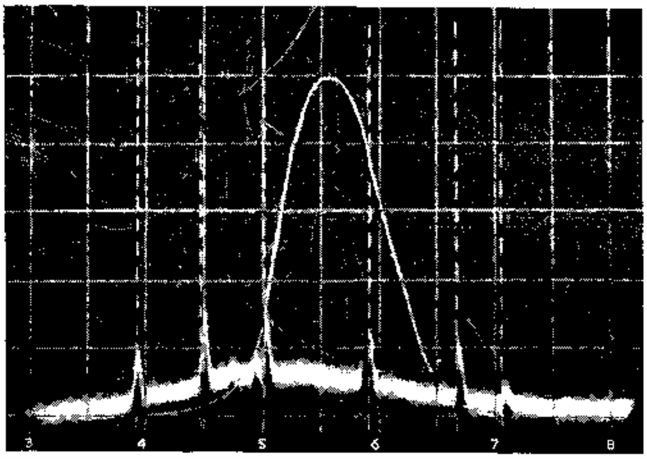


Fig. 3. Waveform monitor graticule and helium spectrum markers

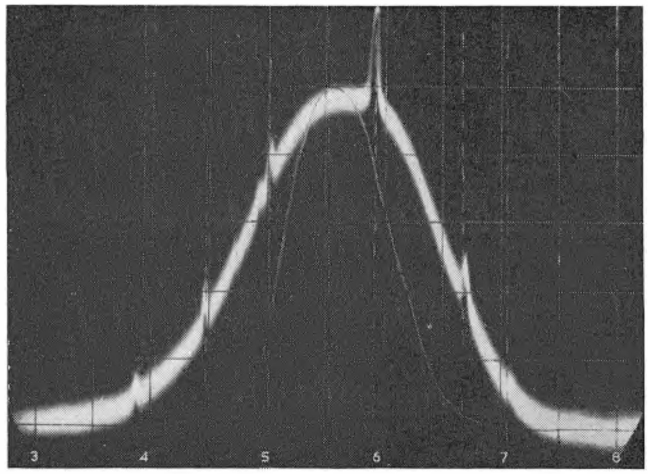


Fig. 5. Type of colour response curve obtained by optical mixing of the light from incandescent and spectral lamps

The spectral lamp is a helium gaseous discharge lamp, chosen because it produces six clearly defined lines over the visible spectrum, these occurring at the following wavelengths in millimicrons: 389, 447, 502, 587, 668, 706, approximately. The 587mμ line is very intense and it is advisable to reduce it in order to avoid over exposure, by the application of a purple filter such as Ilford No. 811. A purple tinted sample of cellophane proved even better for this purpose, but unfortunately it cannot be specified.

The overall transfer characteristic (signal/light) of the camera channel must be adjusted to a unity gamma condition, or, if this is not realizable, due allowance must be made in assessing the colour response.

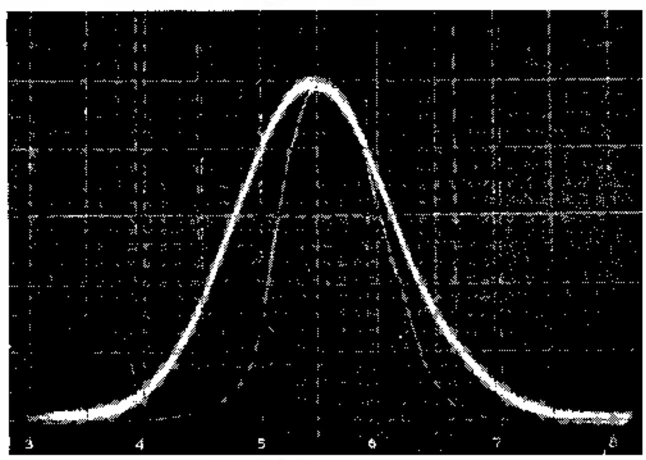


Fig. 6. As Fig. 4 but with one Ilford No. 801 greenish-blue filter in use

The display of the colour response of the camera is obtained on a line selector waveform monitor. This is provided with a graticule ruled for percentage of signal amplitude (or decibels) vertically, and wavelengths of light horizontally; the correct positions of the spectrum markers also being shown, as in Fig. 3. In addition, for the comparison of camera versus visual estimates of relative luminance, it is convenient to have inscribed on the graticule the photopic curve. (It might be argued that, since studio lighting is of the incandescent type, the photopic curve ought to be modified accordingly, i.e. given a bias towards red. Since, however, lighting in a studio has to simulate daylight as well as artificial illumination, it is felt that this would be undesirable and, of course, a high proportion of outside broadcasts occur in daylight in any case).

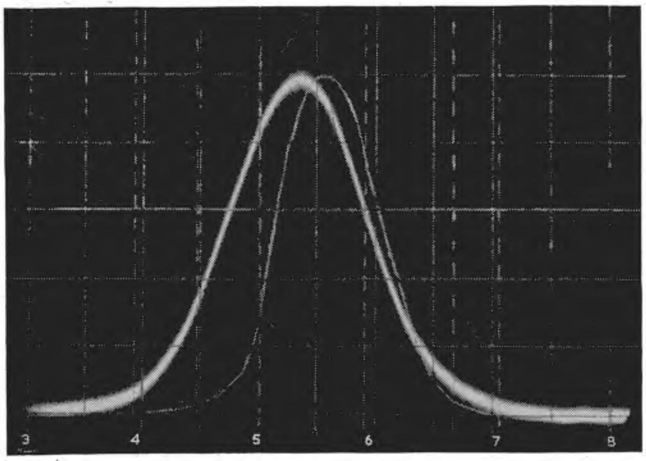


Fig. 7. As Fig. 4 but with two Ilford No. 801 filters in use

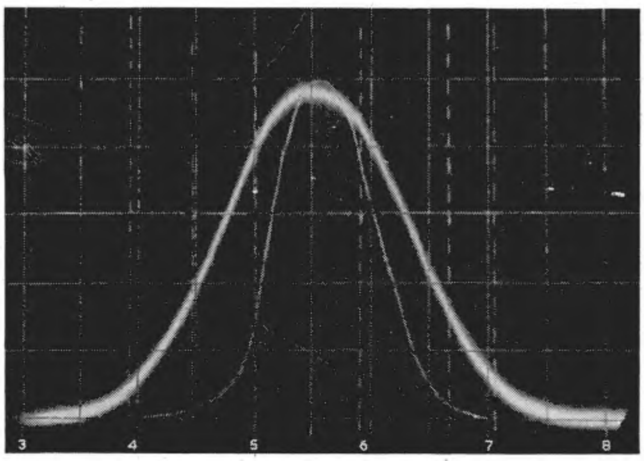


Fig. 8. As Fig. 4 but showing the response of another camera tube of the same type

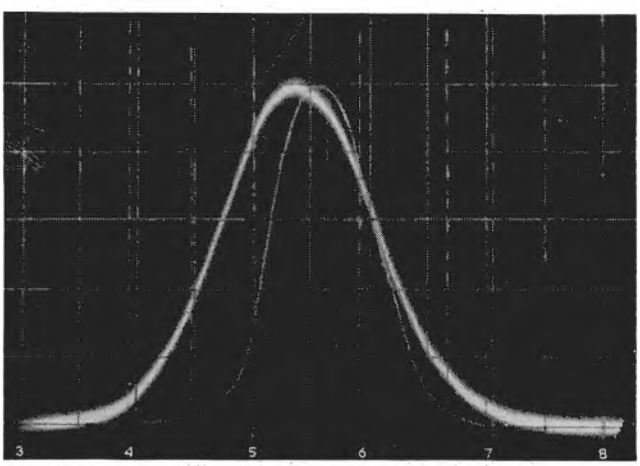


Fig. 9. As Fig. 8 but with one Ilford No. 801 filter in use

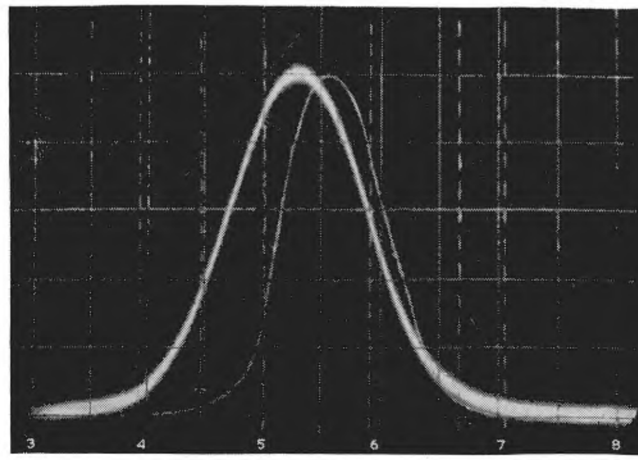


Fig. 10. As Fig. 8 but with two Ilford No. 801 filters in use

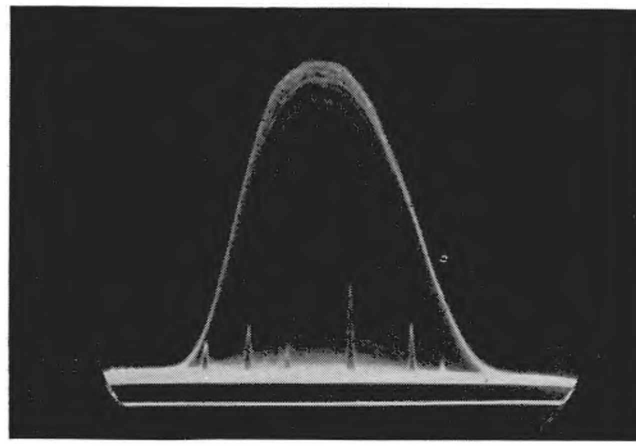


Fig. 11. Colour response of a tube with tri-alkali photo-cathode using a single repetitive time-base and showing (spectrum) line markers

Colour temperature of illuminant 2 750°K

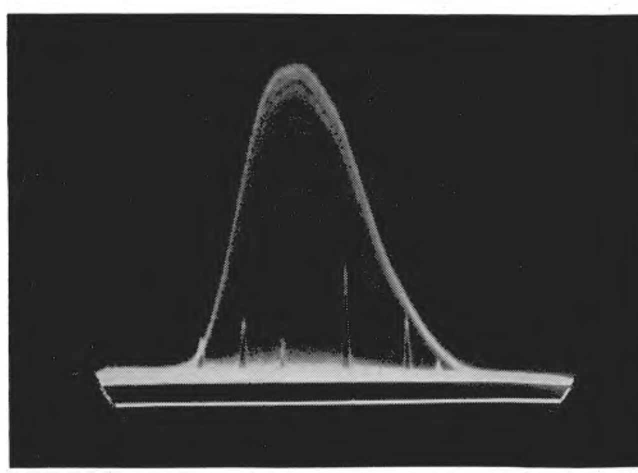


Fig. 12. As Fig. 11 but with one Ilford No. 801 filter in use

The X-sweep is adjusted so that the spectrum line markers fall at the appropriate positions on the graticule, thus calibrating the X-axis in wavelengths of light (Fig. 3); following this, the signal amplitude is adjusted so that the signal excursion due to the incandescent illuminator occupies the range of 0 to 100 per cent on the graticule. The colour response of the camera for the particular light source in use is then displayed as in Fig. 4 and the percentage response can be read off at appropriate wavelengths.

By means of a repetitive time-base and the application of a brightening pulse to the grid of the oscilloscope tube, both spectra can be displayed together. Alternatively, the spectra can be mixed optically by directing both light sources through the same part of the slit together, resulting in the type of presentation of Fig. 5. Either of these combined displays has the advantage of providing a continuous check on the wavelength calibration.

For routine checks, the graticule can be dispensed with and an assessment of colour response may be obtained at the specific wavelengths provided by the spectrum line markers by normal oscilloscope signal voltage measurement.

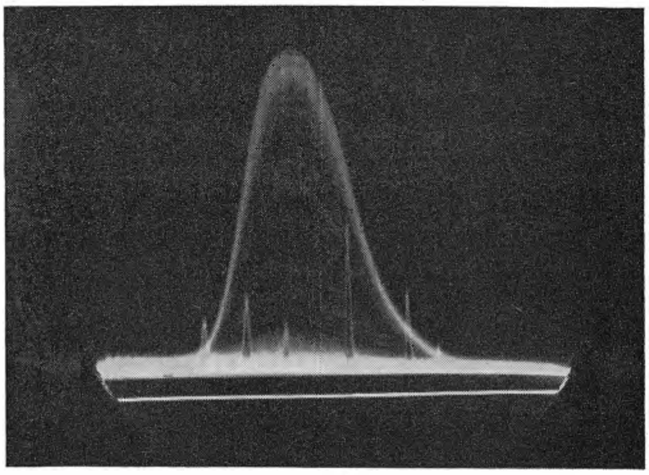


Fig. 13. As Fig. 11 but with two Ilford No. 801 filters in use

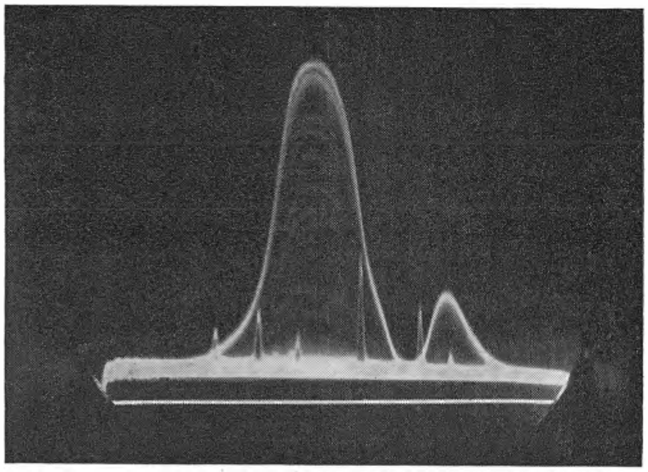


Fig. 14. As Fig. 11 with one Kodak No. 66 light-green filter

of a Kodak No. 66 filter. This type of display is obtained with a simple repetitive time-base without line selection or brightening pulse and measurement of colour response at any wavelength can be made quite easily by placing a suitably scaled transparent graticule (Fig. 15) over the photographs.

Fig. 16 shows the unpleasant result of applying the maximum of variable neutral density filter on a standard type of television camera.

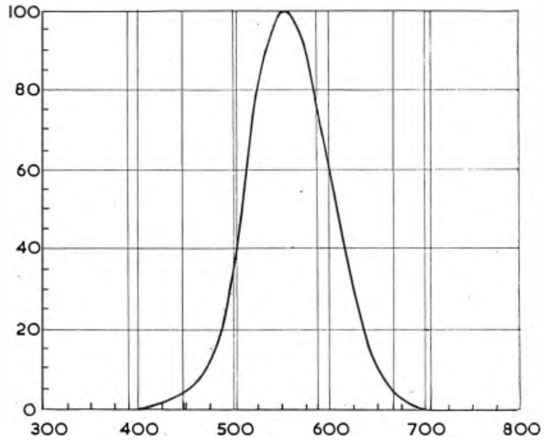


Fig. 15. Transparent graticule for taking readings from the type of display photograph given in Figs. 11 to 14

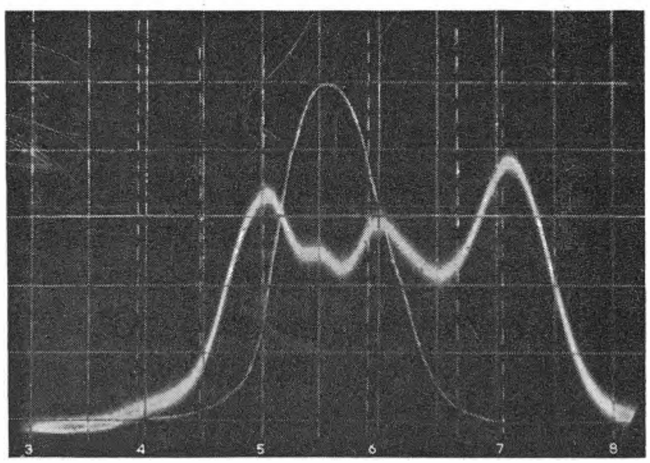


Fig. 16. Distortion of colour response due to use of maximum variable neutral density filter on a television camera

Results

Some camera colour response curves and the effect of adding light filters are shown in Figs. 4 to 14. Figs. 4, 6, and 7 show the colour response under various conditions of a camera tube having a bismuth-silver photo-cathode; Fig. 4 in the condition of having no colour filter, Fig. 6 with one Ilford No. 801 filter and Fig. 7 with two Ilford No. 801 filters. In each case the source of illumination had a colour temperature of 2750°K. Figs. 8, 9 and 10 show the results under the same conditions using another camera tube of the same type.

Figs. 11 to 13 are colour responses obtained with a camera tube having a tri-alkali photo-cathode both with and without Ilford No. 801 filters. Fig. 14 shows the effect

Conclusions

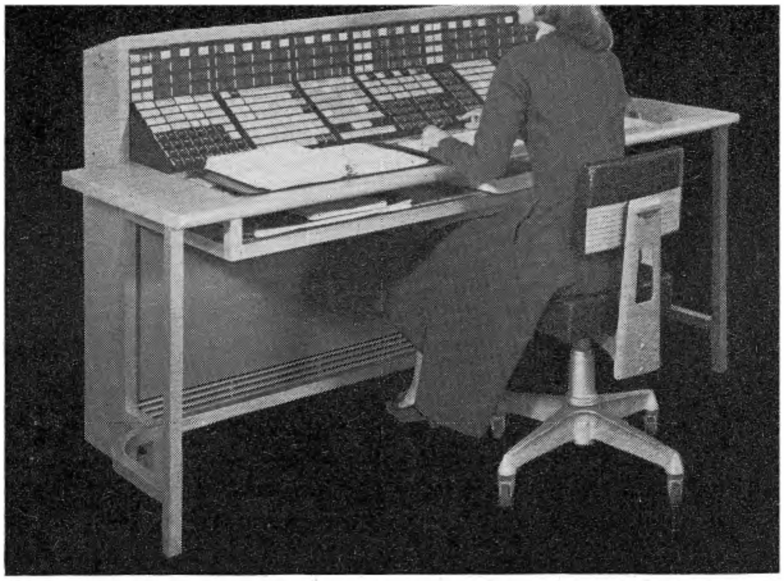
The application of the spectroscope to testing the colour response of camera tubes has proved a quick and reliable method for resolving various uncertainties about the sensitivity of monochrome television cameras throughout, and somewhat beyond, the visible spectrum.

Acknowledgments

Thanks are due to the Chief Engineer of the British Broadcasting Corporation for permission to publish this article, to Mr. H. W. Baker, Superintendent Engineer Television (London Studios) for helpful discussions and for granting various facilities; to Mr. A. B. Palmer and Mr. C. P. N. James for much exacting work during tests in the studio.

Electronic Data-Processing Systems for American Business

By J. C. Hammerton



Electronic data processing systems are now reasonably well established in American business organizations. In the first half of this article an attempt is made to outline the basic requirements of such a system as they now appear; due attention being paid to the areas of agreement and controversy among the various equipment manufacturers. The second half of the article deals with the related engineering problems, and the programming requirements and methods.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

ELECTRONIC data-processing for business is a young technology and its basic techniques are still being developed. In the U.S.A. a post-juvenile stage has been reached. The user now regards the computer realistically as a method of doing a job faster, more accurately, and sometimes cheaper than previously. The manufacturer has accepted the fact that he must live with his customers' methods and problems.

An attempt has been made in this article to present a status report on existing American electronic data-processing (e.d.p.) systems for business. The report summarizes the areas of agreement and disagreement among the basic concepts of business e.d.p. systems.

The report is restricted to medium- and large-sized systems which include a general purpose computer, e.g. a computer which uses a stored program rather than a wired-in program. These systems are being sold to solve the problems of a wide range of users. Variations in size and certain options regarding peripheral equipment are permitted by the manufacturer. But, in general, no alterations are made to the functional specifications of the equipment for specific installations. The report, therefore, excludes all special purpose installations.

Where applicable actual machine characteristics have been quoted from the announced competitive systems on the market. These are the IBM 7070, Radio Corporation of America's 501, National Cash Register Company's 304, the Honeywell Company's 800, the Philco Corporation's

The photograph below shows a general view of the RCA 501, while the one above shows a close-up view of the console. This installation is typical of a modern e.d.p. system.

Transac S-2000 and possibly the Burroughs Datatron 220. However, this report is not a comparative evaluation of these systems. No attempt has been made to present a tabulation of either the characteristics or the relative merits of the systems.

Market Requirements

Competition among the major manufacturers has resulted in a new generation of computing systems cheaper than their predecessors. Certain useful but expensive facilities have been eliminated in order to obtain this price reduction. RCA, for example, no longer markets a central switching unit which, in the Bizmac system, permitted full flexibility in the connexion of magnetic tape units to computing machines.

Besides being cheaper, the new systems are physically smaller (except, possibly, the Datatron 220 which uses valves and is not considered fully competitive for this reason). This change has resulted from the use of transistor circuits, the elimination of ducted air-conditioning, and the development of better packaging and production techniques.

It is wrong to infer that these changes are the result of specifications designed to reach the small- and medium-sized user. In point of fact these smaller, cheaper systems have greater work capacity machine-for-machine than the older generation of machinery.

Modular Construction

All the manufacturers have tried to reach the widest possible market with their product by making the work capacity of their system elastic. Whereas the older systems were designed for the large user (IBM 705, RCA Bizmac) or for the medium-sized user (IBM 650), the new systems are intended to satisfy the requirements of both large and medium-sized users.

For this reason all competitive systems have a modular construction. The high-speed memory, which is universally a magnetic core memory, is specified in modules of so many characters or so many words. The storage medium for the high-capacity memory is magnetic tape, $\frac{1}{2}$ or $\frac{3}{4}$in wide, in 2 400ft reels which can be handled on a wide range of tape units. Provision is made so that any one of the basic tape units, usually eight, can be replaced by switching units or tape controllers. One such device enables an additional module of tape units to be incorporated into the system.

On-Line Peripheral Equipment

Another feature arising from the necessity for elastic work capacities is the provision in varying degrees of on-line operation of peripheral equipments.

The business data-processing problem, insofar as it can be thought of as having distinctive characteristics, absorbs large quantities of input data into master files by relatively simple computational processes and produces large quantities of reports, listings, and other visual output data.

Formerly, the discrepancy between the electronic speed of the computer and the electro-mechanical speeds of the peripheral devices meant poor utilization of the capabilities of the computer. The problem was solved by off-line operation of the peripheral equipment. Input machines produced a magnetic tape which could be applied later to the computer. Output devices were connected to a magnetic tape which had been produced earlier by the computer. Intercommunication through the use of magnetic tape resulted in concentration on increasing the transfer rate to and from the tape and on improving computer control techniques to permit simultaneous operation of tape units.

Although systems including magnetic tape units are now available at modest prices, some of the medium-sized users have applications which do not include the maintenance of large volumes of reference data. To reach these users the new systems include optional on-line operation of the peripheral devices.

The old problem of the discrepancy in operating speeds is mitigated by the use of three techniques.

(1) The speed of the peripheral devices has been increased.

(2) The control section of the central computer is designed to operate more than one peripheral device at a time.

(3) Further refinement of the control section permits the simultaneous operation of the peripheral devices and the arithmetic section of the computer.

These techniques have been applied in varying degrees by the manufacturers using cost as the governing criterion.

Scientific Market

The manufacturers have also tried to reach the scientific market with their product. There appear to be sections of the computer market in which the user can justify the leasing of a business machine only if the machine can also perform some of his scientific work. Beyond these users there are, of course, others whose primary requirement is for scientific work.

Scientific applications can be defined as those which involve small amounts of input and output data but considerable and complex computation using a wide range of values. The machines for this work require the following minimum specifications:—

(1) Fast arithmetic speeds necessitating parallel access to 'words' in the high speed memory and in the arithmetic unit.

(2) Adequate on-line peripheral devices for input and output since in the typical scientific application no requirement exists for storing large volumes of reference data.

(3) Floating point arithmetic to handle the wide range of numbers.

In addition a pure binary code appears to be necessary. A pure binary code is the natural language of the machinery and, therefore, tends to permit the simplest and cheapest mechanization of the control and arithmetic logic. In addition the code need contain no redundancy and hence for numerical data it is least wasteful of storage.

Mathematicians have become accustomed to binary coding by long usage. However, it is not immediately obvious from the user's point of view that a binary coded decimal notation is unacceptable. And, in practice, since an adequate method of 'automatic programming' is a prerequisite of a scientific system, the user need have nothing to do with the particular notation used within the machine.

Nevertheless, machines which have been designed with at least equal emphasis on the scientific market, include a pure binary code. The Philco S-2000 uses a pure binary code exclusively. The Honeywell 800 is unique in being able to handle both pure binary arithmetic and binary coded decimal arithmetic.

System Configuration and Cost

The basic configuration of the modern American business data-processing system is, therefore, a central processor with core memory, a complement of not less than eight tape stations with an associated control unit, and off-line peripheral equipment including at least a card reader and a 'line-a-time' printer.

The basic module of memory varies from 1 000 to 5 000 words where a word consists of eleven or ten characters plus a sign position. The maximum size of memory available in systems which have dispensed with the storage of programs on drums, varies between 4 000 and 25 000 words. The current notion of a useful memory size is somewhere between 5 000 and 10 000 words.

The speed of the card reader varies between 400 and 1 000 cards per minute. The printer's speed is usually 600 to 900 lines per minute.

The monthly rental for minimum systems of comparable work capacity ranges from $16 000 to $21 000 exclusive of maintenance and floor space. The variation can be attributed to some differences in what is actually offered for the price. The IBM 7070's rental includes a high priced tape system in which all the tape units have a read-after-write feature. A two-gap head permits checking of data immediately after it has been transcribed to magnetic tape. This removes one of the causes of inefficient operation, namely, that in the absence of this feature poor transcription is not detected until the next time the tape is scheduled for use. The Honeywell 800 system includes the highest priced tape system. This arises in part from the high rate of information transfer and in part from the ability of the control unit to handle up to sixteeen tape units simultaneously.

Auxiliary Peripheral Devices

In addition to the basic peripheral devices all manufacturers offer a card punch in order to accommodate users with well-established punched card installations.

A paper tape reader is usually offered with reading speeds up to 1 000 characters per second.

Currently paper tape is not necessary as an output medium. Modern systems thinking, however, includes introducing and receiving data at a location remote from the computer. This is largely a communication problem. At present 5-hole punched paper tape is the most widely used medium in this field.

Random Access File

The status of the large capacity, 'random-access' file is uncertain. The devices which are currently in use are magnetic drums, magnetic disks, and short lengths of magnetic tape. The mechanizations employ both single and multiple read-write heads for retrieval or entry of data. These devices are essential to certain applications which, like interrogation and reservation services, are fundamentally 'on-line'. The position of the random-access file in off-line applications is less obvious. The basic function in business data-processing is to update master reference records, e.g. account statements, insurance policies, in accordance with transaction information. The present method of performing this function in magnetic tape systems is to collect or batch the transaction information, order it by the same criterion as is used to order the reference file, and process it against the reference file. The purists argue that the function is more efficiently performed by the use of a large capacity, random-access file to which the transactions can be posted as they are received without the necessity for pre-sorting.

Conceptionally, this approach may be correct. The processing of a large percentage of inactive records is not a useful part of the work done in updating magnetic tape files on a batch basis. However, as a matter of practical economics the use of random access files can only be justified in certain specialized applications. Based on capacity, speed, flexibility, and cost the figures of merit of the existing devices are unfavourable. The capacity of a typical unit with 50 disks is 6 million numeric digits as compared with the 20 to 50 million digits which constitute the typical business file. The average search time for a unit of this size is 600msec which does not provide a marked improvement over the conventional method. The storage cost per digit is greater because the storage elements are permanently mounted whereas a reel of magnetic tape can be dismounted from a tape unit.

Most manufacturers provide some form of random access memory with their systems in order to handle applications which have a specialized need.

Character-Sensing

Adoption by the American Bankers' Association of magnetic ink as an acceptable method of recording data has prompted the development of devices for sensing characters recorded in this medium. IBM and General Electric, two of the companies most active in the banking industry, have produced machines for reading arabic numerals printed in magnetic ink on cheques. Apart from the cheque-handling application, however, character-sensing is not at this time a prerequisite for a manufacturer's data-processing system.

System Efficiency

One of the key concepts in the specification of data-processing systems is system efficiency, i.e. the balancing of machine speeds and data transfer rates so that the most use is made of the equipment while it is operating. As explained above, the older generation of systems operated peripheral devices off-line to circumvent the large discrepancy between the data transfer rate of these devices and the internal speed of the computer. Increased tape speeds (120in/sec) and closer pulse packing (300 to 550characters/in) yielded character transfer times of 30 to 16μsec. These times came close to matching the time of the basic operating cycle of the core memory (20-6μsec). System efficiency was improved by providing the ability to read from and write to tape simultaneously.

However, these gains in efficiency from the improved design of tape-handling mechanisms have been offset by other features of the design of the new computers. The provision of small buffer units between the tape machines and the core memory is justifiable economically. Thus, in the RCA 501 a buffer is employed which enables four characters read from tape in 120μsec to be transferred to the core memory in 15μsec. In the machines which can be considered for scientific work, access to the information in the memory is in parallel by word. A word of 10 digits plus sign which is transferred from tape to memory serially in say 170μsec, is handled thereafter in 6μsec.

In business applications which are, as noted above, characterized frequently by the processing of large files of low activity, these discrepancies result in inefficient use of the system's computing abilities.

The most direct attack on this problem among the newer systems is contained in the multi-programming technique embodied in the Honeywell 800. This system is engineered in four modules each of which can handle two independent programs. In the maximum case, therefore, eight independent programs can be processed simultaneously. Provision has apparently been made to permit the programs to be started, interrupted and completed independently. The computer keeps processing as many programs as are connected to it by seeking out each one in turn and, if appropriate, processing the next instruction. If a particular program has not completed its previous instruction, control is immediately transferred to the next program. The fundamental intention is to utilize every cycle of the core memory in some way.

While manufacturers agree about the desirability of an efficient system, there is less agreement about the way to design one. In some instances the user's operating problems run counter to the design requirements. The multi-programming approach as employed in the Honeywell 800 has yet to be tested operationally. It is open to the following criticisms:—

(1) Restrictions are imposed on access to the core memory so that inefficient use of storage may have replaced inefficient use of the control and arithmetic logic.

(2) The high cost of the tape control unit and of the program control unit appear to be due to the multi-programming facility.

(3) Operational difficulties may arise due to running programs concurrently; for example, an unscheduled stop in one program, if attended to at once, will probably necessitate interruption of the other programs.

Organization of Data

In general a business record contains a number of items and these may or may not be identified with the word structure of the computer. On magnetic tape the records are organized in several ways which can be classified according to the permissible flexibility of the record size.

'Fixed-word, fixed-record length' means that every record on the tape contains the same number of words and every word contains the same number of characters. By definition a record organized in this way has no flexibility.

'Fixed-word, variable-record length' means that words which contain no data in certain of the records in a file can be omitted from those records. In practice the omission of words other than those at the end of the record requires the use of some designating information. Hence the flexibility provided is not always significant.

'Fixed-item length but variable maximum' provides additional flexibility. The items which constitute the record can be of different lengths. However, the corresponding items in different records are of the same fixed length. This method of organization is described as 'variable-length'.

A completely flexible organization of data is one which combines the characteristics of variable length organization with the ability to omit blank items and adds to these the ability to handle variability in the length of the corresponding items in different records. This results in data on tape which is fully compressed and which contains neither spaces nor non-significant zeros. This method of organization may be described as 'fully variable'.

Record flexibility is a desirable characteristic of a business system. Unrestricted planning of some reference files has resulted in records in which the ratio of maximum to average length is as high as ten. The principal gain from variable length records is the reduction in the time taken to scan the records during tape operations.

However, record variability is attended by certain complications in design.

(1) The core memory must be addressable by character whereas fixed-word length permits the memory to be addressed by word. Addressing by word produces some economies in storing the programs by reducing the number of characters which are necessary to specify an address in an instruction.

(2) It is not convenient to gain access to data in the memory in parallel by item whereas this facility can be provided easily in a fixed-word machine.

(3) In the case of 'variable-length' records each instruction must specify the length of the operand addressed. In the case of 'fully variable' records the computer's logic depends on the recognition of a symbol which identifies the beginning or end of each item. In the RCA 501, which is the only system with a fully variable organization of data, the symbol is called an item separator symbol. These symbols are part of the record on tape and hence tend to offset the reduction in the length of the records.

It may also be noted that the flexibility of 'variable-length' data can be obtained in fixed-word machines by other techniques.

In both the NCR 304 and the IBM 7070 it is permissible to combine two or more items into one word providing, of course, that the resulting word is of the required fixed size. In order to handle multi-item words the instruction format permits the specification of the part of the word to be operated on by the computer. The same effect is obtained in the Honeywell 800 by the use of 'masking' instructions. The IBM 7070 also includes the facility of using 'record mark words' to designate the end of a particular item in a tape record. During the reading of such a record from tape to memory the detection of a record mark word causes the computer to select a new address from a table of addresses stored in the memory. Subsequent characters are read into the memory starting at this address until another record mark word is detected. The record mark word is, therefore, analogous to an item separator symbol as used in the RCA 501.

The Burroughs 220 includes a 'preface word' in each tape record to specify the number of words in the record. This arrangement permits the use of records with the characteristics of 'fixed-word but variable record length'. In addition the instruction format of the computer makes possible operations on 'partial-word' fields, i.e. a group of adjacent characters within a word specified by the first two digits of the instruction.

In addition to the design complexities the value of the advantages conferred by data variability is still questioned. The reduction in record length obtained with a 'fully variable' organization arises from items containing names, addresses, and cumulative money amounts. Criticism of this type of organization rests on the question of the prevalence of these items in actual business records.

GAPS ON MAGNETIC TAPE

The conventional method of recording binary-coded characters is with the bits and the synchronizing track, if used, in parallel across the tape and the characters in series along the tape. The characters are grouped in blocks. A block may or may not be identified with a single record from a reference file or with a single transaction record. The size of the block is limited only by the available space in the core memory. The blocks are separated by gaps, usually of blank tape, which are sufficiently long to permit the stopping and restarting of a tape without causing characters to be misread. These gaps vary in length from system to system, ranging typically from 0·4in to 0·7in.

The gap is undesirable for two reasons. Firstly, it represents a wastage of the storage medium which becomes relatively more serious as the pulse packing is increased. In a large installation where the number of tapes in use runs into thousands, the wastage is significant. Secondly, the time taken to traverse these gaps at the running speed of the tape is between 4 and 10msec. In operations such as the updating of low activity files and the sorting of records between tapes, the time to traverse the gaps in the data adds significantly to the overall time of the operation.

In the NCR 304 system the gap is equivalent to three characters, sufficient only to allow the end of a block to be detected. In a file updating operation the blocks can be passed over without stopping the tape until the record is found which matches the transaction record. At this point the tape is stopped, backed up until the gap is detected again, stopped, and then restarted. The relevant record is read into the computer's memory. The tape is stopped at the next gap and repositioned once more ready for restarting when the search for the next active record is initiated. While this procedure adds time to the updating of a record, the inspection and passing over of inactive records takes less time. Evidently the benefits of the technique depend on the activity of the file.

Selective Updating

In file-processing operations the conventional, and still the only widely used, method is to read the old file from one set of tapes and re-write the records, updated as necessary, on to another set of tapes. The latter set then becomes the current master file. To the user, accustomed to static visual files of paper documents, the continual retranscription of inactive records appears to be unnecessary and an additional source of error. Selective updating whereby only those records which need to be changed are retranscribed, is a technique which has, or at any rate used to have, customer appeal. The Datatron 220 system includes this feature.

The difficulties of the technique are considerable and the benefits by no means as real now as they might have been at one time.

The technique demands a fixed-record length recording method so that an updated record will always fit into the same length of tape as the previous version of the record. 'Insertions' into the master file can only be handled periodically in a special operation. This means that a file of insertion records must be maintained in addition to the regular file. Since insertion records are usually active within a few days of insertion, e.g. newly issued insurance policy, the 'double-file' is undesirable.

The benefit of the technique is the elimination of 'unnecessary' transcription errors. In the IBM and Philco tape units a double-gap head permits reading after writing. This enables a transcribed record to be checked transversally and longitudinally for correct parity at the time of transcription. In other systems an error remains undetected until the next time that the tape is used.

Offsetting the benefit of selective updating is the necessity for maintaining back-up files. These files enable any part of the current master file to be reconstituted if it is destroyed due, for example, to a malfunction of one of the tape units. In non-selective updating operations the back-up file is generated as part of the normal procedure. In selective updating a special duplicating operation must be run periodically. An additional disadvantage is the undesirability for security reasons of writing on a tape which contains good data. (For this reason some systems use tape units which can be designated 'for reading only'.)

Selective updating is possible conveniently with any file in which the records are of fixed length. However, the technique has not been adopted by the manufacturers of the new generation of systems.

Summary of Data Organization

The trend in the organization of data appears to be as follows:—

(1) For business applications agreement exists in principle about the desirability of a flexible organization of data on magnetic tape.

(2) There is general agreement about the unsuitability of records on magnetic tape in which the items are identified with computer words on a one-to-one basis.

(3) So far as the internal economies of the computer are concerned, a fixed-word length is very desirable.

(4) For scientific applications fixed-word length is essential because it permits parallel access to a word and hence fast computational ability.

All the new systems except the RCA 501 contain compromise solutions to these conflicting characteristics in which a fixed-word length is used but freedom in the association of items and words is preserved. The RCA 501 system retains the fully variable organization previously associated with the RCA Bizmac, and with it the unrestricted combination of items into records.

Coding Systems

All of the new systems except the Philco S-2000 are designed to handle binary-coded characters. A 7-bit code is used throughout the RCA 501 and NCR 304 systems. The IBM 7070 system records characters on tape only in a conventional 7-bit code. The Honeywell 800 system can handle either a pure binary code or a binary-coded notation. A binary word of 48 bits can be designated as 11 signed decimal digits or 8 alphanumeric characters. The Philco S-2000 has no instructions for doing decimal arithmetic and, hence, its coding method can be regarded as essentially binary.

The choice of codes reflects the general agreement that business systems should stay close to a decimal notation while scientific systems should use a pure binary notation. However, it seems likely that modern automatic programming techniques are liberating the manufacturer from the users' desires in this respect.

Importance of Alphabetic Information

The importance of including a method of handling alphabetic information is accepted by all manufacturers. About the importance of alphabetic information relative to numeric information there is less agreement.

Within the computer the IBM 7070 system uses only numerical digits. Alphabetic characters are carried as double numeric characters. A 10-digit numeric word can be distinguished from a 5-character alphabetic word by the presence of a plus or minus sign in the sign position of the word. A similar arrangement is used in the computer of the Datatron 220 system.

The reason for the adoption of a numeric-only notation within the computer is to effect economy in the use of the memory. A memory of N bits can store either $N/7$ alphanumeric characters or $N/5$ numeric digits. If alphabetic characters are handled as double numeric digits and if x per cent of the information is alphabetic, then the memory in its 5-bit configuration can store $N/(1 \div \cdot 01x)5$ alphanumeric characters. Evidently from the point of view of the design of the core memory the 5-bit configuration is better if the following condition holds:—

$$N/(1 \div \cdot 01x)5 > N/7$$

i.e. if $x < 40$ per cent

This is usually the case. However, the 'pay-off' value is diminished by the additional complexities introduced into the design of the computer's control section.

Programming

Manufacturers agree about the necessity for making programming effort more productive but disagree about the way to achieve this objective. Early coding was done exclusively in machine code. The first step towards more productive programming was the transfer of some of the clerical phases of the coding process, e.g. the assignment of memory locations, from the programmer to the computer. The resulting process is called 'relative programming'. Fundamentally it consists of referring to operating information, stored constants, and the stored program itself symbolically instead of by the actual memory locations which they occupy in the computer. The symbolism can be any suitable system of characters. The use of page and line number is a simple example where the two serve to identify the item's or operand's position in the coding sheets prepared by the programmer. Substitution of actual memory locations for the symbolic addresses is accomplished by the computer using a special routine called a compiler. The overall procedure is machine-orientated, that is, it is closely related to the basic machine code. It does not relieve the programmer of the necessity for understanding the machine code and at least some part of the logic of the machine. Relative programming is of some assistance during the initial writing of a program. Its greatest virtue, however, is that it facilitates the alteration of the program. The alterations occur during the initial programming due to changes in the requirements, during program testing due to errors in the program, and throughout the life of the program due to the evolution or expansion of the requirements. The anticipated volume of changes varies from business to business but two generalizations are permissible. Firstly, the most difficult task in the conversion from a manual to a machine system is to discover what the existing manual system is. It is unusual for the first attempt to result in the definition of 100 per cent of the problem. Secondly, most company operations are dynamic in some degree due, for example, to sales pressure. Banks offer a wide variety of types of accounts designed to attract capital. Insurance companies promote new insurance plans designed to maintain their competitive position. The electronic data processing (e.d.p.) department has to be sufficiently flexible to follow these changes rapidly and cheaply. Relative programming goes a long way towards the realization of this requirement.

Automatic programming has a different objective, namely to divorce programming entirely from the basic machine code. The programmer will then not need to know anything about either the machine's language or the machine's logic. This gets into the area of 'English' or 'plain language' programming in which certain stylized phrases and sentences are defined in order to describe the flow chart of a problem. Special routines are prepared for the computer by either the manufacturer or the customer and these convert the plain language program into a form which the computer can understand more readily.

Some scepticism exists among both manufacturers and users about how successful this approach can be.

The basic difficulty is the development of a sufficiently standard and comprehensive vocabulary. In this respect business and scientific applications are different. The mathematician has a vocabulary which is both limited and internationally acceptable. Providing certain approximations are allowable, the definition of 'add', 'subtract', 'multiply', and 'divide' provides a workable minimum vocabulary. No analogous situation exists in business. Even within one company a word like 'update' may describe a variety of functions.

A less fundamental but still real difficulty is the testing of the program. In theory since the computer itself has interpreted and compiled the machine coding from a plain language program there should be no errors. However, one major source of errors in programs are the so-called logic errors. These arise due to input data which were not anticipated or which were misinterpreted by the programmer. When the computer detects these errors it must provide evidence of them to the programmer in a form which the programmer can understand.

The present status of programming for business appears to be as follows: —

(1) A machine-orientated relative programming method is essential.

(2) The real value of plain language programming, as distinct from its sales value is not yet proven.

For machines which are to be marketed actively for scientific work, a method of problem-orientated automatic programming is also essential. In general, scientific programs have a much shorter life than business programs. The latter may be used daily for months or years with relatively few changes. Consequently the cost of preparing a scientific program cannot be amortized as readily. And hence it becomes important to reduce programming time even though this may result in less efficient programs and somewhat longer machine times.

Assistance to the Customer

In the early days of business e.d.p. it was not unusual for the manufacturer's programmers and analysts to guide, control, and even supplement the efforts of the user's personnel. This situation is unpalatable to most executives because of the divided responsibility implied and it is not now commonplace.

However, customers look to the manufacturer to supply assistance in the following areas: —

(1) Initial training of the customer's personnel.

(2) Some day-by-day assistance at all levels in the customer's organization.

(3) A method of relative programming.

(4) A comprehensive set of tested routines which will ensure productive program-testing sessions, e.g. a static examiner which inspects the program for coding errors, a dynamic tracer which permits selective print-outs from the memory, a memory dump routine which enables a program to be removed rapidly from the machine and reinserted at a later time.

(5) The use of another machine for testing programs so that the customer can be 'in production' as soon as possible after the delivery of his own system, even if this is only on a limited scale.

(6) Assistance in developing suitable operational controls such as tape header messages, record counts per tape, and methods for resuming operation when interrupted by a machine malfunction or by an out-of-balance condition.

(7) In some instances assistance is also requested in establishing the routine procedures for scheduling work on the system.

(8) A basic sorting routine.

The demand for 'advance' program testing time implies that the manufacturer must maintain an accessible, efficiently run service bureau. Attempts to interleave system testing and program-testing are unsatisfactory for both the manufacturer and his customers.

Some manufacturers supply 'packaged' routines for operational controls, end-of-tape conditions and other routine eventualities. Other manufacturers prefer to give direct assistance to the customer in establishing his own standard routines for these contingencies.

Characteristics of Business Data-Processing

The typical business application of today is dominated by the requirement for updating master reference files and by the requirement for sorting the transactions into the same sequence as the reference file before the updating can be attempted. The time spent in sorting is between 20 per cent and 40 per cent of the total operating time of a business installation. The time spent in passing reference files depends on the frequency with which the files are updated, i.e. on the necessity for maintaining current information in the files. In a typical installation the total time may be split equally between sorting, processing inactive reference records, and making computations on active data.

The instruction complements of the new systems permit efficient performance of these two basic functions. Simultaneous reading from and writing to magnetic tape is included in all of them. Fast rates of information transfer to and from tape are also universal (IBM 62·5kc/s; RCA 33kc/s; Honeywell 96kc/s for numeric data).

A less conventional instruction is the ability to read a record from a tape which is being rewound. This instruction is chiefly of use in the sorting of records by passing them through the computer several times from one group of tapes to another. When records can only be read from a tape moving in the forward direction it is necessary to rewind the tapes between 'passes'. The ability to 'read in reverse' eliminates the rewind time. The sorting routine is organized so that the input tapes of any pass except the first move in reverse while the output tapes move forward.

A characteristic of processing low-activity multi-reel files is that the individual reels of the file must be alternated on at least two tape units and possibly on three. This makes it unnecessary to interrupt the operation while a reel of tape rewinds and is dismounted and replaced. The inclusion in a machine of a fast rewind makes it possible to use only two tape units in circumstances where three might otherwise be necessary.

One method of improving the sorting and file-processing operations is to combine records together on magnetic tape into batches while preserving the identity of the records within the batch. Programming techniques are being developed for handling data organized in this way. None of the new systems, however, include any special facility for processing batched records.

A technique of an older vintage can be used for decreasing the time taken to process a reference file. The tape controller is provided with the ability to search a file for active records independently of the computer. During the controller's search for an active record the computer continues other computations, for example the processing of the previous active record. If more than one controller of this type is available, and if the activity of the file is low enough, faster processing is made possible by partitioning the file. The separate pieces of the file are run independently by the controllers and the computer is available to service all the active records. The NCR 304 and the Datatron 220 systems include tape controllers with this ability.

Instruction Complement

The new systems include a basic complement of arithmetic, control, and data-handling instructions.

The arithmetic instructions include decimal addition, subtraction, multiplication, and division and, in addition, a comparison instruction which is some form of binary subtraction.

Because the American currency system has a decimal radix these instructions suffice for monetary calculations which are of course essential to a business system.

No instructions are included for the comparison and manipulation of dates. These operations are handled as sub-routines.

In all of the systems except the RCA 501 instructions for floating point arithmetic are provided either as standard instructions or as an option.

Control instructions provide for conditional and unconditional branching in the programs. Chiefly as an aid in program testing a series of console-controlled breakpoint switches are provided in most of the systems. They provide the programmer with a method of leaving the main path of his program at predetermined points to obtain, for example, print-outs of certain areas of the memory.

Data-handling instructions enable data to be transferred to and from the component parts of the system as necessary. Optional on-line operation of peripheral devices requires instructions and a form of program control which permit the operation of these equipments simultaneously with each other and with computing instructions.

Beyond these basic instructions some of the systems include less proven instructions such as logical add, or logical or, and binary multiply. The NCR 304 system has three 'macro' instructions in which a commonly used function, such as the merging of two tapes, is mechanized. Increased speed is obtained by the elimination of the staticizing of each of the set of instructions which would otherwise be required. Macro-instructions are not, in general favour because of their inflexibility. Thus the 'merge' instruction enables two tapes to be merged to form a third tape. In a typical installation, however, the merging of three, four, five, or even six tapes to form an output tape is just as common as the merging of two tapes.

All of the systems include index registers (*B*-boxes, *B*-lines) a feature which heretofore has been found only in scientific machines. Index registers give the programmer an improved facility in the modification of addresses within his program. The number of registers provided varies from seven to as many as ninety-nine (IBM 7070).

Instruction Format

The new computers offer a choice of 1-, 2-, or 3-addresses. The IBM 7070 and the Datatron 220 computers use a single address. The Honeywell 800 and the NCR 304 computers use three addresses. The RCA 501 computer uses two addresses. There does not appear to be any decisive advantage in terms of instruction power per digit of program storage. Choice of the number of addresses is probably determined by the instruction length which suits the overall machine specification.

Conclusion

An attempt has been made in this article to survey the new generation of electronic business data-processing systems. It has been shown that the systems have certain basic similarities which represent areas of agreement among the manufacturers about the characteristics of the general data-processing problem. In other areas the design specifications have a diversity indicative of differences of opinion.

One sign of maturity in the industry is the importance assigned to helping the customer to use his installation effectively. This help takes the form of direct customer assistance and of the development of easier programming methods. The magnitude of this effort is such that a machine no matter how well designed and engineered, cannot be marketed successfully without a comprehensive, nation-wide sales support organization.

A Simple Wave Filter

By D. G. Wyatt*

It is possible to obtain a useful filter of the high-pass or low-pass type by connecting a parallel-T circuit in series with a suitable LC circuit. Only one inductance is required, and this is especially useful at low cut-off frequencies. The arrangement compares favourably both with filters of the conventional type, and with those derived from negative-feedback amplifiers, on grounds of simplicity, stability, and bulk.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

WHEN phasic flow occurs in an induction flowmeter employing a sinusoidally-varying magnetic field, the potential resulting from flow contains sidebands centred about the frequency of the magnetic field. In order to reduce interference and improve signal-to-noise ratio, it is desirable to use a band-pass filter having uniform and stable amplification over the region covered by the sidebands, while the phase shift should be zero or proportional to frequency over this range. It was in this connexion that the problem arose of designing a filter with a pass-band extending from 30c/s to 70c/s.

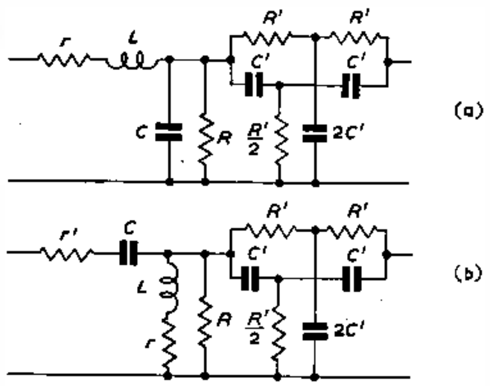


Fig. 1. (a) Low-pass circuit (b) High-pass circuit

It is well known that conventional wave filters with low cut-off frequencies are inconvenient on account of the many inductors and capacitors of high value which are required, and the consequent high cost and large bulk of the complete filter. Attempts[1-7] have been made to overcome these disadvantages by using filters derived from phase-dependent negative-feedback amplifiers, employing either 'parallel-T' or resistance-capacitance elements. Arrangements of this kind can be very useful in certain types of work, but have two disadvantages: first, the exact shape of the amplitude and phase characteristics is usually dependent upon the valve gain within the feedback loop; second, it is not always possible readily to design such filters, and it is usually necessary to resort to empirical adjustment of the circuit elements, based on experimental measurement. Also, the complexity and bulk of the whole filter may be comparable with that of a similar filter of the conventional type.

Consideration of the curvature of the transmission characteristics of conventional tuned circuits, and of parallel-T circuits, led to the construction of the filter circuits shown in Fig. 1. These filters each consists of a simple resistance-terminated L-section in series with a parallel-T circuit.

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The success of the combination depends on the fact that where the curvature of the transmission characteristic of the T-circuit is convex upwards, that of the L-section is concave upwards, and by suitable adjustment the product of the two transmissions can be made nearly constant over a useful frequency range, as shown in Fig. 2. The design

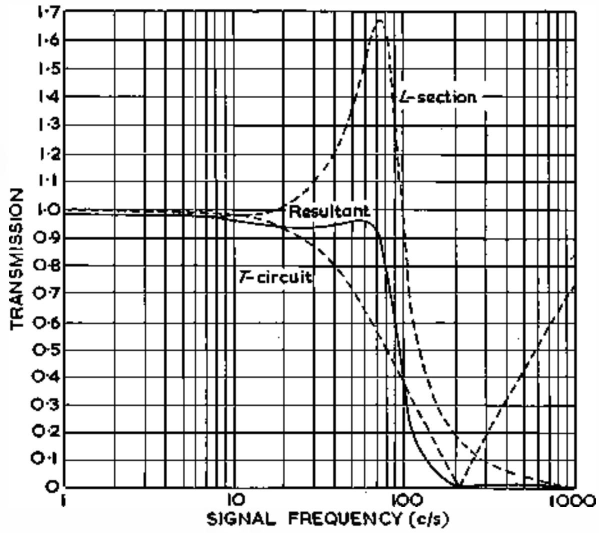

Fig. 2. Synthesis of transmission characteristic from the LC and T circuits

procedure will be illustrated by reference to the band-pass filter problem mentioned above.

Low-Pass Filter

The unloaded T-circuit fed from zero impedance has a transmission characteristic given by

$$y_1 = \left[1 + \left(\frac{4f/f_o}{f^2/f_o^2 - 1}\right)^2\right]^{-\frac{1}{2}} \qquad \text{(1)}$$

and a phase-angle

$$\theta_1 = \tan^{-1}\frac{4f/f_o}{f^2/f_o^2 - 1} \qquad \text{(2)}$$

where f is the signal frequency and f_o the null frequency, given by $f_o = 1/2\pi R'C'$.

The L-section fed from an impedance r into a load R has a transmission characteristic given by

$$y_2 = [(1 + \phi - (f^2/f_c^2))^2 + \alpha' (f^2/f_c^2)]^{-\frac{1}{2}} \qquad \text{(3)}$$

and a phase-angle

$$\theta_2 = \tan^{-1}\frac{-\sqrt{\alpha'}\,(f/f_c)}{1 + \phi - (f^2/f_c^2)} \qquad \text{(4)}$$

where

$\phi = r/R$, $\alpha' = Q_c^2\ (1+\phi/Q_c^2)^2$, $Q_c = \omega_c L/R$, $\omega_c^2 = 1/LC$

The choice of null frequency f_o of the T-circuit is decided by two limiting considerations: (a) if f_o is too high, the composite transmission characteristic will not fall off rapidly enough beyond 70c/s, and (b) if f_o is too low, a very sharply resonant peak will be required in the L-section, which will result in difficulties as regards manufacture and stability; in addition, very non-linear phase-shift can be expected in the pass-band. Therefore f_o is chosen to be 212·2c/s, which can be conveniently obtained if $C'R' = 0{\cdot}00075$. The transmission and phase shift of the T-circuit are now calculated at three frequencies within the pass-band, 30c/s, 50c/s, and 70c/s. The results are given in Table 1.

In order to obtain a transmission factor of 1 with the composite filter, it is necessary to design the L-section so that at the frequencies 30, 50, and 70c/s it has transmission factors of 1/0·866, 1/0·708, and 1/0·56 respectively. A value of R is chosen which is low enough to be only slightly modified by the T-circuit, but not so low that r/R is appreciable, otherwise there will be unnecessary attenuation. Therefore some idea is needed of the value of r, which includes the resistance of the inductance and the output resistance of any valve circuit which feeds the filter (in the present instance a cathode-follower is used). Thus if $r = 2{\cdot}25\text{k}\Omega$ and $R = 50\text{k}\Omega$, $\phi = 0{\cdot}045$. The next step is to use this value of ϕ in equation (3), transforming to obtain simultaneous equations in f_c and α', using the required values of y_2 at the extremes of the pass-band, i.e. 1/0·866 at 30c/s and 1/0·56 at 70c/s. On solving for f_c, the value obtained is 64·2c/s. This is within the pass-band, and will give non-uniform transmission and very non-linear phase shift. It is clearly necessary to accept a transmission factor less than 1 for the composite filter, so that the values of y_2 can be less over the pass-band, and the resonant rise thus made to occur at a higher frequency. If a net transmission factor of 0·935 is chosen, for example, and the equations solved for values of y_2 equal to 0·935/0·866 at 30c/s and 0·935/0·56 at 70c/s, it is found that $f_c = 77{\cdot}5$c/s, and $\alpha' = 0{\cdot}375$. If these values are used in equation (3), the results shown in Table 2 are obtained.

It will be noticed that there is a rise of 2 per cent in the net transmission at 50c/s. This could be prevented by choosing a value for the net transmission at 30c/s and 70c/s slightly less than the value 0·935 which has been used. In the present instance, this correction is made in the design of the high-pass filter.

The value of Q_c^2 can be determined from the value of α', and two values are obtained, 0·276 or 0·0074. Although the higher value requires a larger inductance, it is used because y_2 is then less dependent on r. The value of L works out to be 54·2H, and from this and the value of f_c, the value of C is found to be 0·0780μF.

TABLE 1

f(c/s)	y_1	θ_1(deg.)
30	0·866	—30
50	0·708	—45
70	0·560	—56

TABLE 2

f(c/s)	y_1	y_2	y_1y_2	θ_1(deg)	θ_2(deg)	$\theta_1+\theta_2$(deg)
30	0·866	1·08	0·935	−30	−15	−45
50	0·708	1·35	0·956	−45	−32	−77
70	0·56	1·67	0·936	−56	−68	−124

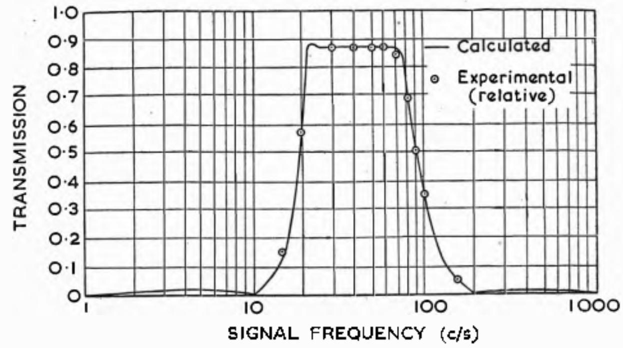

Fig. 3. Calculated resultant transmission of combined low-pass and high-pass circuits with experimental points

High-Pass Filter

The T-circuit characteristics are given by equations (1) and (2).

The L-section fed from impedance r' into a load R has a transmission characteristic given by

$$y_2 = \left[\left(1+\phi'+\frac{\phi\phi'-Q_c^2}{\phi^2+Q_c^2\ (f^2/f_c^2)}\right)^2 + Q_c^2\ (f_c^2/f^2)\left(1+\frac{\phi+\phi'\ (f^2/f_c^2)}{\phi^2+Q_c^2\ (f^2/f_c^2)}\right)^2\right]^{-\frac{1}{2}} \qquad \text{(5)}$$

and a phase-angle

$$\theta_2 = \tan^{-1}\frac{Q_c\,(f_c/f)\left[1+\dfrac{\phi+\phi'\ (f^2/f_c^2)}{\phi^2+Q_c^2\ (f^2/f_c^2)}\right]}{1+\phi'+\dfrac{\phi\phi'-Q_c^2}{\phi^2+Q_c^2\ (f^2/f_c^2)}} \qquad \text{(6)}$$

where $Q_c = \omega_c L/R$, $\phi = r/R$, $\phi' = r'/R$, $\omega_c^2 = 1/LC$ and if $\phi = \phi' = 0$, $y_2 = [(1-(f_c^2/f^2))^2 + Q_c^2\ (f_c^2/f^2)]^{-\frac{1}{2}}$ ... (7)

Since equation (5) is not a simple function of f/f_c, simultaneous equations cannot be solved for f_c as with the low-pass filter. It is necessary first to assume $\phi = \phi' = 0$ and determine f_c and Q_c from equation (7), using the required values of y_2 at 30c/s and 70c/s given by the T-circuit calculations. These values must then be substituted into equation (5), and from the results the necessary adjustment can be made by inspection and repeated calculation. In the present instance, the additional requirement that the net phase shift of the low-pass and high-pass sections be linear with frequency has to be borne in mind. The computed results for this section of the filter are as follows:

Null frequency of T-circuit $f_o = 10$c/s, $\phi = 0{\cdot}0300$, $\phi' = 0{\cdot}0200$, $f_c = 22$c/s, $Q_c^2 = 0{\cdot}14$, $R = 50\text{k}\Omega$, $L = 136$H, $C = 0{\cdot}388\mu$F, the remaining values are shown in Table 3.

It will be noted that this high-pass section has been designed so that the transmission is low by 2 per cent at 50c/s, thus compensating for the rise of the same amount at this frequency in the low-pass section.

The calculated resultant transmission is shown in Fig. 3, together with some experimentally determined points. In Fig. 4, the calculated phase-shifts introduced by the high- and low-pass sections are shown, together with the calcu-

TABLE 3

f(c/s)	y_1	y_2	y_1y_2	θ_1(deg)	θ_2(deg)	$\theta_1+\theta_2$(deg)
30	0·554	1·675	0·928	56	35	91
50	0·769	1·177	0·905	40	13	53
70	0·862	1·072	0·925	30	9	39

lated resultant and some experimental points taken with the complete filter.

The inductors were wound on Ferroxcube pot cores (one core type LA 13 for each inductance). Polystyrene capaci-

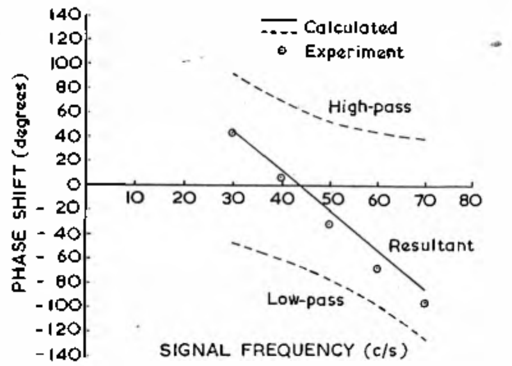

Fig. 4. Calculated phase characteristics with experimental points

tors and high stability resistors are used, the measured values being within ±1 per cent of those required. The differences between the experimental and calculated results are within the tolerance of the components and of the signal generator used for the measurements.

The amplitude stability is dependent on two kinds of variation. First, if the filters are fed from cathode-followers, the source resistance can vary with filament supply. It can be calculated that with the present filter, a change of 20 per cent in the mutual conductance of each of the two cathode-followers used can alter the net transmission factor by 1 per cent. Second, there is the question of temperature stability of the filter. This is not constant within the pass-band, but the calculated variation in transmission (using temperature coefficients of the components as published by the manufacturers) is never greater than 1 per cent for a temperature change of 10°C.

As the filters were used in an amplifier at millivolt level, the high-pass and low-pass sections were enclosed in separate boxes of Mumetal (3in × 3in × 4in × 1/32in) to prevent magnetic interference at mains frequency.

It is possible to design a more simple filter of this type using a single capacitor and resistor in place of the *T*-circuit. However, the attenuation is less rapid beyond the pass-band.

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An Automatic Production Plant for Miniaturized Silicon Diodes

To meet the increasing demand for their ZS30 series 500mA double-ended diffusion diodes, a new automatic plant for their production has now been put into operation by Ferranti Ltd at their Gem Mill Factory in Oldham, Lancashire.

This plant which took about 15 months to develop was designed and built by the Company's own Plant Development Section. It is estimated that it is capable of producing 43 000 diodes a week to test stage.

Until recently, most of the operations in the production of the ZS30 series, specially designed for automatic assembly techniques, had been carried out entirely by hand, but this was only a temporary arrangement until the new automatic plant could be installed. Careful study of the previous hand methods used has enabled the Company's development engineers to break down the process into a number of simple steps.

Now, all operations in the final assembly of the header such as flash welding the wire on the back of it, passing through a hydrogen furnace to remove oxidation, are carried out by automatic transfer mechanisms. As the stages of copper and gold plating the header assembly, and that of pre-soldering the dice to the header, lend themselves well to batch production, no automatic mechanism is used for these processes.

The mechanism used for the assembly of the lead wire to the header is controlled from a common camshaft, the use of which enables the overall index figure, nominally eight seconds, to be varied at will.

From the hopper, the headers are sorted out and presented one at a time to a magazine. An escape mechanism releases the header down an inclined chute on to an indexing table where it is influenced into a cup by means of an air jet. Each time the table indexes, a vacuum arm picks up a header off the table and transfers it through 180° to another vacuum arm which in turn transfers it to a second table where it accurately locates it in a Nimonic alloy jig. This table then indexes round and presents the header to the lead wire, at which time an intense oxy-coal gas flame is brought into position to make the weld. After welding, the wire is measured to length and cropped accurately by transverse guillotine knives.

The completed header is then indexed to a position where it is blown out of the jig and up through a tube in the form of an inverted U which transfers it to a small hydrogen furnace where oxide created by welding is removed. After passing through this furnace, the component is collected in a container and taken away to be copper and gold plated.

The header, with solder disk and silicon dice mounted on top, and in contact with each other, is then assembled in a jig which is passed through a hydrogen furnace for a period of about 15min. During the cooling cycle the dice adheres to the top of the header.

Post-etching treatment which is the next stage of the process is also carried out automatically by means of a specially designed plant. Its use has already shown a marked increase in the efficiency of the diodes.

A notable feature of this plant is that dangerous etching liquors, in this case, a mixture of hydrofluoric, acetic and nitric acids, are stored remotely in a cabinet outside the area where the operator is working.

A rotary indexing table passes the components through a series of etching, cleaning and drying stations before the final index position where automatic varnishing is carried out. The index position before varnishing is utilized for checking the polarity of the dice by means of a wire probe.

The index figure of this mechanism is variable from 5 to 10sec and the period in which the dice is exposed to the atmosphere is limited to 17sec.

Before final encapsulation which is carried out by an automatic machine with an indexing time of 15sec, a solder ring placed round the header plinth together with a small solder disk on top of the silicon slice, is then located in a small ceramic chuck. The can, complete with glass seal through which the lead wire and compensator pass, is located directly above the plinth and the whole assembly is then placed in a vacuum chamber.

The machine indexes round through a series of eddy current heating positions until at a pre-determined time, when the ring and disk are molten, a trip mechanism allows the can to drop on to the plinth, thereby locating the compensator on top of the dice which is positioned directly below it. The table continues to index during which time the assembly is allowed to cool to form the hermetically sealed encapsulation.

A new high frequency, double-diffused, mesa silicon transistor, the ZT20, has also been put into production and it is anticipated that by the middle of this year production will be at the rate of 25 000 per year. It is claimed that when marketed it will be the highest frequency silicon transistor manufactured in the United Kingdom.

The device was developed for use in high frequency i.f. amplifiers, and oscillators up to 100Mc/s, and for any other applications where fast switching characteristics are desirable.

The Single-Ended Diode Phase-Sensitive Detector

By R. Chidambaram*, M.A., M.Sc., A.M.I.R.E., and S. Krishnan*, M.Sc.

The operation of the single-ended diode phase-sensitive detector with load is investigated. As in the case of the simple push-pull detector, the transfer ratios for the two diodes are found to vary considerably with the signal. This introduces a non-linearity in the output which is evaluated and a table is given from which the performance of a given detector of this type may be judged immediately. A comparison is made between this detector and the simple push-pull detector and the loading conditions, under which one is superior to the other from the point of view of linearity, are discussed.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

IN a recent article[1] (hereafter referred to as (I)), the authors investigated the operation of the simple push-pull phase-sensitive detector under various degrees of loading. In this article, a similar investigation is carried out of another type of detector which, in spite of the important advantage of providing a single-ended output, does not appear to be well-known.

The Single-Ended Phase-Sensitive Detector

Fig. 1 shows the circuit of the detector. E_1 and E_2 are the amplitudes of the reference and signal voltages respectively, assumed to be in phase. The sum of the two voltages is applied to one of the diodes, MR_1, and the difference to the other diode, MR_2. MR_1 and MR_2 are connected in opposite sense. R_1's are the effective series resistances in the two diode circuits. If the value of CR_2 is very large compared to the period of the applied sine waves, the voltages E_A and E_B developed at the nodes A and B may be assumed to be steady.

If the transfer ratios of the two diodes are k_1 and k_2, then:

$$E_A = k_1(E_1 + E_2) \text{ and } E_B = -k_2(E_1 - E_2).$$

Suppose that the diodes conduct respectively over angles $2\theta_1$ and $2\theta_2$ during a cycle; their transfer ratios can be written as:

$$k_1 = \cos\theta_1,\ k_2 = \cos\theta_2 \quad \ldots\ldots\ldots\ldots (1)$$

The output voltage is given by:

$$E_o = \frac{R}{R_2 + 2R}\cdot\{k_1(E_1 + E_2) - k_2(E_1 - E_2)\} \quad \ldots. (2)$$

As will be shown below, k_1 and k_2 are in general unequal so that the output is not proportional to the signal amplitude E_2.

The average current flowing through MR_1 into node A is

$$\frac{\pi R_1}{E_1 + E_2}\ \{\sin\theta_1 - k_1\theta_1\}.$$

This is equal to the current flowing through R_2.

$$\frac{E_1 + E_2}{\pi R_1}\{\sin\theta_1 - k_1\theta_1\} = \frac{k_1(E_1 + E_2) - E_o}{R_2} \ldots. (3)$$

Using equations (1) and (2), the above equation and the corresponding one for node B can be rewritten as:

$$n_1/\pi\ (\sin\theta_1 - \theta_1\cos\theta_1) = \cos\theta_1(1 - n_3) + wn_3\cos\theta_2 \ldots. (4)$$

$$n_1/\pi\ (\sin\theta_2 - \theta_2\cos\theta_2) = \cos\theta_2(1 - n_3) + (n_3/w)\cos\theta_1,\ w \neq 0 \quad \ldots\ldots\ldots\ldots (5)$$

where:

$$n_1 \equiv (R_2/R_1),\ n_3 \equiv \frac{1}{2 + n_2},\ n_2 \equiv (R_2/R),\ w \equiv \frac{1 - x}{1 + x},\ x \equiv (E_2/E_1) \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

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As in (I), n_1 and n_2 may be called the *source impedance factor* and the *load factor* respectively. Equations (4) and (5) may be solved by the method described in the Appendix of (I). (The corresponding equations in (I) are equations (9) and (10).

Behaviour of the Transfer Ratios k_1 and k_2

As in (I), the calculations have been made for the source impedance factor $n_1 = 1{\cdot}46\pi$. Fig. 2 gives the variations of k_1 and k_2 against the signal-to-reference voltage ratio x for different values of the load factor n_2. It will be observed that in the absence of the signal (i.e., $x = 0$), k_1 and k_2 are

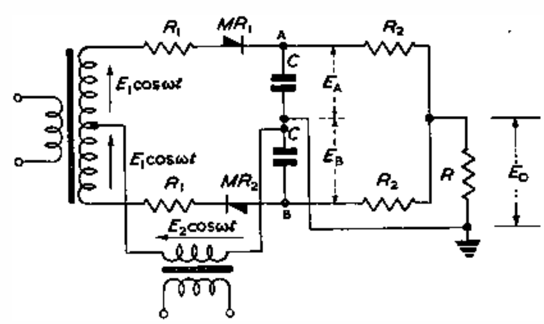

Fig. 1. Circuit of the single-ended phase-sensitive detector

equal for all values of the load factor n_2. This follows from symmetry considerations, the voltages at the nodes A and B in the absence of the signal being equal in magnitude and opposite in sign leading to an output voltage E_o equal to zero. The common value, say $k_o \equiv \cos\theta_o$, of the transfer ratios k_1 and k_2 corresponding to $x = 0$ can be obtained from equation (3) by putting $E_2 = E_o = 0$. θ_o, the semi-angle of conduction of either diode in the absence of the signal, is consequently the root of the equation:

$$\frac{\pi\cos\theta}{\sin\theta - \theta\cos\theta} = (R_2/R_1) = n_1 \quad \ldots\ldots\ldots (7)$$

For any value of the load factor n_2, as the signal voltage (or x) is increased, k_1 increases and k_2 decreases continuously. This means that the angle of conduction of the diode MR_1 to which the sum of the reference and signal voltages is applied decreases and the angle of conduction of the other diode MR_2 increases. As the latter becomes equal to 180°, the transfer ratio k_2 becomes equal to zero. For higher values of x, the conduction angle increases further leading to a negative value for k_2. When k_2 becomes equal to -1, the diode MR_2 begins to conduct over the entire cycle. Beyond this k_2 loses its significance in terms of the conduction angle of MR_2. The deviations of k_1 and k_2 from the no-signal value k_o are more pronounced for lower values of n_2 (i.e., larger load resistances).

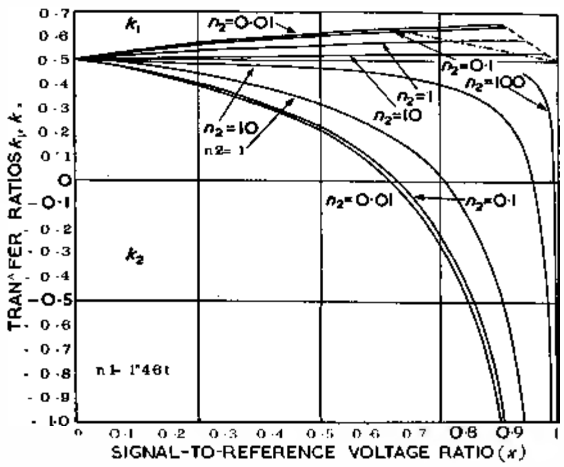

Fig. 2. Variation of the transfer ratios of the two diodes with the signal

The chain and the broken lines are the loci of k corresponding respectively to $k_2 = 0$ and -1 ($\theta_2 = 90°$ and $180°$)

Non-Linearity of the Detector

From equations (2) and (6), it can be seen that the ratio of the output d.c. voltage E_o to the signal voltage amplitude E_2, which may be called the *sensitivity* of the detector (as in (1)), is given by:

$$\alpha \equiv (E_o/E_2) = \frac{1}{n_2+2}\left\{k_1 + k_2 + \frac{k_1 - k_2}{x}\right\} \quad \ldots \; (8)$$

As a criterion of the non-linearity of the detector, one may consider the percentage change in the sensitivity α in the range $0 < x < x_{crit}$, where x_{crit} is the point where the conduction angle of MR_2 becomes 180° or k_2 becomes equal to zero. The total non-linearity of the detector, N_o, may be defined as:

$$N_o \equiv 100 \cdot \frac{\alpha_o - \alpha_{crit}}{\alpha_o} \text{ per cent} \quad \ldots\ldots\ldots\ldots \; (9)$$

where α_o is the limiting sensitivity obtained as $x \to 0$ and α_{crit} is the sensitivity at $x = x_{crit}$.

Even though k_1, $k_2 \to k_o$ as $x \to 0$, α_o is not equal to $2k_o/(n_2+2)$ because $(k_1-k_2)/x$ tends to a finite positive limit. This limit can be evaluated theoretically by the method described in the Appendix of (1) to give:

$$\alpha_o = \frac{2k_o}{n_2 + 2 - \dfrac{2}{((n_1\theta_o/\pi)+1)}} = \frac{2k_o}{n_2 + 2 - (2\pi/n_1)\cot\theta_o} \quad \ldots\ldots\ldots\ldots \; (10)$$

where, as mentioned previously, θ_o is the semi-angle of conduction of either diode in the absence of the signal and is the root of the equation (7).

To evaluate α_{crit}, it may be noted that at $x = x_{crit}$, the node B is at ground potential, so that the node A can be considered connected to ground through a resistance R_{eq}, where

$$R_{eq} = R_2 \cdot \frac{R_2 + 2R}{R_2 + R} = R_2 \cdot \frac{n_2 + 2}{n_2 + 1}$$

The semi-angle of conduction $\theta_{1(crit)}$ of the diode MR_1 at $x = x_{(crit)}$ can therefore be determined from equation (7) after substituting R_{eq} for R_2. The corresponding value of the transfer ratio, $k_{1(crit)}$, is $\cos\theta_{1(crit)}$.

Now, from equation (5), by putting $\theta_2 = \pi/2$,

$$w_{crit} = \frac{1 - x_{crit}}{1 + x_{crit}} = \frac{\pi}{n_1(n_2+2)} k_{1(crit)}$$

Hence, from equation (8), remembering that $k_{2(crit)} = 0$,

$$\alpha_{crit} = \frac{2k_{1(crit)}}{n_2 + 2 - (\pi k_{1(crit)}/n_1)} \quad \ldots\ldots\ldots \; (11)$$

To determine the semi-angles of conduction, θ_o and $\theta_{(crit)}$, from equation (7), a graphical method is used and the approximate values so obtained are refined using Taylor's theorem. Values of α_o, x_{crit} and N_o are given in Table 1 for various values of n_1 and n_2 and the suitability of a detector may be judged immediately from this table.

Comparison of the Single-Ended and the Simple Push-Pull Detectors

On comparing the table given in this article with the table given in (1), it is observed that for a given value of n_1, the non-linearity of the single-ended detector increases as the load resistance is increased while the reverse is the case for the simple push-pull detector. In fact, the single-

TABLE 1

n_1 \ n_2	100	30	10	3	1	0·3	0·1	0·03	0·01
1 ..	0·00432 0·987 —	0·0142 0·957 0·05%	0·0410 0·886 0·15%	0·121 0·726 0·40%	0·271 0·542 0·70%	0·482 0·400 0·95%	0·619 0·350 1·10%	0·688 0·319 1·10%	0·710 0·312 1·15%
1·46π ..	0·00988 0·994 0·05%	0·0320 0·979 0·15%	0·0892 0·943 0·40%	0·238 0·861 1·10%	0·453 0·767 1·85%	0·663 0·693 2·45%	0·764 0·663 2·65%	0·807 0·650 2·75%	0·820 0·645 2·75%
10 ..	0·0127 0·996 0·05%	0·0410 0·987 0·20%	0·133 0·964 0·55%	0·289 0·918 1·25%	0·523 0·862 2·10%	0·730 0·818 2·70%	0·823 0·800 2·85%	0·861 0·792 2·95%	0·873 0·790 3·00%
30 ..	0·0158 0·998 0·05%	0·0506 0·995 0·20%	0·137 0·986 0·45%	0·340 0·966 1·10%	0·590 0·943 1·80%	0·794 0·925 2·25%	0·882 0·917 2·45%	0·917 0·914 2·45%	0·928 0·914 2·50%
100 ..	0·0177 1·000 0·05%	0·0567 0·998 0·10%	0·152 0·995 0·30%	0·371 0·989 0·75%	0·630 0·981 1·15%	0·834 0·975 1·50%	0·918 0·972 1·60%	0·952 0·971 1·65%	0·962 0·971 1·65%

The set of three figures in each square gives in that order the limiting sensitivity α_o, rounded off to three significant figures, the value of x, $x_{crit.}$, where the diode MR_2 starts conducting over an angle 180° and the total non-linearity in the range, $0 < x < x_{crit}$

ended detector is absolutely linear when the output terminal is shorted to ground, while the simple push-pull detector is absolutely linear when the output terminals are open-circuited. This leads to the important design criterion that the simple push-pull detector should be used when the output feeds, for example, a high input impedance valve-voltmeter. On the other hand when it is a low impedance current measuring instrument that is available, the single-ended detector should be chosen.

Acknowledgements

The authors thank Prof. R. S. Krishnan for his kind interest and encouragement and Dr. G. Suryan for many helpful discussions. One of the authors (R.C.) is grateful to the Department of Atomic Energy for a research fellowship and the other (S.K.) to the Council of Scientific and Industrial Research for a Research Assistantship.

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An Events Per Unit Time Meter (EPUT Meter)

By J. D. Storer, A.M.I.E.E., A.M.Brit.I.R.E.

This article describes a simplified form of Events Per Unit Time Meter (EPUT meter), which gives a read-out in cycles per second up to 9 999. The 1sec gating waveform is derived from a 1kc/s crystal oscillator having a long term stability not worse than one part in 10^6. A separate output is provided from this oscillator for checking the accuracy of count, and for use as an external calibrator. Both manual and automatic resets are provided, enabling the instruments to be used as a straight counter if required.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

THE Events Per Unit Time Meter (EPUT meter) to be described was designed to meet the need for a cheap instrument counting up to 9 999 impulses per second. To give a direct read-out in cycles per second the sampling period is fixed at one second, after which there is a read-out period of three quarters of a second before the automatic reset operates and the cycle is repeated. The 1sec sampling waveform is derived from a built-in 1kc/s oscillator having a stability not worse than 1 part in 10^6, and the count is therefore accurate to within one cycle per second. A sinusoidal output from the crystal oscillator is brought out on a jack for external use, this can be linked to the input jack to check the calibration of the counters. A manual reset is provided as an alternative to the automatic one, and the 1sec gate can be switched out enabling the instrument to be used as a straight counter. A sinusoidal input of not less than 1V r.m.s. is required.

General Description

A schematic diagram of the unit is given in Fig. 1, and the circuit in Fig. 2.

The crystal oscillator uses a G.E.C. 1kc/s bimorph crystal having a low temperature coefficient as is shown by the typical frequency temperature characteristic, Fig. 3.

The crystal operates as a three terminal network with the common point taken to earth via C_1. Variation of this capacitor enables the crystal to be trimmed over about 50 parts in 10^6. The two remaining terminations are taken to the grid and anode circuits of the pentode oscillator V_1. Approximately one fifth of the total output is developed across R_2 and applied as a drive to the crystal, the full output is via C_5 to the amplifier stage V_2, automatic gain control being effected by rectifying a portion of this output and applying the filtered d.c. to the grid of V_1. A tuned circuit is included in the cathode of V_2 from which a sinusoidal output is taken, the amplified signal developed across R_8 is fed via a phase shifting network to the guides of the Dekatron V_3.

V_3 to V_7 comprise a conventional Dekatron dividing chain having a divide factor of 1 000 thus producing at the anode of V_{6b} a one per second impulse. This is applied simultaneously to each grid of the double triode V_8 which is connected to form a binary cell. The circuit is balanced by RV_{41} so that when a pulse is applied to the grid of the triode which is conducting it becomes momentarily less conducting, amplification occurs in the triode which was cut off; and the system jumps to its other stable condition. This change takes place almost instantly resulting in a square wave output voltage in the anode circuits the polarity of which reverses with each triggering pulse. This square wave of one second duration is fed via C_{23} to the buffer amplifier V_{9a} and also via R_{46} to the reset pulse generator V_{10}.

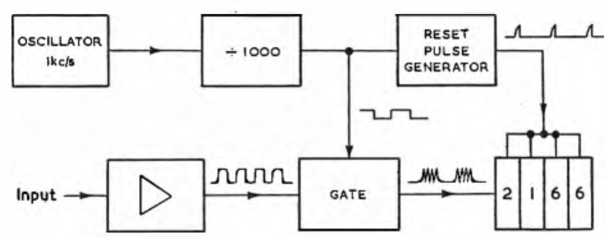

Fig. 1. General arrangement of EPUT meter

The square wave developed across R_{47}, the anode load of V_{9a}, is applied to the suppressor grid of the gating valve V_{12} via a small neon lamp V_{13}. The suppressor is also connected via R_{66} to a negative voltage, which prevents the valve from conducting. During the 1sec when the square wave at the anode of V_{9a} is positive, the neon strikes and the suppressor is driven positive allowing the valve to pass impulses to the counters.

In order to reset the counters it is necessary to produce a reset impulse every 2sec phased as shown in Fig. 4, allowing a reading time of approximately 0·75sec before resetting to zero ready for the next counting period.

This is achieved by feeding the square wave developed across R_{43} to the integrating circuit R_{49}, C_{24} and thence to the grid of V_{10a}. V_{10} is a biased flip-flop the operating level of which—and hence the phasing of the ouput pulse—is controlled by a variable cathode resistance, the effect of which

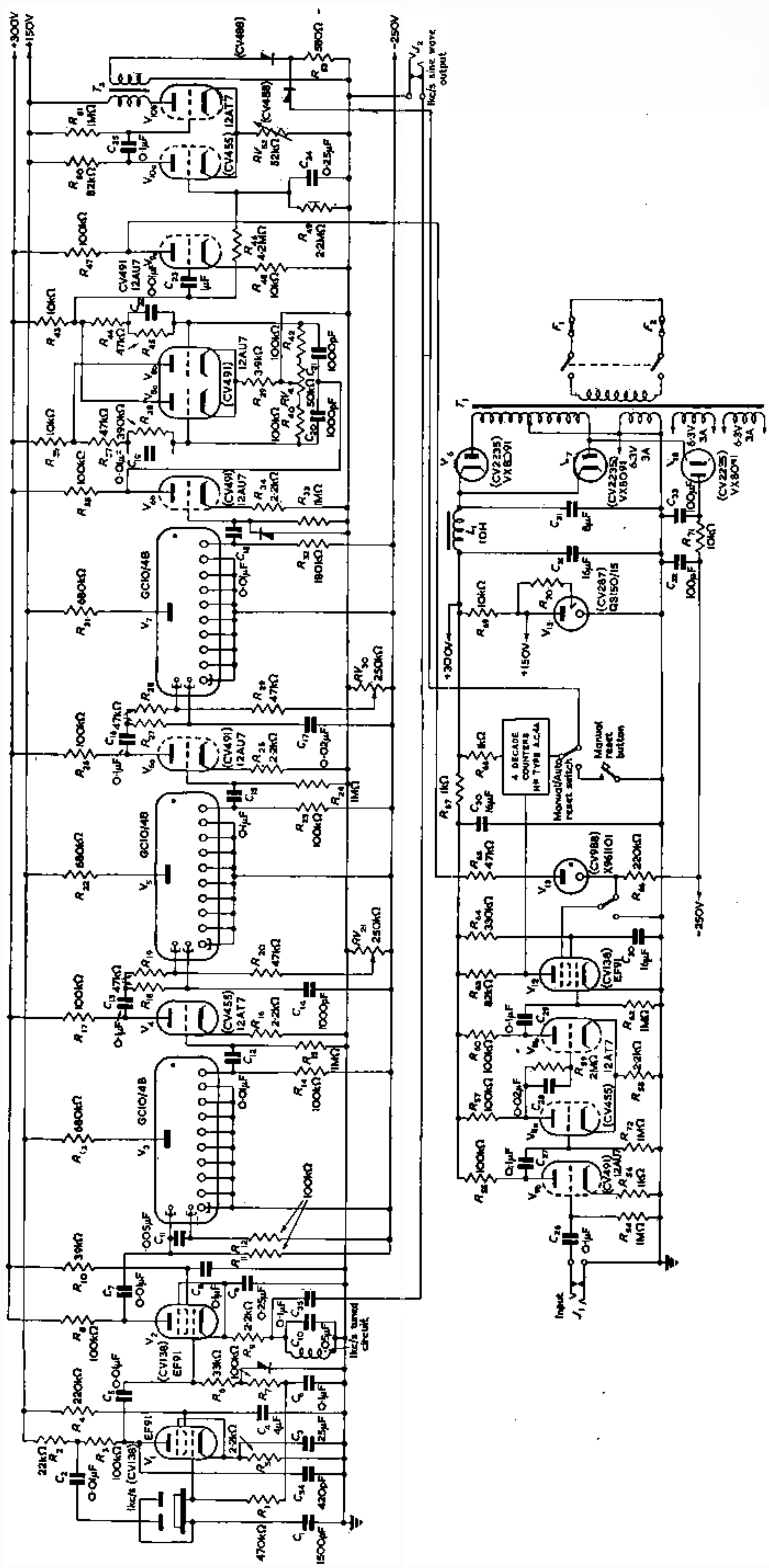

Fig. 2. Complete circuit of EPUT meter

is shown in Fig. 4(d). The resultant positive going impulse developed at the anode of V_{10} is fed via T_3 and a diode network to the counter reset line.

As the counter chain requires an 80V negative going pulse to drive it, sine waves applied to the input-jack J_1 are amplified by V_{9b} then used to drive the biased flip-flop V_{11}. A positive pulse of some 100V amplitude is developed across R_{60}, and fed to the gating valve V_{12}. During the period that this valve conducts, negative going pulses of about the same amplitude are developed across its anode load resistor R_{63} and fed direct to the counter chain.

The counter chain comprises four commercial scaler units type AC44 manufactured by Hewlett Packard. Fig. 5 shows a complete circuit of the unit, which will be seen to consist of four binary cells with a feedback arrangement to produce a count of ten instead of sixteen. Fig. 6 shows how the read-out of ten neon lighted numbers are made to light in their proper sequence.

As input pulses enter, they cause the first binary to continually switch from one state to the other. One half of the binary is connected to one side of all the even numbered lamps. The other half is connected to one side of all the odd numbered lamps. The difference voltage that determines which odd or even lamp is lighted is obtained from combinations of the various halves of the remain-

Fig. 3. Typical frequency/temperature characteristic of 1kc/s crystal

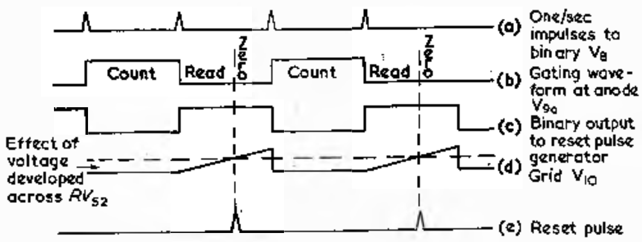

Fig. 4. Circuit waveforms

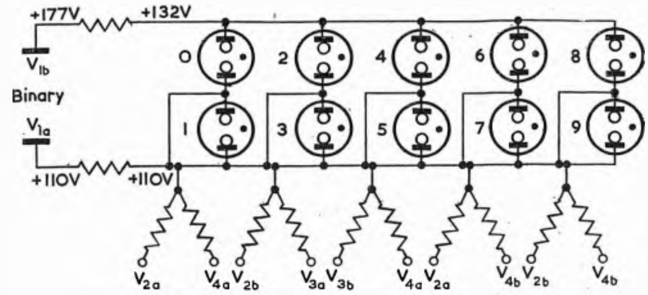

Fig. 6. Simplified circuit scaler read-out neons

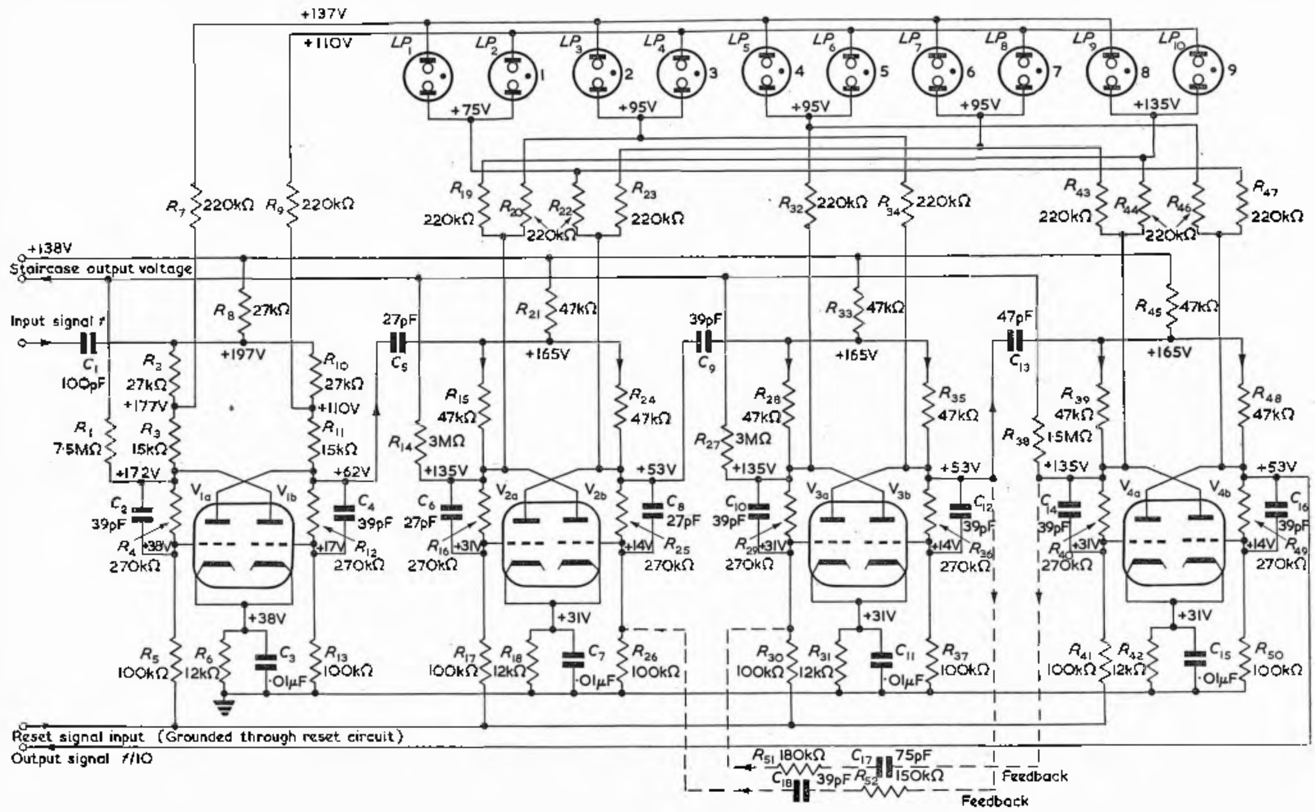

Fig. 5. Complete circuit of scaler unit

ing three binaries, and consists of a resultant voltage when two different binary halves are combined. Three resultant voltages are possible—when both halves are conducting, when both halves are non-conducting and when one is conducting and one is not. Only when both halves are conducting and the voltage is at its lowest is the voltage difference between this combination and that established by the input binary sufficient to light a neon. This voltage, of some 75V amplitude, gradually moves down the bank of neons (Fig. 6), as succeeding input pulses switch the binaries, and the odd and even lamps are alternately given the necessary voltage.

Operation and Maintenance

The EPUT meter should seldom need adjustment and no controls are brought out to the front panel. Internal preset controls are provided to enable adjustment of Dekatron bias, binary balance, and reset pulse phasing. The latter may need to be adjusted as V_{10} ages but it is most unlikely that the others will need any adjustment unless an associated valve has to be changed. During periods of use the 1kc/s output should be frequently jacked across to the input when the counter should read 1 000 ±1 steadily. At the same time the auto reset may be checked by switching to manual and resetting by pushing the button at the appropriate instant, there should be no difference in reading between the auto and manual conditions. It should be noted that the crystal oscillator has a considerable build-up time and from switching on at least three minutes should be allowed to elapse before suspecting an oscillator fault. If no input is applied, or one below the critical level—this varies with frequency but 1·0V r.m.s. is a reasonable figure—an erratic or random count will result due to part triggering and or circuit noise.

Acknowledgment

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TRANSISTOR NOISE FACTOR CALCULATIONS

By F. Hibberd*, B.A.

A method of estimating transistor noise factors is given; it is based on the use of four noise parameters, which are expressed in terms of the transistor equivalent circuit parameters. A general expression for the minimum noise factor is derived, which can be simplified according to circumstances.

(Voir page 192 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 200)

The equation

$$F = A + (B/R_s) + CR_s \quad \ldots\ldots\ldots\ldots (1)$$

giving the narrow-band or 'spot' noise factor F of an amplifier† as a function of the source resistance R_s, occurs frequently in noise problems[1,2,3,4]. It is a general equation; given any amplifier, if the reactive (or susceptive) component of the source is held constant and the resistive (or conductive) component varied, the variation of noise factor should follow this law. The noise performance of an amplifier can therefore be characterized by three parameters A, B and C if the source is resistive; as will be shown later, if the source is partly reactive a fourth 'noise parameter' is necessary to complete the specification. One advantage of specifying noise properties in this way is that the amplification properties of the amplifier do not appear in the noise factor calculations.

Equivalent Noise Input Generators

Over a narrow frequency band df a noisy amplifier can be completely represented by a noiseless amplifier with a noise voltage generator and a noise current generator (E and J, say) at the input[5,6] as in Fig. 1. If now a source of conductance G_s in parallel with a susceptance jB_s is connected at the input of the amplifier, the formula for the noise factor is[5]

$$F = 1 + \frac{1}{4kTG_s df}\{(G_s^2 + B_s^2)\langle EE^*\rangle + \langle JJ^*\rangle + G_s(\langle E^*J + EJ^*\rangle) - jB_s(\langle E^*J - EJ^*\rangle)\} \quad \ldots (2)$$

In this equation a star indicates a complex conjugate, and angled brackets enclosing a quantity indicate a mean value (averaged over a time much longer than $1/df$). Four noise parameters R_{eq}, G_r‡ A and D can now be chosen such that

$$\left.\begin{aligned} R_{eq} &= \frac{\langle EE^*\rangle}{4kT\,df} \\ G_r &= \frac{\langle JJ^*\rangle}{4kT\,df} \\ A &= 1 + \frac{\langle E^*J + EJ^*\rangle}{4kT\,df} \\ D &= -j\,\frac{\langle E^*J - EJ^*\rangle}{4kT\,df} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (3)$$

Equation (2) for the noise factor now becomes

$$F = A + R_{eq}G_s + \frac{G_r + R_{eq}B_s^2 + DB_s}{G_s} \quad \ldots\ldots (4)$$

giving the A, B and C of equation (1). If the source susceptance is zero, the equation becomes

$$F = A + R_{eq}G_s + (G_r/G_s) \quad \ldots\ldots\ldots\ldots (5)$$

In the case of valves at low frequencies J is usually negligible, so that $G_r = 0$ and $A = 1$, and equation (5) reduces to the familiar

$$F = 1 + R_{eq}G_s = 1 + (R_{eq}/R_s).$$

Minimum Noise Factor

Equation (4) shows that F as a function of B_s has a minimum when $B_s = B_{opt}$, where

$$B_{opt} = -(D/2R_{eq}) \quad \ldots\ldots\ldots\ldots (6)$$

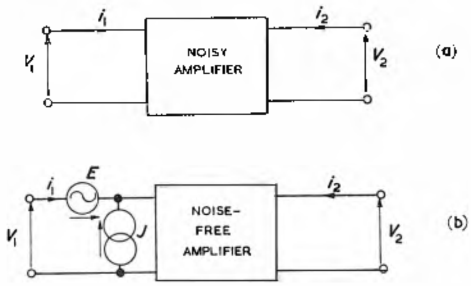

Fig. 1. Two equivalent networks

whatever the value of G_s. With this value of B_s, F as a function of G_s has a minimum when $G_s = G_{opt}$, where

$$G_{opt} = \sqrt{\left[\frac{G_r - (D^2/4R_{eq})}{R_{eq}}\right]} \quad \ldots\ldots\ldots\ldots (7)$$

Thus the noise factor has a minimum value given by

$$F_{min} = A + 2\sqrt{[R_{eq}(G_r - (D^2/4R_{eq}))]} \quad \ldots\ldots (8)$$

If, as is often the case in practice at low frequencies, $D = 0$, then

$$F_{min} = A + 2\sqrt{(R_{eq}G_r)} \quad \ldots\ldots\ldots (9)$$

and

$$G_{opt} = (1/R_{opt}) = \sqrt{(G_r/R_{eq})} \quad \ldots\ldots\ldots 10$$

Noise Parameters for a Transistor

Insofar as a transistor can be represented by the equivalent circuit[4,7,8] of Fig. 2, with the noise generators i_{ne}, i_{nc} and V_{nb} given by

$$\left.\begin{aligned} \langle i_{ne}\, i_{ne}^*\rangle &= 4kT\,df\,\mathscr{R}(y_e) - 2q\,df\,I_e \\ \langle i_{nc}\, i_{nc}^*\rangle &= 2q\,df\,I_c + 4kT\,df\,\mathscr{R}(y_c) \\ \langle i_{ne}^*\, i_{nc}\rangle &= 2kT\,df\,y_{ce} = -2kT\,df\,\alpha y_e \\ \langle V_{nb}\, V_{nb}^*\rangle &= 4kT\,df\,r_b \end{aligned}\right\} \quad \ldots\ldots\ldots (11)$$

(neglecting $1/f$ noise)

the values for the noise parameters are (see Appendix):

$$\left.\begin{aligned} R_{eq} &= (q/2kT)\left(I_c\left|\frac{r_b + (1/y_e)}{\alpha}\right|^2 - I_e r_b^2\right) \\ G_r &= (q/2kT)\left((I_c/|\alpha|^2) - I_e\right) \\ A &= (q/kT)(I_c/|\alpha|^2)\,\mathscr{R}(r_b + (1/y_e)) - (q/kT)\,I_e r_b \\ D &= -(q/kT)(I_c/|\alpha|^2)\,\mathscr{I}(1/y_e) \end{aligned}\right\} \ldots (12)$$

* *Mullard Research Laboratories*

† *The term 'amplifier' will be used as shorthand for 'linear four-terminal network with transmission between input and output terminals'.*

‡ *This parameter, which he calls 'the equivalent noise conductance,' was suggested by Rothe[8].*

with the transistor in grounded emitter or grounded base. In these equations I_c and I_e are the collector and emitter direct currents; $\mathscr{R}$ and $\mathscr{I}$ denote real and imaginary parts.

The extent to which these equations can be simplified depends on the type of transistor and the operating conditions; for all transistors, however, at frequencies up to the α cut-off frequency f_{co}, α good approximation is[9]

$$\alpha = \frac{\alpha_0 \exp[-j\phi(f/f_{co})]}{1 + j(f/f_{co})} \quad \ldots\ldots\ldots\ldots \quad (13)$$

The quantity ϕ is a function of the 'built-in' drift field in the base region[9], if any; only $|\alpha|^2$ occurs in the equations, however, and equation (13) shows that

$$|\alpha|^2 = \frac{\alpha_0^2}{1 + (f^2/f_{co}^2)} \quad \ldots\ldots\ldots\ldots \quad (14)$$

The approximation

$$y_e = (1/r_e)(1 + j(f/f_{co})) \quad \ldots\ldots\ldots\ldots \quad (15)$$

is less accurate at high frequencies, especially with high values of drift fields[9], but it will be used here as it leads to considerable simplification without introducing gross errors.

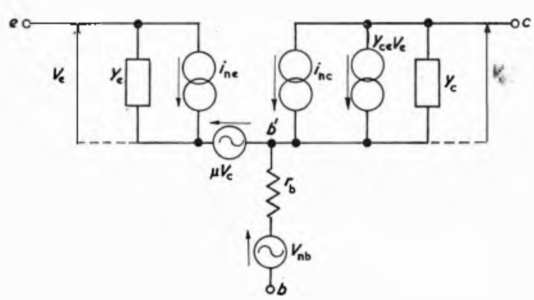

Fig. 2. The transistor equivalent circuit

With the further assumptions (a) that the collector contribution to the collector cut-off current I_{co} is much greater than the emitter contribution, (b) that I_e is large enough to allow the approximation $r_e = (kT/qI_e)$, (c) that α_0 is independent of current, so that $I_c = \alpha_0 I_e + I_{co}$; by putting $1/\alpha_0 = 1 + (1/\alpha_0')$, and treating $1/\alpha_0'$ and I_{co}/I_e as small quantities, the following approximate values for the noise parameters can be derived:

$$\left.\begin{aligned}
R_{eq} &= (r_b + (r_e/2))((1/\alpha_0) + (I_{co}/I_e)) + \\
&\quad + (r_b^2/2r_e)[(1/\alpha_0') + (I_{co}/I_e) + ((1/\alpha_0) + (I_{co}/I_e))f^2/f_{co}^2] \\
G_r &= (1/2r_e)[(1/\alpha_0') + (I_{co}/I_c) + ((1/\alpha_0) + (I_{co}/I_e))f^2/f_{co}^2] \\
A &= (1/\alpha_0) + (I_{co}/I_e) + (r_b/r_e)[(1/\alpha_0') + (I_{co}/I_e) + \\
&\quad + ((1/\alpha_0) + (I_{co}/I_e)) f^2/f_{co}^2] \\
D &= ((1/\alpha_0) + (I_{co}/I_e)) f/f_{co}
\end{aligned}\right\} (16)$$

These equations can usually be further simplified in particular cases; for instance, if I_{co} is small and α_0 is close to unity, there will be little error in putting

$$\left.\begin{aligned}
R_{eq} &= r_b + (r_e/2) + (r_b^2/2r_e)((1/\alpha_0') + (f^2/f_{co}^2)) \\
G_r &= (1/2r_e)((1/\alpha_0') + (f^2/f_{co}^2)) \\
A &= 1 + (r_b/r_e)((1/\alpha_0') + (f^2/f_{co}^2)) \\
D &= (f/f_{co})
\end{aligned}\right| \ldots (17)$$

Transistor Noise Factors

After putting $Z_s = R_s + jX_s = 1/(G_s + jB_s)$, the values of equations (12) in equation (4) give

$$F = \frac{2qI_c|r_b + (1/y_e) + Z_s|^2 - 2qI_e|r_b + Z_s|^2}{4kTR_s} \quad \ldots \quad (18)$$

This is the equation obtained by Guggenbühl and Strutt[7].

Equation (8) for the minimum noise factor gives

$$F_{min} = A + \sqrt{(A^2 - P)} \quad \ldots\ldots\ldots\ldots \quad (19)$$

where

$$P = (q^2/k^2T^2)(I_cI_e/|\alpha|^2)|1/y_e|^2$$

In many cases P is close to unity. Equations (7) and (12) combined give

$$G_{opt} = \frac{\sqrt{(A^2 - P)}}{2R_{eq}}, \sim \frac{\sqrt{(A^2 - 1)}}{2R_{eq}} \quad \ldots \quad (20)$$

At high frequencies, if $(1/\alpha_0')$ in equations (17) can be neglected, equation (19) becomes

$$F_{min} = 1 + (r_b/r_e)(f^2/f_{co}^2) + \sqrt{[(1 + (r_b/r_e)(f^2/f_{co}^2))^2 - 1]} \quad \ldots\ldots\ldots\ldots \quad (21)$$

Conclusions

The spot noise factor of a transistor in grounded emitter or grounded base with any source admittance can be estimated by using equation (4) and the four noise parameters of equations (16), or some appropriate simplification of equations (16); the calculations are particularly simple if the source is resistive.

Equation (19) gives a general formula for the minimum noise factor, which again can be simplified to an extent depending on the circumstances, leading for example to equation (21) at high frequencies and moderate emitter currents. The optimum source resistance can also be estimated from equation (20) or equation (10).

These calculations are based on a theory which applies to germanium transistors at low injection levels; at high injection levels (typically, greater than 1mA) and with silicon transistors, therefore, the inaccuracy may be large.

Acknowledgments

The author wishes to acknowledge the help he has received from his colleagues at Mullard Research Laboratories, and also from many private communications from the Natuurkundig Laboratorium, Eindhoven, Holland. He also wishes to thank the Director of Mullard Research Laboratories and the Directors of Mullard Limited for permission to publish this article.

Appendix

One method of finding E and J, suggested by Becking, is to put $V_2 = 0$ and $i_2 = 0$ (Fig. 1(a)) and solve for V_1 and i_1; then $E = -V_1$ and $J = -i_1$.

With the transistor in grounded emitter

$$V_2 = V_c(1 - \mu) - V_e$$

$$V_c = \frac{i_2 - i_{nc} - y_{ce}V_e}{y_c}$$

$$V_e = -\frac{i_1 + i_2 + i_{ne}}{y_e}$$

Combining these equations and putting $V_2 = 0$, $i_2 = 0$,

$$0 = -(1 - \mu)(i_{nc}/y_c) + [1 + (1 - \mu)(y_{ce}/y_c)]\frac{i_1 + i_{ne}}{y_e}$$

therefore:

$$i_1 = -i_{ne} + \frac{y_e i_{nc}}{[(y_c/(1 - \mu)) + y_{ce}]}$$

For V_1:

$$V_1 = -V_{nb} + i_1 r_b - V_e + V_2$$

Again putting $V_2 = 0$, $i_2 = 0$,

$$V_1 = -V_{nb} - \frac{V_e}{(1 - \mu)} + i_1 r_b$$

hence

$$V_1 = -V_{nb} + \frac{i_1 + i_{ne}}{(1-\mu)\,y_e} + i_1 r_b$$

$$= -V_{nb} + \frac{i_{nc}}{(1-\mu)\left[\left(y_c/(1-\mu)\right) + y_{ce}\right]}(1 + r_b y_e) - i_{ne} r_b$$

Putting $(y_{ce}/y_e) = -\alpha$, $V_1 = -E$, $i_1 = -J$, and making the reasonable assumptions $\mu \ll 1$, $|y_c| \ll |y_{ce}|$

$$E = V_{nb} + (i_{nc}/\alpha)\left(r_b + (1/y_e)\right) + i_{ne} r_b$$

$$J = i_{ne} + (i_{nc}/\alpha)$$

Taking mean values and assuming no correlation between V_{nb} and either of i_{ne} and i_{nc}, it is found that

$$\langle|E|^2\rangle = \langle|V_{nb}|^2\rangle + \langle|i_{ne}|^2\rangle r_b^2 + \frac{\langle|i_{nc}|^2\rangle}{|\alpha|^2}|r_b + (1/y_e)|^2 + 2\,\mathscr{R}\left[\langle i_{ne}^*\, i_{nc}\rangle (r_b/\alpha)\left(r_b + (1/y_e)\right)\right]$$

$$\langle|J|^2\rangle = \langle|i_{ne}|^2\rangle + \frac{\langle|i_{nc}|^2\rangle}{|\alpha|^2} + 2\,\mathscr{R}\left(\frac{\langle i_{ne}^*\, i_{nc}\rangle}{\alpha}\right)$$

$$\langle E^*J\rangle = \langle|i_{ne}|^2\rangle r_b + \frac{\langle|i_{nc}|^2\rangle}{|\alpha|^2}\left(r_b + (1/y_e^*)\right) + 2\,\mathscr{R}\left(\langle i_{ne}^*\, i_{nc}\rangle (r_b/\alpha)\right) + \frac{\langle i_{ne}\, i_{nc}^*\rangle}{\alpha^* y_e^*}$$

One now wishes to put in the values of equations (11); first, however, the second value is considered

$$\langle i_{nc}^2\rangle = 2q\,df\,I_c + 4kT\,df\,\mathscr{R}(y_c)$$

Putting $r_e \simeq \dfrac{kT}{q(I_c/\alpha_0)}$

$$\langle|i_{nc}|^2\rangle = 2kT\,df\,(\alpha_0/r_e) + 4kT\,df\,\mathscr{R}(y_c)$$

It has already been assumed that $|y_c| \ll |y_{ce}| = |\alpha y_e|$; therefore it seems reasonable to take $\langle|i_{nc}|^2\rangle = 2q\,df\,I_c$.

It is then found that

$$\langle|E|^2\rangle = 4kT\,df\,r_b + r_b^2\left[4kT\,df\,\mathscr{R}(y_e) - 2q\,df\,I_e\right] + \frac{2q\,df\,I_c}{|\alpha|^2}|r_b + (1/y_e)|^2 - 2\,\mathscr{R}\left[2kT\,df\,r_b y_e\left(r_b + (1/y_e)\right)\right]$$

$$= 2q\,df\left(I_c\left|\frac{r_b + (1/y_e)}{\alpha}\right|^2 - r_b^2 I_c\right)$$

$$\langle|J|^2\rangle = 4kT\,df\,\mathscr{R}(y_e) - 2q\,df\,I_e + 2q\,df\,(I_c/|\alpha|^2) - 2\,\mathscr{R}(2kT\,df\,y_e)$$

$$= 2q\,df\left((I_c/|\alpha|^2) - I_e\right)$$

$$\langle E^*J\rangle = r_b\left[4kT\,df\,\mathscr{R}(y_e) - 2q\,df\,I_e\right] + 2q\,df(I_c/|\alpha|^2)\left(r_b + (1/y_e^*)\right) - 2\,\mathscr{R}(2kT\,df\,r_b y_e) - 2kT\,df$$

$$= -2kT\,df + 2q\,df\,(I_c/|\alpha|^2)\left(r_b + (1/y_e^*)\right) - 2q\,df\,I_e r_b$$

These values in equations 3 give the equations (12).

If the additional assumptions

$$|y_c| \ll |\alpha/r_b|$$
$$|y_e|^2 \ll (q/2kT)(|\alpha|^2/r_b)\left((I_c/|\alpha|^2) - I_e\right)$$

are permissible, the same values are obtained for the transistor in grounded base.

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An Analogue Computer for the Petroleum Industry

An analogue computer designed by General Precision Systems Ltd, Aylesbury, has recently been delivered to British Petroleum for investigation into a wide range of dynamic problems relating to processes in oil refining, distribution and plant economics.

Known as CERES (Control Engineering Research Electronic Simulator) it is, it is claimed, the first analogue computer of its size in this country to be used in a process industry.

In addition to its principal use as an analogue computer CERES will be used extensively as a simulator in the training of plant operators. Typical and exceptional situations which may occur in controlled refining processes can be simulated and operators trained at negligible cost in handling these situations. Pre-simulation of new processes will enable plants to be commissioned with the minimum of delay and disturbance.

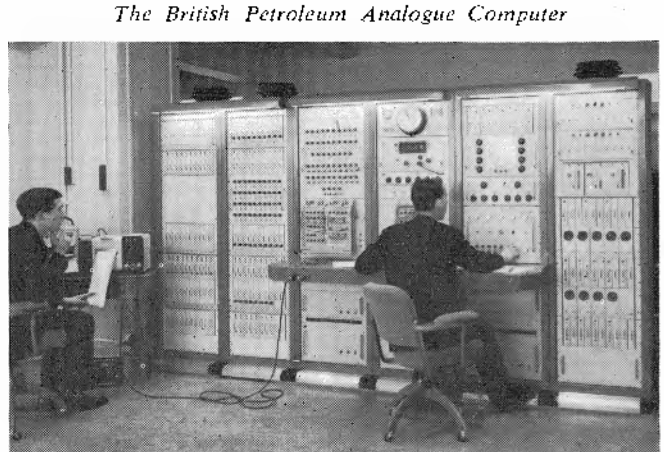
The basic computer uses in all 69 high gain chopped stabilized d.c. amplifiers designed to give very high stability over long periods. Amplifier drifts (referred to input) as low as 35×10^{-6}V over 24 hours have been recorded.

Ninety-two potentiometers have been provided for trimming amplifier gains and for adjustment of problem parameters. These will be set up in the first instance using digital voltage presentation and may later be set up automatically from punch paper tape programmes.

The ancillary equipment includes recorders, *XY* plotters, transport lag simulators and will later include a graphic display panel for use when the computer is used as a training simulator.

The complete equipment is mounted in 6 standard 19in racks. All units of the same type are interchangeable both physically and electrically. A comprehensive switching arrangement enables the various computing elements to be monitored continuously during computation using either built-in or external displays and recorders.

The British Petroleum Analogue Computer



ANALOGUE COMPUTER TECHNIQUES

(Part 2)

An Approximate method for the Solution of Partial Differential Equations

By F. C. Harbert*, B.A.

(Voir page 126 pour le résumé en français: Zusammenfassung in deutscher Sprache Seite 131)

The Solution of Partial Differential Equations on an Analogue Computer

A great number of problems that arise in engineering and physics require the solution of partial differential equations subject to certain boundary conditions. Analytical and numerical methods are available but are most often laborious and unwieldy.

A direct approach to the problem is impossible as the analogue computer is restricted to integration with respect to one independent variable. However, by using finite difference techniques, the partial difference equation expressed as a function of two independent variables can be represented by a system of ordinary differential equations with only one independent variable.

A dependent variable $Y(x,t)$ is a function of distance x and time t. The transformation to ordinary differential equations can be accomplished by expressing Y only at certain values of x; for convenience, these values are chosen at equal steps Δx, as in Fig. 6. At a point $x = n\Delta x$ (where $n = 0$, 1, 2, etc.) the partial derivatives may be expressed as follows:

$$\frac{\partial Y(x,t)}{\partial x} \simeq \frac{Y_{n+\frac{1}{2}} - Y_{n-\frac{1}{2}}}{\Delta x} \quad \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

$$\frac{\partial^2 Y(x,t)}{\partial x^2} \simeq \frac{Y_{n+1} - 2Y_n + Y_{n-1}}{(\Delta x)^2} \quad \ldots\ldots\ldots\ldots (17)$$

$$\frac{\partial^3 Y(x,t)}{\partial x^3} \simeq \frac{Y_{n+3/2} - 3Y_{n+\frac{1}{2}} + 3Y_{n-\frac{1}{2}} - Y_{n-3/2}}{(\Delta x)^3} \ldots (18)$$

$$\frac{\partial Y(x,t)}{\partial t} \simeq \frac{dY_n}{dt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (19)$$

The degree of accuracy in the above equations is readily seen to depend on the size of Δx and the equations are exact in the limit as Δx tends to zero.

By making use of these approximations, the partial differential equation can be written in finite difference form.

To illustrate the method the following example is presented.

An insulated rod of length 6 metres is at a temperature of 100°C. The ends are suddenly held at 0°C. It is desired to find the temperature distribution along the rod as a function of time, given that for the rod $k/cp = 10$.

The equation describing heat flow in one dimension is

$$\frac{\partial T(x,t)}{\partial t} = k/cp\,\frac{\partial^2 T(x,t)}{\partial x^2} \ldots\ldots\ldots\ldots\ldots (20)$$

The first step in solving the problem is to divide the rod into segments of equal length. For this solution the rod is divided into lengths of 1 metre, therefore $\Delta x = 1$.

Let $T_1, T_2 \ldots T_6$ denote the temperatures at the extremes of the segments as in Fig. 7. $T_0 = T_6 = 0°$; $T_1, T_2 \ldots T_5$ the temperatures of the five internal points are 100°C initially and vary with time.

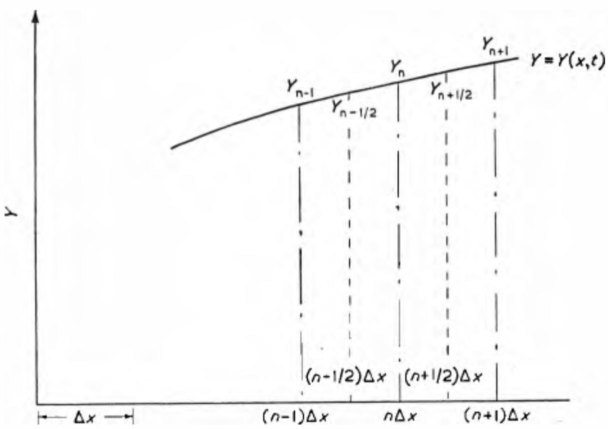


Fig. 6. Basis for partial difference form of derivatives

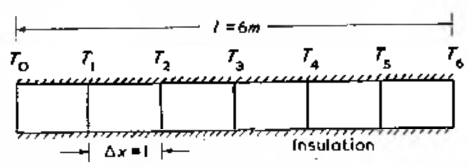


Fig. 7. Problem in one dimensional heat flow

Making use of finite difference techniques, equation (20) becomes

$$dT_n/dt = 10\,\frac{T_{n+1} - 2T_n + T_{n-1}}{(\Delta x)^2} \ldots\ldots\ldots\ldots (21)$$

Because $\Delta x = 1$, the system of differential equations relating the five unknown temperatures are as $n = 1$, 2, 3, 4, 5;

$$\begin{aligned}
dT_1/dt &= 10\,(T_2 - 2T_1 + T_0)\\
dT_2/dt &= 10\,(T_3 - 2T_2 + T_1)\\
dT_3/dt &= 10\,(T_4 - 2T_3 + T_2)\\
dT_4/dt &= 10\,(T_5 - 2T_4 + T_3)\\
dT_5/dt &= 10\,(T_6 - 2T_5 + T_4)
\end{aligned} \quad \ldots\ldots\ldots\ldots (22)$$

This system of equations may now be solved on the analogue computer.

* *Louis Newmark Ltd.*

A computer diagram containing five amplifiers is shown in Fig. 8 and this basic form may be used to solve any one dimensional heat flow problem. In general one amplifier is required for each unknown. Temperatures are represented by output voltages with alternative algebraic signs, although additional amplifiers may be used to invert the signs of the negative voltages if required. The initial conditions are

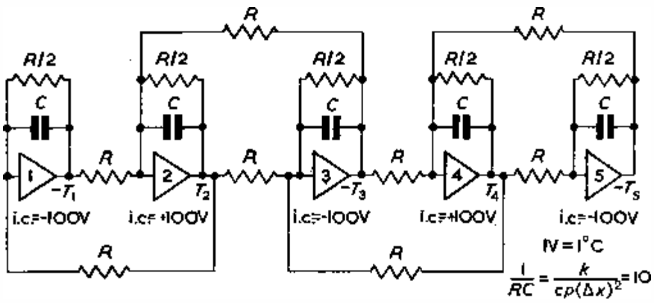


Fig. 8. Computer diagram for quantitative solution of particular one-dimensional heat flow problem

set up on the integrators as indicated. The relationship between the problem constants and the analogue component values is given in Fig. 8.

The analogue solution is shown graphically in Fig. 9. The temperatures at the equally spaced points chosen are plotted against time.

The partial equation has been solved analytically to examine the accuracy of the computer solution and it has been found that at no value of t does the error exceed 2°C, thus the computer solution is sufficiently accurate for a number of engineering applications.

Because of the symmetry of this particular problem ($T_1 = T_5$, $T_2 = T_4$) the computer solution can be executed with only three amplifiers without loss of accuracy.

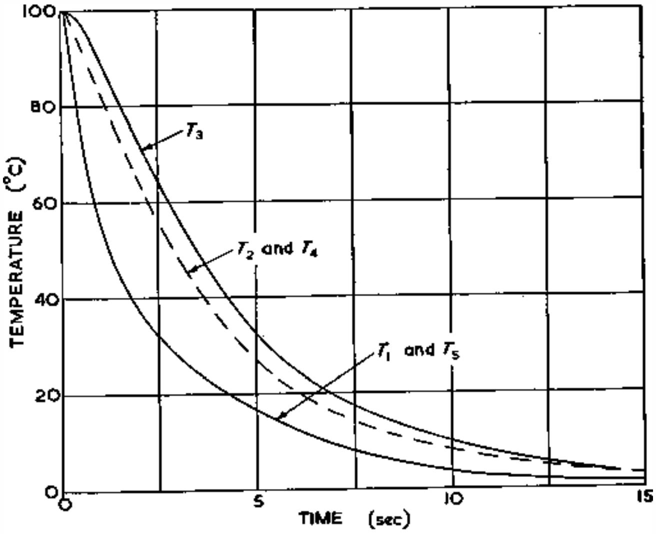


Fig. 9. Analogue computer solution of temperature against time for one-dimensional heat flow

The accuracy can be improved, of course, by taking more segments along the rod. The basis of the computer set up would be the same as in Fig. 8 but with more amplifiers.

The main advantage of the analogue computer solution over other methods is that the initial conditions can be varied quickly and simply and that a wide variety of linear and non-linear problems can be solved in a relatively short period of time.

The same basic techniques can be applied to obtain solutions to the two or three dimensional heat flow case. Solutions to other partial differential equations such as the wave equation, equations describing the vibration of beams are also possible using the same methods.

(Part 3)

The Simulation of Transportation Delay and its use in Control Systems

Transport delay or velocity-distance lag is the time taken in transmitting information between two points and is simply the distance between the two points divided by the velocity $T = d/v$.

The amount of delay is not dependant upon the characteristics of the information—all frequency components are delayed equally in time. The phase shift experienced by a frequency component in this delay interval is determined by the product of the frequency and the delay time.

$$\phi = 360\,fT \qquad (23)$$

where ϕ = phase shift (degrees)

f = frequency (c/s)

T = delay time (sec).

A closed loop containing transportation delay often presents difficulties as regards stabilization. It is interesting to note that the presence of a delay of only 10 per cent the size of the largest single time-constant in a closed loop may exhibit an appreciable effect upon the response of the system.

The delay may be effectively simulated on an analogue computer with linear components over a finite frequency range, thereby enabling a systems designer to investigate the effects of such delays.

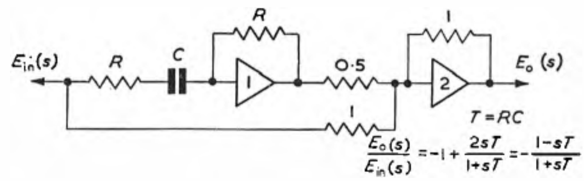


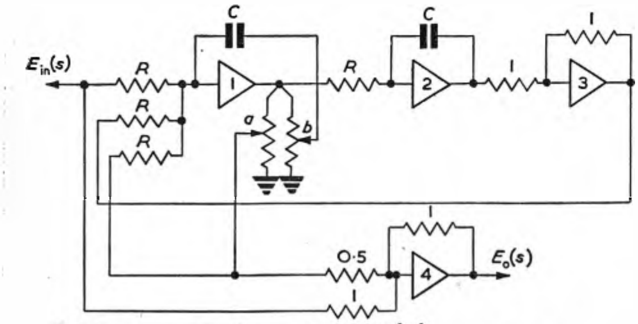
Fig. 10. First order transportation delay simulator

The ideal transfer function expressing transport delay is

$$E_o/E_i = e^{-sT} \qquad (24)$$

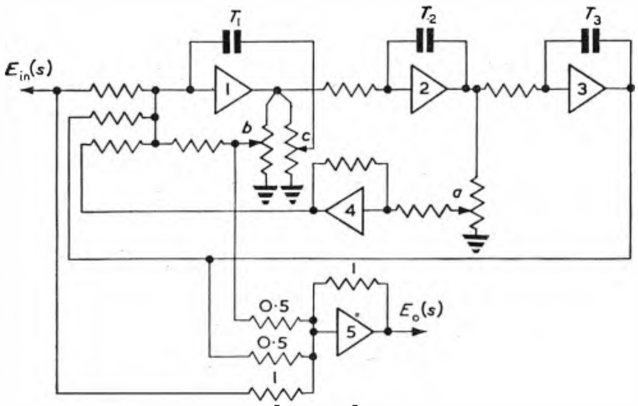
The gain ratio $|E_o/E_i| = 1$ for all frequencies and the phase shift varies linearly with frequency for any given value of T.

The exponential expression e^{-sT} can be approximated by means of algebraic expressions listed in the Padé tables.



$$\frac{E_o(s)}{E_{in}(s)} = -1 + \frac{2asT}{1+asT+bs^2T^2} = -\frac{1-asT+bs^2T^2}{1+asT+bs^2T^2} \qquad T = RC$$

Fig. 11. Second order transportation delay simulator



$$\frac{E_o(s)}{E_{in}(s)} = -\frac{1-asT_3+bs^2T_2T_3-cs^3T_1T_2T_3}{1+asT_3+bs^2T_2T_3+cs^3T_1T_2T_3}$$

Fig. 12. Third order transportation delay

alternative is to select an expansion of e^{-sT} which converges more rapidly.

Consider the polynomial expression

$$e^{-sT} = \lim_{n\to\infty}\left(\frac{1 - asT + bs^2T^2}{1 + asT + bs^2T^2}\right)^n \quad \ldots\ldots\ldots\ldots (28)$$

If $a = 2$, $b = 1$, $n = 1$ it can be shown that equation (28) is identical with equation (25) where $n = 2$. The proportional phase lag will be 120° but as, in general, four amplifiers are required to set up the expansion, little has been gained.

The performance can, however, be considerably improved by judiciously selecting the poles and zeros in equation (28).

Consider the expansion

$$e^{-sT} = \lim_{n\to\infty}\left(\frac{1 - sT/2 + s^2T^2/12}{1 + sT/2 + s^2T^2/12}\right)^n \quad \ldots\ldots\ldots (29)$$

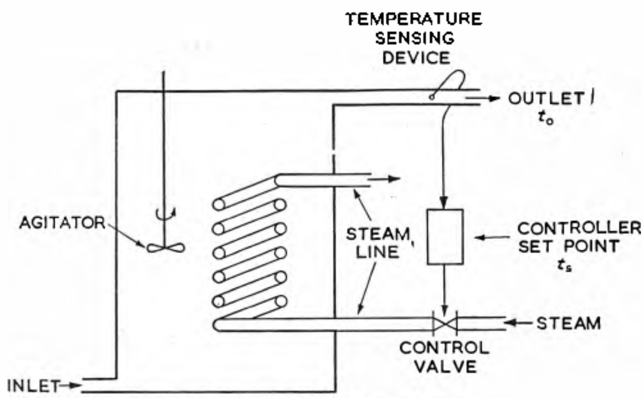


Fig. 13. Basic thermal control

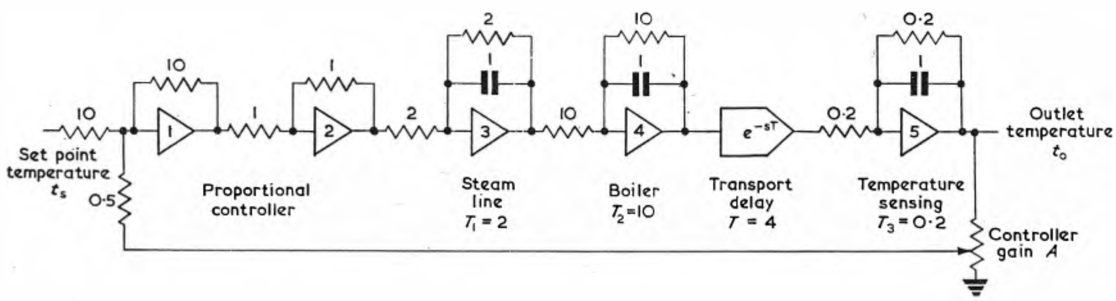


Fig. 14. Computer arrangement for transport delay problem

One of the simplest approximations is:

$$e^{-sT} = \lim_{n\to\infty}\left(\frac{1 - sT}{1 + sT}\right)^n \quad \ldots\ldots\ldots\ldots (25)$$

This expression has unity amplitude ratio regardless of frequency; the phase shift is given by

$$\phi = -2\,n\tan^{-1}(\omega T) \quad \ldots\ldots\ldots\ldots (26)$$

and it can be shown that the phase lag is proportional to frequency up to $60n$ degrees with less than 5 per cent error.

If $n = 1$, the transfer function can be set up with the simple computer circuit shown in Fig. 10 and up to 60° of phase lag can be obtained before the error exceeds 5 per cent. By making use of equation (23)

$$T = (0{\cdot}16/f) \quad \ldots\ldots\ldots\ldots\ldots\ldots (27)$$

Equation (27) states that this approximation will permit frequencies up to f c/s to be delayed T seconds with an accuracy of 5 per cent. By cascading identical circuits greater accuracy can be obtained. However, a more efficient

the phase shift is given by

$$\phi = -2n\left(\tan^{-1}\frac{\omega T + \sqrt{3}}{3} + \tan^{-1}\frac{\omega T - \sqrt{3}}{3}\right) \ldots (30)$$

The four amplifier simulator shown in Fig. 11 is based upon the expansion of equation (29) and exhibits 180° of linear phase shift. This is a 50 per cent improvement over the first result obtained from equation (28).

The circuit in Fig. 12 shows the simulator and expression for the generation of proportional phase to over 430°. Expansions of higher order converge more rapidly and are readily applied to analogue computer work. Alternatively two or more of the circuits illustrated in Fig. 12 can be cascaded to provide greater accuracy in approximating transport delay.

In order to illustrate the influence of transport delay upon a closed loop system, consider the system in Fig. 13.

The liquid in the boiler is agitated and heated by the steam line. The temperature is measured by the sensing device in the outlet pipe and compared with a fixed reference. The difference or error is amplified and adjusts the valve controlling the steam inlet so as to reduce the error.

In this system there is a transport delay between the heating and sensing elements. This delay is proportional to the distance between the elements and inversely proportional to the velocity of the liquid.

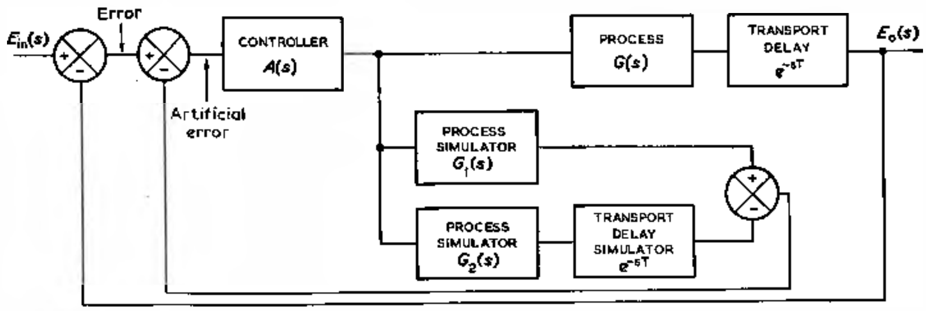


Fig. 18. Close control of process with transport delay

So as to illustrate the influence of transport delay on the system stability as simply as possible, the basic process will be considered to be of the third order. The system has two energy storage elements, the volume of liquid in the boiler and the pipes of the steam line. Typical response times are 10sec and 2sec respectively. The sensing element is assumed to have a response time of 0·2sec. All other time-constants are assumed small in comparison with 0·2 and are therefore neglected. If A is the open loop gain and T the transport delay time, the open loop transfer function is:

$$\frac{A\,e^{-sT}}{(1 + 10s)(1 + 2s)(1 + 0{\cdot}2s)}$$

The analogue computer diagram is shown in Fig. 14; each element in the computer behaves as the analogue of the corresponding element in the system and the loop can be closed as shown.

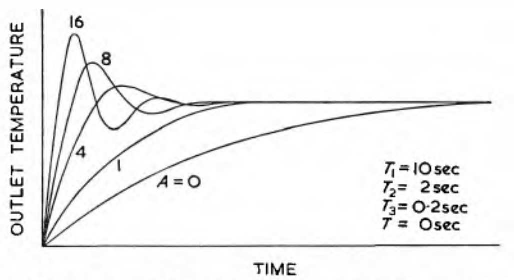


Fig. 15. Response for different controller gain settings A

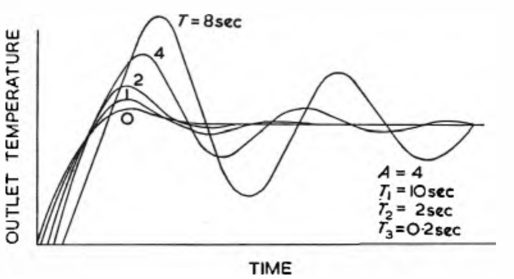


Fig. 16. Step function response of outlet temperature for different values of T transport delay

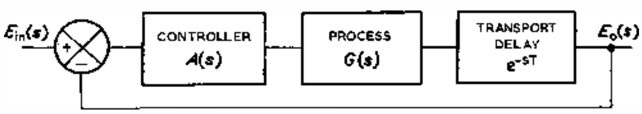


Fig. 17. Simple process control with transport delay

Fig. 15 illustrates the response for different values of A, when $T = 0$. When $A = 4$ the outlet temperature, for example, overshoots by 21 per cent in response to a step change in reference temperature.

Fig. 16 illustrates the response for $A = 4$ and various values of T. It can be seen that the presence of a transport delay only 10 per cent the size of the largest single time constant has an appreciable effect upon the response of the system.

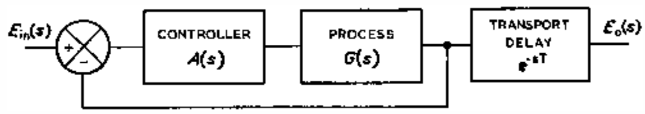


Fig. 19. Effective block diagram of closely controlled process with simulated transport delay

As the sensing element is moved further away from the boiler and the delay time thereby increased, the system becomes less stable. If the sensing element is remotely situated or the velocity of the liquid through the boiler is low, the value of A will have to be small to achieve system stability.

A technique can be used which will eliminate the instability caused by transportation delay in a closed loop system.

A typical process control system with transportation delay is shown in Fig. 17. Its transfer function is

$$E_o/E_i = \frac{A(s)\,G(s)\,e^{-sT}}{1 + A(s)\,G(s)\,e^{-sT}} \quad \ldots\ldots\ldots\ldots (31)$$

In such a system the dead time is a part of the overall feedback loop and influences the system stability. Modification of the control system with a conventional controller may have little or no effect in improving stability.

Consider the control system in Fig. (18). It can be seen that the transfer function of this system is

$$E_o/E_i = \frac{A(s)\,G(s)\,e^{-sT}}{1 + A(s)\,G(s)} \quad \ldots\ldots\ldots\ldots (32)$$

Fig. (19) shows the effective block diagram of process with transport delay control. Note that the transport delay still exists as the last state but has no effect on the stability of the closed loop. Thus the use of an analogue computer with simulated transportation delay in the closed loop can eliminate instability.

Acknowledgment

The author wishes to thank the Directors of Louis Newmark Ltd for permission to publish this article.

Short News Items

The Council of The Institution of Electrical Engineers have elected the following to Honorary Membership: Colonel B. H. Leeson, C.B.E., T.D., in recognition of his extensive contributions to the application of electrical science and engineering in the manufacture of electrical plant and equipment and of the services he has rendered to the Institution over nearly half a century. Dr. Richard L. Hearn, for his notable contributions in the development of electricity generation and its supply for the benefit and use of mankind, particularly in Canada, and for the part he has played in international co-operation in this field. The Institution's thirty-eighth award of the Faraday Medal has been made to Sir George Thomson, D.Sc., F.R.S., in recognition of his outstanding contribution to the advancement of electrical science, of the leadership in research which he has given to others in this field, and of his inspiring services to education in science and technology.

The Electronic Forum for Industry is to hold a three-day conference at Olympia, London, on 24 to 26 May 1960 when the Instruments, Electronics and Automation Exhibition is in progress. Details of the conference will be announced later, when applications to take part will be invited, but broadly the three sessions will cover practical experience of data processing, factory applications (including machine tool control) and instrumentation. A prospectus and form of application will be issued shortly by the Honorary Secretary E.F.F.I., c/o The Electronic Engineering Association, 11 Green Street, London, W.1.

The International Federation of Information Processing Societies has recently been formed as a direct result of the first International Conference on Information Processing, sponsored by UNESCO and held in Paris last June. A provisional bureau for the International Federation has now been established, with Isaac L. Auerbach, president of Auerbach Electronics Corporation, Narberth, Pennsylvania, acting as provisional chairman. The countries whose national computer technical societies have ratified the statutes include Canada, Denmark, Finland, France, Germany, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the United States. In addition, Belgium, Israel, and Japan are forming national computer societies to qualify for membership. It is expected that the first meeting of the IFIPS council later this year will result in plans for a second International Conference on Information Processing with an associated technical exhibit in 1963.

The Post Office, to encourage recruitment to its expanding engineering branches, is launching a scheme under which it will guarantee university training or a diploma-in-technology course at a college of advanced technology to about 20 suitable students. Under the scheme the Post Office will pay university fees, college union dues and the costs of examination and examination registration. In addition, half the cost of essential textbooks will be met. The training course has been designed to meet the requirements of the professional engineering institutions, who have been consulted in its preparation. The Post Office has published a booklet which explains the scheme, the scope of work which Post Office engineers do and career prospects.

The new NATO headquarters in Paris has what is claimed to be the most up-to-date electro-acoustical installation of any public building in Europe, possibly the world. Fifteen television, thirty radio and twenty camera points in public rooms, two television studios and eight radio studios have been provided. With this equipment sixteen radio and television commentaries can be given, six television cameras can be operated and thirty sound cameras can film simultaneously. The NATO building can also be connected directly into the Eurovision network. A simultaneous interpretation equipment for a thousand delegates is provided. This has been installed in the main council chamber, the Press theatre and in six smaller conference halls in the building. It involves hundreds of microphones and more than a thousand headsets and languages selectors as well as small personal loudspeakers for use in some of the more important conference rooms. The equipment has been supplied by the Philips organization with the co-operation of its companies in Holland, Germany and Belgium.

Cossor type CR.787 10cm surveillance radar has been ordered for the new international airport which the Yugoslav Government is building at Belgrade. The contract, which is being financed out of the funds made available to the Yugoslav Government by the U.K. Government under an agreement signed in 1959, has been placed with Cossor Radar and Electronics Limited by 'Intercont' acting on behalf of the Yugoslav Directorate General of Civil Aviation. The order covers duplicate radar transmitters of the latest type, together with four display consoles. Two of the displays will be used for Air Traffic Control, a third will be used for Approach Control and the fourth will be used as a monitor.

Australia's electronic and communications equipment industry offers potential scope for the British manufacturer, according to a survey of investment opportunities in Victoria, prepared for the Victoria Promotion Committee. The survey, made by the Stanford Research Institute of California, reports that although Australia's own industry is already well established, substantial quantities of equipment must still be imported. As evidence, it cites the following import figures of major value for 1958-59.

Valves and valve parts ...	£1·6M
Telephones and accessories	£1·2M
Switchboards	£940 000
Transmitters and accessories	£880 000
Other telephone and telegraph parts and appliances	£590 000
Radio receiving sets	£360 000

The magnitude of these imports, concludes the survey, suggests possibilities for increased production in Australia by British manufacturers of such equipment.

The Donovan Electrical Co. Ltd, of Stechford, Birmingham, announce the establishment of an Industrial Electronics Division, and that the Company has been licensed by The Austin Motor Co. Ltd, and Hivac Ltd, to supply and manufacture equipment employing the 'ACCESS' System of Electronic Control (Austin Cold Cathode Electronic Switching System), with particular reference to complex machine tool and conveyor applications. The 'ACCESS' system was described in the November 1959 issue of Electronic Engineering (pp. 646-654).

The Technical Committee of the Audio Manufacturers' Group of the British Radio Equipment Manufacturers' Association, immediately after its formation in May last applied itself to remedying two of the main shortcomings in the audio equipment field, namely a standard method of measuring and expressing the performance of amplifiers, and a standard range of inter-unit connectors. The aim of the standard on connectors has been to facilitate the interconnexion of units of different manufacture, provided that their electrical characteristics are matched. This standard applies to equipment which has its chassis isolated from the mains by a double wound transformer. Work on this standard has now been completed and the result published in booklet form. Copies of this document, "Recommended Practice for Plugs, Sockets and Connectors for use with Audio Amplifying Equipment", are obtainable, free of charge, from The Secretary, Audio Manufacturers' Group, 49 Russell Square, London W.C.1.

The Hon. R. T. B. Wynn, C.B.E., will on 19 April retire from the position of Chief Engineer of the BBC after thirty-four years' service with the Corporation. He will be succeeded by F. C. McLean, C.B.E., Deputy Chief Engineer, who will have the title of Deputy Director of Engineering. The post of Deputy Chief Engineer will be abolished. Mr. McLean joined the BBC in 1937 in the Planning and Installations Department and became Deputy Chief Engineer in 1952.

The Institute of Radio Engineers announces that the National Electronics Conference will be held at the Sherman Hotel, Chicago, Illinois, on 10 to 12 October 1960. Authors of papers are invited to submit abstracts of 100-150 words for publication in the programme and either a 400-500 word summary, or the completed paper for review to: Professor Thomas F. Jones, Jr., Programme Chairman, NEC, School of Electrical Engineering, Purdue University, Lafayette, Indiana.

The G.P.O. has carried out work in connexion with a television system for The Westminster Bank in Manchester. The Bank plans to use the system to enable them to show customers on screens at three branches, statements of their accounts and other documents from a central accounting section. The vision links provided by the Post Office for the Westminster Bank from their main office at York Street to their Knotts Mill Branch in Deansgate and to their Royal Exchange Branch are equipped to transmit high quality pictures of the 625-line standard. The links are 0·8 miles and 0·4 miles long respectively and consist of coaxial cables equipped at the receiving ends with simple and unobtrusive video amplifiers and distortion correctors. The video signal from the camera equipment is transmitted along the links to the picture receivers without any change of frequency. The video amplifiers which provide a gain of 20dB are of standard P.O. design identical with those used at appropriate points throughout the national television networks provided by the P.O. for the BBC and ITA. The closed circuit television system installed at the three offices of the Westminster Bank was supplied by the Pye Industrial Television Division. An operator at the control desk in the York Street office controls the transmissions from a small television camera which looks downwards, by means of a mirror, at cheques and other documents placed on the desk. The desk also incorporates a small viewing screen and a sound system of telephones and talk-back keys so that the operator can hold instant two-way conversations with the receiving ends of the system. For complete secrecy the central operator uses a monitoring system which, in conjunction with an 'inner and outer' office routine, ensures that no documents are shown to customers until they are first checked on the master screen.

E.M.I. Electronics Ltd has received an order from Elektroimpex, Budapest, on behalf of the Hungarian Broadcasting Authority for one of the Company's latest Outside Broadcast Units for delivery in June. The vehicle, which will be used for televising outdoor events from all over Hungary, will be equipped with four of the latest E.M.I. Image Orthicon cameras and a zoom lens. Four video outputs and four sound outputs from the vehicle are provided to make it possible to distribute signals independently to four monitors, when the vehicle is used as the control room for a Television Studio. Another interesting feature is the provision of a special position in the Unit for a 'Production Chief Engineer' Besides inspecting the picture quality of all four camera channels, he can check the output of a microwave link, the picture received by the off-air monitoring receiver and one external video source.

Armstrong Whitworth Equipment have developed a special amplifier and filter unit to drive the Glennite Interferometer made by Gulton Industries of America. The Interferometer is used for the calibration of accelerometers and there are several such instruments in this country but some difficulty has been found in using the instrument to the full extent of its capabilities. The A.W.E. equipment enables correct excitation to be obtained at greatly reduced power output from the driving source and, at the same time, minimizes the effects of any harmonics present in the driving source output. The maximum number of fringe disappearances can be obtained (subject to the instrument's 50g limit) over the whole of the 1-10kc/s range and the equipment permits calibration to an accuracy of ± 10 per cent at 14 spot frequencies, dependent on those previously set up.

The Electronic Engineering Association of 11 Green Street, Mayfair, London W.1, has now published "Recommendations for Card Readers and Punches" and copies are obtainable on application to the Secretary. This document has been prepared in order to make available general data on the basic requirements of computer manufacturers for card readers and punches. The purpose of the document is to promote the adoption of such designs and production practices as have proved to date to be desirable and to make a contribution to any national standards that may be prepared on the subject.

B & K Laboratories Ltd announce that, in view of the international aspect of the several electronic exhibitions to be held in this country in the forthcoming year, they will discontinue their International Instrument Show which has been an annual event in London for the past five years.

The British Sound Recording Association is holding a Convention on Saturday, 23 April, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, in conjunction with the London Audio Fair. The Convention is designed to be of particular appeal to out-of-town members visiting London for the Audio Fair. Registration will cost 5s. for B.S.R.A. members and 10s. for non-members. Full details can be obtained from S. W. Stevens-Stratten, 40 Fairfield Way, Ewell, Surrey.

The English Electric Co. Ltd have opened a new Central Computing Bureau at Kidsgrove, Staffs. The new Computing Bureau has been built as part of a plan to concentrate all the production, research and service activities in connexion with computers and control systems under one roof. The Bureau will continue to provide computer time for outside customers on an hourly hire basis and will maintain and expand all the services until recently available at the Company's Nelson Research Laboratories, Stafford. Two computers have been installed, a DEUCE Mark IIA, with magnetic tape, intended for data processing and the larger-scale problems, and a DEUCE Mark I to deal mainly with scientific and research work. Plans are already being made for a Bureau which will use the new fully transistorized KDP.10 Data Processing System, considered to be the most up-to-date system of its kind in the world.

The Commissioners of the Port of Chittagong, East Pakistan, have placed an order with Marconi's Wireless Telegraph Co. Ltd for the establishment of a v.h.f. radio-telephone network to improve ship-to-shore communications within the port area and the Kharnaphuli river. Besides the installation of duplicate v.h.f. transmitters and receivers in the shore stations at the Port Office and at the signal station at Juldia, the order also includes the supplying of mobile stations for use in two harbour tugs and a pilot launch. A particularly important feature of the new project is that the equipment will conform to the recommendations of the International Maritime V.H.F. Conference which was held at The Hague in 1957. This will enable all visiting ships which are suitably equipped to enter or leave the port in full radio communication with the Port Authorities.

A Flight Test Instrumentation Symposium is to be held at the College of Aeronautics from Thursday, 7 April, to Saturday, 9 April. The registration fee for the Symposium is 10s. and the inclusive cost of the accommodation at the College from lunchtime on Thursday, 7 April, to lunchtime on Saturday, 9 April, is £4 4s. per person, including staff gratuities. Further particulars can be obtained from Mr. M. A. Perry, Lecturer in Instrumentation, Department of Flight, The College of Aeronautics, Cranfield, Bletchley, Bucks.

LETTERS TO THE EDITOR

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

A Stabilizer With Wide Range Voltage Regulation

DEAR SIR,—A variable high-voltage stabilizer of an interesting concept has been described recently[1]. Another circuit of this kind has been developed by myself[2]. Perhaps the most surprising aspect is the fact that a voltage of several thousands of volts can be stabilized to better than one part in ten thousand with a 4·5V dry battery as the reference-voltage source. The basic circuit is shown in Fig. 1.

A symmetric two-stage voltage amplifier with a small positive feedback loop[3] is used also as the upper part of a voltage divider. Its lower part, realized as a resistor chain, enables a simple output voltage control. The resistor RV_1, changing stepwise the value of V_2, is coupled with another resistor RV_2, regulating the a.c. supply to the rectifier. The underlined values of resistors closing the two symmetric positive feedback paths are of a special sort with reduced value of temperature coefficient. They are all embedded in a metal block securing them a practically zero temperature difference (see Fig. 1). A decade box 0·1 ... 111 111Ω, or a Helipot can be used as the resistor RV_2. A simple 4·5V dry battery, unloaded, is used as the voltage-reference element for all ranges.

The output voltage V_2 may immediately be set to any value between 260 and 2 300V by changing RV_1 and RV_2. The long-term stability determined experimentally with an ink-recorder is better than 2×10^{-4} per hour after 60 min warm-up period. The short-term stability is better than 1×10^{-4}. The ripple voltage is under 3mV. The inner impedance of the output up to 1kc/s has its value between $\pm1\Omega$. These qualities remain unchanged over the entire output voltage range.

The instrument has been used for some 18 months as the accelerating voltage supply in a Nier-type mass spectrometer[4] and has provided excellent stability.

Yours faithfully,

M. PACÁK,

Institute of Physical Chemistry,
Czechoslovakia.

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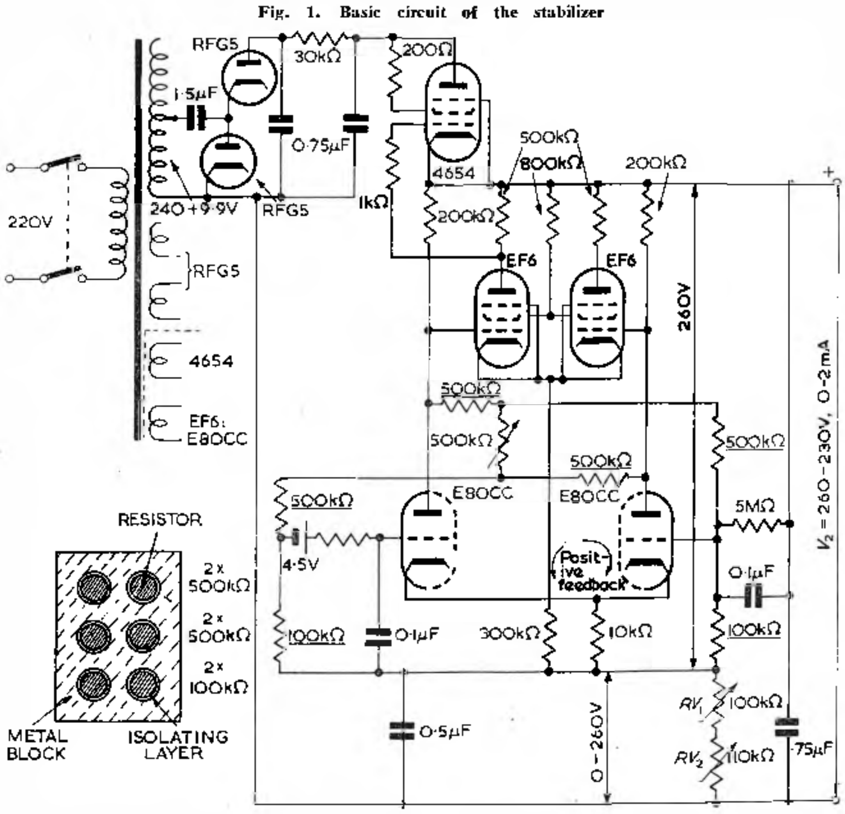
Fig. 1. Basic circuit of the stabilizer



An Overload Protection Circuit

DEAR SIR,—A junction transistor offers a simple means of protecting a low impedance type of recording milliammeter against damage due to overloading. Since the voltage required to produce full scale deflexion with such a recorder is low (e.g. 2·5V for a 5mA recorder having a resistance of 500Ω), the protection circuit, to be effective, must operate on a voltage which is only a few tenths of a volt in excess of that required for full scale deflexion.

The circuit to be described will protect such a recorder when driven from a voltage source having an internal impedance of 350Ω or more. The emitter and collector of a transistor type V10/50 are connected to the recorder terminals

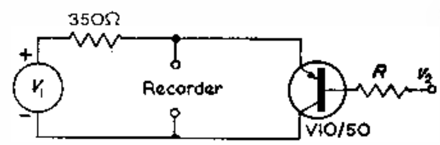


Fig. 1. Simplified circuit diagram
V_1 Source Voltage
V_2 Bias Voltage
R Base Circuit Impedance

as shown in Fig. 1, while the base is biased positively. R is the impedance of the base bias supply. If the bias voltage V_2 is adjusted to be equal to (or very slightly in excess of) the voltage required to produce full scale deflexion of the recorder, then emitter current will not flow during normal operation of the recorder. If, however, the voltage across the recorder exceeds the base bias voltage V_2, the transistor will begin to conduct, preventing any further large rise in voltage across the recorder. Thus the current passing through the recorder will be limited to a value only slightly in excess of the full scale value.

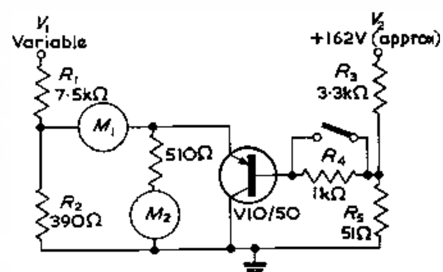


Fig. 2. Circuit of experimental arrangement

The experimental arrangement shown in Fig. 2 was used to assess the performance of the circuit. Base bias for the transistor was provided by the potential divider R_3 (3·3kΩ) and R_5 (51Ω). The voltage V_2 was adjusted to give a bias potential of 2·5V. With R_4 (1kΩ) in circuit, the base circuit impedance is 1kΩ, if this resistance is shorted the base impedance is about 50Ω. The potential divider R_1 (7·5kΩ) and R_2 (390Ω) acts as a voltage source, having an impedance of about 370Ω. The total current i_1, and the recorder current i_2 were measured by Model 8 Avometers (M_1, M_2), the recorder being simulated by connecting a 510Ω resistor in series with the Avometer M_2, the total resistance in this branch being then about 550Ω when using the 10mA range. The results are

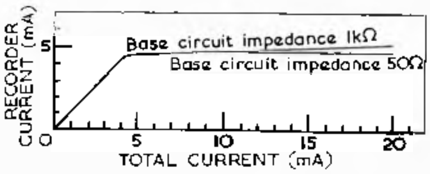


Fig. 3. Recorder current against total current

shown in Fig. 3, in which the recorder current i_2 is plotted against the total current i_1 supplied by the source. As would be expected, the effectiveness of the transistor as a shunt is increased as the impedance in the base circuit is reduced, though a base circuit impedance of about 1kΩ is not too high for satisfactory operation.

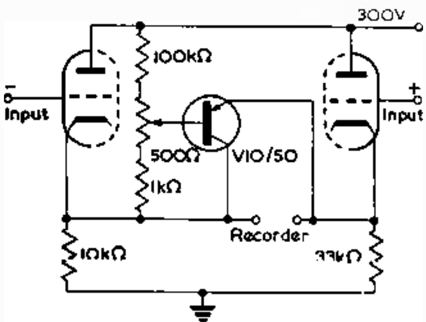


Fig. 4. Typical output stage with protective transistor
Mean Potential at Grids ≈ 100V

Fig. 4 shows a possible method of fitting a protective transistor to a common type of recorder drive circuit.

Yours faithfully,

G. G. Yates,

Department of Physical Chemistry,
University of Cambridge.

Phase-Sensitive Detection in the Presence of Noise of Large Amplitude

Dear Sir,—A disadvantage of the scheme described by Boyd and Thompson in their letter in the October issue is that a highly selective circuit has a steep phase characteristic, so that by placing such a circuit in front of a phase-sensitive detector a system is set up which is very liable to suffer from unwanted changes in gain caused by relative drift between the frequency of the wanted signal and the tuning of the selective amplifier.

A further disadvantage is that the proper performance of a selective amplifier using parallel-T feedback depends on accurate balance of the two T's, small changes in component values producing much larger changes in Q and peak gain. This is particularly severe when a high Q is aimed at. Indeed quite small drifts or inaccuracies in component values in unfortunate directions can cause oscillation.

Thus a system using a parallel-T selective amplifier in front of a phase sensitive detector is, for two reasons, unlikely to give a reliable or stable performance when high selectivity is used.

It may be useful, therefore, to call attention to a system due to Noble and Baxandall[1, 2] which offers both stable performance and the ability to detect weak signals in the presence of very large amplitudes of noise.

An outline of the system is shown in

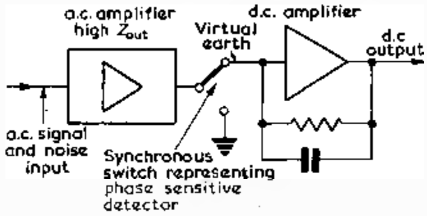


Fig. 1. Outline of system

Fig. 1, and the following principles of design should be observed:—

(1) The phase sensitive detector proper, shown here as a simple switch, feeds into a virtual earth (a low impedance). This means that even large signal or noise currents develop only small voltages, and this greatly eases the design and operation of a satisfactory switch, which in practice will probably be an arrangement of diodes or transistors. The problem of designing the a.c. amplifier is also eased.

(2) The resistance to d.c. looking back from the virtual earth through the switch is made high by ensuring that the switch is 'current fed', i.e. the a.c. amplifier which feeds a.c. signal, and noise, to the switch is given a high output impedance at the a.c. signal frequency. This is done so that the d.c. amplifier works with almost 100 per cent feedback. Internal drifts in the d.c. amplifier then appear at the output without appreciable magnification, and this allows the minimum working level of the wanted signal to be as low as possible.

(3) Bandwidth restriction, so that at the output the wanted signal may be seen above noise, is carried out mainly after rectification. This is equivalent to having in front of the phase sensitive detector a selective circuit which is automatically exactly in tune with the signal, and thus phase and amplitude difficulties which would occur with an actual selective circuit are avoided. In order to avoid an unnecessarily high amplitude of noise at the input to the detector, it is usually convenient to have a small degree of selectivity before it, but not enough to cause significant phase shift over the frequency band in which the a.c. signal may lie.

If the method of bandwidth restriction is the simple one of putting a capacitor across the feedback resistor, as shown in Fig. 1, the capacitor will carry the majority of the noise current, and the d.c. amplifier must be able to absorb this current at its output. Similarly the a.c. amplifier feeding the phase sensitive detector must be able to handle the noise current present. But as in each position the handling capacity can easily be made several milliamperes, while if proper attention is paid to point (2) and to other features in the design of the d.c. amplifier the minimum useful signal level may be of the order of 10^{-9}A or even less, it is clear that a large noise-to-signal ratio can readily be handled.

It is difficult to give a definite figure for the maximum noise-to-signal ratio that can be dealt with by this system—perhaps it is sufficient to say in conclusion that the system has been used with success in radio astronomy, where very low levels of 'noise signal' from the aerial (synchronously chopped) are detected in the presence of relatively very high levels of receiver noise.

Yours faithfully,

E. F. Good,

Royal Radar Establishment,
Malvern.

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The Author replies:

Dear Sir,—What Mr. Good says is both true and well known. Indeed we refer in our letter to the limitation due to tolerances in the twin-T circuit and in fact it has long been our custom[1, 2] to follow amplifiers of the type we described with the kind of phase sensitive detection arrangement described by Mr. Good.

Our reason for using a narrow band amplifier before a phase sensitive detector has been simply to ensure the very high degree of linear operation required in our experiments. We have not been concerned to obtain the highest values of Q in the amplifier but we have used an integrating circuit following the phase sensitive detector which at times has a bandwidth as small as 0·1c/s.

In short, we agree entirely with Mr. Good but have the additional point to make that if the signal-to-noise ratio is extremely small then we have found it necessary to replace his a.c. amplifier with our narrow band amplifier in order to ensure that the operation of the amplifier is extremely linear.

Yours faithfully,

R. L. F. Boyd and J. B. Thompson,

University College, London.

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BOOK REVIEWS

Magnetic Sound Recording

By D. A. Snel. 230 pp. 162 figs. Demy 8vo. Phillips Technical Library, Holland. 1959. Price 25s.

WHEN any art or science becomes a subject of popular interest, a number of books always appear on the market. The first few may be disappointing, because it takes time for all the ramifications of the subject to be developed and exploited. Subsequent authors are then usually divided into two categories; the academic professional and the enthusiastic amateur. The subject matter for one class of reader does not suit the other.

There have already been many books on magnetic recording, easily separable into these two classes. Mr. Snel has the rare gift of being able to write for the enthusiast while retaining the approach of the scientist. In this way, his book is unique. As a member of the Philips research organization he is obviously able to draw on the knowledge and experience of his many colleagues, and the manufacturing resources of this Company ensure that all the apparatus germane to the subject matter is at hand, for both amateur and professional purposes. Therefore the book ought to be good, but it is not only good, it is eminently readable. How much of this can be credited to the English translator, Mr. E. Harker, we do not know.

To condense the whole subject into 209 pages and, in addition, devote a good deal of space to matters not usually mentioned, requires a high order of literary skill. There is not an unnecessary line in the whole book.

Of the 23 chapters, the first four deal with sound and magnetism, the fourth being particularly good. Then follows a most detailed description of the mechanism of tape recorders and the design of heads. Tape manufacture receives a special chapter and this is right up to date. Amplifiers, loudspeakers and microphones are adequately if briefly summarized, but all the essentials are examined and a vast amount of practical information is condensed into the 20 pages allotted to these items.

It is the subsequent material which is so thoughtfully presented, and for which this book is especially noteworthy. Extremely full and concise instructions are given for recording almost every conceivable source of music and speech. A chapter then deals with the best ways to play back such recordings. Stereophony, dictating machines and sub-standard film receive separate chapters, there is one on fault-finding and another on professional equipment. Then follows a remarkable list of possible applications of recording, which will certainly stimulate much thought.

The reviewer has often deplored the paucity of information on the study of the mind in relation to music; in chapter 22 Mr. Snel not only delves into this subject, but has much to say on the use of recorders for education generally, and the value of tapes for critically examining one's own progress in musical proficiency.

A final chapter deals with miscellaneous matters of a practical nature which are not often touched on in this kind of book, and in conclusion there is a glossary containing definitions of terms in general use in the art.

The type is of a particularly readable kind, and although the paper is not of good quality the line drawings are plentiful and very good. Art paper insets take care of the excellent photographs. All of this is done for the modest price of 25s., on which the publishers are to be congratulated. All in all, this is a stimulating and refreshing approach to magnetic recording, and is without doubt both authoritative and enjoyable—a combination rarely encountered. It should be on the bookshelf of everyone interested in the subject.

A. DOUGLAS

Electric Circuit Theory

By F. A. Benson and D. Harrison. 360 pp. 339 figs. Demy 8vo. Edward Arnold (Publishers) Ltd. 1959. Price 30s.

THIS book covers the circuit theory appropriate to the first two years of a university degree course in electrical engineering. The text is based on lectures given to students at the University of Sheffield and includes numerous worked examples and tutorial questions. For the engineer the utility of circuit theory is directly related to the extent to which it can be applied to practical problems and the provision of adequate examples provides a bridge between the concepts of circuit theory and the solution of actual problems. However, the liberal use of examples undoubtedly slows up the text and in some cases tends to obscure the fundamental tenets on which analysis is based.

The initial part of the book deals with elementary ideas such as Kirchhoff's laws, superposition and Thevenin's theorem which are illustrated by application to d.c. circuits. The representation of a.c. quantities by the 'j' notation is then discussed and the basic theorems are applied to a.c. circuits. This material represents about one third of the book and, together with some discussion of the transformer which is dealt with later, it would cover the requirement of the first-year of most electrical engineering degree courses.

In the latter part of the book the space is equally divided between heavy-current and light-current topics. The heavy current topics include symmetrical components, fault-currents and the induction motor while light current subjects include amplifiers, oscillators and rectifier-filters. The transmission-line and wave-filters are dealt with very briefly and the section on resonance would have been much improved if the various quantities had been dealt with in terms of normalized frequency.

Throughout the book worked examples are integrated with the text and this makes it difficult for the reader to separate in his mind the underlying general principles from this particular application. However, the profusion of examples will make the book useful to the student who wishes to obtain adequate practice in the application of circuit theory.

V. H. ATTREE

Servomechanisms and Regulating System Design. Volume I

By H. Chestnut and R. W. Mayer. 672 pp. 401 figs. Demy 8vo. 2nd Edition. John Wiley & Sons Inc., New York. Chapman & Hall Ltd., London. 1959. Price 94s.

The success of a technical book is usually assured when readers for whom it is intended begin to refer to it by the name of its author, or authors, instead of its formal title and for some years "Chestnut and Mayer" has occupied a high place in any list of books recommended for study by control engineers. The authors are senior members of the control engineering staff of the American General Electric Company and in addition they have lectured to its courses on servomechanisms so they were well qualified to write a book which would appeal to students as well as to practising control engineers. They are also in a position to be in close touch with the latest ideas on the presentation of feedback control philosophy.

The first edition of Volume I was published in 1951 and dealt with the fundamentals of the subject, then in 1955 Volume II appeared dealing with a wide field of design problems. As a rule books which treat the fundamentals of a subject are not altered very much whenever new additions are published but feedback control is an expanding subject which has demanded drastic changes in the approach to its theory as well as its practice during the past decade. With this in mind the second edition of Volume I was read with special interest to see how the authors, as up-to-date practising control engineers, have reacted to the effects of these changes on the excellent book which they wrote ten years ago, particularly since their declared intention in the new edition remains unchanged, namely to train engineers in the basic principles of feedback control.

Very wisely they have retained the earlier parts of the first edition and in fact Chapters 1 to 12 have the same headings, which include the mathematical processes needed in linear control theory (complex number manipulation, Laplace transforms, stability criteria), typical elements and their transfer functions, complex plane representation of system performance, attenuation phase diagrams (Bode and Nicholls). The first major and very welcome addition is then found as a 63 page chapter on the use of the root locus in design problems, which is very clearly written and uses numerical examples to illustrate the practical application of this important technique in system design work.

Chapters 14 and 15 then deal with multiple-loop and multiple-input systems and steady state and transient performance, respectively. They are taken from Volume I but engineers who have not already used that book will be glad to hear that a set of graphs is provided which presents a detailed comparison between the frequency and transient response characteristics of representative servomechanisms.

The final chapter is another entirely new one dealing with the fundamentals of analogue computers and contributed by W. E. Sollecito. It could perhaps be argued that as there is already a large bibliography on analogue computers the subject is out of place in a book on servomechanisms, but in the reviewer's opinion this new chapter is an extremely useful addition because computers are invaluable, when used as simulators, for the presentation of fundamental control system behaviour to students, as well as for the solution of specific design problems. The authors use the transfer function method of simulation, and they include simulation of non-linearities which many students find difficult to grasp when considered only as mathematical expressions.

Finally there is a large number of problems, helpfully set out under the chapter headings, and a bibliography containing 137 references to a wide range of books and original papers. Engineers who already possess well-thumbed and cherished copies of the first edition of Volume I will without doubt be moving with the times if they obtain the second edition.

E. B. PEARSON

Heatsealing and High-Frequency Welding of Plastics

By H. P. Zade. 200 pp. 12 figs. Demy 8vo. Temple Press Ltd. 1959. Price 35s.

DR. ZADE'S latest book can be enjoyably read through and reasonably digested in one evening. This desirable feature has been achieved by a most excellent selection of photographs, charts, graphs and diagrams linked together by a minimum of text. Production managers and engineers who normally 'talk through their pencils' with the minimum of verbiage will, the reviewer is sure, appreciate such a concise treatment of the subject.

This book will be most useful to the individual requiring guidance in the selection of the most appropriate type of welding equipment for a particular application or type of material. The comprehensive trade name index on pages 190-197 and the 'weldability' tables on pages 3-30, will also greatly assist selection of materials and equipment.

The reviewer was rather disappointed not to find any photographs or design information on high frequency welding electrodes. Dr. Zade states: "It would lead too far to go into details of all possible configurations and shapes of electrodes used for the high frequency welding of plastics". This points to the requirement for a future book to be written for the jig and tool designer and for the personnel actually applying the equipment. Inclusion of a factual treatment of the problems of radio and television interference would have helped to clarify this perplexing problem for the user of r.f. welding equipment.

W. D. WILKINSON

Ferrites

By J. Smit and H. P. J. Wijn. 347 pp. 247 figs. Medium 8vo. Philips Technical Library, Eindhoven. 1959. Price 72s.

THIS book, I believe, is the first to be written wholly on ferrites and as such fills a serious gap in the library of any student of magnetism. It can be wholeheartedly recommended to all those working on the development or applications of ferrites, and also perhaps to that large, but fortunately decreasing, multitude of engineers who believe that there is a single material called 'Ferrite' which when placed in a magnetic circuit will solve all their problems.

The authors work in the Phillips Research Laboratories, Eindhoven, where the majority of the work and development on ferrites originated, and therefore both speak with authority on their subject.

The book is written, in the words of the author 'on an intermediate level' and is neither too elementary nor highly mathematical, and should be readable to the average science graduate. C.G.S. and practical units are used throughout.

The authors have divided the subject matter into four parts, the first of which describes the basic theory of magnetism both as applied to metallic magnetic materials (ferromagnetism) and oxide magnetic materials (ferrimagnetism). The second part outlines the methods used for making the technical and intrinsic measurements on ferrites. It describes, for example, the various measurement techniques required to obtain a complete frequency spectrum of the complex permeability from d.c. to 2 000Mc/s. The rest of the book is devoted to the properties of ferrites and is divided into two parts; the first is concerned with the intrinsic properties fundamental to each particular chemical composition, such as Curie temperature, saturation magnetization, magnetostriction, etc. The second describes the technical properties of polycrystalline ceramics; permeability, coercivity, etc.

A large part of the section on the intrinsic properties of ferrites is devoted to the comparatively new class having a hexagonal crystal structure. This discovery by the members of the Philips Research Laboratories has more than doubled the field of soft ferrites. Both their intrinsic and polycrystalline properties are fully described and particular attention is given to their permeability frequency spectrum.

The space allotted to the class of ferrites containing rare earth oxides and possessing the garnet crystal structure is disappointingly small, especially as over a hundred papers have been published on these materials since their discovery in 1956. However the basic intrinsic properties of these materials are given.

The last section of the book on the properties of polycrystalline ferrites should prove useful to those primarily concerned with using them as core materials. The relevant properties of the materials for most ferrite applications are shown and discussed although the applications themselves are not described. There are sections on permanent magnet materials, on the switching time in square loop ferrites, etc., as well as consideration of initial permeability and its variation with frequency and other factors.

The only omission noted was any discussion of reversible magnetostriction for ultrasonic generators or filters.

On the whole an invaluable contribution to a specialized but important subject.

A. W. SIMPSON

Transistors in Radio, Television and Electronics

By M. S. Kiver. 424 pp. 338 figs. Demy 8vo. 2nd Edition. McGraw-Hill Publishing Co. Ltd., New York, London. 1959. Price 44s.

THIS edition has been generally revised, and contains as well as chapters on amplifiers, oscillators, radio and television receivers, and the servicing of transistor equipment, additional chapters dealing with applications of transistors to computers, voltage regulators, pulse generators and instrumentation, and with amplifier design.

The aim of this comprehensive book is to give a working knowledge of transistors and transistor circuits to radio and electronic technicians. The presentation is basically descriptive, elaborate mathematical treatment being avoided throughout the book, which begins with a useful introduction to electron theory and the mechanism of current flow in semiconductor materials, leading easily to a description of transistor operation, their physical construction and electrical characteristics. Various commonly encountered types of transistors are thoroughly described, and the chapter on additional transistor developments covers more specialized types, such as the 'drift' or diffused-base v.h.f. transistor, and a high current switch, the thyristor, as well as photo-transistors and field-effect devices. Silicon transistors are described, and other semiconductor materials briefly noted. No mention is made of the recently developed 'mesa' structure for v.h.f. use.

Very many complete circuits are given throughout the chapters on amplifiers, oscillators, and radio and television receivers, providing a useful reference source. Negative feedback and direct-coupled amplifiers are briefly described, and various a.g.c. methods are illustrated. Video amplifiers and waveform generators appear in the chapter on television, some basic computer circuits, d.c. convertors and regulators, proximity detectors and counters in the chapter on electronic circuits.

Many of the basic amplifier and oscillator circuits are compared with corresponding valve circuits, so that those who are already familiar with valve techniques should find little difficulty in understanding transistor circuit operation. A number of simple experiments are described to demonstrate the operation of transistors in a wide range of interesting circuits, ranging from resistance-capacitance and transformer-coupled amplifiers to elementary radio receivers and oscillators. The beginner may find some difficulty in obtaining suitable coupling transformers, and the demonstration of improved performance in a transformer coupled amplifier may not be as effective as it should be. A somewhat more detailed description of the transformers to be used would have been helpful.

The book ends with a chapter on amplifier design, including the use of published curves, the design of bias circuits and a discussion of thermal stability. Some basic equivalent circuits for the transistor are also described in this last chapter, but the section on the high-frequency equivalent circuit is somewhat sketchy and might have been extended to show more fully the relationship between cut-off frequency and the equivalent circuit elements, and the effects of phase shifts in oscillators and high-frequency amplifiers. The reader is referred, however, to a bibliography which lists suitable references on this subject.

This book is, of course, not intended to be a design handbook, but does state quite adequately the principles of transistor circuit operation, and the precautions to be taken when dealing with transistors.

The reader will require to translate some of the American phraseology and symbols to those in current use in this country, and to refer to published data to find available transistor types equivalent to the American series.

The wide range covered by this book, and its practical and descriptive approach should make it very popular not only with the technician, but with anyone concerned with transistor circuits in general applications, and with technical students meeting the transistor for the first time.

I. D. JACK

Principles of Electronic Instruments and Instrumentation

By G. R. Partridge. 383 pp. 256 figs. Medium 8vo. Sir Isaac Pitman & Sons Ltd. 1959. Price 40s.

THIS book has been based on a series of post graduate lectures by the author in America and in consequence is of a fairly advanced nature.

It would be absurd to expect one volume to contain the endless variety of applications that are possible to modern electronic instrumentation. Nevertheless, into the 393 pages covered by 19 chapters, a great deal of information has been compressed.

Commencing with 'Why Electronic Instruments,' the author proceeds to chapters on valve-voltmeters, wattmeters, valves and circuits followed by frequency measurement and digital display.

Physical subjects are not neglected and measurement of mechanical movement is followed by electronic measurement of light, sound, time, temperature and pressure. There is also a chapter devoted to measurement of radioactivity.

The arrangement of the chapters is such that the book is virtually divided into two portions. The first dealing with instruments to measure electrical quantities by electronic methods and the latter on transducers that convert the quantity in question into an electrical signal that may then be measured by one of the instruments discussed earlier.

The mathematical level varies considerably which is inevitable when dealing with such a variety of circuits and is of an advanced standard in some instances. It is apparently assumed that the reader has an adequate background. This method of presentation has enabled the author to attack a given problem based on considerations of getting to a solution in the shortest time.

The wording of the text is quite delightful and makes for easy reading and throughout is rendered flexible by numerous circuit diagrams and drawings. In many instances commercial instruments are used to illustrate the principles involved.

It may be said that the book is useful not only to the graduate student but also to the practising engineer who is faced with the need for developing instruments for special applications.

It is exceedingly good value for the compartively modest price asked for by the publishers.

R. H. MAPPLEBECK

The Practical Hi-Fi Handbook

By G. J. King. 219 pp. 158 figs. Medium 8vo. Odhams Press Ltd. 1959. Price 25s.

EACH successive publication on this subject brings to the reader some specialized aspect of the art with which the author is particularly familiar. In this case, the servicing and maintenance aspects are stressed, as generally applicable to any equipment, and this is then extended to include many commercial amplifiers, record players and tape machines. The book covers, in a condensed manner, every aspect of radio, disk and tape reproduction (including stereophony) and is noteworthy because Mr. King very properly insists that the basic requirements and standards of 'hi-fi' are quite different from those tolerable in commercial a.m. receivers, and explains in detail why this is so.

A valuable feature is the section dealing with 'conditioning' the serviceman so that he will think hi-fi and most of the suggestions are directed at ensuring a really high standard of musical appreciation on his part so that he can meet the customer on his own often rather exacting ground. It is regrettably true that many servicemen have a poor appreciation of the ingredients of good reproduction, frequently considering that if they provide enough 'top' all will be well. Mr. King disillusions them admirably, and supplies all the information necessary to properly match the various units for optimum results. This aspect of equipment design is better treated than in any other book so far reviewed.

Of the ten chapters, some appear to lean heavily on manufacturers' literature, while all are inevitably condensed in a book of 200 pages. On some matters, therefore, one might equally well be served by any of the other books on the same subject; but on the matters touched on above, which indicate a considerable appreciation of art as well as technology, Mr. King's book is very good.

The production and illustrations are excellent and the price very moderate. The book is recommended to those wishing to know something of the psychology as well as the technicalities of 'hi-fi'.

A. DOUGLAS

THE PHYSICAL SOCIETY EXHIBITION

A description, compiled from information supplied by the manufacturers, of a small selection of the electronic equipment, exhibited at the 44th Physical Society Exhibiton, held in London from 18-22 January.

(Voir page **185** pour la traduction en français: Deutsche Übersetzung Seite 193)

ADVANCE COMPONENTS LTD

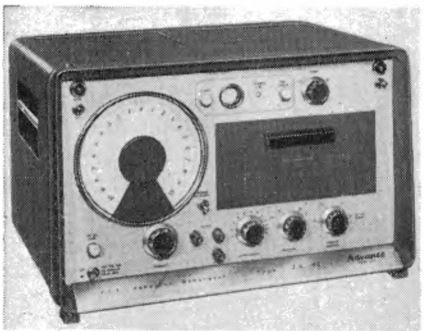
Roebuck Road, Hainault, Ilford, Essex

V.L.F. Function Generator

(Illustrated below)

The Advance v.l.f. function generator has been designed to produce any required function or waveshape over the frequency range of 10mc/s to 100c/s in four ranges. It thus has applications in computer design and operation, servo system analysis, pen recorder testing, vibration equipment, and many types of simulator equipment.

The method of waveform generation differs from conventional oscillators in that an optical-mechanical system is employed whereby a narrow slit of light is scanned by a rotating disk on which is impressed an opaque area corresponding to the function to be produced. The rotating disk may be readily interchanged



with disks on which various other waveshapes are formed. It is apparent that great flexibility is available to the user as it is only necessary to be able to plot a function in polar co-ordinates for it to be available in varying voltage form.

The disks are driven via a four speed gear-box by a servo-controlled motor to achieve frequency accuracy and stability. There is also the facility for automatically sweeping the two higher frequency ranges when required, as, for instance, in vibration testing.

The acceleration on the two lower ranges is sufficiently high for it to be possible to start the waveform at any pre-determined point. The circumference of the disk is calibrated in degrees for this purpose.

The direct voltage at the output terminals may be set at any value between ±25V about earth, allowing all functions to be generated with zero d.c. component or any value between these limits. The output voltage of the waveform can be varied between 200μV and 20V peak-to-peak.

EE 19 751 *for further details*

Measuring Counter

(Illustrated on right)

The Advance measuring counter is a portable, fully transistorized equipment employing printed circuits. Six drum type meters provide presentation of counts up to a maximum of 999 999. Frequencies up to 1Mc/s can be measured during an accurate time period generated by an internal crystal controlled 1Mc/s oscillator of either one tenth, one or ten seconds.

More accurate readings can be taken for frequencies lower than 1kc/s by measuring the time period in units of 1μsec, between two zero transits of the input signal, or one period. Even greater accuracy can be achieved by measuring the periods.

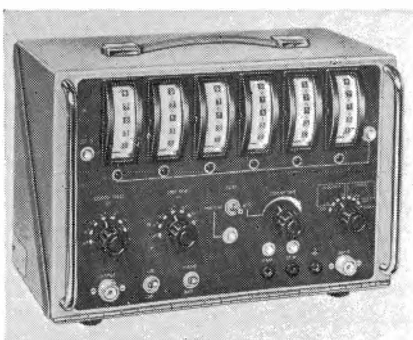
Reading accuracy is partly dependent upon the counter, which will register accurately to within ±1 count, and partly upon the internal oscillator, the crystal for which is enclosed in a temperature controlled oven. The short term accuracy of the crystal is ±1 part in 10^6 at 25°C and is ±5 parts in 10^6 over the equipment operating temperature range of 0°C to +40°C.

Manual or automatic reset facilities are provided; in the latter case the display time can be varied between 1 and 5sec.

Additional facilities are provided which enable the time elapsing between 'start' and 'stop' signals to be measured in units of time which may be 1μsec, 10μsec, 100μsec, 1msec, 10msec, 100msec, 1sec or 10sec. Random counts may also be totalled and the equipment incorporates a self checking facility which measures the frequency of the internal oscillator during a self generated 10sec period.

Normally, the equipment is operated from 100 to 135V or 200 to 250V mains supplies, but provision is also made for operation from a 6V battery.

On battery operation the crystal oven is inoperative and some deterioration in accuracy may be expected depending upon the ambient temperature; this will be less than ±2·5 parts in 10^7/°C below 55°C.



EE 19 752 *for further details*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

33 Grosvenor Place, London S.W.1

Thermoelectric Recording Hygrometer

The dew point hygrometer which was demonstrated, is one of many instruments in which their moelectric refrigeration may find an application. The refrigerating thermocouple made from p- and n-type bismuth telluride cools a mirror, and when dew forms on this it is detected optically. The optical system operates a control unit which switches the current off when dew forms and on again when it disappears, enabling the instrument to work continuously. The temperature of the mirror is measured by a thermocouple and indicated on a pen recorder.

EE 19 753 *for further details*

Microwave Heating Equipment

The microwave heating equipment which was demonstrated uses a BM6787 continuous wave magnetron generating 2½kW at approximately 900Mc/s. Low loss materials are heated faster and with lower electric stress than with conventional h.f. heaters at low frequencies. The heating may be rapid and uniform throughout the material without the usual heat conduction limitations. The material to be heated, in the shape of blocks, sheets or strips, is passed through a resonant cavity which is arranged to provide a matched load for the magnetron by adjustment of a coupling iris and a tuning plunger, the reflected power being monitored with a directive coupler and detector.

Typical applications include the drying of sheet materials, the pre-heating of plastics, cooking, and the melting of special glasses.

EE 19 754 *for further details*

Digital Differential Analyser

This machine is designed to perform the functions of an electronic analogue computer, and to the operator does not appear very different from such an analogue computer. All the computations are, however, performed digitally. This confers a number of advantages over the analogue machine, chief of which is that it is possible to integrate with respect to variables other than real time. This greatly increases the scope of the machine, for example, non-linear problems can be solved almost as easily as linear problems. The machine was shown as an experimental rig for investigating the problems associated with this method of computation. It is intended to work almost as fast as an analogue machine, i.e. many problems can be tackled in real time. The main stores use magnetic cores. The clock frequency is 2Mc/s.

EE 19 755 *for further details*

1Mc/s Digital Circuits

Circuits have been designed for performing data processing operations at a digit rate of 1Mc/s and at a maximum ambient temperature of 45°C. They use an experimental alloy-junction transistor with an alpha cut-off frequency exceeding 10Mc/s and an experimental aluminium-bonded diode. Complete digital systems can be built using a number of logic units in conjunction with delay-line circulating stores.

Two types of magnetostrictive delay-line store were shown: one has a delay of 100μsec and the other a delay of 1msec. They therefore store 100 and 1 000 binary digits respectively. The lines use Permendur wire to transmit a longitudinal stress wave. The 1msec line has a temperature-compensating device that adjusts the distance between the transducer coils in order to keep the delay time constant to within ±0·1μsec over a temperature range of 20°C.

EE 19 756 *for further details*

BRITISH PHYSICAL LABORATORIES

Radlett, Hertfordshire

Revolution Counter

This instrument is intended as a motor car accessory and has been developed for the accurate measurement of the revolutions per minute of internal combustion engines. Its advantages over the mechanical type being greater accuracy, complete silence at all speeds and simplicity of fitting.

The complete instrument including all electronic components and indicator is housed in a round metal case of 3½in diameter by 2½in deep. The only connexion required being two leads to the battery supply and a single lead which is coiled around the insulated h.t. lead.

Basically the circuit consists of a transistorized monostable oscillator which is triggered by the h.f. pulses from the ignition coil, these pulses are picked up capacitively from the h.t. lead.

The variation of repetition rate of the pulses causes the mark-to-space ratio of the oscillator to change and the resultant level of d.c. is thus proportional to the engine speed. The indicator used is one of the Company's new 270° arc meters.

EE 19 757 *for further details*

Megohmmeter

The megohmmeter model RM160 is a new instrument for the measurement of insulation resistance up to 400MMΩ. The instrument is completely self-contained providing its own variable test pressure up to 500V and a fixed test voltage of 1 000V.

The megohmmeter is capable of determining the one minute insulation resistance of capacitors including polystyrene dielectric capacitors having insulation resistances in excess of 750 000MΩ-μF. A novel feature is a fully automatic delay circuit which computes the charging time of the test sample. After the elapse of the computed delay time the test sample is presented to the measuring circuit.

The instrument has been rendered virtually drift free by using a chopper amplifier. Total range of measurement is 90kΩ to 400MMΩ.

This instrument can be used for carrying out tests on the surface and volume resistivity of insulating soft rubber and ebonite as laid down in BS903, Part 33, 1950. A complete set of equipment in accordance with section 33, 23 of the above specification can be supplied.

EE 19 758 *for further details*

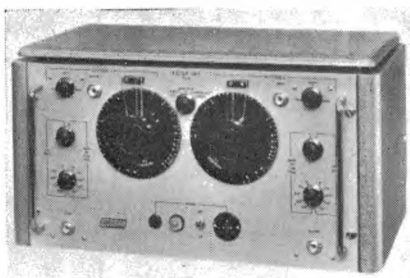
CAWKELL RESEARCH AND ELECTRONICS LTD

Scotts Road, Southall, Middlesex

Variable Filter

(Illustrated below)

This is a new filter with a wide range of facilities. Basically it consists of two basic filters, each of which can be either high-or low-pass, in one case. The −3dB point of each filter section can be varied continuously over the range 2c/s to 150kc/s and each has a cut-off rate of



36dB/octave. By appropriate connexions the following configurations can be achieved.

Band-pass filter with 36dB/octave slopes
Band-stop ,, ,, ,, ,, ,,
Low-pass ,, ,, ,, ,, ,,
High-pass ,, ,, ,, ,, ,,
Low-pass ,, ,, 72dB/ ,, ,,
High-pass ,, ,, ,, ,, ,,

The filter has unity gain and contains no inductive elements. The input impedance is high while the output impedance is low. It is capable of handling high level signals.

The filter was demonstrated in conjunction with a swept-frequency oscillator and a 'Remscope' used in its long-persistence mode of operation.

EE 19 759 *for further details*

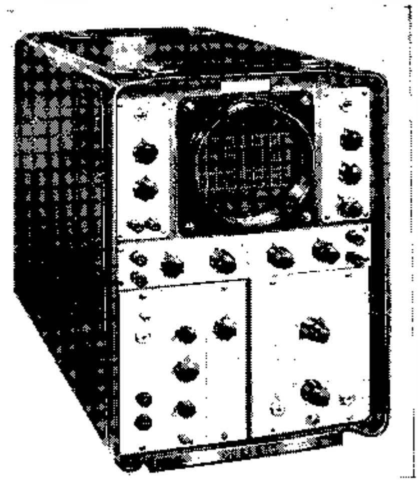
COSSOR INSTRUMENTS LTD

Cossor House, Highbury Grove, London N.5

High Speed Oscilloscope

(Illustrated above right)

The model 1076 high speed single beam oscilloscope employs a 5in tube with an overall accelerating potential of 10kV. Interchangeable plug-in units provide for a very wide performance selection both for the vertical and horizontal



channels. A typical combination of plug-in units provides a Y amplifier bandwidth from d.c. to 60Mc/s at a maximum sensitivity of 50mV/cm with full 6cm output deflexion together with a triggered time-base with a maximum calibrated sweep speed of 20mμsec/cm, ranging down to the lowest sweep of 10sec/cm. A 10cm sweep is obtainable on all ranges and sweep expansion facilities are incorporated. Voltage calibration of the oscilloscope provides an accuracy to ±2 per cent in the measurement range 50mV to 120V, and this range may be extended upwards by the use of suitable attenuating probes. The time-measuring facilities provide an accuracy to ±5 per cent while a gated 500Mc/s oscillator presents intensity modulation pips at 2mμsec intervals to provide accurate measurement of pulse rise times.

All internal e.h.t., h.t. and relevant l.t. voltages are fully stabilized against supply and load variations.

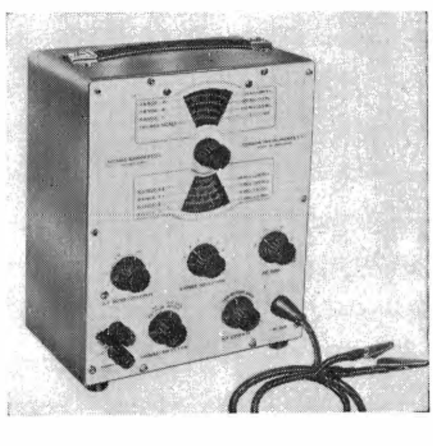
The oscilloscope was displayed using plug-in units, type 1078 wide-band pre-amplifier and type 1079 trigger unit. Other plug-in units to provide extended facilities on both X and Y channels, for example, high-gain differential Y pre-amplifier, precision delayed trigger unit, will be available shortly.

EE 19 760 *for further details*

Signal Generator

(Illustrated below)

The model 1450 is a general-purpose



signal generator which provides an output tunable on seven ranges of frequency with a calibration accuracy to ±1 per cent up to 33Mc/s. On the higher ranges, calibration accuracy is to ±1·5 per cent. The signal is available unmodulated, modulated by the internal audio-frequency oscillator, or externally modulated. The depth of modulation is controllable up to a maximum of 50 per cent when using internal modulation.

EE 19 761 *for further details*

DYNATRON RADIO LTD

Maidenhead, Berkshire

STABILIZED POWER UNIT

(Illustrated below)

The function of the power unit type NN104/5 is to provide a source of stabilized e.h.t. for G.M. tubes and ionization chambers. It is of flexible design and provides one, two or three separately adjustable and stabilized outputs by using N.106 plug-in sub-units. The voltage range covered is 350 to 1700V, and stabilization is effected by corona discharge tubes. Two versions are available, the completely independent mains powered unit N.104 and the N.105 designed to receive its power from scalers such as the Dynatron 1009E.

Another unit shown was the N.103. This is a highly stabilized power unit which will supply the high voltage needed by most types of counters used in nuclear physics, especially scintillation counters and other proportional

counters where extreme stability is required.

The output voltage is continuously variable from 300 to 3300V of either polarity and output currents of up to 1mA are available. The stability is of the order of 0·02 per cent.

EE 19 762 *for further details*

SOIL DENSITY AND MOISTURE MEASUREMENT

To assist in the control of soil compaction, a single-unit portable battery-powered combined density and moisture measuring system has been designed. The density measuring system is composed of a Geiger tube and a source of gamma rays, and may be used with the source on the ground surface or at a suitable depth. The moisture measuring system consists of a BF3 proportional counter and a source of fast neutrons. A sealed 10Mc/s radium-beryllium source supplies high-energy gamma rays and fast neutrons. Both systems are contained in a single box, which also houses a transistorized e.h.t. source and a pre-amplifier. Pulses from the Geiger tube and BF3 tubes are measured by the Dynatron transistor portable scaler, type 1287A.

EE 19 763 *for further details*

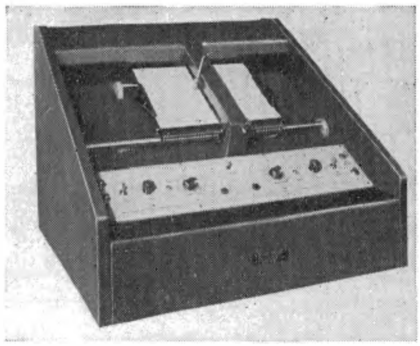
EKCO ELECTRONICS LTD

Southend-on-Sea, Essex

X-Y RECORDER

(Illustrated below)

This high-speed X-Y recorder, type E193, plots the relationship between two



interdependent variables directly on standard 10in by 7½in graph paper. It is unusually versatile in the spheres of process control and performance investigation, due to its wide sensitivity range and fast response. The input impedance is 1MΩ and the sensitivity range on each each axis is 1mV/in to 10V/in in 12 steps.

EE 19 764 *for further details*

ELECTRONIC TUBES LTD

Kingsmead Works, High Wycombe, Buckinghamshire

LOW COST C.R.T.

This 5in tube is under development for applications where low cost together with a large screen diameter are of paramount importance, but where very high performance is not essential. In the interest of cost, all connexions are brought out to the base of the tube; and considerable simplifications of the internal structure have been made. Due to its flat face, the tube gives a presentation equal to that of more expensive devices.

EE 19 765 *for further details*

HIGH SENSITIVITY INSTRUMENT C.R.T.

In cathode-ray tubes employing p.d.a. systems a converging lens is formed by the accelerating fields penetrating the region inside the deflexion plates nearest the fluorescent screen. This effectively limits the permissible p.d.a. ratio. However, greater sensitivities with reduced distortion can be obtained if this field penetration is removed by the introduction of a transmission grid or shield interposed between the deflexion system and the p.d.a. system.

By adjusting the position of this shield with respect to the deflexion system, the fields may be so shaped as to incur deflexion expansion through the p.d.a. system. Thus, a tube may be made having deflexion sensitivities which vary in either direction, or are independent of the p.d.a. ratio.

In the 5CLP1, the X deflexion plates are nearer to the screen than the Y plates. Consequently, no position of the shield will ensure complete independence of both deflexion sensitivities from variations in the p.d.a. ratio. The position chosen maintains a slight decrease in X deflexion sensitivity and a very slight increase in Y deflexion sensitivity as the p.d.a. ratio is raised.

EE 19 766 *for further details*

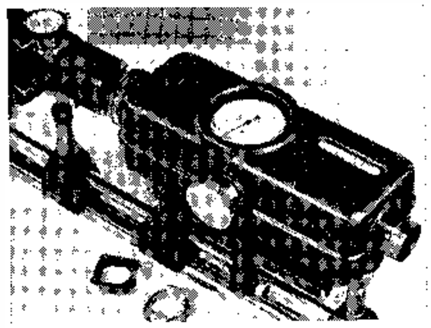
ELLIOTT BROTHERS (LONDON) LTD

Century Works, Lewisham, London S.E.13

SLOTTED SECTION STANDING WAVE METER

(Illustrated below)

The precision slotted section standing wave meter, type B433, is a highly accurate instrument in which the slotted section has been specially designed to have both phase velocity and impedance very close to the nominal value for No. 16 waveguide throughout its length. The carriage carrying the travelling detector is kinematically located on continuously cleaned tracks cut parallel to the waveguide surfaces and the coupling, as the carriage is traversed, remains constant within one or two hundredths of a decibel. There is a micrometer control of coupling to the travelling detector and a hybrid matching transformer enables the probe to be tuned to resonance thus minimizing errors due to its own reflections in the waveguide. A precise and easily read scale and dial gauge enables phase



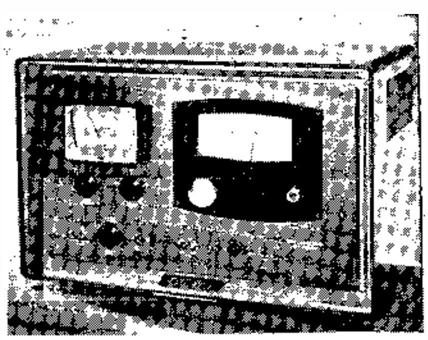
measurements to be carried out to 0·002 radian.

EE 19 767 *for further details*

MICROWAVE TEST OSCILLATOR

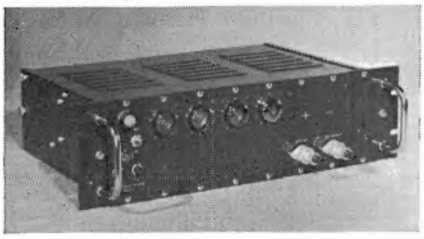
(Illustrated below)

This instrument, type B689, operates over the frequency range 7 to 12Gc/s and consists of a coaxial line cavity designed for use with the plug-in klystron type CV2346 together with stabilized power supplies for operation of the klystron and



a built-in square wave generator providing a signal from 400c/s to 4kc/s for cathode modulation. Provision is also made for external modulation at the cathode or the reflector. The r.f. energy is extracted through a coaxial plug and adequate power output is obtained over a wide band for all normal microwave bench measurements. A direct reading frequency dial on the front panel gives unambiguous indication of the operating frequency.

EE 19 768 *for further details*



ERICSSON TELEPHONES LTD
Beeston, Nottingham

BI-DIRECTIONAL REGISTER

(Illustrated above)

Typical of a range of eight bi-directional counters, the 135A/A2 is designed to accept and count pulses of positive polarity and minimum amplitude 45V from two sources, displaying on Dekatron tubes the arithmetic difference between the two counts, with visible indication as to which channel the displayed count refers. The instrument has a maximum count rate of 100 per second per channel, and a count range of 10^4 on either side of zero.

EE 19 769 *for further details*

UNITIZED NUCLEONIC EQUIPMENT

(Illustrated below)

Developed by E.T.L. from the A.E.R.E. Harwell Type 2000, this range of equipment is built in the form of standard dimensioned units which can be assembled to produce nucleonic counting equipment to suit applications from scintillation counting, to use with ionization chambers and proportional counters.

The complete equipment comprises: a fast pre-scaling unit having a resolution time better than 1μsec and a scaling factor of 10^2; a slow scaling unit having a resolution time of 250μsec and a scaling factor of 10^4; a discriminator providing a discrimination of 200mV fixed and 1 to 10V variable, 2Mc/s amplifier consisting of a cathode-follower, head amplifier, and high- and low-level amplifiers having gains of 150dB and 60dB respectively. The overall hum level for all the amplifiers in cascade is better than 35mV peak-to-peak at maximum gain settings referred

to the input of the cathode-follower. Quench unit giving six switch selected paralysis times between 100 and 600μsec; timing unit; e.h.t. unit providing an output continuously variable from 300 to 2 000V; scintillation head for the detection of alpha, beta, gamma, and x-radiation, as well as fast and slow neutrons; power supply units.

The units plug into shelf units and control shelf units which provide mechanical support and electrical interconnexions.

EE 19 770 *for further details*

FERRANTI LTD
Hollinwood, Lancashire

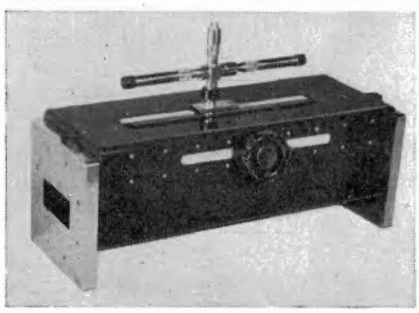
MAGNETIC DRUM

A new magnetic drum known as the type MD5 was shown.

This unit consists of a double drum driven by an externally mounted motor which is interchangeable for speed and power supply. Each drum is 6in high and has a diameter of 14in.

Storage capacity is 160 tracks, each holding 128 words of 50 bits (1 024 000 bits). The drum speed of the unit shown is 2 500rev/min but with certain restrictions the figures for packing density and speed may be increased. The heads are mounted in blocks of 18 (16 in normal use) and each block is removable for cleaning without loss of adjustment. Track width is 0·03in and the head gap 0·002in.

EE 19 771 *for further details*



FLANN MICROWAVE INSTRUMENTS LTD
9 Old Bridge Street, Kingston-on-Thames, Surrey

STANDING WAVE METERS

(Illustrated above)

Included in a comprehensive range of microwave instruments was a range of grade 1 standing wave meters which cover the frequency band from 2·6 to 26·5kMc/s; the one illustrated is the model 10/3 which covers from 2·6 to 3·95kMc/s.

These instruments feature a heavy section waveguide with a matched slot running down the centre of one broad face through which there is coupled a series-parallel tuned variable insertion probe that is supported on a kinematically designed carriage.

The proble tip that passes through the longitudinal slot is surrounded by a fully choked and matched tongue. Complete r.f. symetry is maintained around the centre of the slot and carriage to ensure freedom from spurious resonances.

A dial gauge system displays the distance, in millimetres, between the probe and the terminal flange on all instruments except types 10/3 and 12/3 where vernier scales are used. Around the whole of the system a close fitting dust cover is arranged to give adequate protection to ballraces etc.

The instruments are supplied with a built-in coaxial crystal to give a rectified output and silver and rhodium plate finishes are applied to the waveguide.

EE 19 772 *for further details*

THE GENERAL ELECTRIC CO. LTD
(Research Laboratories)
Wembley, Middlesex

ELECTRON BEAM PARAMETRIC AMPLIFIER

(Illustrated below)

This equipment is designed to amplify weak signals without increasing the noise level in proportion.

When a sound wave passes through a gas the molecules respond in a series of compressions and rarefactions, and the wave travels at a constant velocity, irrespective of frequency. Similarly, when an r.f. signal is applied to a constant d.c. electron beam, it is propagated by a bunching and de-bunching effect among the electrons but in this case as two separate waves, one with a velocity slightly higher, and the other slightly lower, than the electron beam. These are the fast and slow space charge waves.

Until now, all beam type amplifiers (klystrons, travelling-wave tubes etc) have been of the slow space charge wave type, where this wave is amplified as the r.f. signal grows. Noise from the cathode cannot be removed from this wave and will increase with the signal.

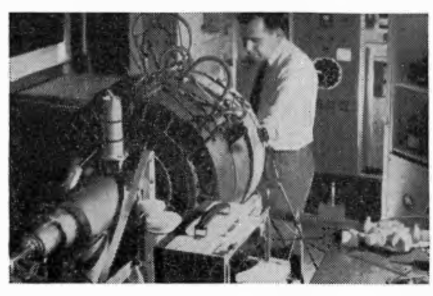
The equipment shown amplifies the fast space charge wave from which the cathode noise can be removed before the signal is applied. Amplification is caused by the interaction between the fields set up by bunching processes at the signal frequency with those of the driver (called the pump) working at twice this frequency.

The demonstration showed the existence in the beam of growing waves caused by this interaction. An electron beam passing through a series of cavities which enabled signals to be applied to it. The output was taken off by a movable cavity which travelled down the beam, monitoring the waves as they progressed. These growing waves were shown on the display equipment.

EE 19 773 *for further details*

DIGITAL DISPLAY TUBE

This cathode-ray type device is used for displaying digital information. The



tube operates on an overall voltage of a few hundred volts, while the switching voltage required is only a few tens of volts.

Advantages of this type of display compared with other devices are the low switching power requirements and the possibility of using the tube in time-sharing circuits.

EE 19 774 *for further details*

MULLARD LTD

Mullard House, Torrington Place, London W.C.1

In addition to a range of commercially available equipment the following research items were exhibited.

Thin Magnetic Films

This exhibit showed something of the Laboratories' investigations into the properties of very thin magnetic films (of the order of 1000Å thick), which appear to have considerable potentialities as fast bistable memory elements for computers.

A thin nickel-iron film evaporated in a uniform magnetic field exhibits uniaxial anisotropy. When influenced by a magnetic field perpendicular to the anisotropy axis and weaker than the anisotropy field, the magnetic vector has two possible stable states. This allows information to be stored in binary form. Transition between the two states, under the influence of a drive field parallel to the anisotropy axis, may be accomplished in tens of millimicroseconds.

Such elements may afford faster switching than conventional magnetic cores, and they may also prove cheaper.

A matrix configuration of 64 thin-film elements was shown, and a demonstration illustrated the behaviour of an element in the matrix. A second demonstration featured apparatus for measuring the fundamental characteristics of the elements.

EE 19 775 *for further details*

Submicrosecond Magnetic Matrix Store

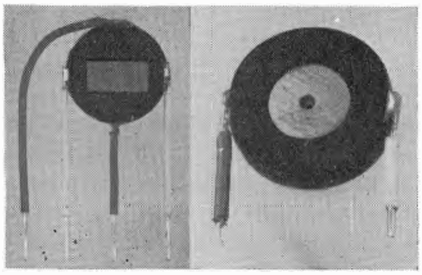
Investigations into high-speed computer techniques have led to the development of a magnetic matrix store that can be switched by pulses of only 0·1μsec duration, and has a read/write cycle time of less than 1μsec.

The system, the principle of which was demonstrated at last year's exhibition, uses two cores for each digit stored. During the writing operation both cores are driven from one remanent state towards the other with a short duration (about 0·1μsec) current pulse which only partly switches the cores. At the same time, a digit pulse of much smaller amplitude is applied to the two cores in such a direction that it aids the 'write' pulse in one core and opposes it in the other. Thus one core will switch further than the other during the 'write' pulse.

To read information from the cores they are both returned to their original state by a 'read' pulse applied in the opposite direction to the 'write' pulse. The core which had switched further will now provide a larger signal on an output wire which threads the cores in series opposition. Thus the difference of the two outputs appears on this wire and the sign of this signal will indicate the polarity of the digit pulse applied during the 'write' process. One polarity of this pulse can be used to indicate a '1' and the other a '0'. The small amplitude of the digit pulse enables the digit wire to pass through other unaddressed words without disturbing them.

Part of a 1 024 word ferrite core store using this principle was demonstrated.

EE 19 776 *for further details*



G.V. PLANER LTD

Windmill Road, Sunbury-on-Thames, Middlesex

Magneto-Sensitive Elements

(Illustrated above)

Indium antimonide and indium arsenide Hall elements were shown, utilizing extremely thin semiconductor sections (0·0003in) and hence allowing a minimum gap in the controlling magnetic circuit. The units are of rugged construction, the sensitive element with attached low-loss pole pieces being encapsulated in a high temperature resin. As a result of the thin semiconductor sections used relatively high resistance values can be produced, and Hall voltages of up to 4V are obtained in the case of intrinsic indium antimonide, or correspondingly higher values for the

p-type or indium arsenide. The units can withstand temperatures of up to 200°C.

The use of these elements in multiplier circuits was demonstrated. Among other applications are amplifier and oscillator circuits.

New types of indium antimonide magneto-sensitive Corbino resistors were also shown. These allow increased power dissipation and are likewise of rugged construction; the sensitive element and high permeability pole pieces, arranged to serve as field concentrators, are again encapsulated in high temperature resin. The resistance of these units increases by a factor of 20 in response to a field of 10 000 gauss.

(This development was carried out in conjunction with Cosmocord Ltd. Patents pending.)

In the illustration an InSb Hall element is shown on the left and an InSb Corbino resistor on the right.

EE 19 777 *for further details*

Oxide Coated Glass Fibre

(Illustrated below left)

A machine for the continuous deposition of conducting oxide film on glass fibre for use in electrical resistors was shown. The machine comprises precision gear for the advancement of the fibre through the coating furnace into which the oxide-forming mixture is injected. Fine control over the resistance value is effected by automatic regulation of the fibre speed with the use of probes to monitor the resistance at the exit of the furnace.

The coated fibre, normally of 1 mil diameter, is wound on to glass or ceramic formers to make up high value resistors, and experimental samples of such units were shown.

Among the advantages of the system are the high ohmic values per unit volume attainable, the resistance currently used ranging up to several megohms per inch of fibre, as well as the stability and inertness of oxide films on glass base in general. As in other oxide film resistors, the temperature coefficient of resistance can be held to low limits by appropriate correlation of film thickness and oxide composition. (Patents pending.)

EE 19 778 *for further details*

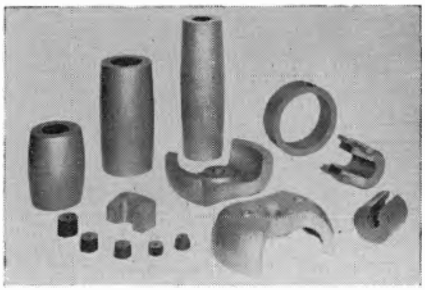
THE PLESSEY CO. LTD

Vicarage Lane, Ilford, Essex

Cast Permanent Magnets

(Illustrated on next page)

Magloy magnets are available for a wide variety of applications, especially in the microwave field, i.e. for magnetrons, klystrons, carcinotrons, radar isolators, masers and travelling-wave amplifiers. The magnets can be supplied with a jacket made from a synthetic material or with an aluminium die-cast housing which facilitates the rapid assembly of packaged valves. The aluminium jacket can readily be machined to close dimensional tolerances in accordance with design requirements. Most magnets in this class are made from



Magloy 1 which has a BH_{max} of $5{\cdot}2 \times 10^6$ gauss-oersteds, but several other alloys are also available. This high energy product is attainable even in large castings due to the development of new manufacturing techniques.

The magnets are also used for loudspeakers, moving-coil instruments, meters and applications in nuclear magnetic resonance, mass spectrography and similar fields.

EE 19 779 *for further details*

W. G. PYE & CO. LTD

Granta Works, Cambridge

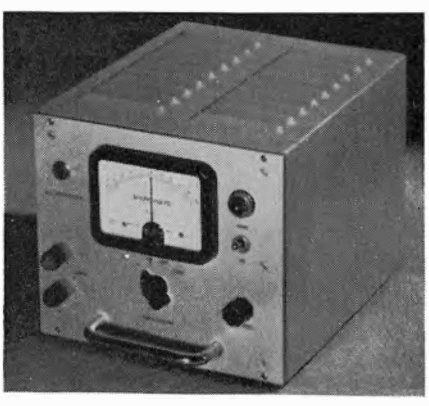
D.C AMPLIFIER

(Illustrated below)

This instrument is designed as a reliable low-level amplifier for industrial or laboratory measurement and the recording of small voltage signals such as those produced by thermocouples or thermopiles.

The use of a reliable contact modulator, with amplification of the alternating carrier and employing a phase sensitive sampling circuit and overall negative feedback, gives excellent stability of gain and a very low order of drift. Bearing in mind the shortcomings of the majority of modulator amplifiers using the power supply frequency as a carrier, the instrument has been designed to operate without either terminal grounded under all normal conditions, this performance being achieved by incorporation of filter circuits to reduce the effect of supply frequency components in the input circuit.

Full scale signals of $\pm 100\mu$V, ± 1mV, ± 10mV and ± 100mV on its four ranges give outputs of ± 10V at currents up to 5mA. Drift after warm-up does not exceed $\pm 1\mu$V. Linearity is better than to $\pm 0{\cdot}5$ per cent. Input resistance is $3{\cdot}5$kΩ.



EE 19 780 *for further details*

ROYSTON INSTRUMENTS LTD

Hanworth Lane, Chertsey, Surrey

ROTATING MACHINERY NOISE ANALYSER

This instrument was originally developed to carry out routine testing of automobile gear boxes for noise arising from gear meshing at the various gear speeds, over a wide range of input shaft speeds. There is a choice of two fixed bandwidths and the tuning of the analyser is automatically adjusted to suit the input shaft speed. In addition to a noise or vibration transducer, the only accessories required are the series of toothed wheels with a magnetic pick-up, the toothed wheels being mounted upon the drive shaft. The number of teeth on each wheel is chosen to suit the various gear meshes and the frequency of the signal derived from the magnetic pick-up sets the tuning frequency of the analyser. The pass band is rectangular in shape and there is a rejection of over 50dB of signals outside the pass band and the analyser will operate over a frequency range from 2c/s to 20kc/s. The analyser may also be operated as a conventional wide range, high accuracy wave analyser by feeding in the output from a normal laboratory oscillator instead of the output from the magnetic toothed wheel generator.

EE 19 781 *for further details*

SERVOMEX CONTROLS LTD

Crowborough, Sussex

TRANSFER FUNCTION ANALYSER

This equipment is the prototype of a comprehensive instrument for determining the dynamic frequency response of servo-mechanisms and automatic control systems.

Rotating synchros generate the sine wave and multiply the measured signal by the fundamental frequency component. The multiplier synchro produces two outputs, one of which is proportional to the real part, and the other the imaginary part of the measured signal.

Special integrator circuits integrate each output over a period of one cycle of the fundamental frequency. This eliminates the effect of cyclic components, i.e. harmonics and the effect of uncorrelated signals of high frequency relative to the fundamental.

The output of each integrator is sampled at the end of each complete cycle and held until the end of the next cycle when a fresh sample is taken. Thus, a steady measurement can be made one cycle period after the system under test has settled down.

The drive for the rotating synchros is a motor with servo speed control. The controls for this are calibrated in time period or frequency depending on the range selection. A direct mechanical output with a small torque is available at the fundamental frequency.

Electrical sine wave outputs at fundamental freqnency or fundamental frequency imposed on carrier are supplied. When a carrier frequency system is tested, the analyser uses the local carrier supply.

For measurement, the instrument accepts electrical signals at fundamental frequency or on carrier over a wide amplitude range. Input impedance is high, enabling transducers of many types to be used.

The frequency range is sufficient to cover the analysis of all systems from chemical processes with long response times to high speed electromechanical servos.

The phase reading is accurate to $\pm 1°$ and amplitude reading to ± 2 per cent.

EE 19 782 *for further details*

THE SOLARTRON ELECTRONIC GROUP LTD

45 Thames Street, Kingston-on-Thames, Surrey

DOUBLE BEAM OSCILLOSCOPE

(Illustrated below)

The CD.1014 is a high performance, portable double beam oscilloscope utilizing the latest ETEL 3½in diameter flat faced double gun tube and weighing only 22lb.

The two vertical deflexion amplifiers employ identical circuits, each channel having a bandwith in excess of d.c. to 5Mc/s(-3dB) at a maximum sensitivity of 100mV/cm. Calibrated attenuators enable the sensitivity to be reduced to 100V/cm, while a built-in a.c. coupled pre-amplifier can be used to increase the sensitivity to 1mV/cm with a bandwidth from $2{\cdot}5$c/s to 50kc/s. The sensitivity is thus continuously variable from 1mV/cm to 100V/cm.

A highly linear time-base generator provides sweep speeds continuously variable from 1μsec/cm to 1sec/cm and an additional calibrated expansion of up to 10 times is available.

The accuracy of both time and amplitude measurement is ± 5 per cent or better. A ± 1 per cent calibrating waveform enables even higher accuracies to be obtained.

Synchronization and triggering may be effected internally or from external waveforms. 'Trigger level' control enables the time-base to be triggered from a selected point of the waveform. This useful facility, together with d.c. coupled bright-up and stabilized e.h.t. supplies ensures a stable and well defined trace.

The provision of an isolated 'signal low' enables signals to be displayed relative to any d.c. potential up to 500V.

EE 19 783 *for further details*

STABILIZED AMPLITUDE SIGNAL GENERATOR

(Illustrated above)

When operated into a properly matched load the D0905 produces a constant amplitude sine wave output throughout its frequency range of 350kc/s to 50Mc/s.

The output amplitude is continuously variable from 40mV to 10V peak-to-peak in seven ranges. The amplitude indicated on the 0 to 10V scale of the meter is the peak-to-peak voltage at the input to the attenuator head. Indication is accurate within 10 per cent of full scale.

When the meter indication is in the 'constant amplitude' region, and the load resistance is not less than 1kΩ, with load shunt capacitance of less than 10pF, the variation of the attenuator-output amplitude (as frequency is varied) is less than ±2 per cent at 50kc/s and from 350kc/s to 30Mc/s; less than ±5 per cent from 30Mc/s to 50Mc/s.

EE 19 784 *for further details*

TEXAS INSTRUMENTS LTD

Dallas Road, Bedford

INFRA-RED DETECTOR

The M-1000 infra-red detector is of the photovoltaic type and requires no bias current. The sensitive material is a diffused junction indium antimonide wafer and it can be used in the 2 to 5 micron range. The nominal optical operating temperature of the detector is −196°C (liquid nitrogen) and it can be supplied with any desired active area up to 1cm² maximum. The small signal a.c. cell impedance is 100 to 1 000Ω, with a time-constant less than 1µsec. Noise equivalent power is dependent on area, a typical figure measured under U.S. Naval Ordnance Laboratory, Corona test conditions (500°K, 90c/s, $\Delta f = 5$c/s) being 4×10^{-10}W for areas of 4mm². The noise voltage is less than 10^{-8}V (90c/s. 5c/s bandwidth) and apparently varies inversely as f^3.

EE 19 785 *for further details*

MICROMINIATURE SEMICONDUCTOR SOLID CIRCUITS

Microminiature semiconductor solid circuits are formed by the selection and shaping of conduction paths upon and through a semiconductor wafer. They represent a very close approach to the ultimate reduction in the size of electronic equipment and give equivalent component densities ranging from 5 000 000 to 50 000 000 per cubic foot. One example shown was a multivibrator circuit measuring about ¼ by ⅛ by 1/32in with a performance identical to that of a conventional circuit containing eight resistors, two capacitors and two transistors, representing an equivalent component density of 30 000 000 parts per cubic foot.

In the semiconductor solid circuits, resistors are formed by the bulk resistance of the semiconductor material, capacitors by utilizing the capacitance-forming techniques, and transistors and diodes by diffusion methods. The performance of semiconductor solid circuits is similar to conventional circuits using diffused-base devices.

EE 19 786 *for further details*

UNICAM INSTRUMENTS LTD

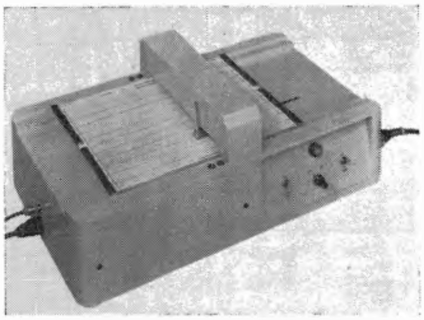
Arbury Works, Cambridge

FLAT BED RECORDER

(Illustrated below)

Designed primarily for spectroscopic purposes this recorder is expected to find general application in any discontinuous process with definite start and stop points.

Presentation is on a flat chart 30cm by 20cm which is driven past the pen carriage. Linear or logarithmic recording is selected by simple switch with 0 to 10mV full scale linear and 0 to 200mV full scale logarithmic recording. Response time is nominally 0·7sec full scale. Chart



drive is through a magnetic clutch from a synchronous motor connected to a gear chain giving speed ratios of 1 : 1, 2 : 1 and 4 : 1.

The recorder may be operated from a synchronous input (e.g. spectrometer slave recorder) or as a normal independent function recorder.

EE 19 787 *for further details*

VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

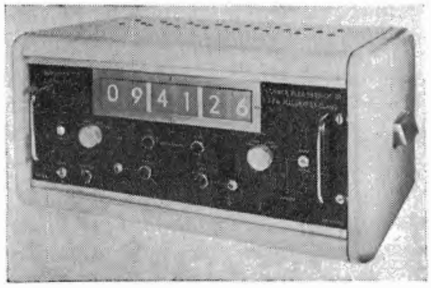
TRANSISTORIZED DIGITAL CLOCK

(Illustrated above right)

The TSA88 is basically a crystal clock, which has been designed to provide visible indication, by means of in-line indicators, of time in seconds, minutes and hours.

In data logging it is often desirable to record the time at which results of processes are obtained. The TSA88 provides this facility. Both the time and the data may be recorded by the transistorized printer type TSA65 or the reperforator control unit type TSA101 when associated with the digital clock.

Delay of a 'Print Command Signal' is provided from 0·2sec before to 0·01sec after the clock is ready to change its indication of the time. This ensures that the correct time is always recorded.



During this delay period a 'Hold' signal is available for feeding to the data measuring unit. This in conjunction with the 'Hold' signal of the 'print-out' device prevents the data measuring equipment from resetting during the print cycle.

Changeover contact operation by an internal relay is provided, and may be arranged to operate every second, every minute, or every hour.

After resetting the TSA88 to zero, the time may be re-established by depression of a 'Rapid' push-button, and to greater accuracy by depression of a 'Slow' push-button. This resets the in-line indicators in hours, minutes and seconds to the desired setting.

Turning the 'Setting up' switch to 'Standby' renders the TSA88 ready for operation. No further timing pulses are present at the 'Rapid' or 'Slow' push-buttons.

The instrument may be started locally or remotely, or by positive pulses from one or two sources.

EE 19 788 *for further details*

THE WAYNE KERR LABORATORIES LTD

Sycamore Grove, New Malden, Surrey

TRANSFER FUNCTION COMPUTER

The accepted method of determining the transfer function of communication and control systems has, up to the present time, been the measurement of amplitude and phase of the system as a function of frequency. This procedure does not provide information of the transfer function directly but in general it is possible to obtain an approximate expression by lengthy and tedious calculations.

A basically new approach to the problem has been devised by Wayne Kerr in which the actual coefficients in the transfer function are measured. Direct readings are presented on completion of a straightforward operating procedure lasting a matter of minutes. Provision is made for obtaining the roots of the transfer function, from which a root locus diagram can readily be constructed.

These facilities enable the effects of design changes on servo-controlled equipments to be analysed without the need for complex and lengthy calculations. Thus, the stability margin of a system can quickly be determined and in the case of an unstable system the causes of instability can readily be localized.

The instrument is demonstrated computing the coefficients in the transfer function of a known passive network.

EE 19 789 *for further details*

MEETINGS THIS MONTH

THE BRITISH COMPUTER SOCIETY LIMITED

Glasgow Branch
Date: 7 March. Time: 6.45 p.m.
Held at: Royal College of Science & Technology, Glasgow.
Lecture: Use of Computers in Operations Research.
By: Dr. K. D. Tocher.

Leeds Branch
Date: 2 March. Time: 6.30 p.m.
Held at University Computing Laboratory, Eldon Hall, Woodhouse Lane, Leeds.
Lecture: Application of a Computer to the Determination of Least Cost Mixes in the Animal Feeding Industry.
By: E. Reed.

Leicester Branch
Date: 17 March. Time: 7 p.m.
Held at: Room 104, Leicester College of Technology.
Lecture: Data Processing in Local Government.
By: J. E. Tinker.

Manchester Branch
Date: 3 March. Time: 7 p.m.
Held at: College of Science and Technology, Sackville Street, Manchester.
Lecture: The Royal Army Pay Corps Computer Application.
By: Lt. Col. L. D. Slater.

Middlesbrough Branch
Date: 7 March. Time: 7.30 p.m.
Held at: Constantine Technical College, Borough Road, Middlesbrough.
Lecture: The Computer and Monte Carlo Methods.
By: M. I. Musk.

South Wales & Monmouthshire
Date: 24 March. Time: 6.30 p.m.
Held at: Small Shanlon Lecture Theatre, University College, Cardiff.
Lecture: Interesting Cases of Linear Programming.
By: C. M. Berners-Lee.

THE BRITISH INSTITUTION OF RADIO ENGINEERS

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

Computer Group
Date: 3 March.
Lecture: Time Sharing in On-Line Computer Applications.
By: A. St. Johnston.

Medical Electronics Group
Date: 24 March.
Lecture: The Continuous Recording of Heart Activity.
By: Dr. I. Boyd and W. R. Eadie.

Radar Group
Date: 14 March.
Discussion: Short Range Navigational Aids.

North Western Section
Date: 3 March. Time: 6.30 p.m.
Held at: Reynolds Hall, College of Technology, Sackville Street, Manchester 1.
Lecture: Electronics in Oceanography.
By: M. J. Tucker.

Scottish Section
Date: 24 March. Time: 7 p.m.
Held at: Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow.
Lecture: Radio Guidance in the Automatic Landing of Aircraft.
By: J. Shayler.
Date: 25 March. Time: 7 p.m.
Held at: Department of Natural Philosophy, The University, Drummond Street, Edinburgh.
Repeat of above lecture.

South Midlands Section
Date: 4 March. Time: 7 p.m.
Held at: North Gloucestershire Technical College, Cheltenham.
Lecture: The Use of Radio Aids in the Control of Modern Transport Aircraft.
By: K. Fearnside.
Date: 29 March. Time: 7 p.m.
Held at: Winter Gardens, Malvern.
Lecture: Microwave Propagation—Some Characteristics and Curiosities.
By: M. W. Gough.

South Wales Section
Date: 16 March. Time: 6.30 p.m.
Held at: Welsh College of Advanced Technology, Cardiff.
Lecture: Recent Developments in Printed and Potted Circuits.
By: H. G. Manfield.

South Western Section
Date: 30 March. Time: 7 p.m.
Held at: School of Management, Unity Street, Bristol 1.
Lecture: Training for Operating and Maintaining Television Broadcasting Equipment.
By: K. R. Sturley and A. E. Robertson.

West Midlands Section
Date: 8 March. Time: 7.15 p.m.
Held at: Matthew Boulton Technical College, Birmingham.
Lecture: Transistor Power Amplifiers.
By: F. Butler.

THE INSTITUTE OF PHYSICS

Electronics Group
Date: 22 March. Time: 5.30 p.m.
Held at: The Institute of Physics, 47 Belgrave Square, London S.W.1.
Annual General Meeting of the Group followed by lecture: Neutron Sources.
By: P. O. Hawkins.

THE INSTITUTION OF ELECTRICAL ENGINEERS

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

Electronics and Communications Section
Date: 7 March.
Lecture: An Introduction to the Theory of Masers with Particular Reference to the Travelling-Wave Maser.
By: P. N. Butcher.
Date: 23 March.
Lecture: The Challenge of the Propagation Medium to the Radio Engineer.
By: G. Millington.

Measurement and Control Section
Date: 1 March.
Lecture: Digital Computer Developments at Manchester University.
By: T. Kilburn.
Supported by the following papers: A Digital Computer Store with Very Short Read Time.
By: T. Kilburn and R. L. Grimsdale.
High-Speed Light Output Signals from Electroluminescent Storage Systems.
By: G. R. Hoffman, D. H. Smith and D. C. Jeffreys.
Ferrite Magnetic Core Memory Systems with Rapid Cycle Times.
By: D. B. G. Edwards, M. J. Lanigan and T. Kilburn.

East Anglian Sub-Centre
Date: 14 March. Time: 6.30 p.m.
Held at: Electric House, Ipswich.
Lecture: Some Engineering Aspects of Automatic Control.
By: S. H. Dale.

Irish Branch
Date: 10 March. Time: 6 p.m.
Held at: Physical Laboratory, Trinity College, Dublin.
Lecture: Aviation Communications and Navigational Systems.
By: G. E. Enright and G. Jones.

Mersey and North Wales Centre
Date: 10 March. Time: 6.45 p.m.
Held at: Philharmonic Hall, Liverpool.
Lecture: Electrical Machines.
By: Professor M. G. Say.

North-Eastern Measurement and Electronics Group
Date: 14 March. Time: 6.15 p.m.
Held at: Rutherford College of Technology, Newcastle-on-Tyne.
Discussion: Component Reliability.

North Midland Centre
Date: 1 March. Time: 6.30 p.m.
Held at: Leeds and County Conservative Club, South Parade, Leeds 1.
Lecture: The Transmission of News Film over the Trans-Atlantic Cable.
By: C. B. B. Wood and I. J. Shelley.
Date: 16 March. Time: 7 p.m.
Held at: Co-operative Hall, Barnsley.
Joint Meeting with the Sheffield Sub-Centre.
Lecture: The Reliability and Life of Impregnated-Paper Capacitors.
By: J. P. Pitts.
Date: 29 March. Time: 6.15 p.m.
Held at: Headquarters Mess, School of Signals, Catterick Camp.
Lecture: Progress on Problems in Ionospheric Propagation during the International Geophysical Year.
By: W. R. Piggott.
Date: 31 March. Time: 6.30 p.m.
Held at: Y.E.B. Offices, Ferensway, Hull.
Lecture: Recent Developments in Colour Television.
By: I. J. P. James.

(Pages 185 to 200 French and German section)

North-Western Electronics and Communications Group
Date: 16 March. Time: 6.15 p.m.
Held at: Engineers' Club, Albert Square, Manchester.
Lecture: Data Processing.
By: J. C. Gladman.

Oxford Branch
Date: 9 March. Time: 7 p.m.
Held at: Southern Electricity Board Service Centre, 37 George Street, Oxford.
Lecture: Automation of the National Telephone System.
By: H. E. Francis.

Southern Centre
Date: 3 March. Time: 6.30 p.m.
Held at: South Dorset Technical College, Weymouth.
Lecture: Nuclear Magnetism.
By: J. E. Wood.
Date: 9 March. Time: 6.30 p.m.
Held at: S.E.B. Showrooms, Salisbury.
Lecture: The Transmission of News Film over the Trans-Atlantic Cable.
By: C. B. B. Wood and I. J. Shelley.
Date: 16 March. Time: 6.30 p.m.
Held at: Brighton Technical College.
Lecture: Television Recording: A Survey of the Problems and the Methods Currently in Use.
By: J. Redmond.

South Midland Centre
Date: 7 March. Time: 7.30 p.m.
Held at: Winter Gardens, Malvern.
Lecture: Masers.
By: M. H. Oliver.
Date: 15 March. Time: 6 p.m.
Held at: College of Technology, Gosta Green.
Discussion: The Teaching of Magnetic Amplifier Theory.
Opened by: K. C. Parton.

THE JUNIOR INSTITUTION OF ENGINEERS

North Western Section
Date: 22 March. Time: 7 p.m.
Held at: Engineers' Club, Albert Square, Manchester.
Presidential Address: The Engineer's Role in Nuclear Power.
By: Professor J. M. Kay.

Sheffield Section
Date: 14 March. Time: 7.30 p.m.
Held at: Livesey Clegg House, 44 Union Street, Sheffield 1.
Paper: Electrostatic Precipitators.
By: B. J. Duncan.
Date: 21 March. Time: 7.30 p.m.
Held at: Royal Victoria Hotel, Sheffield.
Presidential Address: The Engineer's Role in Nuclear Power.
By: Professor J. M. Kay.

THE RADAR AND ELECTRONICS ASSOCIATION

Date: 28 March. Time: 7.30 p.m.
Held at: Royal Society of Arts, John Adam Street, Adelphi, London W.C.2.
Lecture: Computers—Some Design Problems of Large Scale Computers.
By: P. D. Hall.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

Date: 16 March. Time: 7 p.m.
Held at: Manson House, 26 Portland Place, London W.1.
Lecture: The Simulation of a Large Chemical Plant on an Electronic Analogue Computer.
By: A. H. Doveton and K. C. W. Pedder.
Date: 29 March. Time: 7 p.m.
Held: As above.
Lecture: Application of Transistors in Instrumentation.
By: G. G. Bloodworth.

THE TELEVISION SOCIETY

All meetings will be held at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London W.C.2, commencing at 7 p.m.
Date: 11 March.
Lecture: Television Receiver Production: Modern Manufacturing Techniques and Maintenance of Quality.
By: S. T. Palmer.
Date: 24 March.
Lecture: Operating a Commercial Television Station in U.S.A.
By: J. H. Battison.

Une description, basée sur des renseignements fournis par les fabricants, d'un choix de matériels électroniques exposés au 44ème Salon de la Physical Society, tenu à Londres du 18 au 22 janvier 1960.

(Traduction des pages 177 à 183)

ADVANCE COMPONENTS LTD

Roebuck Road, Hainault, Ilford, Essex

Générateur de Fonctions F.T.B.

(Illustration à la page 177)

Le générateur de fonctions à fréquences très basses Advance a été conçu pour produire n'importe quelle fonction ou forme d'onde dans la gamme de fréquences de 0·01 Hz à 100 Hz, dans quatre bandes. Il trouve donc des applications dans la construction et le fonctionnement des calculateurs pour l'analyse des servo-systèmes, le contrôle des enregistreurs à plume, les vibromètres et de nombreux types d'appareils simulateurs.

Le système de production de formes d'ondes de ce générateur diffère de celui des oscillateurs conventionnels en ce qu'il utilise un procédé optico-mécanique se caractérisant par le balayage d'une étroite fente lumineuse au moyen d'un disque tournant sur lequel se trouve imprimée une surface opaque correspondant à la fonction devant être produite. Le disque tournant est facilement interchangeable avec des disques sur lesquels diverses autres formes d'ondes sont façonnées. L'usager dispose donc d'un appareil d'une grande souplesse et il suffit de pouvoir faire le tracé d'une fonction en coordonnées polaires pour qu'elle puisse être utilisable sous forme de tensions variées.

Les disques sont actionnés, au moyen d'une boîte à quatre vitesses, par un servomoteur, afin d'assurer la précision et la stabilité de la fréquence. Il y a également un dispositif pour le balayage automatique des deux gammes de fréquences supérieures, s'il y a lieu, comme, par exemple, pour le contrôle des vibrations.

L'accélération dans les deux bandes inférieures est suffisamment élevée pour pouvoir déclencher une forme d'onde en n'importe quel point prédéterminé. La circonférence du disque est étalonnée en degrés à cet effet.

La tension directe aux bornes de sortie peut être réglée à n'importe quelle valeur située entre ±25V par rapport à la masse, permettant de produire toutes les fonctions avec la composante Oc.c. ou n'importe quelle valeur se trouvant entre ces limites. On peut faire varier la tension de sortie de la forme d'onde entre 200μV et 20V de crête à crête.

EE 19 751 *pour plus amples renseignements*

Appareil de Mesure et Compteur

(Illustration à la page 177)

L'appareil de mesure et compteur ADVANCE est un matériel portatif entièrement transistorisé, à circuits imprimés. Six compteurs de type tambour affichent les comptages jusqu'à un maximum de 999 999. Des fréquences allant jusqu'à 1 MHz peuvent être mesurées pendant une période de temps précise, produite par un oscillateur intérieur de 1 MHz piloté par quartz, de un dixième de seconde, une seconde ou dix secondes.

Des lectures plus précises peuvent être effectuées pour des fréquences inférieures à 1 kHz en mesurant la période de temps en unités de 1 μsec, entre deux parcours zéro du signal d'entrée, ou une période. On peut même atteindre une précision encore plus grande en mesurant les périodes.

La précision de la lecture dépend en partie du compteur qui enregistre avec précision jusqu'à ±1 coup près, et en partie de l'oscillateur intérieur, dont le cristal piézoélectrique est contenu dans un four à thermostat. La précision à court terme du cristal est de ±1 partie sur 10^6 à 25°C, et elle est de ±5 parties sur 10^6 dans la gamme de températures de service allant de 0°C à + 40°C.

L'appareil est muni de dispositifs de réenclenchement manuel ou automatique. Dans ce dernier cas, on peut faire varier la durée de l'affichage de 1 à 5 sec.

On peut également, grâce à d'autres dispositifs, mesurer le temps s'écoulant entre les signaux "marche" et "arrêt" en unités de temps de 1μsec, 10μsec, 100μsec, 1msec, 100msec, 1sec ou 10sec. Des comptages effectués au hasard peuvent être totalisés et l'équipement comprend un dispositif d'auto-vérification qui mesure la fréquence de l'oscillateur interne durant une période autoproduite de 10 secondes.

L'équipement est ordinairement appelé au fonctionnement sur courant secteur de 100 à 135V ou de 200 à 250V, mais on peut aussi l'utiliser sur pile de 6V. Dans ce dernier cas, cependant, le four piézoélectrique demeure inopérant et il faut s'attendre à une légère dégradation de la précision, dépendant de la température ambiante. Cette dernière est, toutefois, inférieure à ±2,5 parties dans 10^7°C sous 55°C.

EE 19 752 *pour plus amples renseignements*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

33 Grosvenor Place, London S.W.1

Hygromètre Enregistreur Thermoélectrique

L'hygromètre à point de rosée qui a été exposé au Salon de cette année est l'un des nombreux appareils où la réfrigération thermo-électrique peut trouver une application. Le thermocouple réfrigérant, fait en bismuth tellurique de type p- et n-, refroidit un miroir, et lorsque la rosée se forme sur ce dernier, elle est décelée optiquement. Le système optique actionne un élément de commande qui coupe le courant lorsque la rosée se forme et le branche à nouveau lorsqu'elle disparaît, assurant ainsi le fonctionnement continu de l'instrument. La température du miroir est mesurée par un thermocouple et elle est indiquée sur un enregistreur à plume.

EE 19 753 *pour plus amples renseignements*

Equipement de Chauffage pour Hyperfréquences

Cet équipement de chauffage pour hyperfréquences utilise un magnétron BM6787 à ondes entretenues, produisant 2,5 kW à environ 900 MHz. Les matériaux à faibles pertes sont chauffés plus rapidement et avec un moindre effort électrique qu'avec des réchauffeurs h.f. conventionnels aux basses fréquences. Le chauffage peut s'effectuer rapidement et uniformément à travers le matériau sans les restrictions habituelles de conduite de chaleur. On fait passer le matériau devant être chauffé, sous forme de blocs, feuilles ou bandes, par une cavité sonore prévuepour fournir une charge équilibrée au magnétron, par le réglage d'un diaphragme de couplage et d'un plongeur d'accord, la puissance réfléchie étant contrôlée par un coupleur directif et un détecteur.

Les applications typiques de cet instrument comportent le séchage des matériaux en feuilles, le pré-chauffage des plastiques, la cuisine, et la fusion de verres spéciaux.

EE 19 754 *pour plus amples renseignements*

Analyseur Différentiel Numéral

Cette machine a été conçue pour remplir le rôle d'un calculateur analogique électronique et elle ne paraît, en effet, à l'opérateur que peu différente d'un calculateur analogique. Tous les calculs sont, cependant, effectués numériquement. Ceci lui confère un nombre d'avantages par rapport au calculateur à analogie, le principal étant la possibilité d'intégration quant aux variables autres que le temps réel. Ceci augmente considérablement le champ d'action de la machine: des problèmes non-linéaires peuvent, par exemple, être traduits aussi facilement que des problèmes linéaires. Cette machine a été exposée en tant qu'équipement expérimental pour l'étude des problèmes se rapportant à cette méthode de calcul. Elle a été prévue pour fonctionner presqu'aussi vite qu'une machine analogique, c'est à dire qu'elle est en mesure de résoudre plusieurs problèmes dans le temps réel. Les mémoires principales sont à noyaux magnétiques. La fréquence pour les impulsions de référence de temps est de 2 MHz.

EE 19 755 *pour plus amples renseignements*

Circuits Numériques de 1 MHz

Ces circuits sont prévus pour les opérations de dépouillement de données à un taux numérique de 1 MHz et à une température ambiante maxima de 45° C. Ils mettent en oeuvre un transistor expérimental à jonction en alliage avec une fréquence de coupure alpha dépassant 10 MHz et une diode expérimentale à liaison d'aluminium. Des systèmes numériques complets peuvent être construits en utilisant un nombre d'éléments logiques conjointement avec des matrices à mémoire circulantes à lignes à retard.

Deux modèles de matrices à mémoire à lignes à retard magnétostrictives ont été exposés, l'un ayant un retard de 100 μsec et l'autre de 1 msec. Ils peuvent donc stocker 100 et 1000 signes binaires respectivement. Leg lignes en fil Permendur transmettent des ondes d'efforts longitudinaux. La ligne de 1 msec est munie d'un dispositif de compensation de température qui règle la distance entre les bobines transductrices de manière à maintenir la ligne à retard constante à ± 0,1 μsec près, dans une gamme de températures de 20°C.

EE 19 756 *pour plus amples renseignements*

BRITISH PHYSICAL LABORATORIES

Radlett, Hertfordshire

Tachymètre

Il s'agit-là d'un accessoire d'automobile adapté à la mesure précise des révolutions par minute des moteurs à combustion interne. Ses avantages par rapport au modèle mécanique sont une précision accrue, le silence complet à toutes les vitesses et la simplicité de fixage.

L'instrument complet, comprenant toutes les pièces électroniques et l'indicateur, est logé dans un coffret métallique rond de 38,9 mm de diamètre par 63,5 mm de large. Les seules connexions nécessaires sont deux fils de l'alimentation pile et un fil enroulé autour du conducteur isolé h.t.

Le circuit consiste, fondamentalement, d'un oscillateur monostable transistorisé, déclenché par les impulsions h.f. de la bobine d'allumage. Ces impulsions sont captées capacitivement du conducteur h.t.

La variation de cadence des impulsions modifie le rapport repère/espace de l'oscillateur, de sorte que le niveau résultant de courant continu devient proportionnel à la vitesse du moteur. L'indicateur utilisé est l'un des nouveaux compteurs à arc de 270° de cette société.

EE 19 757 *pour plus amples renseignements*

Mégohmmètre

Le mégohmmètre modèle RM160 est un nouvel instrument pour mesurer la résistance d'isolement jusqu'à 400 MΩ. Il est entièrement complet par lui-même, fournissant sa propre pression d'essai variable jusqu'à 500V et une tension d'essai fixe de 1000V.

Ce mégohmmètre peut déterminer la résistance d'isolement d'une minute de condensateurs, y compris les condensateurs diélectriques au polystyrène dont les résistances d'isolement dépassent 750 000 MΩ-μF. Une des particularités les plus intéressantes est un circuit à retard entièrement automatique qui calcule le temps de charge de l'échantillon soumis à l'essai. A l'expiration du temps de retard calculé, le spécimen est présenté au circuit de mesure.

L'instrument est virtuellement à l'épreuve de toute dérive grâce à l'emploi d'un amplificateur écrêteur. La gamme de mesure totale est de 90 kΩ à 400 MΩ.

Le mégohmmètre RM160 peut être utilisé pour effectuer des essais de résistivité de surface et de volume de caoutchouc mou isolant et d'ébonite, selon la Norme Britannique 903, Partie 33, 1950. Un jeu complet d'équipement conforme à la section 33/23 de la dite norme peut être fourni.

EE 19 758 *pour plus amples renseignements*

CAWKELL RESEARCH & ELECTRONICS LTD

Scotts Road, Southall, Middlesex

Filtre variable

(Illustration à la page 178)

Ce nouveau filtre offre de multiples services. Il consiste essentiellement en deux filtres de base, l'un ou l'autre pouvant être passe-haut ou passe-bas, selon le besoin. On peut faire varier continûment le point -3dB de chaque section de filtre dans la gamme de 2 Hz à 150 kHz, et chaque section a un taux de coupure de 36 dB par octave. Par des connexions appropriées, on peut obtenir les configurations suivantes:

- Filtre passe-bande avec pentes de 36 dB/octave.
- Filtre arrêt-bande avec pentes de 36 dB/octave.
- Filtre passe-bas avec pentes de 36 dB/octave.
- Filtre passe-haut avec pentes de 36 dB/octave.
- Filtre passe-bas avec pentes de 72 dB/octave.
- Filtre passe-haut avec pentes de 72 dB/octave.

Le nouveau filtre est à gain unité et ne contient pas d'éléments inductifs. L'impédance d'entrée est élevée et celle de sortie est basse. Il peut faire face à des signaux de niveau élevé.

Une démonstration de ce filtre a été donnée, conjointement avec celle d'un oscillateur en dents de scie et un REMSCOPE utilisé dans son mode de fonctionnement à longue persistance.

EE 19 759 *pour plus amples renseignements*

COSSOR INSTRUMENTS LTD

Cossor House, Highbury Grove, London N.5

Oscilloscope à action rapide

(Illustration à la page 178)

L'oscilloscope à action rapide et faisceau unique, modèle 1076, utilise un tube cathodique de 12,7 cm ayant un potentiel total d'accélération de 10 kV. Des éléments interchangeables assurent une sélection à très grande performance, tant dans les canaux verticaux que dans les canaux horizontaux. Une combinaison caractéristique d'éléments interchangeables donne une largeur de de bande à amplification Y du courant continu à 60 MHz, à une sensibilité maximum de 50 mv/cm, avec une déviation de sortie totale de 6 cm, ainsi qu'une base de temps déclenchée avec une vitesse de balayage étalonnée maximum de 20 mμsec/cm, allant jusqu'au balayage le plus réduit de 10 sec/cm. On peut obtenir un balayage de 10 cm sur toutes les gammes et l'appareil comprend, en outre, un dispositif d'extension de balayage. L'étalonnage de la tension de l'oscilloscope garantit une précision de ±2% dans la gamme de mesure de 50 mV à 120 V, et cette gamme peut être augmentée par l'emploi de sondes d'atténuation adéquates. Le dispositif de mesure de temps donne une précision de ±5%, cependant qu'un oscillateur à déclenchement périodique de 500 MHz produit des tops de modulation d'intensité par intervalles de 2 mμsec, afin d'assurer la mesure précise des temps de montée des impulsions.

Toutes les tensions—basse, haute et très haute—sont entièrement stabilisées contre les variations d'alimentation et de charge.

L'oscilloscope exposé employait les éléments interchangeables type 1078, le préamplificateur à large bande et l'élément de déclenchement type 1079. D'autres éléments interchangeables donnant un rendement accru dans les canaux X et Y, par exemple, un préamplificateur Y différentiel à grand gain, un élément de déclenchement retardé de précision, seront livrables prochainement.

EE 19 760 *pour plus amples renseignements*

Générateur de Signaux

(Illustration à la page 178)

Le générateur de signaux type 1450 est un appareil universel donnant une sortie s'accordant sur sept gammes de fréquences avec une précision d'étalonnage de ±1%, jusqu'à 33 MHz. Pour les gammes plus élevées, la précision d'étalonnage est de 1,5%.

Le signal peut être soit non-modulé par l'oscillateur d'audio-fréquence intérieure, soit modulé extérieurement. La profondeur de modulation peut être contrôlée jusqu'à un maximum de 50% lorsqu'on emploie la modulation intérieure.

EE 19 761 *pour plus amples renseignements*

DYNATRON RADIO LTD

Maidenhead, Berkshire

Bloc d'Alimentation Stabilisée

(Illustration à la page 179)

La fonction du bloc d'alimentation type N104/5 consiste à donner une source de très haute tension stabilisée pour tubes Geiger et chambres d'ionisation. Il est d'un emploi très souple et fournit une, deux ou trois sorties stabilisées, réglables séparément par l'utilisation de sous-éléments à prises N.106. La gamme de tensions couverte est de 350 à 1700 V et la stabilisation s'effectue par tubes à décharge Corona. Deux versions sont livrables, soit le modèle N.104 fonctionnant sur secteur et complètement indépendant, et le modèle N.105 recevant sa puissance d'échelles telles que le Dynatron 1009E.

Un autre élément montré fut le N.103. C'est un bloc d'alimentation hautement stabilisée, qui fournit la haute tension nécessaire à la plupart des compteurs utilisés en physique nucléaire, en particulier les compteurs à scintillations et autres compteurs proportionnels nécessitant une stabilité très sûre.

La tension de sortie est à variation continue de 300 à 3300 V à deux polarités, et des courants de sortie allant jusqu'à 1 mA peuvent être fournis. La stabilité est de l'ordre de 0,02%.

EE 19 762 *pour plus amples renseignements*

Mesure de la Densité et de l'Humidité du Sol

Ce système de mesure combinée de la densité et de l'humidité du sol a été conçu en vue du contrôle du compactage du sol. C'est un appareil portatif à élément unique et actionné par pile, se composant d'un tube de Geiger et d'une source de rayons gamma, et il peut être employé avec la source se trouvant à la surface du sol ou à une profondeur convenable. Il comporte un compteur proportionnel BF3 et une source de neutrons rapides. Une source scellée de radium-béryllium de 10 MHz fournit des rayons gamma de haute énergie et des neutrons rapides. Les deux systèmes sont contenus dans une seule boîte qui englobe également une source transistorisée de tres haute tension et un préamplificateur. Les impulsions du tube de Geiger et des tubes BF3 sont mesurées par l'échelle portative à transistors Dynatron type 1287A.

EE 19 763 *pour plus amples renseignements*

EKCO ELECTRONICS LTD

Southend-on-Sea, Essex

Enregistreur X-Y

(Illustration à la page 179)

Cet enregistreur à grande vitesse X-Y, type EL93, trace le graphique du rapport entre deux variables interdépendants, directement sur papier quadrillé ordinaire de 254 mm × 184,15 mm. Grâce à sa gamme de sensibilité étendue et à sa réponse rapide, c'est un instrument d'une souplesse d'emploi remarquable dans le domaine du contrôle de procédés et de l'étude du rendement. L'impédance d'entrée est de 1 MΩ et la gamme sensibilité, sur chaque axe, va de 0,4 mV/cm à 4V/cm, en douze degrés.

EE 19 764 *pour plus amples renseignements*

ELECTRONIC TUBES LTD

Kingsmead Works, High Wycombe, Buckinghamshire

Tube Cathodique à Bas Prix

Ce tube de 127 mm est destiné à des applications où un bas prix de revient et un grand diamètre d'écran sont d'une suprême importance, mais où un très grand rendement n'est pas essentiel. Afin de réduire le coût, toutes les connexions sont ramenées vers la base du tube et des simplifications considérables ont été apportées à la structure intérieure. Grâce à sa face plate, le tube donne une présentation égale à celle de dispositifs plus coûteux.

EE 19 765 *pour plus amples renseignements*

T.R.C. à Haute Sensibilité

Dans les tubes cathodiques utilisant les systèmes à accélération de post-déviation, une lentille convergente est formée par les champs d'accélération pénétrant la zone à l'intérieur des plaques de déviation les plus rapprochées de l'écran fluorescent. Ceci limite efficacement le rapport admissible d'accélération de post-déviation. On peut obtenir, cependant, des sensibilités accrues avec déformation réduite si cette pénétration de champ est éliminée par l'introduction d'une grille ou d'un blindage de transmission, intercalé entre le système de déviation et le système à accélération de post-déviation.

En réglant la position de ce champ par rapport au système de déviation, les champs peuvent être formés de manière à subir une déviation étalée à travers le système à accélération de post-déviation. On peut ainsi faire un tube ayant des sensibilités de déviation variant dans les deux sens ou indépendantes du rapport d'accélération de post-déviation.

Dans le cas du tube 5 CLP1, les plaques de déviation X sont plus près de l'écran que les plaques Y. Par conséquent, aucune position du champ ne rendra les deux sensibilités de déviation complètement indépendantes des variations du rapport d'accélération de post-déviation. La position choisie maintient un léger décroissement dans la sensibilité de déviation X et un très léger accroissement dans la sensibilité de déviation Y, à mesure que le rapport d'accélération de post-déviation augmente.

EE 19 766 *pour plus amples renseignements*

ELLIOTT BROTHERS (LONDON) LTD

Century Works, Lewisham, London S.E.13

Compteur d'Ondes Entretenues, à Section à Fentes

(Illustration à la page 179)

Le compteur d'ondes entretenues, à section à fentes, type B433, est un instrument de haute précision dont la section à fentes a été spécialement étudiée pour que la vitesse de phase aussi bien que l'impédance soient très proches de la valeur nominale pour le guide d'ondes No. 16, sur toutes sa longueur. Le chariot portant le détecteur roulant est monté cinématiquement sur pistes nettoyées continûment et tracées parallèlement aux surfaces du guide d'ondes, et le couplage demeure constant à mesure que le chariot se déplace, à un ou deux centièmes de décibel près. L'appareil est muni d'une commande micrométrique du couplage au détecteur roulant, et un transformateur d'adaptation hybride permet d'accorder le palpeur à la résonance, réduisant ainsi les erreurs dues à ses propres réflexions dans le guide d'ondes. Un indicateur à échelle de lecture facile permet d'effectuer des mesures de phase jusqu'à 0,002 radian.

EE 19 767 *pour plus amples renseignements*

Oscillateur d'Essai Hyperfréquencies

(Illustration à la page 179)

Cet oscillateur type B689 opère dans la gamme de fréquences de 7 à 12 Hz et il comporte une cavité à ligne coaxiale, prévue pour l'emploi avec le klystron à prises, type CV2346, et avec des blocs d'alimentation de puissance stabilisée pour le fonctionnement du klystron, ainsi qu'un générateur d'ondes carrées incorporé, fournissant un signal de 400 Hz à 4 kHz pour la modulation cathodique. On peut aussi effectuer une modulation extérieure, à la cathode ou au réflecteur. L'énergie haute fréquence est extraite au moyen d'une fiche coaxiale, et une sortie de puissance suffisante est obtenue dans la gamme étendue pour toutes les mesures normales hyperfréquences d'établi. Un cadran de fréquences à lecture directe sur le panneau avant donne une indication claire et distincte de la fréquence de fonctionnement.

EE 19 768 *pour plus amples renseignements*

ERICSSON TELEPHONES LTD

Beeston, Nottingham

ENREGISTREUR BIDIRECTIONNEL

(Illustration à la page 180)

L'enregistreur 135A/A2, caractéristique de la série des huit compteurs bidirectionnels que fabrique la susdite société, a été étudié pour l'enregistrement et le comptage d'impulsions de polarité positive et d'une amplitude minima de 45 V, provenant de deux sources, ainsi que pour l'affichage sur tubes Dékatron de la différence arithmétique entre les deux comptes, avec une indication visible du canal particulier auquel le compte affiché se rapporte. L'instrument a un taux de comptage maximum de 100 coups par seconde et par canal, et une gamme de comptage de 10^4 des deux côtés de zéro.

EE 19 769 *pour plus amples renseignements*

ÉQUIPEMENT NUCLÉAIRE À ÉLÉMENTS

(Illustration à la page 180)

Mis au point dans sa forme actuelle par la société Ericsson, à partir du type 2000 du Centre de Recherches de l'Energie atomique de Harwell, ce modèle d'équipement est construit sous forme d'éléments de dimensions courantes, pouvant être assemblés pour produire un matériel de comptage nucléaire s'appliquant aussi bien au comptage à scintillations qu'aux chambres d'ionisation et aux compteurs proportionnels.

L'équipement complet comprend: un élément de pré-démultiplication rapide avec un temps de résolution supérieur à 1 μsec et un coefficient de démultiplication de 10^2; un élément de démultiplication lente à temps de résolution de 250 μsec et coefficient de démultiplication de 10^4; un discriminateur fournissant une discrimination de 200 mV fixes et 1 à 10 V variables; un amplificateur de 2 MHz se composant d'un palpeur cathodique, d'un préamplificateur, ainsi que des amplificateurs de haut et bas niveaux, à gains de 150 dB et 60 dB respectivement. Le niveau de ronflement général pour tous les amplificateurs en cascade est supérieur à 35 mV de crête aux réglages de gain maxima rapportés à l'entrée du palpeur cathodique. Il comprend encore un élément d'étouffement donnant six temps de paralysie choisis par commutateur allant de 100 à 600 μsecs; un élément de minutage; un élément de très haute tension donnant une sortie à variation continue de 300 à 2000 V; une tête à scintillations pour la détection d'irradiations alpha, beta, gamma et X, et de neutrons lents et rapides; des blocs d'alimentation.

Les divers éléments sont connectés à des ensembles à panneaux ainsi qu'à des ensembles de commande assurant l'appui mécanique et les interconnexions électriques. Un rupteur à retard thermique, incorporé aux ensembles de commande, donne aux tubes à cathodes chaudes le temps voulu pour atteindre des températures d'emploi normales avant d'appliquer la haute tension.

EE 19 770 *pour plus amples renseignements*

FERRANTI LTD

Hollinwood, Lancashire

TAMBOUR MAGNÉTIQUE

Un nouveau tambour magnétique, du type MD5, a été exposé au Salon.

Cet appareil consiste en un double tambour actionné par moteur monté extérieurement et interchangeable pour l'alimentation de puissance et la vitesse. Chaque tambour, a 152,4 mm de haut × 355,6 mm de diamètre.

La capacité de stockage est de 160 pistes, chaque piste contenant 128 groupes de 50 chiffres binaires (1 024 000 chiffres binaires). La vitesse du tambour de l'appareil exposé est de 2 500 tours/minute, mais avec certaines restrictions, ces chiffres peuvent être augmentés. Les têtes sont montées en blocs de 18 pièces (16 pour l'usage courant) et tous les blocs peuvent être détachés pour être nettoyés, sans perte de réglage. La largeur de piste est de 0,76 mm et l'écartement de tête est de 0,05 mm.

EE 19 771 *pour plus amples renseignements*

FLANN MICROWAVE INSTRUMENTS LTD

9 Old Bridge Street, Kingston-on-Thames, Surrey

APPAREILS DE MESURE D'ONDES ENTRETENUES

(Illustration à la page 180)

Le vaste assortiment d'instruments pour hyperfréquences comprenait une gamme d'appareils de mesure d'ondes entretenues couvrant la bande de fréquences de 2,6 à 26,5 kMHz. Le modèle 10/3 que montre notre gravure s'étend de 2,6 à 3,95 kMHz.

Ces appareils comportent un guide d'ondes à section lourde avec pente équilibrée le long du centre d'une large face, à travers laquelle est accouplé un palpeur accordé en série parallèle à insertion variable, supporté par un chariot de construction cinématique.

L'extrémité du palpeur qui passe à travers la fente longitudinale est entourée d'une armature équilibrée et entièrement munie de bobines d'arrêt. Une symétrie haute fréquence complète est maintenue autour du centre de la fente et du chariot de façon à exclure toute résonance parasite.

Un système à indicateur affiche la distance en millimètres entre le palpeur et la flasque terminale sur tous les appareils à l'exception des types 10/3 et 12/3 pour lesquels des échelles démultiplicatrices sont employées. Autour de l'ensemble du système, un obturateur anti-poussières à adhérence étroite est disposé, de manière à assurer une protection sûre aux roulements à billes, etc.

Les appareils sont fournis avec cristal coaxial incorporé pour donner une sortie redressée et le guide d'ondes est argenté et rhodié.

EE 19 772 *pour plus amples renseignements*

THE GENERAL ELECTRIC CO. LTD

Wembley, Middlesex

AMPLIFICATEUR PARAMÉTRIQUE À FAISCEAU ÉLECTRONIQUE

(Illustration à la page 180)

Cet équipement a été conçu pour amplifier les signaux faibles sans augmenter le niveau de bruit en proportion.

Lorsqu'une onde sonore traverse un gaz, les molécules répondent par une série de compressions et de raréfactions, de sorte que la course de l'onde se fait à une vitesse constante, quelle que soit la fréquence. De même, lorsqu'un signal haute fréquence est appliqué à un faisceau électronique c.c. constant, il se propage, par un effet de groupement et de dégroupement, parmi les électrons, mais en ce cas là en deux ondes à part, l'une ayant une vitesse légèrement supérieure, l'autre légèrement inférieure à celle du faisceau électronique. Ce sont des ondes de charge d'espace lentes et rapides.

Jusqu'ici tous les amplificateurs du type à faisceau (klystrons, tubes à ondes voyageuses, etc.) ont été du genre à ondes à charge d'espace lentes, ces ondes étant amplifiées à mesure que le signal haute fréquence augmente. Le bruit provenant de la cathode ne peut être supprimé de cette onde et il s'accroît avec le signal.

L'équipement qu'on a pu voir amplifie l'onde à charge d'espace lente, d'où le bruit cathodique peut être supprimé avant l'application du signal. L'amplification est produite par l'interaction entre les champs établis par procédés de groupement à la fréquence de signal avec ceux du préamplificateur fonctionnant à deux fois cette fréquence.

La démonstration a démontré l'existence dans le faisceau d'ondes croissantes causées par cette interaction. Un faisceau électronique passant par une série de cavités permet de lui appliquer des signaux. La sortie fut obtenue par une cavité mobile parcourant le faisceau, contrôlant les ondes au fur et à mesure de leur progression. Ces ondes croissantes ont pu être vues sur l'appareil indicateur.

EE 19 773 *pour plus amples renseignements*

TUBE D'AFFICHAGE NUMÉRIQUE

Ce dispositif, du type à rayons cathodiques, est utilisé pour l'affichage d'informations numériques. Le tube fonctionne sur une tension générale de quelques centaines de volts, cependant que la tension de commutation requise n'est que de quelques dizaines de volts.

Les avantages de ce genre d'affichage par rapport à d'autres dispositifs sont les conditions de basse puissance de commutation nécessaire et la possibilité d'employer le tube dans des circuits retardateurs.

EE 19 774 *pour plus amples renseignements*

MULLARD LTD

Mullard House, Torrington Place, London W.C.1

En plus de l'assortiment d'appareils vendus dans le commerce, les instruments de recherches suivants furent exposés:

FILMS MAGNÉTIQUES MINCES

Ces films constituaient un aperçu des

recherches entreprises par les Laboratoires Mullard sur les propriétés des films magnétiques très minces (de l'ordre de 1000° A d'épaisseur), qui semblent posséder un potentiel considérable en tant qu'éléments de mémoire bistables rapides pour ordinateurs.

Un film mince de nickel-fer s'évaporant dans un champ magnétique uniforme manifeste une anisotropie uniaxiale. Lorsque le vecteur magnétique est influencé par un champ magnétique perpendiculaire à l'axe anisotropique et plus faible que le champ anisotropique, le vecteur a deux états stables possibles. Ceci permet de stocker des informations sous forme binaire. La transition entre les deux états, sous l'effet d'un champ d'entraînement parallèle à l'axe anisotropique, peut être effectuée en quelques dizaines de microsecondes.

Ces éléments autorisent une commutation plus rapide que les noyaux magnétiques conventionnels et ils sontà meilleur marché par surcroît.

Une configuration matricielle de 64 éléments de films minces a été exposée par la Société Mullard et une première démonstration a montré le comportement d'un élément dans la matrice. La seconde démonstration comprenait des appareils pour mesurer les caractéristiques fondamentales des éléments.

EE 19 775 *pour plus amples renseignements*

Matrice à Mémoire Magnétique Sub-Microsecondes

Les recherches dans le domaine des techniques des calculatrices à action rapide ont mené à la réalisation d'une matrice à mémoire magnétique pouvant être commutée par impulsions d'une durée de 0,1 μsec seulement, et ayant un temps cyclique lecture/écriture de moins de 1 μsec.

Ce système, dont le principe a été montré au Salon de l'année dernière, utilise deux noyaux pour chaque chiffre stocké. Durant l'opération d'écriture, les deux noyaux sont entraînés d'un état rémanent à un autre, par une impulsion de courant de courte durée (environ 0,1 μsec) qui ne commute que partiellement les noyaux. Dans le même temps, une impulsion de chiffre d'une amplitude beaucoup plus réduite est appliquée aux deux noyaux dans une direction telle qu'elle aide l'impulsion ' d'écriture ' dans un noyau et l'oppose dans l'autre. Ainsi un noyau commutera davantage que l'autre durant l'impulsion "d'écriture".

Pour lire des informations sur les noyaux, ceux-ci sont tous deux rétablis dans leur état original par une impulsion de "lecture" appliquée dans la direction opposée à l'impulsion "d'écriture". Le noyau qui a été commuté davantage fournira alors un plus grand signal sur un fil de sortie qui entoure les noyaux en opposition de série. Ainsi, la différence des deux sorties apparaîtra sur ce fil et le repère de ce signal indiquera la polarité de l'impulsion de chiffre appliquée durant le procédé "d'écriture". Une des polarités de cette impulsion pourra être employée pour indiquer un "1" et l'autre pour indiquer un "0". L'amplitude réduite de l'impulsion de chiffre permet le passage du fil du chiffre à travers d'autres groupes de signes non adressés sans les déranger.

Une partie de matrice à noyau de ferrite de 1 024 groupes de signes, employant ce principe, fut montrée.

EE 19 776 *pour plus amples renseignements*

G. V. PLANER LTD

Windmill Road, Sunbury-on-Thames, Middlesex

Eléments Magnéto Sensibles

(Illustration à la page 181)

Des éléments d'antimoniure d'indium et d'arséniure d'indium Hall furent exposés par cette Société. Ces éléments utilisent des sections semi-conductrices extrêmement minces (0,0003") permettant ainsi un espacement minimum dans le circuit magnétique de commande. Ces éléments sont de construction robuste, l'élément sensible avec pièces polaires fixées étant sous moulage de résine à haute température. En raison des sections semi-conductrices minces employées, des valeurs de résistance relativement élevées peuvent être produites et on peut obtenir des tensions de Hall allant jusqu'à 4V. dans le cas de l'antimoniure d'indium intrinsèque, ou des valeurs proportionnellement plus élevées pour le type p ou arséniure d'indium. Ces éléments peuvent supporter des températures atteignant 200°C.

L'utilité de ces éléments dans des circuits multiplicateurs fut démontrée par les exposants. Les applications possibles comprennent les circuits d'amplificateur et d'oscillateur.

De nouveaux types de résistances Corbino magnétosensibles à l'antimoniure d'indium ont pu également être vus. Ces derniers permettent une dissipation de puissance accrue et sont aussi de construction robuste. L'élément sensible et les pièces polaires à grande perméabilité, disposés de façon à servir de concentreurs de champ, sont, de même, sous moulage de résine à haute température. La résistance de ces éléments augmente par un coefficient de 20 en réponse à un champ de 10 000 gauss.

(Cette réalisation a été mise au point avec le concours de la Société Cosmocord Ltd. Les brevets à cet effet sont attendus).

Dans notre gravure, un élément InSb Hall figure à gauche et une résistance InSb Corbino à droite.

EE 19 777 *pour plus amples renseignements*

Fibre de Verre à Pellicule D'Oxyde

(Illustration à la page 181)

Une machine pour l'application continue d'une pellicule d'oxyde conductrice sur la fibre de verre, à l'usage des résistances électriques, a été exposée au Salon. Cette machine comprend un appareillage de précision pour l'avance de la fibre à travers le four de revêtement dans lequel le mélange formant l'oxyde est injecté. La valeur de résistance est minutieusement commandée par le réglage automatique de la vitesse d'avance de la fibre au moyen d'une sonde contrôlant la résistance à la sortie du four.

La fibre revêtue, dont le diamètre normal est de 0,025 mm, est enroulée sur des gabarits de verre ou en céramique pour former des résistances de grande valeur. Des spécimens expérimentaux de ces éléments ont pu être vus au Salon.

Les avantages de ce système sont la haute valeur ohmique par volume unitaire qu'on peut obtenir, la résistance atteignant plusieurs mégohms par pouce de fibre, de même que la stabilité et l'inertie sur la base de verre caractérisant généralement les pellicules d'oxyde. Ainsi que pour les autres résistances à pellicule d'oxyde, le coefficient de température de résistance peut être maintenu à des limites basses par une corrélation adéquate entre l'épaisseur de la pellicule et la composition de l'oxyde. (Brevets attendus).

EE 19 778 *pour plus amples renseignements*

THE PLESSEY CO. LTD

Vicarage Lane, Ilford, Essex

Aimants Permanents Moulés

(Illustration à la page 182)

Les aimants Magloy sont destinés à une variété étendue d'applications, particulièrement dans le domaine des hyperfréquences, c'est à dire pour les magnétrons, les klystrons, les carcinotrons, les isolateurs de radar, les sondes Maser et les amplificateurs à ondes progressives. Ces aimants peuvent être fournis avec chemise en matière synthétique ou sous moulage d'aluminium, ce qui facilite l'assemblage rapide des valves groupées. La chemise d'aluminium peut être usinée facilement pour des tolérances dimensionnelles étroites, conformément aux conditions de construction. La plupart des aimants de cette catégorie sont faits en Magloy 1, ayant une saturation magnétique maxima de $5,2 \times 10^6$ gauss-oersteds, mais il existe également plusieurs autres alliages. Ce produit à haute énergie s'obtient même en gros moulages grâce à la mise au point des nouvelles techniques de fabrication.

Ces aimants sont employés également pour les haut-parleurs, les instruments à bobinage mobile, les compteurs, les appareils de résonance magnétique nucléaire, la spectographie de masse et les applications analogues.

EE 19 779 *pour plus amples renseignements*

W. G. PYE & CO. LTD

Granta Works, Cambridge

Amplificateur C.C.

(Illustration à la page 182)

Cet amplificateur constitue un instrument sûr de bas-niveau pour les mesures industrielles ou de laboratorie, ainsi que pour l'enregistrement de signaux de faible tension, tels que ceux produits par les thermocouples ou les thermopiles.

L'emploi d'un modulateur de contact sûr, à amplification du courant porteur alternatif et à circuit d'échantillonnage sensible aux phases et à réaction négative générale, donne une stabilité de gain excellente et une dérive très limitée.

Compte tenu des insuffisances de la plupart des amplificateurs de modulation utilisant la fréquence d'alimentation comme fréquence porteuse, cet instrument a été prévu pour le fonctionnement sans aucune borne à la masse dans toutes les conditions normales, ceci pouvant être effectué par l'incorporation de circuits de filtrage afin de réduire l'effet des composantes de fréquence d'alimentation dans le circuit d'entrée.

Des signaux de ± 100 μV, ± 10 mV et $\pm$ 100 mV sur ses quatre gammes donnent des sorties de ± 10 V à des courants allant jusqu'à 5 mA. La dérive après chauffage ne dépasse pas $\pm$ 1 μV. La linéarité est supérieure à $\pm 0,5\%$. La résistance d'entrée est de 3,5 kΩ.

EE 19 780 *pour plus amples renseignements*

ROYSTON INSTRUMENTS LTD

Hanworth Lane, Chertsey, Surrey

ANALYSEUR DE BRUIT DE MACHINE TOURNANTE

Cet instrument a été conçu originellement pour le contrôle courant des boîtes de vitesses d'automobiles, afin de déterminer le bruit provenant de l'engrènement aux différentes vitesses, dans une gamme étendue de vitesses d'arbre d'entrée. Un choix de deux largeurs de bandes fixes est prévu et l'accord de l'analyseur est réglé automatiquement en fonction de la vitesse de l'arbre d'entrée. En plus du transducteur de bruit ou de vibrations, les seuls accessoires nécessaires sont une série de roues dentées avec capteur magnétique, montées sur l'arbre d'entraînement. Le nombre de dents sur chaque roue est choisi pour s'adapter aux différentes mailles d'engrènement et la fréquence du signal provenant du capteur magnétique détermine la fréquence d'accord de l'analyseur. La bande passante est de forme rectangulaire et il y a un rejet de plus de 50 dB de signaux hors de la bande passante. L'analyseur fonctionne dans une gamme de fréquences de 2 Hz à 20 kHz. On peut aussi l'employer comme analyseur conventionnel d'ondes à gamme étendue et de haute précision, en l'alimentant avec la sortie d'un oscillateur ordinaire de laboratoire au lieu de la sortie d'un générateur à roues dentées magnétique.

EE 19 781 *pour plus amples renseignements*

SERVOMEX CONTROLS LTD.

Crowborough, Sussex

ANALYSEUR DE FONCTION DE TRANSFERT

Cet équipment est le prototype d'un instrument très complet pour établir la réponse de fréquence dynamique de servomécanismes et de systèmes de commande automatique.

Les systèmes de synchronisation tournants produisent une onde sinusoïdale et multiplient le signal mesuré par la composante de fréquence fondamentale. Le système de synchronisation multiplicateur produit deux sorties, dont l'une est proportionnelle à la partie réelle et l'autre à la partie imaginaire du signal mesuré.

Des circuits intégrateurs spéciaux intègrent chaque sortie pendant une période d'un cycle de la fréquence fondamentale. Ceci élimine l'effet des composantes cycliques, c'est à dire les harmoniques, et l'effet des signaux non corrélatifs de haute fréquence dûs à la fondamentale.

La sortie de chaque intégrateur est échantillonnée à la fin de chaque cycle complet et elle est maintenue jusqu'à la fin du cycle suivant, à l'issue duquel un nouvel échantillon est prélevé. On peut ainsi effectuer une mesure stable, une période cyclique après le "tassement" du matériel sous essai.

Les systèmes de synchronisation tournants sont mûs par servomoteur. Les commandes de ce dernier sont étalonnées en périodes de temps et en fréquences, selon la gamme choisie. Une sortie mécanique directe avec un couple de format réduit est aménagée à la fréquence fondamentale. Ce dispositif s'avère fort utile lorsqu'on actionne des systèmes mécaniques ou hydrauliques.

L'equipement assure des sorties d'ondes sinusoïdales électriques à une fréquence fondamentale ou, encore, une fréquence fondamentale imposée à une fréquence porteuse. Lorsqu'on contrôle un système à fréquence porteuse, l'analyseur utilise l'alimentation en fréquence porteuse locale.

Pour la mesure, l'instrument admet des signaux électriques à une fréquence fondamentale ou sur fréquence porteuse dans une gamme d'amplitude très étendue. L'impédance d'entrée est élevée, permettant l'emploi de nombreux types de transducteurs.

La gamme de fréquences suffit à autoriser l'analyse de multiples procédés, des traitements chimiques à temps de longue réponse jusqu'aux systèmes de synchronisation électromécanique à action rapide.

La lecture de phase est précise à $\pm 1°$ près, et la lecture d'amplitude à $\pm 2\%$ près.

EE 19 782 *pour plus amples renseignements*

THE SOLARTRON ELECTRONIC GROUP LTD

45 Thames Street, Kingston-on-Thames, Surrey

(Illustration à la page 182)

OSCILLOSCOPE À DOUBLE FAISCEAU

L'oscilloscope CD1014 est un appareil portatif à double faisceau de grand rendement, utilisant le tube cathodique ETEL de création toute récente, à double canon et face plate de 88,9 mm de diamètre, qui ne pèse que 9 kg.

Les deux amplificateurs à déviation verticale ont des circuits identiques, chaque canal ayant une largeur de bande dépassant le courant continu jusqu'à 5 MHz (-3 dB) à une densité maximum de 100 mV/cm. Les atténuateurs étalonnés permettent de réduire la sensibilité à 100 V/cm, tandis qu'un préamplificateur incorporé à couplage de courant alternatif sert à porter la sensibilité à 1 mV/cm, avec largeur de bande de 2,5 Hz à 50 kHz. La sensibilité est donc à variation continue de 1 mV à 100 V/cm.

Un générateur de base de temps à haute linéarite fournit des vitesses de balayage à variation continue de 1 μsec/cm et l'expansion étalonnée supplémentaire peut être décuplée.

La précision de la mesure de durée et d'amplitude est de $\pm 5\%$ ou supérieure à ce chiffre. Une forme d'onde d'etalonnage de $\pm 1\%$ permet d'obtenir des précisions plus élevées encore.

La synchronisation et le déclenchement s'effectuent intérieurement ou à partir de formes d'ondes extérieures. La commande de "niveau de déclenchement" permet de déclencher la base de temps d'un point déterminé de la forme d'onde. Ce dispositif fort utile, allié aux sources d'alimentation de très haute tension stabilisée et de brillance à couplage de courant continu, garantit une image stable et bien définie.

Grâce, enfin, à un "signal bas" isolé, on peut indiquer des signaux se rapportant à n'importe quel potentiel de courant continu allant jusqu'à 500 V.

EE 19 783 *pour plus amples renseignements*

GÉNÉRATEUR DE SIGNAUX À AMPLITUDE STABILISÉE

(Illustration à la page 183)

Lorsque le générateur de signaux DO905 est mis en action dans une charge convenablement équilibrée, il produit une sortie d'ondes sinusoïdales d'une amplitude constante dans toute sa gamme de fréquences qui va de 350 kHz à 50 MHz.

L'amplitude de sortie est à variation continue de 40 mV à 10 V, de crête, dans sept gammes. L'amplitude indiquée sur l'échelle de 0 à 10 V de l'appareil de mesure est la tension de crête à crête à l'entrée de la tête de l'atténuateur. L'indication est précise dans une proportion de 10% de l'echelle totale.

Lorsque l'indication de l'appareil de mesure est dans la zone "d'amplitude constante" et que la résistance de charge n'est pas inférieure à 1 kΩ, avec une capacité de dérivation de charge inférieure à 10 pF, la variation de l'amplitude de sortie d'atténuateur (en fonction de la variation de fréquence) est alors inférieure à $\pm 2\%$ à 50 kHz et de 350 kHz à 30 MHz, et inférieure à $\pm 5\%$ de 30 MHz à 50 MHz.

EE 19 784 *pour plus amples renseignements*

TEXAS INSTRUMENTS LTD

Dallas Road, Bedford

DÉTECTEUR À RAYONS INFRAROUGES

Le détecteur à rayons infrarouges M-1000 est du type photovoltaïque et ne nécessite aucune tension de polarisation. Le matériel sensible est une plaquette d'antimoniure d'indium à jonction diffuse, qui peut être utilisée dans la gamme de 2 à 5 microns. La température de fonctionnement optique nominal du détecteur est de $-196°$C (azote liquide) et il peut être fourni en n'importe quelle surface active requise jusqu'à un maximum de 1cm^2. L'impédance à cellule c.a. de faible signal est de 100 à 1000 ohms, avec une constante de temps inférieure à 1μsec.

La puissance équivalente au bruit dépend de la surface, un chiffre caractéristique à cet égard, mesuré par les laboratoires de la marine militaire américaine áu cours d'essais Corona (500°K, 90 Hz, Δ f = 5 Hz), étant 4×10^{-10} W pour des surfaces de 4 mm². La tension de bruit est inférieure à 10^{-8} V (90 Hz, 5 Hz largeur de bande) et, apparemment, elle varie inversement en tant que f^3.

EE 19 785 *pour plus amples renseignements*

CIRCUITS SOLIDES À SEMICONDUCTEURS MICROMINIATURE

Les circuits solides à semiconducteurs microminiature sont formés par la sélection et le façonnage de parcours de conduction au dessus et à travers une plaquette semiconductrice. Ils constituent ce qui serait en quelque sorte une version très proche de la réduction ultime des dimensions du matériel électronique et ils donnent des densités de composantes équivalentes allant de 5 000 000 à 50 000 000 par pied cube. Un des spécimens montrés était un circuit multivibrateur mesurant environ 6,35 mm × 3,17 mm × 0,19 mm, avec un rendement égal à celui d'un circuit ordinaire à huit résistances, deux condensateurs et deux transistors, représentant une densité de composante équivalente de 30 000 000 de parties par pied cube.

Dans les circuits solides à semiconducteurs, les résistances sont formées par la résistance de masse du matériau semiconducteur, les condensateurs par l'emploi des techniques de formation des capacités, et les transistors et les diodes par les méthodes de diffusion. Le rendement des circuits solides à semiconducteurs est semblable à celui des circuits ordinaires à dispositifs à base diffuse.

EE 19 786 *pour plus amples renseignements*

UNICAM INSTRUMENTS LTD

Arbury Works, Cambridge

ENREGISTREUR À ABAQUE PLAT

(Illustration à la page 183)

Conçu principalement pour les applications spectroscopiques, cet enregistreur sera, pense-t-on, d'un usage généralisé pour tout procédé discontinu avec points définis de marche et d'arrêt.

L'indication est donnée sur abaque plat de 30 × 20 cm, entraîné au delà du chariot à plume. L'enregistrement linéaire ou logarithmique se fait par simple bouton et l'on obtient soit un enregistrement linéaire total de 0 à 10 mV soit un enregistrement logarithmique total de 0 à 200 mV. Le temps de réponse total est nominalement de 0.7 sec. L'abaque est entraîné au moyen d'un embrayage magnétique par un moteur synchrone relié à une chaîne de transmission donnant des rapports de vitesse de 1:1, 2:1 et 4:1.

L'enregistreur peut être actionné par une entrée synchrone (par exemple, un enregistreur asservi à spectromètre).

EE 19 787 *pour plus amples renseignements*

VENNER ELECTRONICS LTD

Kingston By-Pass, New Malden, Surrey

HORLOGE ARITHMÉTIQUE TRANSISTORISÉE

(Illustration à la page 183)

L'horloge TSA 88 est, fondamentalement, une horloge piézo-électrique étudiée pour donner, au moyen d'indicateurs en ligne, une indication horaire en secondes, minutes et heures.

L'inscription de données rend souvent souhaitable l'enregistrement simultané du moment auquel les résultats de procédés sont obtenus. La TSA88 fournit ce précieux appoint. L'heure aussi bien que les données peuvent être enregistrées par l'appareil imprimeur transistorisé type TSA65 ou par l'élément de commande de reperforation type TSA101, lorsque ceux-ci sont reliés à l'horloge arithmétique.

Le retard d'un signal "d'ordre d'imprimer" est effectué entre 0,2 secondes avant et 0,01 seconde après que l'horloge est sur le point de changer son indication de l'heure. Ceci garantit l'enregistrement de l'heure exacte à tout moment.

Durant cette période de retard, un signal "tenue" est prêt à être transmis à l'appareil de mesure de données. Ce signal, conjointement avec le signal "tenue" du dispositif imprimeur, empêche le réenclenchement de l'appareil de mesure de données durant le cycle d'impression.

Le contact de commutation est déclenché par relais intérieur et il peut être déclenché toutes les secondes, toutes les minutes ou toutes les heures.

Après avoir remis l'horloge TSA88 à zéro, l'heure peut être rétablie en pressant un bouton-poussoir "rapide". Elle peut aussi être rétablie de façon plus précise en pressant un bouton-poussoir "lent". Ce dernier remet au réglage voulu les indicateurs en ligne d'heures, de minutes et de secondes.

Lorsqu'on tourne le bouton "réglage" vers "attente," l'horloge TSA88 est prête à fonctionner et il ne se trouve plus d'impulsions de minutage aux boutons-poussoirs "rapide" et "lent".

L'instrument peut être mis en marche sur place ou à distance, ou encore par impulsions positives d'une ou de deux sources.

EE 19 788 *pour plus amples renseignements*

THE WAYNE KERR LABORATORIES LTD

Sycamore Grove, New Malden, Surrey

CALCULATEUR DE FONCTIONS DE TRANSFERT

La méthode reconnue pour déterminer la fonction de transfert de systèmes de communication et de commande a été jusqu'ici la mesure de l'amplitude et de la phase du système en tant que fonction de fréquence. Ce procédé ne fournit pas d'information directe sur la fonction de transfert mais on peut obtenir, en général, une expression approximative par de longs et fastidieux calculs.

Un traitement fondamentalement nouveau du problème a été mis au point par la Société Wayne Kerr, selon lequel on mesure les coefficients effectifs de la fonction de transfert. Des lectures directes sont présentées à l'issue d'un procédé de fonctionnement élémentaire ne durant que quelques instants. On peut obtenir, en outre, les racines de la fonction de transfert, à partir desquelles on peut aisément établir un schéma des lieux géométriques des racines.

Ces caractéristiques permettent d'analyser les effets de changements de dessin sur des équipements servo-commandés, sans que cela n'occasionne des calculs longs et compliqués. La marge de stabilité d'un système peut, de la sorte, être déterminée rapidement et, dans le cas d'un système instable, les causes de cette instabilité peuvent être localisées facilement.

Une démonstration fut donnée de l'instrument en cours de calcul des coefficients dans la fonction de transfert d'un réseau passif connu.

EE 18 789 *pour plus amples renseignements*

Résumés des Principaux Articles

Un générateur de groupes de huit signaux réalisé avec des transistors à barrage de surface utilisant la logique à couplage direct

par P. L. Owen et T. R. H. Sizer

Résumé de l'article aux pages 134 à 139

Cette étude traite d'un générateur de groupes de signes binaires, conçu pour servir d'équipement d'essai en vue du développement subséquent d'éléments de calculateurs arithmétiques. Durant la phase initiale de ces travaux, les auteurs furent frappés par la simplicité de la technique du couplage direct, de sorte que le dessin logique de l'équipement est basé sur l'utilisation de cette technique.

Après une explication succincte du fonctionnement série et parallèle, qui est à la base de la conception de la présentation de groupes de signaux série et, par conséquent, de la nécessité d'un générateur de signaux en tant qu'outil de base pour ce genre de travaux, les auteurs décrivent un

simple générateur de groupes de signaux et donnent une définition des symboles logiques employés dans les schémas.

Ceci est suivi d'une description de la technique du couplage direct à transistors à barrage de surface, ainsi que d'une section sur les éléments logiques transistorisés et d'une analyse détaillée de l'équipement. L'étude se termine par un aperçu des facteurs restrictifs de cette technique.

La conception du transistor en tant que commutateur logique est examinée en annexe, et il y est démontré que dans le cas d'un dispositif p-n-p, il existe un rapport entre la vitesse du fonctionnement, la mémoire à ouverture dans la partie de base et le degré de saturation. Il est bien précisé, cependant, que ce rapport n'est considéré que dans la mesure voulue pour démontrer qu'une vitesse de commutation rapide est possible sans contrôle de saturation, à condition d'employer certains types de transistors tels que celui à barrage de surface SB-240 ou celui à microalliage MA-393.

Le "Digitron": un tube indicateur à cathodes froides par N. McLoughlin, D. Reaney et A. W. Turner

Résumé de l'article aux pages 140 à 143

Une gamme de tubes indicateurs à cathodes froides est décrite dans cet article qui compare les qualités respectives des tubes à vision latérale et à vision d'extrémité. Les principes du fonctionnement au courant continu et l'emploi des données de construction sont ensuite expliqués. Enfin, mention est faite des divers circuits pouvant être utilisés avec ces tubes ainsi que des méthodes d'emploi d'alimentation en courant alternatif.

Une nouvelle méthode d'essai de la sensibilité chromatique des tubes de caméra de télévision par A. G. Warren

Résumé de l'article aux pages 144 à 147

Il n'y a eu jusqu'ici aucun moyen facile de vérifier la sensibilité chromatique complète d'une caméra de télévision monochrome. Le propos de cet article est précisément de montrer comment pareil essai peut être effectué avec un équipement assez simple. On peut, en effet, obtenir avec celui-ci une image de sensibilité chromatique effective pour n'importe quel illuminant choisi, quoique les essais aient été généralement limités jusqu'à ce jour à l'éclairage de studio du type à incandescence.

Systèmes électroniques de dépouillement de données pour organisations commerciales américaines par J. C. Hammerton

Résumé de l'article aux pages 148 à 154

L'usage des systèmes électroniques de dépouillement de données s'est maintenant généralisé dans les organisations commerciales américaines. Dans la première partie de cet article, l'auteur s'attache à donner un aperçu des conditions de base qu'exigent ces systèmes, telles qu'elles se présentent actuellement, et il relève à cet égard certaines différences de points de vue existant parmi les divers constructeurs de ces installations. La seconde moitié de l'article traite des problèmes de construction proprement dite, ainsi que des conditions et des méthodes de programmation.

Un filtre à ondes simples par D. G. Wyatt

Résumé de l'article aux pages 155 à 157

On peut obtenir un filtre efficace du type passe-haut ou passe-bas en reliant un circuit à T-parallèle en série avec un circuit inductif-capacitif approprié. Une seule inductance est nécessaire, qui est particulièrement utile aux basses fréquences de coupure. Ce dispositif se compare favorablement, tant avec les filtres de type courant qu'avec ceux dérivant d'amplificateurs à contre-réaction, en ce qui a trait à la simplicité, à la stabilité et à l'encombrement.

Le détecteur sensible aux phases à diodes à entrée déséquilibrée par R. Chidambaram et S. Krishnan

Résumé de l'article aux pages 158 à 159

Le fonctionnement du détecteur sensible aux phases, à diodes à entrée déséquilibrée avec charge, est analysé dans cet article. Comme dans le cas du simple détecteur push-pull, les rapports de transfert des deux diodes varient considérablement selon le signal. Ceci provoque une non-linéarité dans la sortie, dont les auteurs évaluent l'importance et donnent une table permettant de juger immédiatement du rendement d'un détecteur donné de ce type. Ils comparent ensuite ce détecteur avec celui à simple push-pull et discutent les conditions de charge qui font la supériorité de l'un par rapport à l'autre, du point de vue de la linéarité.

Un chronomètre "d'événements par unités" par J. D. Storer

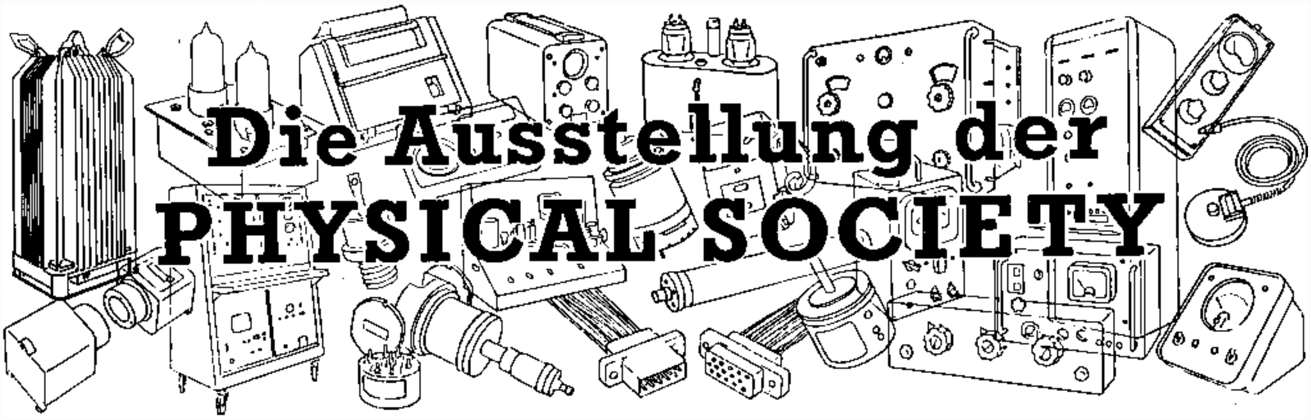
Résumé de l'article aux pages 160 à 162

Cet article décrit un modèle simplifié de chronomètre "d'événements par unités (Chronomètre E.P.U.T.) donnant une lecture en cycles par seconde et ce jusqu'à 999. La forme d'onde à déclenchement toutes les secondes dérive d'un oscillateur à cristal de 1 kHz, ayant une stabilité à long terme non inférieure à une partie dans 10^4. Une sortie à part dans l'oscillateur permet de vérifier la précision du comptage et elle peut être utilisée comme calibre extérieur. Il existe aussi des réenclancheurs manuels et automatiques afin de pouvoir employer l'appareil comme compteur direct.

Calcul des facteurs de bruit des transistors par F. Hibberd

Résumé de l'article aux pages 163 à 164

L'auteur indique une méthode pour estimer les facteurs de bruit des transistors. Cette méthode est basée sur l'utilisation de quatre paramètres de bruit, exprimés en fonction des paramètres de circuits équivalents de transistors. Il en découle une expression générale pour le facteur minimum de bruit, qui peut être simplifiée selon les circonstances.



Die Ausstellung der PHYSICAL SOCIETY

Beschreibung einer kleinen Auswahl der auf der 44. Austellung der Physical Society vom 18. bis 22. Januar in London gezeigten elektronischen Geräte nach Angaben der Hersteller

Übersetzung der Seiten 177 bis 183

ADVANCE COMPONENTS LTD

Roebuck Road, Hainault, Ilford, Essex

FUNKTIONSGEBER FÜR SEHR NIEDRIGE FREQUENZEN

(Abbildung Seite 177)

Der Advance Funktionsgeber für sehr niedrige Frequenzen wurde zur Erzeugung beliebiger Funktionen oder Wellenformen im Frequenzband 10^{-3} Hz . . . 100 Hz entwickelt, das in vier Bereiche unterteilt ist. Er findet daher in Entwicklung und Betrieb von Rechnern, Analyse von Servosystemen, Prüfung von Schreib- und Vibrationsgeräten sowie verschiedenen Nachbildnertypen Anwendung.

Die Methode der Wellenformerzeugung unterscheidet sich von der herkömmlicher Oszillatoren, da ein optisch-mechanisches System benutzt wird, in dem ein enger Lichtschlitz durch eine Drehscheibe mit aufgedrückter lichtundurchsichtiger Fläche abgetastet wird, wobei die Fläche der gewünschten Funktion entspricht. Die Drehscheibe kann leicht gegen Scheiben ausgewechselt werden, die andere Wellenformen bilden. Die dem Benutzer gebotene grosse Anpassungsfähigkeit ist augenfällig, da eine Funktion nur in Polarkoordinaten aufgetragen zu werden braucht, um sie in den verschiedensten Spannungsformen benutzen zu können.

Zur Erreichung von Frequenzgenauigkeit und -stabilität werden die Scheiben über ein Vierganggetriebe von einem Motor mit Servosteuerung getrieben. Für die zwei höheren Frequenzbereiche besteht auch die Möglichkeit eines automatischen Durchlaufs, der z.B. für Vibrationsprüfungen benötigt wird.

Für die beiden niedrigen Bereiche ist die Beschleunigung gross genug, um den Anlauf der Wellenform von einem vorherbestimmten Punkt zu ermöglichen. Für diesen Zweck ist der Scheibenumfang in Winkelgraden geeicht.

Die Gleichstromspannung an den Ausgangsklemmen kann auf jeden Wert zwischen ±25 V gegenüber Masse eingestellt werden und ermöglicht Erzeugung aller Funktionen mit einer Gleichstromkomponenten von Null oder jedem Wert innerhalb dieser Grenzen. Die Ausgangsspannung der Wellenform kann zwischen 200 µV...20 V doppeltem Spitzenwert eingestellt werden.

EE 19 751 *für weitere Einzelheiten*

MESSZÄHLER

(Abbildung Seite 177)

Der Advance Messzähler ist ein tragbares, volltransistorisiertes Gerät mit gedruckten Schaltungen. Sechs Trommelinstrumente zeigen Impulse bis zu einem Maximum von 999 999 an. Taktfrequenzen bis zu 1 MHz können in genauen Zeitspannen gemessen werden, die von einem eingebauten Quarzoszillator für 1^{-10}, 1 oder 10 Sekunden erzeugt werden.

Genauere Anzeigen können für Frequenzen unter 1 kHz durch Messung der Zeitspanne in Einheiten von 1 µs, zwischen zwei Nulldurchgängen des Eingangssignals oder einer Periode erreicht werden. Eine noch grössere Genauigkeit kann durch Messung der Perioden erzielt werden.

Die Ablesegenauigkeit hängt z.T. vom Zähler ab, der genau innerhalb ±1 Impuls anzeigt und z.T. vom eingebauten Oszillator, dessen Quarz von einem temperaturgeregelten Ofen umgeben ist. Die kurzfristige Genauigkeit des Quarzes ist ±1 Teil in 10^6 bei 25°C und ±5 Teile in 10^6 über den Temperaturbereich des Gerätes von 0°...40°C.

Manuelle und automatische Rückstellvorrichtungen sind vorhanden, und für die letztere kann die Anzeigezeit zwischen 1...5 s eingestellt werden.

Zusätzlich kann die zwischen „Start" und „Stop" Signalen abgelaufene Zeit in Einheiten von 1 µs, 10 µs, 100 µs, 1 ms, 10 ms, 100 ms, 1 s oder 10 s gemessen werden. Zufällige Impulse können auch gezählt werden, und mit einer Eigenprüfung kann die Frequenz des eingebauten Oszillators über eine selbsterzeugte 10 s Periode gemessen werden.

In Normalausführung arbeitet das Gerät an Netzspannungen von 100...135 V oder 200...250 V, aber es kann auch für 6 V-Batteriebetrieb geliefert werden.

Bei Batteriebetrieb ist der Ofen stillgelegt, und je nach der Umgebungstemperatur muss eine Verschlechterung der Genauigkeit erwartet werden. Unter 55°C ist die Verschlechterung geringer als 1 Teil in 10^7/°C.

EE 19 752 *für weitere Einzelheiten*

ASSOCIATED ELECTRICAL INDUSTRIES LTD

33 Grosvenor Place, London S.W.1

THERMOELEKTRISCHER REGISTRIERFEUCHTIGKEITSMESSER

Der vorgeführte neue Taupunkt-Feuchtigkeitsmesser ist eines der vielen Geräte, in denen thermoelektrische Abkühlung Anwendung findet. Das aus p- und n-Wismuthtellurid bestehende abkühlende Thermoelement kühlt einen Spiegel; wenn sich Tau niederschlägt, wird er optisch erfasst. Das optische System betätigt einen Regler, der den Strom abschaltet, wenn sich Tau niederschlägt und wieder einschaltet, wenn er verschwindet, so dass das Gerät dauernd arbeitet. Die Spiegeltemperatur wird mittels eines Thermoelementes gemessen und durch einen Schreiber aufgezeichnet.

EE 19 753 *für weitere Einzelheiten*

MIKROWELLEN-ERWÄRMUNGSGERÄT

Das vorgeführte Mikrowellen-Erwärmungsgerät benutzt ein CT-MAGNETRON BM6787, das bei ungefähr 900 MHz 2½ kW abgibt. Verlustarme Werkstoffe werden schneller und mit geringerer elektrischer Beaufschlagung erwärmt als mit den üblichen HF Geräten niedriger Frequenz. Die Erwärmung kann schnell und einheitlich ohne die übliche Wärmeleitungsbegrenzung durch den ganzen Werkstoff stattfinden. Das zu erwärmende Material wird in Block-, Folien- oder Streifenform durch einen Resonanzhohlraum geführt, der durch Abgleich einer Kopplungsblende und eines Abstimmstiftes eine angepasste Belastung für das Magnetron darstellt, wobei die reflektierte Leistung mit einem Richtungskoppler und Detektor überwacht wird.

Von typischen Anwendungen sollen besonders Trocknen von Folien, Vorwärmung von Kunststoff, Kochen und Schmelzen von Spezialglas erwähnt werden.

EE 19 754 *für weitere Einzelheiten*

Digital Differentialanalysator

Diese Maschine wurde zum Ausführen aller Funktionen eines elektronischen Analogrechners entwickelt, und das Bedienungspersonal wird im Vergleich mit einem Analogrechner nicht viel Unterschied sehen. Alle Rechnungen werden jedoch ziffernmässig ausgefürt, und das ergibt Vorteile über den Analogrechner. Der Hauptvorteil ist die Möglichkeit, in Bezug auf Variable zu integrieren, die nicht Istzeit sind. Dadurch wird die Anwendung der Maschine wesentlich erweitert, da z.B. nichtlineare Aufgaben fast so leicht gelöst werden können wie lineare. Die Maschine wurde in versuchsmässiger Ausführung zur Untersuchung der durch diese Rechnermethode anfallenden Probleme gezeigt. Sie soll fast so schnell wie ein Analogrechner arbeiten, d.h. viele Aufgaben können in Istzeit bearbeitet werden. Der Hauptspeicher verwendet Magnetkerne. Die Taktfrequenz ist 2 MHz.

EE 19 755 *für weitere Einzelheiten*

1 MHz-Digitalschaltungen

Schaltungen für Datenverarbeitung mit Digitgeschwindigkeit von 1 MHz und einer maximalen Umgebungstemperatur von 45°C wurden entwickelt. Sie verwenden einen versuchsmässigen Legierungs-Flächentransistor mit Alpha-Grenzfrequenz über 10 MHz und eine versuchsmässige aluminisierte Diode. Mit Hilfe einer Anzahl logischer Bausteine in Verbindung mit Laufzeitspeichern können vollständige Digitalsysteme aufgebaut werden.

Ausgestellt waren zwei Typen der Magnetostriktions - Laufzeitspeicher mit einer Verzögerung von 100 µs bzw. 1 ms. Sie können daher 100 bzw. 1 000 binäre Digits speichern. Die Laufzeitspeicher verwenden Permandurdraht zur Übertragung der Längsbeaufschlagungswelle. Die 1 ms Kette hat einen Temperaturausgleich, der den Abstand zwischen den Umwandlerspulen ändert, um die Laufzeit über einen Temperaturbereich von 20°C innerhalb ±0,1 µs konstant zu halten.

EE 19 756 *für weitere Einzelheiten*

BRITISH PHYSICAL LABORATORIES

Radlett, Hertfordshire

Drehzahlmesser

Das Gerät ist als Kraftfahrzeugzubehör gedacht und wurde zur genauen Messung der UPM von Verbrennungskraftmaschinen entwickelt. Vorteile gegenüber mechanischen Typen sind grössere Genauigkeit, vollständige Geräuschlosigkeit bei allen Geschwindigkeiten und einfache Montage.

Das vollständige Instrument einschliesslich elektronischer Bausteine und Anzeiger befindet sich in einem runden Metallgehäuse von 89 mm Durchmesser und 63,5 mm Tiefe. Die einzigen erforderlichen Verbindungen bestehen aus zwei Leitungen zur Batterie und einem Draht, der um die isolierte Hochspannungsleitung gewickelt wird.

Grundsätzlich besteht die Schaltung aus einem monostabilen transistorisierten Oszillator, der von den HF Impulsen des Zündgerätes getriggert wird, wobei diese Impulse kapazitiv von der Hochspannungsleitung abgenommen werden.

Die Zählfrequenzschwankungen der Impulse veranlassen Änderungen im Verhältnis der Impulsbreite zum Impulsabstand im Oszillator, und der sich daraus ergebende Gleichstrompegel ist der Motorgeschwindigkeit proportional. Die Firma benutzt ihr neues Messgerät mit 270° Anzeige.

EE 19 757 *für weitere Einzelheiten*

Megohmmeter

Das Megohmmeter Modell RH160 ist ein neues Gerät zur Messung von Isolationswiderständen bis zu 400 TΩ. Das Gerät ist vollständig in sich abgeschlossen mit eigenem variablem Prüfdruck bis zu 500 V und einer festen Testspannung von 1000 V.

Das Megohmmeter kann den 1 min-Isolationswiderstand von Kondensatoren messen, einschliesslich solcher mit Polystyrol Dielektrikum, deren Isolationswiderstand über 750 GΩ-µF liegt. Neu ist die vollautomatische Laufzeitschaltung, die die Ladezeit des Prüflings berechnet. Nach Ablauf der berechneten Verzögerung wird der Prüfling an den Messkreis angeschaltet.

Ein Zerhackerverstärker macht das Instrument praktisch driftfrei. Der Gesamtmessbereich ist 90 kΩ ... 400 TΩ.

Dieses Instrument kann zum Messen des spezifischen Widerstandes und Oberflächenwiderstandes von isolierendem Weichgummi und Hartgummi nach der britischen Norm BS 903, Teil 3, 1950 benutzt werden. Eine vollständige Einrichtung nach Abschnitt 33,23 der Norm ist lieferbar.

EE 19 758 *für weitere Einzelheiten*

CAWKELL RESEARCH AND ELECTRONICS LTD

Scotts Road, Southall, Middlesex

Variables Filter

(*Abbildung Seite 178*)

Dieses neue Filter hat einen weiten Anwendungsbereich und besteht hauptsächlich aus zwei Filtern in einem Gehäuse. Jedes dieser Filter kann entweder Hoch- oder Tiefpass sein. Der −3dB Punkt jedes Filterabschnitts kann kontinuierlich von 2 Hz...150 kHz verändert werden, und die Flankensteilheit ist 36dB/Oktave. Durch geeignete Verdrahtung können folgende Filter hergestellt werden:

- Bandpassfilter mit 36dB/Oktave Flankensteilheit.
- Bandsperrfilter mit 36dB/Oktave Flankensteilheit.
- Tiefpassfilter mit 36dB/Oktave Flankensteilheit.
- Hochpassfilter mit 36dB/Oktave Flankensteilheit.
- Tiefpassfilter mit 72dB/Oktave Flankensteilheit.
- Hochpassfilter mit 72dB/Oktave Flankensteilheit.

Das Filter hat den Verstärkungsfaktor 1 und enthält keine induktiven Elemente. Die Eingangsimpedanz ist hoch, die Ausgangsimpedanz niedrig. Es ist für Signale mit hohem Pegel geeignet.

Das Filter wurde zusammen mit einem Frequenzkurvenschreiber und einem für lange Nachwirkung eingestellten „Remscope" vorgeführt.

EE 19 759 *für weitere Einzelheiten*

COSSOR INSTRUMENTS LTD

Cossor House, Highbury Grove, London N.5

Schnelloszillograf

(*Abbildung Seite 178*)

Der schnelle Einstrahl-Oszillograf 1076 ist mit einer 127 mm Bildröhre mit einem gesamten Beschleunigungspotential von 10 kV ausgerüstet. Einsteckbausteine ergeben eine weite Leistungswahl für horizontale und vertikale Kanäle. Eine typische Kombination von Einsteckbausteinen gibt für den Y-Verstärker eine Bandbreite von 0...60 MHz, Höchstempfindlichkeit von 50 mV/cm bei 6 cm voller Ausgangsablenkung sowie einem getriggerten Ablenkteil mit geeichten Ablenkgeschwindigkeiten von max. 20 ns/cm bis zu 10 s/cm herunter. Für alle Bereiche ist eine 10 cm Ablenkung vorhanden und Ablenkungsausdehnung ist eingebaut. Die Eichung ist genau innerhalb ±2% für Spannungen von 50 mV...120 V. Mit Hilfe geeigneter dämpfender Messköpfe kann dieser Bereich nach oben ausgedehnt werden. Die Zeitmessungen sind innerhalb ±5% genau. Ein 500 MHz Oszillator in Torschaltung gibt Helltastpulse in 2 ps Abständen zur genauen Messung der Impulsanstiegzeit.

Alle Hoch-, Anoden- und wichtigen Niederspannungen sind gegen Netz- und Belastungsschwankungen stabilisiert.

Der Oszillograf wurde mit folgenden Einsteckbausteinen vorgeführt: Breitband-Vorverstäker Modell 1078 und Triggergerät Modell 1079. Andere Bausteine zur Erweiterung der X- und Y-Kanalfunktion, z.B. Hochleistungs-differential-Y-Vorverstärker und ein Triggergerät mit Präzisionsverzögerung, werden in Kürze lieferbar sein.

EE 19 760 *für weitere Einzelheiten*

Signalgenerator

(*Abbildung Seite 178*)

Modell 1450 ist ein Mehrzweck-Signalgenerator, der in sieben Frequenzbereichen einen abstimmbaren Ausgang mit einer Eichgenauigkeit von ±1% bis 33 MHz und ±1,5% auf höheren Frequenzen abgibt.

Das Signal kann unmoduliert, moduliert mit eingebautem NF-Oszillator oder fremdmoduliert abgegeben werden. Die Modulationstiefe kann mit Eigenmodulation bis zu einem Maximum von 50% geregelt werden.

EE 19 761 *für weitere Einzelheiten*

DYNATRON RADIO LTD

Maidenhead, Berkshire

STABILISIERTES NETZGERÄT

(*Abbildung Seite 179*)

Die Funktion des Netzgerätes Type N104/5 ist die Abgabe stabilisierter Hochspannung für G. M. Zählrohre und Ionisationskammern. Die Konstruktion ist anpassungsfähig, und bei Verwendung von Einsteck-Bausteinen N106 können ein, zwei oder drei getrennte, einstellbare und stabilisierte Ausgangsspannungen vorgesehen werden. Der Spannungsbereich liegt zwischen 350...1700 V, und Stabilisation erfolgt durch Koronaentladungsröhren. In zwei Ausführungen lieferbar: Type 104 für vollständig unabhängigen Netzanschluss und Type 105, die durch Anschluss an einen Untersetzer, z.B. Dynatron 1009E versorgt wird.

Type N103 wurde auch gezeigt; es ist ein hochstabilisiertes Netzgerät für Hochspannungen, die für die meisten Zähler in der Kernphysik, besonders Szintillationszähler und andere Proportionalzähler mit äusserster Stabilität, benötigt werden.

Die Ausgangsspannung ist durchgehend zwischen 300...3300 V jeder Polarität einstellbar, und Ausgangsstrom wird bis zu 1 mA abgegeben. Die Stabilität ist in der Grössenordnung von 0,02%.

EE 19 762 *für weitere Einzelheiten*

BODENDICHTE UND -FEUCHTIGKEITSMESSUNGEN

Ein kombiniertes System zum Messen der Bodendichte und -feuchtigkeit in einem tragbaren Gerät mit Batterieantrieb wurde entwickelt, um bei der Kontrolle der Bodenverdichtung zu helfen. Das Dichtemesssystem besteht aus einem Geigerrohr und einer Gammastrahlenquelle und kann mit der Quelle auf der Bodenoberfläche oder in geeigneter Tiefe benutzt werden. Das Feuchtigkeitsmesssystem besteht aus einem Proportionalzähler Muster BF3 und einer Quelle schneller Neutronen. Eine eingeschlossene 10 MHz-Radium-Beryllium-Quelle gibt energiereiche Gammastrahlen und schnelle Neutronen ab. Beide Systeme sind zusammen mit einer transistorisierten Hochspannungsquelle und einem Vorverstärker in ein Gehäuse eingebaut. Impulse vom Geigerrohr und dem BF3-Rohr werden mit dem tragbaren Dynatron Transistor-Untersetzer Type 1287A gemessen.

EE 19 763 *für weitere Einzelheiten*

EKCO ELECTRONICS LTD

Southend-on-Sea, Essex

X-Y-SCHREIBGERÄT

(*Abbildung Seite 179*)

Dieses schnelle X-Y-Schreibgerät Type E193 zeichnet die Beziehungen zwischen zwei Variablen direkt auf Standardregistrierpapier 254 × 184 mm auf. Auf Grund des weiten Empfindlichkeitsbereiches und schnellen Ansprechens findet es ungewöhnlich vielseitige Anwendung auf den Gebieten der Verfahrensüberwachung und Leistungsuntersuchung. Die Eingangsimpedanz ist 1 MΩ, und der Empfindlichkeitsbereich für jede Achse geht in 12 Stufen von 0,4 mV/cm...4 V/cm.

EE 19 764 *für weitere Einzelheiten*

ELECTRONIC TUBES LTD

Kingsmead Works, High Wycombe, Buckinghamshire

PREISGÜNSTIGE ELEKTRONENSTRAHLRÖHRE

Die 127 mm Bildschirmröhre wird für Anwendungszwecke entwickelt, für die niedrige Kosten und grosser Schirmdurchmesser von ausschlaggebender Bedeutung sind, hohe Leistung jedoch keine Rolle spielt. Um die Kosten herabzusetzen, werden alle Verbindungen durch den Sockel geführt, und die innere Struktur wurde wesentlich vereinfacht. Durch ihren flachen Schirm gibt die Röhre eine Darstellung, die der teurerer Röhren gleichwertig ist.

EE 19 765 *für weitere Einzelheiten*

HOCHEMPFINDLICHE ELEKTRONENSTRAHLRÖHRE FÜR INSTRUMENTE

In Elektronenstrahlröhren mit Nachbeschleunigung wird eine Sammellinse von Beschleunigungsfeldern gebildet, die in die Gegend innerhalb der Ablenkplatten eindringen, die dem Bildschirm am nächsten liegen. Dadurch wird das zulässige Nachbeschleunigungsverhältnis effektiv begrenzt. Höhere Empfindlichkeiten mit reduzierter Verzerrung können jedoch erreicht werden, wenn dieses Durchdringen des Feldes durch Einschaltung eines Übertragungsgitters oder einer Abschirmung zwischen dem Ablenkungs- und Nachbeschleunigungssystem entfernt wird.

Durch Justieren der Schirmlage gegenüber dem Ablenksystem kann das Feld so geformt werden, dass dadurch das Nachbeschleunigungssystem Ablenkexpansion hervorruft. Dadurch können Röhren hergestellt werden, deren Ablenkempfindlichkeiten in jeder Richtung abweichen oder vom Nachbeschleunigungsverhältnis unabhängig sind.

Im Modell 5CLP1 sind die X-Platten dem Bildschirm näher als die Y-Platten. Daher wird die Abschirmung in keiner Lage die Unabhängigkeit beider Ablenksysteme von Schwankungen im Nachbeschleunigungsverhältnis garantieren. Die gewählte Lage bringt mit erhöhtem Nachbeschleunigungsverhältnis eine kleine Erhöhung der X-Ablenkempfindlichkeit und eine sehr kleine Empfindlichkeitserhöhung der Y-Ablenkung.

EE 19 766 *für weitere Einzelheiten*

ELLIOTT BROTHERS (LONDON) LTD

Century Works, Lewisham, London S.E.13

MESSHOHLLEITER FÜR STEHWELLEN

(*Abbildung Seite 179*)

Der Präzisions-Messhohlleiter Type B433 ist ein sehr genaues Instrument, dessen Hohlleiter mit Schlitz besonders entwickelt wurde, um sowohl Phasengeschwindigkeit wie Impedanz über die ganze Länge den Nennwerten für Hohlleiter Nr. 16 sehr nahe zu halten. Der Schlitten, auf dem sich der Detektor mitbewegt, ist kinematisch auf dauernd gereinigten Führungen gelagert, die parallel zur Hohlleiteroberfläche gearbeitet sind, so dass die Kopplung während des Schlittendurchlaufs innerhalb ein oder zwei Hundertstel Dezibel konstant bleibt. Die Kopplung zu dem mitlaufenden Detektor hat Mikrometereinstellung, und der Messkopf kann mittels eines Zwitter-Anpassungsumformers auf Resonanz abgestimmt werden, wodurch Fehler durch seine eigene Reflexion im Hohlleiter verringert werden. Mittels einer genauen und leicht ablesbaren Skala und eines Ziffernblattes können Phasenmessungen bis zu 0,002 Bogeneinheiten ausgeführt werden.

EE 19 767 *für weitere Einzelheiten*

MIKROWELLEN-TESTOSZILLATOR

(*Abbildung Seite 179*)

Dieses Instrument Type B689 arbeitet im Frequenzbereich 7...12 GHz und besteht aus einem koaxialen Leitungshohlraum, der für Verwendung mit Einsteck-Klystron Type CV2346 konstruiert ist, dem stabilisierten Netzteil für den Betrieb des Klystrons und einem Rechteckgenerator, der ein Signal von 400 Hz...4 kHz für Kathodenmodulation liefert. Fremdmodulation der Kathode oder des Reflektors ist auch vorgesehen. Die HF-Energie wird durch einen koaxialen Stecker abgenommen, und über ein breites Band steht für normale Mikrowellenmessungen genügend Ausgangsleistung zur Verfügung. Eine frequenzgesicherte Skala auf der Frontplatte gibt eine eindeutige Anzeige der Betriebsfrequenz.

EE 19 768 *für weitere Einzelheiten*

ERICSSON TELEPHONES LTD

Beeston, Nottingham

ZÄHLER MIT ZWEIFACHORIENTIERUNG

(*Abbildung Seite 180*)

Modell 135A/A2 ist typisch für eine Serie von acht Zählern mit Zweifachorientierung. Es nimmt von zwei Quellen positive Impulse einer Mindestamplitude von 45 V auf und zählt sie. Auf Daktron-Röhren wird die arithmetische Differenz der beiden Zählungen angezeigt. Eine Sichtanzeige gibt den Kanal an, auf den sich die Zählung bezieht. Die höchste Taktfrequenz ist 100 Hz pro Kanal und der Zählbereich 10^4 jederseits von Null.

EE 19 769 *für weitere Einzelheiten*

STRAHLUNGSMESSGERÄT-BAUSTEINE

(*Abbildung Seite 180*)

Diese Geräteserie wurde von E.T.L. aus dem A.E.R.E. Harwell Type 2000 entwickelt und wird in Form von Bausteinen mit genormten Abmessungen gebaut, die als Strahlungszählgeräte zusammengestellt werden können, um als Szintillationszähler mit Ionisationskammern oder Proportionalzählern Verwendung zu finden.

Das vollständige Gerät umfasst: einen

schnellen Voruntersetzer, dessen Auflösungszeit besser als 1 µs ist mit einem Untersetzungsfaktor von 10^2; einen langsamen Untersetzer mit einer Auflösungszeit von 250 µs und einem Untersetzungsfaktor von 10^4; einen Diskriminator, der feststehende 200 mV und variable Spannungen von 1 ... 10 V unterscheidet; einen 2 MHz Verstärker bestehend aus einem Kathodenverstärker, Kopfverstärker, Verstärker für hohe und niedrige Signalpegel mit 150 dB bzw. 60 dB Verstärkung. Das gesamte Brummen aller hintereinander geschalteten Verstärker ist besser als 35 mV doppelter Spitzenwert bei Höchstverstärkung und bezogen auf den Kathodenverstärkungseingang. Löschschaltungen haben sechs vorgewählte Stillegungszeiten zwischen 100 ... 600 µs; Zeitmesser; Hochspannungsquellen mit kontinuierlich variablem Ausgang zwischen 300 ... 2 000 V; Szintillationskopf zum Nachweis von Alpha-, Beta-, Gamma- und Röntgenstrahlungen sowie schnellen und langsamen Neutronen; Netzgeräte.

Die Bausteine werden in Gestelle und Steuergeräte eingeschoben, die mechanische Stabilität geben und die elektrischen Verbindungen herstellen. Ein in den Steuergeräten vorgesehener thermischer Verzögerungsschalter erlaubt Zeit zum Anwärmen der Röhren, bevor die Anodenspannung angelegt wird.

EE 19 770 *für weitere Einzelheiten*

FERRANTI LTD

Hollinwood, Lancashire

MAGNETTROMMELSPEICHER

Eine neue Magnettrommel Type MD5 wurde ausgestellt. Das Gerät besteht aus einer Doppeltrommel und wird von einem aussen angebauten Motor getrieben, der für Geschwindigkeit und Netzspannung auswechselbar ist. Jede Trommel ist 152,4 mm hoch und hat 355,6 mm Durchmesser.

Der Speicher hat 160 Spuren mit je 128 aus 50 Bits bestehenden Worten und damit 1 024 000 Bits. Die Nenngeschwindigkeit der Trommel ist 2 500 UPM, aber in gewissen Grenzen können die Werte für Kapazität und Geschwindigkeit erhöht werden. Die Magnetköpfe sind in Gruppen von 18 montiert, von denen 16 in normalem Gebrauch sind. Jede Gruppe kann ohne Einstellungsänderung zum Reinigen abgenommen werden. Die Spur ist 0,76 mm und der Magnetkopfspalt 0,05 mm breit.

EE 19 771 *für weitere Einzelheiten*

FLANN MICROWAVE INSTRUMENTS LTD

9 Old Bridge Street, Kingston-on-Thames, Surrey

STEHWELLENMETER

(*Abbildung Seite 180*)

Zu einer umfangreichen Auswahl von Mikrowelleninstrumenten gehört eine Serie von Stehwellenmetern Klasse 1, die über den Bereich 2,6 ... 26,5 GHz geht; abgebildet ist Modell 10/3 mit einem Frequenzbereich von 2,6 ... 3,95 GHz.

Der Hohlleiter des Messgerätes hat einen grossen Querschnitt, und entlang der Mittellinie der längeren Seite befindet sich ein angepasster Schlitz, durch den ein variabler serien-parallel abgestimmter Abtaststift gekoppelt ist, der von einem kinematisch gelagerten Schlitten getragen wird.

Die Spitze des Abtaststiftes geht durch den Schlitz und ist von einer vollständig gedrosselten und angepassten Zunge umgeben. Um das Schlitz- und Schlitzenzentrum ist völlige HF-Symmetrie erhalten, um Freiheit von unechten Resonanzen zu garantieren.

Zifferblattanzeigen geben die Entfernung vom Abtaststift zum Endflange für alle Geräte mit Ausnahme der Modelle 10/3 und 12/3, für die Feineinstellung vorgesehen ist. Um das ganze System ist eine eng anliegende Staubhaube angeordnet, die für Kugellager usw. ausreichenden Schutz gibt.

Die Instrumente werden mit eingebautem koaxialem Quarz für gleichgerichteten Ausgang geliefert. Hohlleiter sind versilbert und mit Rhodium plattiert.

EE 19 772 *für weitere Einzelheiten*

THE GENERAL ELECTRIC CO. LTD

(Research Laboratories)

Wembley, Middlesex

PARAMETRISCHER ELEKTRONENSTRAHL-VERSTÄRKER

(*Abbildung Seite 180*)

Dieses Gerät wurde für Verstärkung schwacher Signale ohne proportionale Erhöhung des Geräuschpegels entwickelt.

Wenn eine Tonwelle durch ein Gas geht, werden die Moleküle in einer Serie von Verdichtungen und Verdünnungen ansprechen und die Welle bewegt sich, unabhängig von der Frequenz, mit konstanter Geschwindigkeit. In ähnlicher Weise wird sich ein HF-Signal, das einem konstanten Gleichstrom-Elektronenstrahl zugeführt wird, durch den Zusammenbündlungs- und Entbündlungseffekt der Elektronen fortpflanzen, in diesem Falle aber als zwei verschiedene Wellen: eine mit einer etwas höheren Geschwindigkeit als der Elektronenstrahl und eine mit etwas niedrigerer. Sie sind die schnellen und langsamen Raumladungswellen.

Bisher haben alle Strahltypen-Verstärker (Klystrons, Wanderwellenröhren usw.) von der langsamen Raumladungswelle Gebrauch gemacht, und diese Welle wird mit wachsendem HF-Signal verstärkt. Das von der Kathode herrührende Geräusch kann nicht von der Welle entfernt werden und erhöht sich mit dem Signal.

Das gezeigte Gerät verstärkt die schnelle Raumladungswelle, von der das Kathodengeräusch entfernt werden kann, bevor das Signal zugeführt wird. Die Verstärkung wird durch gegenseitige Einwirkung der Felder erzielt, die durch den Bündlungsvorgang der Signalfrequenz und den Treiber (Pumpe genannt), der auf der doppelten Frequenz arbeitet, hervorgerufen werden.

Die Vorführung zeigt, dass im Elektronenstrahl wachsende Wellen vorhanden sind, die durch solche Einwirkungen entstehen. Der Elektronenstrahl läuft durch eine Reihe von Hohlräumen, die die Signalzuführung ermöglichen. Der Ausgang wurde durch einen beweglichen Hohlraum aufgenommen, der entlang dem Elektronenstrahl läuft und die Wellen während des Fortschrittes überwacht. Die wachsenden Wellen wurden durch Sichtanzeige demonstriert.

EE 19 773 *für weitere Einzelheiten*

DIGITAL-ANZEIGERÖHRE

Diese Elektronenstrahlröhre wird als Sichtanzeige für Digitalinformation eingesetzt. Sie arbeitet mit einer Gesamtspannung von einigen hundert Volt. Die notwendige Schaltspannung ist jedoch nur einige Zehner-Volt.

Vorteile dieser Sichtanzeige gegenüber anderen Typen sind geringer Schaltleistungsbedarf und die Möglichkeit, die Röhre in Zeitselektionsschaltungen zu benutzen.

EE 19 774 *für weitere Einzelheiten*

MULLARD LTD

Mullard House, Torrington Place, London W.C.1

Ausser Geräten, die schon lieferbar sind, wurden folgende Forschungsprojekte ausgestellt:

DÜNNER MAGNETISCHER FILM

Die ausgestellten Filme geben einen Einblick in die Laboruntersuchungen der Eigenschaften sehr dünner magnetischer Filme (ungefähr 1000 Å dick), die ausgezeichnete Anwendungsmöglichkeiten als bistabile Speicherelemente für Rechner haben.

Ein in einem gleichförmigen magnetischen Feld verdampfter Nickeleisenfilm zeigt einachsige Anisotropie. Wenn der magnetische Vektor von einem magnetischen Feld senkrecht zur Anisotropieachse beeinflusst wird, das schwächer als das Anisotropiefeld ist, kann er zwei stabile Zustände haben. Auf diese Weise kann binäre Information gespeichert werden. Der Übergang von einem Zustand in den anderen kann unter dem Einfluss eines Triebfeldes parallel zur Anisotropieachse innerhalb von Zehnteln ns erfolgen.

Diese Elemente können schneller geschaltet werden als die üblichen Magnetkerne, und es ist möglich, dass sie billiger sein werden.

Eine Matrizenanordnung aus 64 dünnen Filmelementen wurde vorgeführt und zeigte das Verhalten der Elemente in der Matrize. Eine weitere Demonstration zeigte die zur Messung der Grundkennzeichen der Elemente notwendigen Geräte, die abgebildet sind.

EE 19 775 *für weitere Einzelheiten*

Schneller Magnetkernspeicher

Untersuchungen der schnellen Rechnertechnik haben zur Entwicklung eines Magnetkernspeichers geführt, der mit Impulsen von nur 0,1 μs Dauer geschaltet werden kann und einen Schreib-/Lesetakt von weniger als 1 μs hat.

Das System, dessen Prinzip im vorigen Jahr auf der Ausstellung gezeigt wurde, benutzt zwei Kerne für jede gespeicherte Ziffer. Während der Schreiboperation werden beide Kerne von einem remanenten Zustand durch einen kurzen Stromimpuls von ungefähr, 0,1 μs zu dem anderen getrieben, der die Kerne nur teilweise schaltet. Zur gleichen Zeit wird beiden Kernen ein Digitimpuls viel kleinerer Amplitude in einer solchen Richtung zugeführt, dass er dem Schreibimpuls in einem Kern hilft und in dem anderen entgegenwirkt. Dadurch wird während des Schreibimpulses ein Kern weiter geschaltet als der andere.

Zum Lesen der Information von den Kernen werden diese durch einen Leseimpuls in entgegengesetzter Richtung zum Schreibimpuls wieder in den ursprünglichen Zustand zurückgeführt. Der weiter geschaltete Kern ruft am Ausgangsdraht, der in Serienopposition durch die beiden Kerne geführt ist, ein grösseres Signal hervor. Dadurch erscheint die Differenz der beiden Signale am Draht, und das Vorzeichen dieses Signals zeigt die Polarität des während des Schreibvorganges zugeführten Digitimpulses an. Eine Polarität dieses Impulses kann zur Anzeige von L, die andere für O benutzt werden. Die geringe Amplitude des Digitimpulses ermöglicht Anordnungen, in denen der Digitdraht durch die unadressierten Worte führt, ohne sie zu stören.

Ein Teil eines 1024-Wort-Speichers nach diesem Prinzip wurde vorgeführt.

EE 19 776 *für weitere Einzelheiten*

G. V. PLANNER LTD

Windmill Road, Sunbury-on-Thames, Middlesex

Magnetempfindliche Elemente

(*Abbildung Seite 181*)

Die gezeigten Indiumantimonid- und Indiumarsenid-Hall-Elemente mit äusserst dünnen Halbleiterquerschnitten (7,6 μ) machen einen Minimumspalt im magnetischen Steuerkreis möglich. Die Elemente sind robust konstruiert, und die empfindlichen Halbleiter mit den anhaftenden Polschuhen sind in Hochtemperaturharz eingekapselt. Durch Verwendung der dünnen Halbleiterquerschnitte werden relativ hohe Widerstandswerte erreicht, und die Hall-Spannungen sind bis zu 4 V für Eigenindiumantimonid oder entsprechend höher für die p-Type oder Indiumarsenid. Die Elemente können Temperaturen bis zu 200°C aushalten.

Die Verwendung dieser Elemente in Vervielfacherschaltungen wurde gezeigt. Unter anderen Anwendungsbeispielen werden Verstärker- und Oszillatorschaltungen genannt.

Neue Typen der magnetempfindlichen Indiumantimonid - Corbino - Widerstände wurden auch gezeigt. Sie erlauben höhere Leistungszerstreuung und sind auch robust konstruiert.

Das empfindliche Element und die hochpermeablen Polschuhe, die für Feldkonzentration angeordnet sind, sind auch in Hochtemperaturharz eingekapselt. Der Widerstand dieser Elemente wird durch ein Feld von 10 000 Gauss zwanzigfach erhöht.

Die Abbildung zeigt links ein InSb-Hall-Element und rechts einen InSb-Corbino-Widerstand.

(Diese Entwicklung wurde in Zusammenarbeit mit Cosmocord Ltd. durchgeführt.)

EE 19 777 *für weitere Einzelheiten*

Oxydüberzogene Glasfaser

(*Abbildung Seite 181*)

Eine Maschine für kontinuierliche Beschichtung von Glasfaser mit einem leitenden Oxydfilm für elektrische Widerstände wurde gezeigt. Die Maschine besteht aus einem Präzisionsgetriebe für den Vorschub der Glasfaser durch den Beschichtungsofen, in den die oxydbildende Mischung eingespritzt wird. Feinregelung des Widerstandswertes erfolgt durch automatische Steuerung der Fasergeschwindigkeit über Messköpfe, die den Widerstandswert am Ofenausgang überwachen.

Die überzogene Faser hat üblicherweise einen Durchmesser von 0,025 mm und wird auf Glas- oder Keramikkörper gewickelt, um hochohmige Widerstände herzustellen. Versuchswiderstände dieser Art werden gezeigt.

Einige der für dieses System genannten Vorteile sind die hohen Ohmwerte pro Raumeinheit (die zur Zeit in Gebrauch befindlichen Widerstände geben bis zu mehreren Megohm pro 25,4 mm Faserlänge) sowie die Stabilität und Trägheit der Oxydbeschichtung auf Glasbasis im allgemeinen. Wie bei anderen Oxydschichtwiderständen kann der Temperaturkoeffizient des Widerstandes durch geeignete Zuordnung der Schichtstärke und Oxydzusammensetzung in niedrigen Grenzen gehalten werden. (Patente angemeldet.)

EE 19 778 *für weitere Einzelheiten*

THE PLESSEY CO. LTD

Vicarage Lane, Ilford, Essex

Gussdauermagnete

(*Abbildung Seite 182*)

Magloy-Magnete sind für die verschiedensten Zwecke lieferbar, besonders aber für das Mikrowellengebiet, d.h. Magnetrons, Klystrons, Carcinotrons, Radarisolatoren, Masars und Wanderwellenverstärker. Die Magnete können mit Kunststoffumhüllung oder in Aluminium - Spritzgussgehäusen geliefert werden, die schnelle Montage von Röhren-Bausteinen erleichtern. Das Aluminiumgehäuse kann leicht entsprechend Konstruktionsanforderungen mit kleinen Toleranzen bearbeitet werden. Die meisten Magnete dieser Art sind aus Magloy 1 mit einem BH_{max} von $5{,}2 \times 10^6$ Gauss-Oersted hergestellt. Andere Legierungen sind auch lieferbar. Infolge der Entwicklung neuer Herstellungsmethoden kann dieses hohe Energieprodukt selbst bei grossen Magneten erreicht werden.

Die Magnete werden auch für Lautsprecher, Drehspulinstrumente, Messgeräte und Einsatz für kernmagnetische Resonanz, Massenspektrografie und ähnliche Gebiete benutzt.

EE 19 779 *für weitere Einzelheiten*

W. G. PYE & CO. LTD

Granta Works, Cambridge

Gleichstromverstärker

(*Abbildung Seite 182*)

Das Gerät wurde als zuverlässiger Niederleistungsverstärker für industrielle und Labormessungen und Aufzeichnung schwacher Spannungssignale von Thermoelementen und -säulen entwickelt.

Verwendung eines zuverlässigen Zerhackers mit Verstärkung des Wechselstromträgers, phasenempfindlicher Abtastschaltungen und Gegenkopplung über den ganzen Verstärker ergibt ausgezeichnete Verstärkungsstabilität und sehr geringe Drift. Die Nachteile der meisten Zerhackerverstärker, die die Netzfrequenz als Träger benutzen, wurden in Betracht gezogen, und das Gerät wurde für Betrieb ohne geerdete Klemme unter allen normalen Bedingungen konstruiert. Zu diesem Zweck wurden Siebkreise eingebaut, die den Einfluss der Netzfrequenz-Komponenten auf den Eingangskreis verringern.

Signale für Vollausschlag in den vier Bereichen von ± 100 μV, ± 1 mV, ± 10 mV und ± 100 mV ergeben Ausgangsspannungen von ± 10 V mit Stromstärken bis zu 5 mA. Nach Anwärmen ist die Drift nicht höher als ± 1 μV. Linearität ist besser als $\pm 0{,}5$%. Der Eingangswiderstand ist 3,5 kΩ.

EE 19 780 *für weitere Einzelheiten*

ROYSTON INSTRUMENTS LTD

Hanworth Lane, Chertsey, Surrey

Geräuschanalysator für Rotierende Maschinen

Ursprünglich wurde das Gerät zur Ausführung regelmässiger Tests der in Kraftfahrzeuggetrieben durch Eingriff auftretenden Geräusche über einen grossen Bereich von Eingangsschaft-Geschwindigkeiten entwickelt. Zwei feststehende Bandbreiten können gewählt werden, und die Analysatorregelung erfolgt automatisch in Abhängigkeit von der Eingangsschaft-Geschwindigkeit. Ausser einem Geräusch- oder Vibrationsumwandler sind als Zubehör nur eine Reihe Zahnräder mit einem magnetischen Abnehmer nötig. Die Zahnräder werden auf den Antriebsschaft montiert. Die Anzahl der Zähne ist den verschiedenen Übersetzungen angepasst, und die vom magnetischen Abnehmer kommende Signalfrequenz regelt die Analysatorfrequenz. Der Durchlass ist rechteckig mit über 50 dB Sperrung für Signale ausserhalb des Durchlassbereiches; der Analysator arbeitet von 2 Hz...20 kHz und kann auch als herkömmlicher, genauer Breitband-Wellenanalysator benutzt werden, indem anstelle des Ausgangs des magnetischen Zahnradgenerators der Ausgang eines normalen Lab-Oszillators zugeführt wird.

EE 19 781 *für weitere Einzelheiten*

SERVOMEX CONTROLS LTD
Crowborough, Sussex

ÜBERGANGSFUNKTIONS-ANALYSATOR

Das Gerät ist der Prototyp eines vielseitigen Instrumentes zur Bestimmung des dynamischen Frequenzganges von Servoeinrichtungen und automatischen Reglersystemen.

Umlaufende Synchronisatoren erzeugen die Sinuswelle und multiplizieren das gemessene Signal mit der Grundfrequenzkomponente. Der multiplizierende Servomotor produziert zwei Ausgänge, von denen einer proportional zur reellen, der andere zur imaginären Komponente des gemessenen Signals ist.

Besondere Schaltungen integrieren jeden Ausgang über eine Periode der Grundfrequenz. Dadurch wird der Einfluss der periodischen Komponente ausgeschaltet, d.h. Harmonische und der Einfluss nicht zugeordneter Signale, deren Frequenzen in Bezug auf die Grundfrequenz hoch sind.

Am Ende jeder vollständigen Periode wird der Integratorausgang abgetastet und bis zum Ende der nächsten Periode gehalten, wenn eine neue Messung stattfindet. Nach einer Frequenzperiode, wenn das System sich eingestellt hat, kann daher eine stetige Messung stattfinden.

Der Antrieb für den umlaufenden Synchronisator erfolgt über einen Motor mit Servogeschwindigkeitsregelung, dessen Bedienungsorgane je nach Bereichwahl in Zeitspannen oder Frequenzen geeicht sind. Eine direkte mechanische Abgabe geringer Drehkraft ist für die Grundfrequenz vorhanden und kann beim Antrieb mechanischer oder hydraulischer Systeme vorteilhaft sein.

Elektrische sinusförmige Ausgänge sind für die Grundfrequenz oder Grundfrequenz auf Träger vorhanden. Bei Prüfung eines Trägerfrequenzsystems benutzt der Analysator die eigene Trägerquelle.

Zum Messen nimmt das Gerät elektrische Signale der Grundfrequenz direkt oder auf Träger über einen grossen Amplitudenbereich auf. Die Eingangsimpedanz ist hoch und erlaubt Verwendung vieler Umwandlertypen.

Der Frequenzbereich ist ausreichend für die Analyse aller Systeme von chemischen Verfahren mit langer Ansprechzeit bis zu elektromechanischen Schnellservos.

Die Phasenanzeige ist innerhalb ±1° und die Amplitudenanzeige innerhalb ±2% genau.

EE 19 782 *für weitere Einzelheiten*

THE SOLARTRON ELECTRONIC GROUP LTD
45 Thames Street, Kingston-on-Thames, Surrey

ZWEISTRAHL-OSZILLOGRAF

(Abbildung Seite 182)

Der CD.1014 ist ein tragbarer Hochleistungs-Zweistrahl-Oszillograf mit der neuesten ETEL Röhre mit flachem Bildschirm von 89 mm (3½ Zoll) Durchmesser und doppelter Elektronenkanone, der nur 10 kg wiegt.

Die beiden vertikalen Ablenkverstärker haben identische Schaltungen, und jeder Kanal hat eine grössere Bandbreite als 0...5 MHz (−3 dB) bei einer Höchstempfindlichkeit von 100 mV/cm. Durch geeichte Dämpfungsregler kann die Empfindlichkeit auf 100 V/cm herabgesetzt werden. Ein eingebauter, wechselstromgekoppelter Vorverstärker kann die Empfindlichkeit für eine Bandbreite von 2,5 Hz...50 kHz auf 1 mV/cm erhöhen. Daher ist die Empfindlichkeit von 1 mV/cm...100 V/cm kontinuierlich regelbar.

Ein sehr linearer Kippgenerator gibt fortlaufend regelbare Ablenkgeschwindigkeiten von 1 μs/cm...1 s/cm, und eine geeichte Ausdehnung bis zu 10 × ist auch vorhanden.

Synchronisierung und Triggerung können durch eingebaute oder Fremdwellenformen betätigt werden. „Triggerpegel"-Steuerung ermöglicht Triggern des Kippgenerators von einem gewählten Punkt der Wellenform. Diese zweckmässige Eigenschaft garantiert zusammen mit aufhellender und stabilisierter Hochspannungsversorgung eine stabile und scharfe Spur.

Eine vorgesehene Funktion „Signal niedrig" ermöglicht es, Signale in Bezug auf jeden Gleichstrompegel bis zu 500 V anzuzeigen.

EE 19 783 *für weitere Einzelheiten*

SIGNALGENERATOR MIT STABILISIERTER AMPLITUDE

(Abbildung Seite 183)

Der DO905 gibt in einen sorgfältig angepassten Abschlusswiderstand einen sinusförmigen Ausgang mit konstanter Amplitude über den Frequenzbereich 350 kHz...50 MHz ab.

Die Ausgangsamplitude ist von 40 mV ...10 V doppelter Spitzenwert in sieben Bereichen kontinuierlich regelbar. Die auf der 0...10 V Skala des Instrumentes angezeigte Amplitude ist der doppelte Spitzenwert am Eingang des Dämpfungsreglers. Die Anzeige ist innerhalb 10% des Vollausschlages genau.

Mit der Anzeige im „konstanten Amplituden"-Bereich, einem Abschlusswiderstand von nicht weniger als 1 kΩ und einer Nebenschlusskapazität unter 10 pF ist die Schwankung der Ausgangsamplitude des Dämpfungsreglers mit schwankender Frequenz unter ±2% für 50 kHz und zwischen 350 kHz...30 MHz und weniger als ±5% von 30...50 MHz.

EE 19 784 *für weitere Einzelheiten*

TEXAS INSTRUMENTS LTD
Dallas Road, Bedford

INFRAROTER DETEKTOR

Der fotovoltaische infrarote Detektor braucht keinen Vorspannungsstrom. Das empfindliche Material ist ein Indiumamonid-Diffusionsflächenelement und kann im Bereich 2...5 μ benutzt werden. Die optische Betriebsnenntemperatur ist −196°C (flüssiger Stickstoff), und aktive Flächen können bis zu 1 cm² geliefert werden. Die Wechselstrom-Zellenimpedanz für schwache Signale ist 100... 1000 Ω mit einer Zeitkonstante unter 1 μs. Die äquivalente Rauschleistung hängt von der Fläche ab. Ein typischer Wert wurde unter den Korona-Testbedingungen des US Naval Ordonance Laboratory (550°K, 90 Hz, Δf = 5 Hz) mit 4×10^{-10} mW für Flächen von 4 mm² gemessen. Die Rauschspannung ist unter 10^{-8} V (90 Hz, 5 Hz Bandbreite) und ändert sich anscheinend umgekehrt zu f^3.

EE 19 785 *für weitere Einzelheiten*

KLEINST-HALBLEITER-FESTKÖRPER-SCHALTUNGEN

Kleinst - Halbleiter - Festkörperschaltungen werden durch Wahl und Formgebung von Leitungswegen auf und durch Halbleiterelemente gebildet. Sie stellen eine sehr gute Annäherung zur endgültigen Reduktion in der Grösse elektronischer Geräte dar und geben äquivalente Bauelementdichten von 175...1760 pro cm³. Gezeigt wurde ein Multivibrator mit Abmessungen von 6,35 × 3,2 × 0,8 mm, dessen Leistung der einer normalen Schaltung mit 8 Widerständen, zwei Kondensatoren und zwei Transistoren entspricht und eine Bauelementdichte von 1055 pro cm³ darstellt.

In Halbleiter-Festkörperschaltungen werden Widerstände aus dem Gesamtwiderstand des Halbleitermaterials, Kondensatoren nach Kapazitätsbildungstechnik, Transistoren und Dioden nach der Diffusionsmethode hergestellt. Die Leistung der HalbleiterFestkörpeschaltungen ist der üblicher Schaltungen gleich, die Elemente mit diffundierter Basis benutzen.

EE 19 786 *für weitere Einzelheiten*

UNICAM INSTRUMENTS LTD
Arbury Works, Cambridge

FLACHFORMSCHREIBER

(Abbildung Seite 183)

Es wird erwartet, dass dieser hauptsächlich für spektroskopische Zwecke entwickelte Schreiber allgemeine Anwendung für diskontinuierliche Verfahren finden wird, die bestimmte Anfangs- und Endpunkte haben.

Die Aufzeichnung erfolgt auf flachem Registrierpapier 30 × 20 cm, das an einem Schreibfederschlitten vorbeigezogen wird.

Lineare Aufzeichnung mit 0...10 mV Vollausschlag oder logarithmische mit 0...200 mV Vollausschlag werden durch einen einfachen Schalter gewählt. Die nominelle Ansprechzeit ist 0,7 s für Vollausschlag. Der Streifenantrieb erfolgt durch eine magnetische Kupplung von einem Synchronmotor über einen Kettenantrieb mit Übersetzungsverhältnissen 1 : 1, 2 : 1 und 4 : 1.

Der Schreiber kann von einem synchronen Eingang betrieben werden (z.B. einem Spektrometer-Tochterschreibgerät) oder als normaler, unabhängiger Schreiber.

EE 19 787 *für weitere Einzelheiten*

VENNER ELECTRONICS LTD
Kingston By-Pass, New Malden, Surrey

TRANSISTORISIERTE ZIFFERNUHR

(Abbildung Seite 183)

Type TSA88 ist grundsätzlich eine Quarzuhr, die für Sichtanzeige in Sekunden, Minuten und Stunden mittels eines einzeiligen Anzeigers konstruiert wurde.

Es ist oft wünschenswert, mit Datenaufzeichungen auch die Zeit zu registricren, zu der die Resultate von Vorgängen aufgenommen wurden. Sowohl Zeit wie Daten können mittels des transistorisierten Druckers TSA65 oder des Steuergerätes für Lochstanzen TSA101 aufgezeichnet werden, wenn sie mit der Ziffernuhr zusammenarbeiten.

Wenn die Uhr zur Umstellung der Zeitangabe bereit ist, wird ein „Druckbefehl" 0,2 s vor und 0,01 s nach dem Zeitpunkt aufgehalten, so dass die Zeitaufzeichnung immer richtig ist.

Während dieser Verzögerung kann dem Messgerät ein „Halt"-Signal zugeführt werden und verhindert so zusammen mit dem „Halt"-Signal des Druckers eine Rückstellung des Datenmessgerätes während des Druckens.

Durch ein eingebautes Relais können Umschaltkontakte jede Sekunde, Minute oder Stunde betätigt werden.

Nach Nullstellung der YSA88 kann die Zeit durch Herabdrücken einer „Schnell"-Taste, und mit grösserer Genauigkeit durch Herabdrücken einer „Langsam"-Taste wieder eingestellt werden. Dadurch wird die einzeilige Anzeige in Stunden, Minuten und Sekunden zur gewünschten Einstellung gebracht.

Wenn ein Schalter von „Einstellung" auf „Bereitschaft" gestellt wird, ist die TSA88 betriebsfertig. Keine weiteren Einstellimpulse sind an den „Schnell"- und „Langsam"-Tasten vorhanden.

Das Gerät kann entweder direkt gesteuert, ferngesteuert oder durch positive Impulse von ein oder zwei Quellen angestellt werden.

EE 19 788 *für weitere Einzelheiten*

THE WAYNE KERR LABORATORIES LTD
Sycamore Grove, New Malden, Surrey

ÜBERGANGSFUNKTIONSRECHNER

Bisher war die anerkannte Methode zur Bestimmung der Übergangsfunktion von Nachrichten- oder Regelungssystemen die Messung der Amplitude und Phase des Systems als Funktion der Frequenz. Dieses Verfahren gibt keine direkte Information über die Übergangsfunktion, aber es ist im allgemeinen möglich, durch lange und mühsame Rechnungen einen Annäherungsausdruck zu erhalten.

Durch eine grundsätzliche neue Problemstellung wurde von Wayne Kerr ein Weg gefunden, die tatsächlichen Koeffizienten der Übergangsfunktion zu messen. Nach Beendung eines unkomplizierten Betriebsablaufs, der nur wenige Minuten dauert, können direkte Anzeigen erfolgen. Die Wurzeln der Übergangsfunktion fallen auch an, so dass ein Wurzel-Ortsdiagramm einfach konstruiert werden kann.

Dadurch kann die Einwirkung von Konstruktionsänderungen in servogesteuerten Anlagen ohne komplizierte und lange Berechnungen analysiert werden. Der Stabilitätsspielraum eines Systems kann schnell bestimmt werden, und für den Fall eines unstabilen Systems ist es einfach, die Ursache der Instabilität zu begrenzen.

Während der Vorführung berechnete das Gerät den Koeffizienten der Übergangsfunktion eines bekannten Netzwerkes.

EE 19 789 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Ein achtstelliger „Wort"-Geber mit Randschicht-Transistoren und direkt gekoppelter Logik von P. L. Owen und T. R. H. Sizer

Zusammenfassung des Beitrages auf Seite 134-139

Der Beitrag beschreibt einen binären Wortgeber, der als Testgerät zur Entwicklung von Digitalrechnerelementen gebaut wurde. Im Anfangsstadium der Arbeit fiel den Verfassern die Einfachheit der direkten Kopplungstechnik auf, und die Entwicklung der Logik des Gerätes stützte sich daher auf diese Technik.

Eine kurze Erklärung des Serien- und Parallelbetriebes führt zum Begriff der Serienwortdarstellung, und daraus ergibt sich der Bedarf für einen Wortgeber als Grundgerät für Arbeiten dieser Art. Ein einfacher Wortgeber wird beschrieben und die in der Zeichnung benutzten logischen Symbole erklärt.

Die Verwendung von Randschicht-Transistoren in der direkten Kopplungstechnik wird beschrieben. Darauf folgt ein Abschnitt über transistorisierte logische Elemente und eine eingehende Beschreibung des Gerätes. Der Beitrag schliesst mit einer Übersicht der Grenzbedingungen dieser Technik.

In einem Anhang wird der Begriff des Transistors als logischer Schalter eingeführt, und es wird für den Fall eines p-n-p Elementes gezeigt, dass die Operationsgeschwindigkeit, die Lochspeicherung im Basisfeld und der Sättigungsgrad zu einander in Beziehung stehen. Es wird jedoch betont, dass diese Beziehung nur eingehend genug diskutiert wird, um zu zeigen, dass schnelles Schalten ohne Kontrolle der Sättigungsbedingungen möglich ist, wenn bestimmte Transistoren, wie z.B. Randschicht-Transistoren SB 240 oder Mikrolegierungs-Transistoren MA 393 verwandt werden.

Das Digitron: Eine Kaltkathoden-Anzeigeröhre von N. McLoughlin, D. Reaney und A. W. Turner

Zusammenfassung des Beitrages auf Seite 140-143

Eine Serie von Kaltkathoden-Anzeigeröhren wird beschrieben und die jeweiligen Vorteile der Seiten-und Endanzeige besprochen. Die Grundsätze des Gleichstrombetriebs und der Benutzung der Konstruktionsdaten werden erklärt. Verschiedene Schaltungen für die Röhren zusammen mit Methoden zur Verwendung von Wechselstromquellen werden gegeben.

Eine neue Testmethode für die spektrale Empfindlichkeit von Fernseh-Aufnahmeröhren von A. G. Warren

Zusammenfassung des Beitrages auf Seite 144-147

Bisher gab es keine einfache Methode zur Messung der spektralen Empfindlichkeit einer schwarz-weissen Fernsehkamera. In diesem Beitrag wird gezeigt, wie die Messung mit verhältnismässig einfachen Geräten durchgeführt werden kann. Eine Anzeige der nutzbaren spektralen Empfindlichkeit einer Kamera für jeden beliebigen beleuchteten Körper kann mit den beschriebenen Apparaten erreicht werden. Versuche waren bisher jedoch hauptsächlich auf Studiobeleuchtung mit Metallfadenlampen beschränkt.

Elektronische Datenverarbeitung für amerikanische Firmen von J. C. Hammerton

Zusammenfassung des Beitrages auf Seite 148-154

Elektronische Datenverarbeitungssysteme sind nunmehr in Amerika verhältnismässig gut eingeführt. In der ersten Hälfte dieses Beitrages wird versucht, die grundsätzlichen Anforderungen für solche Systeme nach den neuesten Erkenntnissen aufzuzeigen; mit besonderer Aufmerksamkeit werden übereinstimmende und streitige Ansichten der verschiedenen Gerätehersteller diskutiert. In der zweiten Hälfte des Beitrages werden die damit zusammenhängenden technischen Aufgaben und die Programmierung besprochen.

Ein einfaches Schwingungssieb von D. G. Wyatt

Zusammenfassung des Beitrages auf Seite 155-157

Zweckdienliche Hoch- und Tiefpassfilter können durch Serienschaltung eines Parallel-T-Kreises mit einem geeigneten LC-Kreis hergestellt werden. Nur eine Induktivität wird benötigt, und das ist besonders wünschenswert für niedrige Grenzfrequenzen. Einfachheit, Stabilität und Grösse dieser Anordnung hat sowohl gegenüber gebräuchlichen Typen, als auch gegenüber den von Gegenkopplungs-Verstärkern abgeleiteten Formen Vorteile.

Der phasenempfindliche Eintakt-Diodenverstärker von R. Chidambaram und S. Krishnan

Zusammenfassung des Beitrages auf Seite 158-159

Die Arbeitsweise des phasenempfindlichen Eintakt-Diodenverstärkers mit Belastung wird untersucht. Wie im einfachen Gegentakt-Detektor ändern sich die Übertragungsverhältnisse der beiden Dioden wesentlich mit dem Signal. Dadurch wird eine Ungeradlinigkeit in den Ausgang eingeführt, die ausgewertet wird. Eine angegebene Tabelle ermöglicht die sofortige Leistungsbeurteilung eines gegebenen Detektors dieser Type. Dieser Detektor und der einfache Gegentakt-Detektor werden unter Belastung verglichen, und die Überlegenheit einer Form über die andere in Bezug auf Geradlinigkeit wird besprochen.

Ein Messgerät für Vorgänge in Zeiteinheiten von J. D. Storer

Zusammenfassung des Beitrages auf Seite 160-162

Dieser Beitrag beschreibt ein vereinfachtes Gerät zur Messung von Vorgängen in Zeiteinheiten mit Taktfrequenzen bis zu 9999 Hz. Die 1 Sekunden-Torwellenform kommt von einem 1 kHz Quarzoszillator, dessen langfristige Stabilität nicht schlechter als 1 Teil in 10^4 ist. Dieser Oszillator hat einen getrennten Ausgang zur Prüfung der Zählgenauigkeit, der auch als Fremdeichquelle Verwendung finden kann. Die Nullstellung kann von Hand oder automatisch erfolgen, wodurch die Geräte auch direkt als Zähler eingesetzt werden können.

Transistor-Grenzempfindlichkeitsberechnungen von F. Hibberd

Zusammenfassung des Beitrages auf Seite 163-164

Eine Methode zur Schätzung der Transistor-Grenzempfindlichkeit wird beschrieben. Sie stützt sich auf die Verwendung der vier Rausch-Parameter, die durch Transistor-Ersatzbild-Parameter dargestellt werden. Ein allgemeiner Ausdruck für die niedrigste Grenzempfindlichkeit, der den Umständen entsprechend vereinfacht werden kann, wird abgeleitet.